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A Randomized Controlled Trial of a Hatha Yoga Intervention for Smokers

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A RANDOMIZED CONTROLLED TRIAL OF A HATHA YOGA INTERVENTION FOR SMOKERS

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To my mother and sisters

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ABSTRACT

Despite well-documented negative effects of smoking, many individuals continue to smoke. Anxiety and depression are associated with poorer cessation outcomes. Three transdiagnostic factors may explain the anxiety/depression-smoking link: anxiety sensitivity (AS), distress tolerance (DT), anhedonia (Anh; Leventhal & Zvolensky, 2015). It therefore follows that changing AS, DT, and Anh could aid cessation efforts. Thus, the current study tested the efficacy of hatha yoga for reducing craving, smoking, AS, and Anh and increasing DT, and whether anxiety/depression moderates these relationships. Participants were 55 community-recruited smokers (62% male, 71% non-Hispanic White, M_{age} = 28.16) motivated to reduce or quit smoking. We randomized participants to one session of hatha yoga (n = 25) or wellness control (n = 30) on their intervention day (when they planned to begin to reduce or quit smoking). We asked them to use the provided intervention materials daily for a week. Hatha yoga was associated with less post-intervention craving but not fewer follow-up cigarettes per day than control. Anxiety/depression did not moderate these relationships. Hatha yoga was associated with less follow-up AS than the control condition. We found a significant Condition x Anxiety/Depression interaction, such that among participants with high anxiety/depression, those in the hatha yoga condition reported less follow-up AS than those in the control condition. Hatha yoga did not impact DT or Anh. In sum, hatha yoga acutely reduces craving but does not impact smoking. Hatha yoga decreased AS, especially among individuals with higher anxiety/depression, a group at particular risk for poorer smoking cessation outcomes.

INTRODUCTION

Cigarette Smoking

The negative health consequences of cigarette smoking (e.g., cardiovascular disease, respiratory illness, cancer) have been well documented over the past several decades (Ezzati, Henley, Lopez, & Thun, 2005; Ezzati, Henley, Thun, & Lopez, 2005; US Department of Health and Human Services, 1982, 1983, 1984). Potentially in part due to greater public understanding of these health-related consequences, along with increased restrictions on smoking (per Pierce, White, & Emery, 2012), smoking rates among adults in the United States have declined from 20.9% in 2005 to 15.5% in 2016 (Centers for Disease Control and Prevention, 2018). Despite this decline, smoking remains the leading cause of preventable disease and death in the United States, with more than 480,000 premature deaths attributable to smoking occurring each year (Centers for Disease Control and Prevention, 2018). According to the Centers for Disease Control and Prevention, during 2015, 55.4% of smokers made a quit attempt that lasted longer than one day and 7.4% of smokers quit smoking during the previous year (Centers for Disease Control and Prevention, 2017c). Moreover, three-fourths of smokers who underwent an unaided quit attempt lapsed within the first week of the quit attempt (Langdon, Farris, Øverup, & Zvolensky, 2016). Similarly, 75.5% of smokers who underwent a one-session relaxation intervention smoked during the two weeks following the intervention (Dickson-Spillmann, Haug, & Schaub, 2013). These findings suggest that many individuals attempt to quit smoking, the majority of individuals smoke within the first couple weeks of their cessation attempts, and few individuals succeed in ultimately quitting smoking. This has led to a call for research to develop more targeted interventions for smokers who are at higher risk for cessation failure (Piasecki & Baker, 2001; Shiffman, 1993).

Anxiety, Depression, and Smoking

One group at risk for higher rates of smoking cessation failure are individuals with anxiety and depression. Rates of current smoking are higher among individuals with lifetime anxiety and depressive disorder diagnoses (35.9%-54.6%) than individuals without lifetime psychiatric diagnoses (22.5%; Lasser et al., 2000). Further, the 12-month prevalence rates of anxiety disorders (22%) and major depressive disorder (16.6%) were at least twice as high among smokers with *nicotine dependence* (i.e., a maladaptive pattern of nicotine use that is typically associated with symptoms such as tolerance, withdrawal, and using nicotine despite it causing or exacerbating physical or psychological problems; American Psychiatric Association, 1994) than among the general population (11.1% and 7.1%, respectively; Grant, Hasin, Chou, Stinson, & Dawson, 2004). These rates may continue to increase as smokers without such diagnoses are better able to quit, while smokers with these problems remain smoking (i.e., the hardening theory; Hughes, 1999; Hughes, 2011).

Smokers with anxiety and depressive disorders have demonstrated poorer smoking cessation outcomes. To illustrate, among over 1,500 smokers who underwent an aided smoking cessation attempt, having a lifetime anxiety or depressive disorder diagnosis was associated with lower abstinence rates eight weeks and six months post-quit (Piper et al., 2010). Similarly, past major depression was associated with 17% lower odds of short-term abstinence and 19% lower odds of long-term abstinence according to a recent meta-analytic study (Hitsman et al., 2013). Additionally, among treatment-seeking smokers, baseline depressive symptoms were associated with increased odds of relapse at days one, seven, and 14 post-quit (Zvolensky, Stewart, Vujanovic, Gavric, & Steeves, 2009). Further, treatment-seeking smokers who met criteria for a lifetime anxiety or depressive disorder reported significantly more prior quit attempts and endorsed using significantly more cessation strategies than individuals without a lifetime anxiety or depressive disorder diagnosis

(Zvolensky, Farris, Leventhal, Ditre, & Schmidt, 2015). Taken together, smokers who have anxiety and depression may need additional interventions strategies to successfully quit smoking.

Why might these smokers have poorer cessation outcomes? One possible explanation is they tend to have more severe nicotine dependence. For example, among smokers who were interested in quitting smoking, those with anxiety disorders reported higher levels of nicotine dependence (e.g., more difficulty refraining from smoking in places where smoking is forbidden, smoking despite being ill; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) than smokers without anxiety disorders (Piper, Cook, Schlam, Jorenby, & Baker, 2011). Further, adolescent smokers who endorsed high levels of anxiety/depression symptoms at baseline were significantly more likely to have nicotine dependence during young adulthood than adolescents who endorsed low baseline levels of anxiety/depression symptoms, even after accounting for the variance attributable to gender and baseline substance use (McKenzie, Olsson, Jorm, Romaniuk, & Patton, 2010).

Considering that both anxiety and depression are related to poorer smoking cessation outcomes, it follows that *transdiagnostic* factors may play a role in this relationship. Transdiagnostic factors are core dispositional traits that reflect maladaptive responses to affective states that underlie multiple types of psychopathology. Indeed, Leventhal and Zvolensky (2015) recently proposed that three transdiagnostic factors underlie the anxiety/depression-smoking relationship: (a) *anxiety sensitivity* (AS), (b) *distress tolerance* (DT), and (c) *anhedonia* (Anh). Leventhal and Zvolensky posit that these transdiagnostic "reactive" factors influence one's response to emotion states, which may include a variety of maladaptive responses, including smoking.

Transdiagnostic Factors and Smoking

Anxiety sensitivity. AS is a transdiagnostic reactive factor that reflects a fear of anxiety-related sensations (e.g., elevated heart rate, dizziness) due to beliefs that these sensations have detrimental physical, cognitive, or social consequences (McNally, 2002). For example, someone with high AS who experiences heart palpitations may believe the sensation is a sign of a heart attack, whereas an individual with low AS may believe the sensation is unpleasant, but benign. AS is stable (Rodriguez, Bruce, Pagano, Spencer, & Keller, 2004), yet malleable (e.g., Schmidt et al., 2007), and is related to but distinct from trait anxiety (Taylor, Koch, & Crockett, 1991). AS amplifies the anxiety response (Reiss, 1991). In other words, when high-AS individuals become anxious, they become anxious about a feared stimulus and about their own anxiety, which further exacerbates their anxiety reaction (as proposed by Collimore & Asmundson, 2014).

The role of AS in the etiology and maintenance of panic disorder has been the subject of a large body of research (for review see McNally, 2002). In addition to AS's influence on panic psychopathology, it is associated with numerous other psychiatric disorders, including social anxiety disorder, generalized anxiety disorder (Deacon & Abramowitz, 2006), and major depressive disorder (Otto, Pollack, Fava, Uccello, & Rosenbaum, 1995). Illustrating AS's transdiagnostic nature and importance as a mechanism of change in the treatment of anxiety and depressive disorders, AS mediated symptom improvement among individuals who underwent a transdiagnostic treatment for anxiety and depressive disorders (i.e., the Unified Protocol; Boswell et al., 2013).

Anxiety sensitivity and smoking cessation. AS is related to poorer cessation outcomes among smokers who are attempting to quit smoking. For example, among smokers who underwent an aided quit attempt, greater AS was robustly related to a greater risk of lapsing at days one, seven, and 14 post-quit after controlling for gender, nicotine dependence,

withdrawal symptom severity, and baseline anxiety/depression (Zvolensky et al., 2009). Greater AS was also associated with a greater risk of lapsing during the first week after a quit attempt among smokers with depression (Brown, Kahler, Zvolensky, Lejuez, & Ramsey, 2001). Additionally, among smokers who underwent nicotine replacement therapy (NRT)-aided cognitive behavioral therapy (CBT) for smoking cessation, smokers who maintained high levels of AS from pre-treatment to one-month post-treatment had a significantly greater risk of lapse and relapse compared to smokers who evidenced a significant reduction in AS (Assayag, Bernstein, Zvolensky, Steeves, & Stewart, 2012). Further, adult daily smokers with higher levels of AS were more likely to report having experienced early (i.e., within one week) smoking relapse in two separate investigations (Zvolensky et al., 2007; Zvolensky, Bonn-Miller, Bernstein, & Marshall, 2006). Moreover, AS significantly predicted greater odds of study dropout prior to attending the scheduled quit day appointment among smokers recruited to participate in a self-guided quit attempt (Langdon, Farris, Hogan, Grover, & Zvolensky, 2016). In sum, these results suggest that AS plays an important role in the early stages of smoking cessation.

Anxiety sensitivity and smoking-related risk factors. AS may be related to poorer cessation outcomes due to its associations with other smoking-related risk factors such as nicotine dependence, withdrawal symptoms, and smoking outcome expectancies. To illustrate, greater AS was related to more severe nicotine dependence in several studies (Farris, Leventhal, Schmidt, & Zvolensky, 2015; Zvolensky, Farris, Schmidt, & Smits, 2014). Further, the presence of an anxiety or depressive disorder diagnosis was indirectly related to higher levels of nicotine dependence, greater perceived barriers to cessation, and greater severity of problematic symptoms during past quit attempts via AS (Zvolensky, Farris, Leventhal, & Schmidt, 2014). Additionally, AS mediated the relationship between trait worry and several smoking-related variables (e.g., nicotine dependence) after controlling for

relevant factors (e.g., negative affect, alcohol use) among treatment-seeking smokers (Olvera et al., 2015). Taken together, greater AS is related to several smoking-related risk factors, including more severe nicotine dependence, which may at least partially account for the relationship between anxiety/depression and nicotine dependence.

AS is related to more severe withdrawal symptoms and craving. Among treatment-seeking smokers, AS was associated with more severe nicotine withdrawal during prior quit attempts and prior to quit day (Farris, Leventhal, et al., 2015). Further, among smokers who underwent an AS reduction-smoking cessation intervention (Schmidt, Raines, Allan, & Zvolensky, 2016), AS moderated the relationship between pre-quit reductions in AS and quit day craving, such that smokers with high AS who demonstrated less reductions in AS prior to quitting reported the highest levels of craving on quit day (Bakhshaie et al., 2016). Greater AS was also incrementally related to more severe withdrawal symptoms and craving after accounting for the variance attributable to gender, nicotine dependence, and depression among non-treatment-seeking smokers who were deprived of nicotine for 16 hours (Zvolensky, Farris, Guillot, & Leventhal, 2014). Greater AS was associated with slower decreases in withdrawal symptoms among smokers who underwent an aided cessation attempt (Johnson, Stewart, Rosenfield, Steeves, & Zvolensky, 2012). These results suggest that greater AS is associated with more severe withdrawal symptoms and individuals with higher levels of AS may continue to experience withdrawal symptoms for longer once cessation has occurred, suggesting that individuals with higher AS may benefit from additional cessation strategies, particularly strategies that could reduce AS.

In line with negative reinforcement models of substance use (e.g., Baker, Brandon, & Chassin, 2004; Conger, 1956; Khantzian, 1997) which posit that individuals use substances in an attempt to relieve unpleasant physical and/or emotional states, AS was related to negative reinforcement smoking expectancies (e.g., beliefs that smoking will reduce negative

affect) and motives among treatment-seeking (Battista et al., 2008; Brown et al., 2001; Garey et al., 2016; Zvolensky, Farris, Schmidt, et al., 2014), college student (Zvolensky et al., 2004), and community-recruited (Gonzalez, Zvolensky, Vujanovic, Leyro, & Marshall, 2008; Gregor, Zvolensky, McLeish, Bernstein, & Morissette, 2008; Guillot, Pang, & Leventhal, 2014; Leyro, Zvolensky, Vujanovic, & Bernstein, 2008) smokers. These findings suggest that individuals with high AS may smoke to cope with negative affect associated with AS or to avoid feared withdrawal symptoms that are synonymous with anxiety symptoms (e.g., sweating, nausea). This may make it more difficult for these individuals to quit smoking, potentially due to a lack of coping skills to manage such states.

In partial support of this hypothesis, smoking reduced anxiety in high AS smokers in a stressful situation (i.e., giving a speech) but not a non-stressful situation (Evatt & Kassel, 2010). Ecological momentary assessment demonstrated that AS interacted with negative affect to predict subsequent smoking, such that individuals with high AS were more likely to smoke on days they experienced high levels of negative affect (Langdon, Farris, Øverup, et al., 2016). In sum, greater AS is related to poorer smoking cessation outcomes and may be one factor linking anxiety/depression with other smoking-related factors (e.g., nicotine dependence, withdrawal symptoms).

Distress tolerance. DT is another transdiagnostic reactive factor, which has been conceptualized as both: (1) the perceived capacity to withstand negative emotional states and (2) the objective behavioral capacity to withstand negative internal states elicited by some type of a stressor. Thus, DT has recently been defined as a higher-order construct that reflects one's ability to withstand any aversive experience (e.g., negative emotional states, physical sensations that provoke negative affect; Leventhal & Zvolensky, 2015). DT is relatively stable (Simons & Gaher, 2005), yet malleable (e.g., Medina, Hopkins, Powers, Baird, & Smits, 2015). Individuals with lower DT (i.e., less able to tolerate distress) tend to respond in

maladaptive ways to distress (e.g., avoidance, substance use; Jeffries, McLeish, Kraemer, Avallone, & Fleming, 2016; Simons & Gaher, 2005).

Lower DT is robustly related to several forms of anxiety, including social anxiety, trait worry, and panic after controlling for other theoretically relevant factors (e.g., AS, gender; Keough, Riccardi, Timpano, Mitchell, & Schmidt, 2010; Norr et al., 2013). Individuals with anxiety disorders have lower levels of DT (Michel, Rowa, Young, & McCabe, 2016) than non-clinical samples (Keough et al., 2010; Norr et al., 2013). Further, lower DT was related to depressive symptoms among individuals with anxiety disorders (Michel et al., 2016), persons with major depressive disorder (Williams, Thompson, & Andrews, 2013), and adults who use substances (Buckner, Keough, & Schmidt, 2007; Gorka, Ali, & Daughters, 2012). Taken together, lower DT is associated with both anxiety and depression among a heterogeneous population.

Distress tolerance and smoking cessation. DT appears to play a role in poorer smoking cessation outcomes. Compared to smokers who had one or more sustained quit attempts for three months or longer, smokers who had never sustained a quit attempt for more than 24 hours exhibited lower behavioral DT (Brown, Lejuez, Kahler, & Strong, 2002). Among smokers who were attempting to quit smoking, lower baseline behavioral DT was related to greater risk of lapse and relapse in several prospective studies (Abrantes et al., 2008; Brandon et al., 2003; Brown et al., 2009; Cameron, Reed, & Ninnemann, 2013; Hajek, Belcher, & Stapleton, 1987). Results from these studies suggest that individuals with lower levels of DT have more difficulty quitting smoking. It may be that some indices of behavioral DT are more related to smoking outcomes than others. Results concerning the impact of behavioral DT on smoking outcomes are somewhat inconsistent, even within individual studies (e.g., Cameron et al., 2013), with some indices of behavioral DT (i.e., Paced Auditory Serial Addition Task [PASAT]) being associated with poorer cessation outcomes and some

not (i.e., Mirror Tracing Persistence Task). Behavioral DT as measured by the breath-holding (BH) task (Hajek et al., 1987) has been most commonly used in the smoking literature (Leventhal & Zvolensky, 2015) and may be an ideal measurement of DT given that it is easy to administer and lower DT as measured by BH duration was associated with greater risk of poorer smoking cessation outcomes in several studies (Brown et al., 2002; Brown et al., 2009; Hajek et al., 1987). Further, DT as measured by the PASAT was related to quicker relapse during a quit attempt (Cameron et al., 2013), demonstrating its utility in smoking cessation research.

Distress tolerance and smoking-related risk factors. Lower DT is related to nicotine dependence and negative reinforcement-motivated smoking. To illustrate, among non-treatment-seeking smokers, lower perceived DT was correlated with more severe nicotine dependence in several studies (Kraemer, McLeish, Jeffries, Avallone, & Luberto, 2013; Leyro, Bernstein, Vujanovic, McLeish, & Zvolensky, 2011). Similarly, among adult smokers, less perceived DT was incrementally related to greater severity of nicotine dependence after controlling for anxiety/depression symptoms (Trujillo et al., 2015) and among non-treatment-seeking smokers, lower behavioral DT was correlated with more severe nicotine dependence (Brandon et al., 2003). Consistent with negative reinforcement models of substance use (e.g., Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), perceived DT correlated with negative reinforcement smoking expectancies (Leyro et al., 2011) and was incrementally related to negative reinforcement-motivated smoking after accounting for the variance attributable to anxiety and depression symptoms (Trujillo et al., 2015).

Among smokers who participated in a smoking cessation attempt, daily life hassles were associated with daily craving (measured using ecological momentary assessment) among smokers who exhibited low baseline behavioral DT (Volz et al., 2014), suggesting that smokers with low DT may desire to smoke more during stressful situations. In light of

these findings, smokers with lower DT may be more prone to smoke while distressed in an attempt to terminate their distress, which may place them at greater risk for lapse and relapse when facing symptoms characteristic of nicotine withdrawal (e.g., increased anxiety). Importantly, lower DT was associated with smoking-related factors (e.g., severity of nicotine dependence) above and beyond the effects of anxiety/depression symptoms (Trujillo et al., 2015), making it an ideal transdiagnostic explanatory mechanism of the anxiety/depression-smoking relationship.

Anhedonia. Anh is another transdiagnostic reactive factor that reflects a reduced capacity to experience pleasure from commonly rewarding stimuli (Hatzigiakoumis, Martinotti, Giannantonio, & Janiri, 2011). Anh is relatively stable (Franken, Rassin, & Muris, 2007) but malleable (Farabaugh et al., 2015). It is closely related to depression but is a conceptually distinct construct (Leventhal, Chasson, Tapia, Miller, & Pettit, 2006). Although Anh was originally implicated in the etiology and maintenance of depressive disorders (e.g., Lewinsohn, 1974), it has since been found to be associated with other forms of psychopathology, such as social anxiety (e.g., Kashdan, 2004).

Anhedonia and smoking cessation. Anh is related to poorer smoking cessation outcomes. To illustrate, among treatment-seeking smokers, greater Anh was associated with greater rates of relapse one, seven, and 14 days post-quit after accounting for the variance attributable to AS (Zvolensky et al., 2009). Among smokers who were enrolled in a smoking cessation program, greater baseline Anh was associated with greater rates of relapse eight (Cook et al., 2015; Leventhal, Ramsey, Brown, LaChance, & Kahler, 2008), 16, and 24 weeks post-quit (Leventhal et al., 2008). Similarly, after accounting for the variance attributable to depressed mood, Anh predicted greater odds of relapse (Leventhal, Piper, Japuntich, Baker, & Cook, 2014) and faster latency to relapse (Cook, Spring, McChargue, & Doran, 2010) among smokers undergoing an aided quit attempt. Moreover, greater Anh was

associated with relapsing more quickly during a month-long self-quit attempt (Niaura et al., 2001). Among non-treatment-seeking smokers, Anh was positively correlated with number of prior quit attempts and a higher proportion of past quit attempts ending in relapse within one day (Leventhal, Waters, Kahler, Ray, & Sussman, 2009). Taken together, Anh has been found to be associated with poorer smoking cessation outcomes in several studies, even after statistically controlling for other transdiagnostic reactive factors (i.e., AS) and depressive symptoms.

Anhedonia and smoking-related risk factors. Greater Anh was associated with greater craving (Cook et al., 2015; Cook, Spring, McChargue, & Hedeker, 2004; Leventhal, 2010) and nicotine withdrawal symptoms (Langdon et al., 2013; Leventhal et al., 2008; Zvolensky et al., 2009) in several studies. In addition, greater Anh was associated with greater behavioral choice melioration motives (e.g., "Very few things give me pleasure each day like cigarettes"; Leventhal et al., 2009; Mickens et al., 2011), suggesting that individuals with higher levels of Anh may smoke to experience pleasure and cope with their inability to experience pleasure from other commonly rewarding stimuli. Further, Anh was significantly positively correlated with severity of nicotine dependence in several investigations (Leventhal et al., 2014; McChargue & Werth Cook, 2007; Mickens et al., 2011; Roys, Weed, Carrigan, & MacKillop, 2016). Taken together, greater Anh is associated with several smoking-related processes (e.g., behavioral choice melioration motives, nicotine dependence), which may partially account for its relation to poorer smoking cessation outcomes.

Aerobic Exercise

Aerobic exercise and smoking. Aerobic exercise acutely reduced smoking craving in numerous experimental studies (for review see Roberts, Maddison, Simpson, Bullen, & Prapavessis, 2012). These results are important given that craving prospectively contributes

to relapse (for review see Serre, Fatseas, Swendsen, & Auriacombe, 2015). In light of these findings, a recent randomized controlled trial (RCT; Smits et al., 2016) tested the efficacy of vigorous-intensity exercise as an aid to smoking cessation and found that for individuals with high AS, follow-up abstinence rates were higher among individuals who participated in the smoking cessation/exercise condition compared to individuals who participated in the smoking cessation/wellness condition.

Aerobic exercise and transdiagnostic factors. Aerobic exercise may impact smoking cessation outcomes through its effects on AS. Aerobic exercise reduced AS in several studies (Broman-Fulks, Berman, Rabian, & Webster, 2004; Broman-Fulks, Kelso, & Zawilinski, 2015; Broman-Fulks & Storey, 2008; LeBouthillier & Asmundson, 2015; Smits et al., 2008), even from a single session (Broman-Fulks et al., 2015; LeBouthillier & Asmundson, 2015). Yet, a single 20-30 minute bout of aerobic exercise did not increase perceived DT (Broman-Fulks et al., 2015; LeBouthillier & Asmundson, 2015) and no known studies have tested whether longer-term aerobic exercise impacts perceived DT. Further, no known studies have examined the effect of exercise on behavioral DT or Anh.

Hatha Yoga

Hatha yoga and smoking cessation. Aerobic exercise may serve as a useful aid for smoking cessation (e.g., Smits et al., 2016), yet some smokers may find aerobic exercise to be intolerable or may be unable to engage in aerobic exercise for medical reasons (as proposed by Elibero, Janse Van Rensburg, & Drobes, 2011). Yoga may serve as an alternative form of exercise to aid these individuals in their smoking cessation attempts. Yoga is a mind-body practice that originates in ancient Indian philosophy and consists of physical postures, breathing exercises, and meditation (National Center for Complementary and Integrative Health, 2016). *Hatha yoga* is the most common type of yoga practiced in the United States and emphasizes postures and breathing techniques to facilitate meditation

(Hofmann, Andreoli, Carpenter, & Curtiss, 2016; National Center for Complementary and Integrative Health, 2016). The utility of hatha yoga has been demonstrated for a number of mental and physical health problems (Hofmann et al., 2016; Raub, 2002; Uebelacker, Epstein-Lubow, et al., 2010) and shows promise as an aid to smoking cessation.

Demonstrating hatha yoga's potential utility as an aid to smoking cessation, one non-randomized pilot study demonstrated that smoking abstinence was 29% following a group behavioral therapy for smoking cessation plus 30 minutes of hatha yoga (Burns, Mayer, Washington-Krauth, Walters, & Arouni, 2016). Another randomized study showed that, among adult women smokers who completed group-based CBT for smoking cessation plus a twice-weekly hatha yoga program or a wellness program, the hatha yoga condition was associated with greater seven-day point-prevalence abstinence (PPA) rates compared to the wellness condition (Bock et al., 2012). At six months post-treatment, abstinence rates among individuals in the hatha yoga group were higher (18.8%) than individuals in the control group (13%; *OR* = 1.54), though this effect was not statistically significant. This small effect could be due to participants failing to continue practicing hatha yoga post-treatment, but this was not explored in Bock and colleagues' study. These results suggest that hatha yoga may be helpful for increasing cessation success in the short-term. Yet, it remains unknown whether hatha yoga could aid smoking reduction or cessation as a standalone intervention or among populations more at-risk for cessation failure, such as smokers with elevated anxiety/depression symptoms.

Hatha yoga and smoking-related risk factors. Among 20 smokers who were not interested in quitting smoking, weekly hatha yoga was associated with in an increase in participants' desire to quit smoking (McIver, O'Halloran, & McGartland, 2004). Another study examined the efficacy of a 32-session yoga intervention implemented within public school for reducing substance use risk factors among adolescents (Butzer, LoRusso, Shin, &

Khalsa, 2017). Adolescents in the yoga condition, as compared to the control condition (physical education as usual), were significantly less willing to try smoking cigarettes after the intervention. In contrast, no significant differences were found between groups in terms of smoking at follow-up.

Hatha yoga acutely affects craving (Elibero et al., 2011). After one hour of nicotine abstinence, 76 daily smokers were randomized to one of two exercise conditions or a control condition. Participants in the exercise conditions engaged in 30 minutes of hatha yoga led by an instructional video or 30 minutes of moderate-intensity aerobic exercise (i.e., walking briskly on a treadmill). Control participants watched a 30-minute educational video about exercise. Participants in both exercise conditions, compared to participants in the control condition, reported a decrease in craving to smoke. Hatha yoga resulted in similar reductions in craving as aerobic exercise, suggesting that it may have as much potential as an aid to smoking cessation as aerobic exercise. These results demonstrate that hatha yoga reduces craving among smokers who are not attempting to change their smoking but it is unclear whether these results would generalize to smokers who are trying to reduce or quit smoking.

Hatha yoga, anxiety, and depression. Hatha yoga has been shown to reduce symptoms of anxiety and depression (e.g., Hofmann et al., 2016; Uebelacker, Epstein-Lubow, et al., 2010). Hatha yoga encourages individuals to use present-centered awareness, non-reaction, and non-judgmental acceptance despite experiencing psychological or physical discomfort (i.e., mindfulness; Medina et al., 2015). This present-focused and nonjudgmental component of hatha yoga effectively reduces anxiety and depression symptoms because it is incompatible with these symptoms because they are associated with orientation to the future (e.g., anxious apprehension, worry) and to the past (e.g., post-event procesing, rumination; Hofmann, Sawyer, Witt, & Oh, 2010; Kabat-Zinn, 2003).

Hatha yoga and transdiagnostic factors. It is possible that hatha yoga impacts smoking and anxiety/depression symptoms through Leventhal and Zvolensky's (2015) putative transdiagnostic mechanisms (i.e., AS, DT, Anh). Hatha yoga requires individuals to focus their attention on interoceptive cues and their breathing while simultaneously engaging in and switching between difficult, and possibly uncomfortable physical positions (Hewitt, 1990). Thus, practice of hatha yoga may help individuals habituate to distressing emotional or physical states. In line with this hypothesis, an eight-week hatha yoga intervention increased perceived DT among women high in emotional eating (Medina et al., 2015). Yet, considering that approximately two thirds of smokers lapsed and one third of smokers relapsed within one week of quitting (Zvolensky et al., 2009), it is important to test whether hatha yoga increases perceived DT more rapidly than eight weeks among smokers. Additionally, no known studies have tested the impact of hatha yoga on behavioral DT.

Hatha yoga may impact AS through similar processes as those proposed to affect DT. For example, the physical activity involved in hatha yoga produces symptoms similar to those characteristic of anxiety, such as increased heart rate and respiration, which causes fear in individuals with higher AS (Raub, 2002; Uebelacker, Epstein-Lubow, et al., 2010). Thus, hatha yoga may expose individuals to fear-provoking anxiety-related symptoms, which could promote habituation of these sensations. Further, the mindfulness aspect of hatha yoga may promote a nonjudgmental, gentle, and curious stance towards and acceptance of anxiety-related sensations. However, we know of no studies testing the impact of hatha yoga on AS. Further, although no known studies have tested the impact of hatha yoga on Anh specifically, hatha yoga (Uebelacker, Epstein-Lubow, et al., 2010) and other mindfulness-based interventions (Hofmann et al., 2010) reduce depressive symptoms. It may be that these interventions impact depressive symptoms in part through their effects on Anh. Hatha yoga may be positively reinforcing in and of itself and the mindfulness aspect of hatha yoga may

aid individuals in engaging in other positively reinforcing activities with a curious, nonjudgmental attitude, thereby decreasing Anh (per Uebelacker, Tremont, et al., 2010). Taken together, hatha yoga may impact AS, DT, and Anh and could serve as an intervention strategy for a heterogeneous population of smokers.

Study Aims and Hypotheses

The current study aimed to further understanding of the utility of hatha yoga in smoking cessation in several ways. First, we aimed to extend prior work that demonstrated acute reductions in craving from one 30-minute session of hatha yoga among nicotine-deprived smokers who were not attempting to reduce or quit smoking (Elibero et al., 2011) by testing whether one 30-minute session of hatha yoga resulted in less craving than a 30-minute wellness control condition among smokers motivated to quit or reduce smoking who completed the intervention on their intervention day (i.e., the day on which they planned to begin reducing or quit smoking). We hypothesized that the hatha yoga condition would be associated with less craving compared to the control condition immediately following the intervention. Second, we aimed to test the impact of one session of hatha yoga on seven-day follow-up smoking outcomes. This is the first known study to test the effect of one session of hatha yoga on follow-up smoking. Considering that 75% of smokers who underwent a one-session relaxation intervention smoked during the two weeks post-intervention (Dickson-Spillmann et al., 2013), we anticipated that the majority of participants in the current study would smoke during the week following their intervention day. However, we hypothesized that participants in the hatha yoga condition would report smoking fewer cigarettes per day (CPD) at follow-up compared to participants in the control condition.

Third, we tested whether anxiety/depression symptoms impacted the utility of hatha yoga for reducing craving and smoking. Specifically, we hypothesized that anxiety/depression symptoms would moderate the relationships between condition and post-

intervention craving and follow-up CPD such that participants in the control condition who endorse greater anxiety/depression symptoms would report greater post-intervention craving and greater follow-up CPD compared to participants in both conditions who endorse less anxiety/depression symptoms and participants in the hatha yoga condition who endorse greater anxiety/depression symptoms.

Fourth, in light of data suggesting that long-term practice of hatha yoga increases perceived DT (Medina et al., 2015), and that other forms of exercise (e.g., aerobic exercise) decrease AS (e.g., Broman-Fulks et al., 2015), we aimed to extend prior work by testing the acute effect of one session of hatha yoga on AS, DT, and Anh. We hypothesized that on intervention day, one session of hatha yoga would be associated with less post-intervention AS and Anh and greater post-intervention DT compared to the control condition. Fifth, we tested whether one session of hatha yoga would be associated with less AS and Anh and greater DT than the control condition at follow-up. This is the first known study to examine the impact of hatha yoga on AS, behavioral DT, and Anh and the first known study to test the short-term impact of hatha yoga on perceived DT.

Sixth, we aimed to test whether anxiety/depression symptoms impacted the utility of hatha yoga for changing AS, DT, and Anh, such that anxiety/depression symptoms would moderate the relationship between condition and post-intervention and follow-up AS, DT, and Anh. We hypothesized that participants in the control condition who endorse greater anxiety/depression symptoms at baseline would report greater post-intervention and follow-up AS and Anh and less post-intervention and follow-up DT compared to participants in both conditions who endorse less anxiety/depression symptoms and participants in the hatha yoga condition who endorse greater anxiety/depression symptoms.

The current study also had several secondary aims and hypotheses that represent novel contributions to the literature. We tested whether continued hatha yoga practice aided

in reducing smoking. Specifically, we gave participants in the hatha yoga condition the hatha yoga video and participants in the control condition wellness-related educational materials. We encouraged participants in both conditions to access their materials daily during the week following their intervention day. We hypothesized that number of minutes participants accessed their materials would moderate the relationship between condition and follow-up CPD, such that participants in the hatha yoga condition who reported accessing their materials more would report fewer follow-up CPD. Further, we tested whether number of minutes participants accessed their materials moderated the relationship between condition and changes in AS, DT, and Anh such that participants in the hatha yoga condition who report accessing their materials more would evidence less AS and Anh and greater DT at follow-up.

Further, we examined the role of AS, DT, and Anh in the relationship between condition and smoking-related outcomes. We hypothesized that AS, DT, and Anh would mediate the relationship between condition and intervention day post-intervention craving. We also hypothesized that AS, DT, and Anh would mediate the relationship between condition and follow-up CPD. Lastly, we examined the impact of condition on seven-day PPA rates. It was hypothesized that the hatha yoga condition would be associated with greater rates of seven-day PPA than the control condition at follow-up.

METHODS

Participants

Participants were current smokers who endorsed a desire to reduce or quit smoking. In addition to recruiting smokers who desired to quit smoking, we also recruited smokers who wanted to reduce their smoking considering that individuals who reduce their smoking are more likely to successfully quit smoking eventually and reductions in smoking are associated with positive health-related consequences (for review see Begh, Lindson-Hawley, & Aveyard, 2015). We recruited participants from the community (e.g., via flyers, through online advertisements on Craigslist and the university's website) and through the university's psychology participant pool. We used a subset of advertisements in an attempt to oversample for individuals with elevated anxiety/depression symptoms (e.g., flyer title: "Feeling stressed or sad? Want to cut down or quit smoking?"). This strategy was successfully used to recruit participants with elevated anxiety/depression symptoms in prior research (e.g., Afram & Kashdan, 2015).

Informed by other smoking studies (Bowen & Marlatt, 2009; Elibero et al., 2011; Langdon, Farris, Hogan, et al., 2016; Olvera et al., 2015; Robles et al., 2017), eligibility criteria included: (1) being 18-65 years old, (2) average smoking rate of at least five CPD for at least the past year per the Smoking History Questionnaire (Brown et al., 2002), and (3) willingness to schedule and attend a laboratory appointment on the day the participant planned to begin reducing smoking or quit smoking. Exclusion criteria included: (1) self-reported pregnancy, (2) using NRT and/or undergoing smoking cessation counseling at baseline, (3) having practiced yoga once per week or more in the past year, and (4) being unable to safely engage in exercise per the Physical Activity Readiness Questionnaire (unless the participant received signed physician permission to participate in the study [n = 0]; Chisholm, Collis, Kulak, Davenport, & Gruber, 1975). We used two additional exclusion

criteria early in study recruitment. “Having decreased the number of daily cigarettes smoked by more than half in the past six months” was removed upon consultation with an expert in smoking cessation research. “If currently receiving treatment for anxiety and/or depression, be willing to remain on stable dose throughout duration of the study” was removed given that the study duration was only one week.

See Figure 1 for a CONSORT flow diagram. Of the 867 individuals who completed the online screening questionnaire between February 2017 and May 2018, 569 were ineligible due to: being unable to safely exercise (n = 162),[1] smoking less than five cigarettes per day (n = 123),[2] indicating unwillingness to attend an appointment (n = 100), having practiced yoga once per week or more during the past year (n = 84), currently using NRT or smoking cessation counseling (n = 37), having recently decreased smoking by at least half (n = 27), having regularly smoked for less than one year (n = 12), being pregnant (n = 8), endorsing low motivation to change smoking (n = 8), being under the age of 18 (n = 7), and planning to change psychiatric treatment during study period (n = 1).

Of the 298 participants who were eligible, 149 scheduled an intervention day appointment. Of the 58 participants who presented for their intervention day appointment, two were ineligible to participate due to smoking less than five cigarettes per day. Of the 56 participants enrolled in the study, 52 completed follow-up. One participant in the wellness condition was classified as a random responder at baseline (as described below), thus, that participant’s data were not analyzed. The final baseline sample consisted of 55 participants (hatha yoga n = 25, wellness condition n = 30) and the follow-up sample consisted of 51 participants (hatha yoga n = 25, wellness condition n = 26). The majority of participants (85.5%) were community-recruited. The final sample was primarily male and non-Hispanic White (Table 1), aged 18 to 60 years old. The majority of the sample reported having education beyond high school, being a student, and being employed (Table 1).

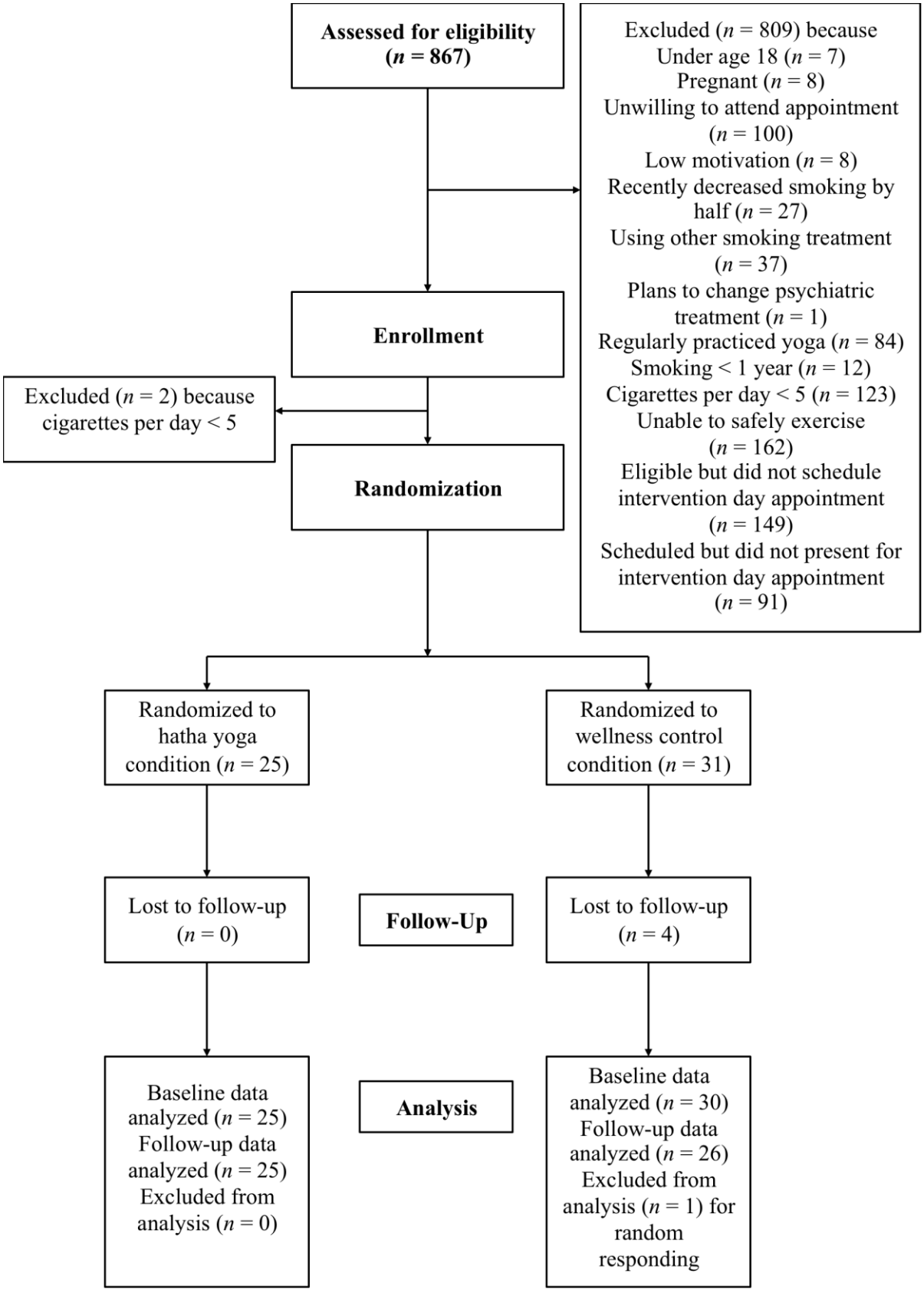

Figure 1. Participant flow chart following Consolidated Standards of Reporting Trials guidelines

Table 1. Demographic and Baseline Characteristics of Sample by Condition

	Total (N = 55)	Yoga (n = 25)	Control (n = 30)	F or χ^2	p	d or Cramer's V
Age	28.16 (10.40)	28.44 (10.88)	27.93 (10.17)	0.03	.859	0.05
Gender (% male)	61.81	68.00	56.67	0.74	.389	0.12
Sexual orientation (% heterosexual)	85.45	88.00	83.33	0.24	.625	0.07
Lesbian (%)	1.82	0.00	3.33			
Gay (%)	1.82	4.00	0.00			
Bisexual (%)	10.91	8.00	13.33			
Race/Ethnicity (% White/Non-Hispanic)	71.00	72.00	70.00	0.03	.871	0.02
White/Hispanic (%)	7.27	8.00	6.67			
African American (%)	9.10	8.00	10.00			
Asian (%)	7.27	8.00	6.67			
Multiracial (%)	1.82	0.00	3.33			
Other (%)	3.64	4.00	3.33			
Employment status (% employed)	67.27	64.00	70.00	0.22	.637	0.06
Family income	85,612 (80, 707)	61,896 (72,226)	104,585 (83,241)	3.94	.053	0.55
Student status (% student)	65.45	56.00	73.33	1.81	.178	0.18
Level of education (% > high school)	87.76	83.36	88.89	0.07	.789	0.04
Marital status (% single)	67.27	72.00	63.33	0.47	.495	0.09
Religion (% Atheist/Agnostic)	27.27	24.00	30.00	0.25	.619	0.07
Treatment status (% in treatment)	21.82	20.00	23.33	0.09	.766	0.04
DASS-21 total	29.53 (19.21)	28.24 (19.01)	30.60 (19.63)	0.20	.654	0.12
DASS-21 depression	8.29 (8.35)	8.16 (9.64)	8.40 (7.27)	0.01	.917	0.03
DASS-21 anxiety	8.25 (6.88)	8.40 (7.30)	8.13 (6.62)	0.02	.888	0.04
DASS-21 stress	11.16 (7.34)	10.08 (6.77)	12.07 (7.78)	0.99	.322	0.27
Anxiety sensitivity	22.35 (13.38)	20.20 (12.75)	24.13 (13.84)	1.18	.282	0.30
Perceived distress tolerance	3.17 (0.96)	3.34 (1.01)	3.03 (0.91)	1.45	.235	0.32

(Table 1 continued)

	Total (N = 55)	Yoga (n = 25)	Control (n = 30)	F or χ^2	p	d or Cramer's V
Breath-holding	47.25 (20.81)	45.44 (18.63)	48.76 (22.68)	0.34	.561	0.16
PASAT	199.85 (129.70)	180.18 (134.12)	216.23 (125.80)	1.06	.309	0.28
Anhedonia	18.93 (4.16)	18.36 (3.87)	19.40 (4.39)	0.85	.361	0.24
Past-week cigarettes per day	9.02 (5.22)	8.35 (5.21)	9.60 (5.26)	0.77	.385	0.24
Hours since last cigarette	10.37 (13.19)	12.42 (16.36)	8.65 (9.79)	1.13	.294	0.28
CO in breath	8.69 (7.69)	7.40 (5.45)	9.77 (9.11)	1.30	.260	0.32
FTND	2.98 (2.01)	2.52 (1.98)	3.37 (1.99)	2.48	.122	0.43
Total years smoking	10.53 (9.70)	10.48 (10.15)	10.57 (9.49)	0.00	.974	0.01
Number of quit attempts	3.20 (2.59)	2.92 (2.45)	3.43 (2.73)	0.53	.470	0.20
Electronic nicotine use (%)	14.55	12.00	16.67	0.24	.625	0.07
Past-week cannabis use (%)	34.55	40.00	30.00	0.60	.437	0.11
Past-week alcohol use (%)	72.73	64.00	80.00	1.76	.185	0.18

Note. Means and standard deviations are presented unless noted otherwise. DASS-21 = Depression Anxiety and Stress Scales (Lovibond & Lovibond, 1995); treatment status = whether participant is being treated for anxiety and/or depression; FTND = Fagerström Test for Nicotine Dependence (Heatherton et al., 1991).

Participants randomized to hatha yoga (100%) were not significantly more likely to complete follow-up than participants randomized to the control condition (86.67%), χ^2 (1, *N* = 55) = 3.60, *p* = .058, φ = 0.26. Completers did not significantly differ from non-completers in terms of gender (35.29% vs. 75% female), χ^2 (1, *N* = 55) = 2.48, *p* = .115, φ = 0.21, age (*M* = 28.02, *SD* = 10.55 vs. *M* = 30.00, *SD* = 9.42), *F*(1, 53) = 0.13, *p* = .718, *d* = 0.20, or race and ethnicity (72.55% vs. 50.00% non-Hispanic White), χ^2 (1, *N* = 55) = 0.91, *p* = .339, φ = 0.13. Completers also did not differ from non-completers on baseline CPD (*M* = 9.39, *SD* = 5.93) vs. *M* = 8.86, *SD* = 1.94), *F*(1, 53) = 0.03, *p* = .860, *d* = 0.12, or anxiety/depression (*M* = 28.24, *SD* = 18.02 vs. *M* = 46.00, *SD* = 28.98), *F*(1, 53) = 3.31, *p* = .075, *d* = 0.68.

Measures

Screening. Participants were asked if they were engaging in NRT or smoking cessation counseling and if they were women, if they were pregnant. Participants who answered "yes" to either of these questions were excluded from the study. Items from the Smoking History Questionnaire (Brown et al., 2002) assessed the total number of years participants have been daily smokers and the average numbers of cigarettes smoked per day since becoming a regular smoker and during the past week. The Physical Activity Readiness Questionnaire (Chisholm et al., 1975) is a self-report questionnaire consisting of seven items that assessed physical symptoms that could limit participants' ability to safely engage in exercise.

Descriptive information. Biochemical verification of smoking status was obtained at baseline using CO (carbon monoxide) analysis of breath samples. Additionally, we assessed number of hours since participants last smoked a cigarette at baseline. Participants completed the 6-item Fagerström Test for Nicotine Dependence (Heatherton et al., 1991) to provide descriptive information about their level of nicotine dependence at baseline and follow-up. The Fagerström Test for Nicotine Dependence has demonstrated high test-retest reliability

and concurrent validity (Heatherton et al., 1991; Pomerleau, Carton, Lutzke, Flessland, & Pomerleau, 1994), though has generally demonstrated low internal consistency reliability (e.g., Pomerleau et al., 1994). Similar to previous research (e.g., Pomerleau et al., 1994), the Fagerström Test for Nicotine Dependence evidenced poor internal consistency reliability in the current sample (baseline α = .53). Additional questions from the Smoking History Questionnaire (e.g., number of past "serious" quit attempts) were asked to provide descriptive information about the sample. At follow-up, participants indicated whether they used any methods to help them reduce or quit smoking other than the materials we gave to them (e.g., NRT, counseling). Participants also indicated whether they completed any yoga other than the yoga from the study and whether they read any wellness materials other than the wellness materials from the study.

Dependent variables. Participants completed the self-report Timeline Followback (TLFB; Sobell & Sobell, 1992) to provide information about cigarettes smoked per day during the seven days prior to baseline and seven days prior to follow-up. We also assessed past-week cannabis and alcohol use with the self-report TLFB to assess whether use of these substances changed from baseline to follow-up. Self-report versions of the TLFB for these substances have demonstrated high reliability and validity (Harris et al., 2009; Pedersen, Grow, Duncan, Neighbors, & Larimer, 2012; Ramo, Hall, & Prochaska, 2011). Additionally, computer-administered versions of the TLFB have shown good test-retest reliability (Sobell, Brown, Leo, & Sobell, 1996). Prior work evaluating smoking outcomes following brief interventions for smoking have used self-report measures of smoking (e.g., Bowen & Marlatt, 2009). In the current study, past-week CPD per the TLFB was significantly correlated with expired CO in breath samples at baseline, $r(53) = .51$, $p < .001$, demonstrating convergent validity.

We assessed craving (i.e., desire to smoke) by asking participants to rate the statement, "I have a desire for a cigarette right now", on a 7-point Likert-type scale with 1 indicating *strongly disagree*, 4 indicating *neither agree nor disagree*, and 7 indicating *strongly agree* (Tiffany & Drobes, 1991). Utilizing a single-item measure of craving is appropriate in situations in which craving is expected to be high (e.g., during nicotine abstinence) and is assessed repeatedly in a short timeframe as using a single item may reduce reactivity associated with self-report assessment of craving (Sayette et al., 2000). We assessed craving on intervention day immediately prior to randomization and immediately post-intervention and at follow-up.

We assessed AS using the Anxiety Sensitivity Index-3 (ASI-3; Taylor et al., 2007), an 18-item self-report measure. Participants rated items (e.g., "It scares me when my heart beats rapidly") on a 0 (*very little*) to 4 (*very much*) Likert-type scale. Higher scores indicate higher levels of AS. The ASI-3 has evidenced good internal consistency reliability, convergent and discriminant validity, and test-retest reliability among smokers (Farris, DiBello, et al., 2015). The ASI-3 evidenced excellent internal consistency reliability in the current sample (baseline α = .90). Participants completed the ASI-3 at baseline on intervention day, post-intervention on intervention day, and at follow-up.

We assessed perceived DT using the Distress Tolerance Scale (DTS; Simons & Gaher, 2005), a self-report questionnaire consisting of 15 items (e.g., "I can't handle feeling distressed or upset") that participants rated on a 1 (*strongly agree*) to 5 (*strongly disagree*) Likert-type scale. A total score was computed by averaging responses on all DTS items. Lower scores on the DTS represent lower perceived ability to tolerate negative emotional states. The DTS has demonstrated good internal consistency reliability, convergent and discriminant validity, criterion-related validity, and test-retest reliability (Simons & Gaher, 2005). Additionally, the DTS has demonstrated excellent internal consistency reliability

among smokers (Kraemer et al., 2013). The DTS also demonstrated excellent internal consistency reliability in the current sample (baseline α = .93). Participants completed the DTS at baseline on intervention day, post-intervention on intervention day, and at follow-up.

We assessed behavioral DT in two ways: using a BH assessment (Hajek et al., 1987) and using a computerized PASAT (Lejuez, Kahler, & Brown, 2003). We assessed BH at baseline on intervention day, post-intervention on intervention day, and at follow-up and participants completed the PASAT at baseline and post-intervention on intervention day. We did not administer the PASAT at follow-up because participants cannot complete it remotely. Although the BH assessment has been the most commonly used measure of behavioral DT in the smoking literature (Leventhal & Zvolensky, 2015), the PASAT was used as a second measure of behavioral DT because hatha yoga could impact participants' BH abilities without actually impacting their ability to tolerate physical distress. During the BH assessment, we asked participants to hold their breath for as long as possible. Each participant completed two trials per time period (i.e., pre-intervention, post-intervention, follow-up) and the two trials were averaged to create a total BH score. Shorter BH duration indicates lower behavioral DT. Participants completed the BH assessment remotely using instructions on Qualtrics.com at follow-up.

The PASAT required participants to add a newly presented numeric digit to a numeric digit previously presented. After inputting the sum on the keyboard, participants were required to ignore that sum and add the numeric digit presented next to the numeric digit presently immediately prior. Digits were presented more quickly over the course of the task, which consisted of three trials. Additionally, participants heard an unpleasant noise when they gave incorrect responses. Participants were allowed to quit the task at any time during the final trial. The amount of time until participants quit the task during the final trial was used as the measure of DT. Numerous studies of smokers have utilized these behavioral

measures of DT (e.g., Brown et al., 2002; Cameron et al., 2013; Daughters et al., 2005; Hajek et al., 1987; MacPherson, Stipelman, Duplinsky, Brown, & Lejuez, 2008).

We assessed Anh using the 14-item Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995). Participants rated the degree of pleasure they believed they would experience if they engaged in several hypothetical activities (e.g., "I would find pleasure in my hobbies and pastimes"). Each item has four response options: *definitely agree* (0), *agree* (1), *disagree* (2), and *definitely disagree* (3). Higher total scores indicate greater Anh. The SHAPS has demonstrated good internal consistency reliability among smokers (Leventhal et al., 2009), excellent construct, convergent, and divergent validity (Leventhal et al., 2006), and excellent test-retest reliability (Franken et al., 2007). In the current sample, the SHAPS demonstrated good internal consistency reliability (baseline α = .81). Participants completed the SHAPS at baseline on intervention day, post-intervention on intervention day, and at follow-up.

Putative moderators. We assessed anxiety/depression with the DASS-21 (Lovibond & Lovibond, 1995) at baseline and follow-up. The DASS-21 consists of three subscales each comprising seven items assessing past-week anxiety, depression, and stress. The total score was used as a measure of anxiety/depression. Respondents rated items (e.g., "I felt I was close to panic", "I felt down-hearted and blue") on a 0 (*did not apply to me at all)* to 3 (*applied to me very much, or most of the time*) Likert-type scale. The total score is multiplied by two. The DASS-21 has evidenced good internal consistency reliability, convergent and discriminant validity, and criterion validity (Antony, Bieling, Cox, Enns, & Swinson, 1998; Henry & Crawford, 2005). In the current sample, the DASS-21 total score evidenced good internal consistency reliability (baseline α = .89). At follow-up, participants indicated for how many minutes they accessed the materials given to them each day during the follow-up period using a calendar adapted from the TLFB (Sobell & Sobell, 1992). We summed minutes per day to create a total number of minutes materials were used.

We used the Infrequency Scale (Chapman & Chapman, 1983) at baseline and follow-up to identify random responders who may have provided random or grossly invalid responses. Four questions from the IS (e.g., "I find that I often walk with a limp, which is the result of a skydiving accident") were included. As in prior studies (Buckner, Ecker, & Dean, 2016), individuals who endorsed three or more infrequency items were classified as random responders (n = 1 at baseline, n = 0 at follow-up).

Conditions

Hatha yoga condition. Hatha yoga in the current study was conceptualized by previous research conducted in the United States (Bock et al., 2012; Elibero et al., 2011) and by the National Center for Complementary and Integrative Health (National Center for Complementary and Integrative Health, 2016) but may not be fully reflective of traditional hatha yoga practice. Participants in the hatha yoga condition were in a room with a yoga mat and were asked to follow a 30-minute instructional hatha yoga video. A certified yoga instructor developed the video specifically for the current study. The video starts with a breathing exercise, followed by a warm-up, and a basic hatha yoga routine that can be completed easily by a relatively healthy individual. The video ends with meditation. To ensure adherence with the video instructions, a research assistant observed participants in an adjacent room using video recording equipment. We instructed research assistants that if they observed that the participant was not adhering to the instructions, the research assistant was to encourage the participant to follow the instructions (however, all participants were adherent). At the end of the session, we gave participants a copy of the video and emailed them a link of the video. We encouraged participants to practice hatha yoga once per day during the next seven days. Participants were not explicitly told that there is a relationship between hatha yoga and smoking cessation.

Wellness control condition. Participants in the control condition read educational materials about wellness for 30 minutes per prior smoking cessation trials (Smits et al., 2012). Wellness has been successfully used as a control condition in other exercise intervention studies (Chasan-Taber et al., 2009; Marcus et al., 1995; Pekmezi et al., 2009; Smits et al., 2016). We provided participants a description of the program and asked them to read about wellness-related topics such as cancer prevention and stress management for 30 minutes. We gave participants a printout copy of the wellness materials and emailed them a copy of the wellness materials. We encouraged them to read the materials once per day during the next seven days. Participants were not told that there is a relationship between overall wellness and smoking cessation.

Procedures

Participants completed an online screening survey via Qualtrics.com, a secure, online data-collection website. We provided ineligible participants smoking cessation resources, including referrals for local smoking cessation clinics and a link to a website detailing smoking cessation strategies (Centers for Disease Control and Prevention, 2017b). We invited eligible participants to choose an appointment date on which they would begin to reduce smoking or quit smoking within the following four weeks. In addition to asking participants to refrain from smoking cigarettes on their intervention day, we asked them to refrain from smoking other substances that day (because smoking other substances increases expired CO levels; e.g., Newmeyer, Swortwood, Abulseoud, & Huestis, 2017).

During the appointment, participants provided written informed consent prior to data collection. We obtained a certificate of confidentiality from the National Institutes of Health to ensure confidentiality and security of data. Next, we obtained biochemical verification of smoking status using CO analysis of breath samples and we asked participants when they last smoked a cigarette. Participants who were not abstinent from smoking that day (n = 34)

remained eligible to participate. Participants then completed baseline measures. We gave all participants a handout describing strategies that can be used to quit smoking (Centers for Disease Control and Prevention, 2017b). Next, while participants read the handout, we used urn randomization (i.e., randomization that is systematically biased in favor of balancing; Stout, Wirtz, Carbonari, & Del Boca, 1994) to randomize them to ensure equal distribution of relevant variables (i.e., gender, race and ethnicity, baseline CPD, anxiety, depression, currently receiving treatment for anxiety and/or depression) between conditions. Participants then completed 30 minutes of hatha yoga per an instructional video or read wellness-related educational materials for 30 minutes. Next, participants completed post-intervention measures. In addition to their intervention materials (described above), we provided all participants the link to a website describing the strategies that can be used to quit smoking and we encouraged them to review the website (Centers for Disease Control and Prevention, 2017b).

We informed participants that they would be sent an email seven days after their appointment to complete follow-up measures via Qualtrics.com. Upon completion of the study, we compensated LSU psychology undergraduate students with research credit points. We compensated community-recruited participants $25 for attending the laboratory appointment and entered them into a drawing to win money (i.e., one $100, two $50 prizes) for completing the follow-up assessment. We also provided participants with referrals for mental health and smoking cessation treatment upon completion of the study. Additionally, after participants completed the follow-up assessment, we provided them the materials from the other condition (i.e., hatha yoga video or wellness materials) via email.

Data Analytic Strategy

First, to ensure that conditions did not differ on relevant variables (i.e., gender, race and ethnicity, time since last cigarette, baseline CPD, anxiety, depression, currently receiving

treatment for anxiety and/or depression), we conducted a one-way analysis of variance (ANOVA) for each continuous dependent variable and a chi-square analysis was conducted for each categorical dependent variable. To test the impact of condition on post-intervention craving and follow-up smoking outcomes, we conducted an ANOVA for each outcome variable. To test the moderating role of anxiety/depression symptoms on the relationships between condition and post-intervention craving and follow-up smoking, we conducted a series of hierarchical linear regressions. Regression with dichotomous independent variables is robust against differences in sample size between conditions (West, Aiken, & Krull, 1996). We conducted separate hierarchical linear regressions for each outcome variable. Predictor variables were: Step 1: baseline craving or baseline CPD, Step 2: main effects of condition (wellness control condition = 0, hatha yoga condition = 1) and anxiety/depression symptoms, and Step 3: the Condition x Anxiety/Depression interaction. This strategy ensured that effects at Step 3 were not attributable to the variance shared with variables in Steps 1 and 2 (Cohen & Cohen, 1983). For all regression analyses, we centered continuous independent variables (Holmbeck, 2002) and squared part (i.e., semipartial) correlations to estimate effect sizes (Cohen & Cohen, 1983). Further, we examined the forms of significant interactions by graphing regression lines of the association between condition and the outcome variable (e.g., follow-up CPD) for individuals with high (one *SD* above the sample mean) and low (one *SD* below the sample mean) levels of the moderator (e.g., anxiety/depression) and probed significant interactions by testing whether simple slopes of the regression lines were significantly different from zero (Aiken & West, 1991; Holmbeck, 2002).

To test the impact of condition on post-intervention and follow-up AS, DT, and Anh, we conducted an ANOVA for each outcome variable. To test the moderating role of anxiety/depression in the relationship between condition and post-intervention and follow-up AS, DT, and Anh, we conducted a series of hierarchical linear regressions. We conducted

separate regressions for each dependent variable after controlling for baseline levels of each variable. Predictor variables were: Step 1: baseline AS, DT, or Anh, Step 2: main effects of condition and anxiety/depression, and Step 3: the Condition x Anxiety/Depression interaction.

To test whether number of minutes participants accessed their materials during the follow-up period moderated the relationship between condition and each continuous outcome after controlling for baseline levels of each outcome variable, we conducted another series of hierarchical linear regression analyses. We conducted separate hierarchical linear regressions for each outcome: follow-up CPD, follow-up AS, follow-up DT, and follow-up Anh. Predictor variables were: Step 1: baseline score for each outcome variable, Step 2: main effects of condition and number of minutes participants accessed their materials, and Step 3: the Condition x Number of Minutes Participants Accessed Their Materials interaction.

PROCESS (a macro used within IBM SPSS) was used was used to test our mediation hypotheses (Hayes, 2013). PROCESS uses an ordinary least squares regression-based path analytical framework to test for direct and indirect effects (Hayes, 2013). The program estimated bias-corrected 95% confidence intervals using bootstrapping analyses with 10,000 resamples (Hayes, 2009). First, we examined whether condition was associated with putative mediators, including post-intervention AS, post-intervention DT, post-intervention Anh, follow-up AS, follow-up DT, and follow-up Anh. We conducted mediation analyses for each dependent variable (i.e., post-intervention craving or follow-up CPD) using only proposed mediators that were significantly associated with condition. We estimated effect sizes of indirect effects using partially standardized effects given that the independent variable (i.e., condition) is dichotomous (Hayes, 2013). Lastly, we conducted a hierarchical logistic regression to test the impact of condition on seven-day PPA. Predictor variables were: Step 1: baseline CPD, Step 2: condition. We used an odds ratio (Field, 2009) to determine effect size.

A Priori Power Analysis

Previous studies investigating the effects of exercise on smoking craving have found medium to large effects (for review see Roberts et al., 2012). Although no studies have examined the effects of hatha yoga alone compared to a control condition on follow-up smoking, a study investigating the effects of a brief mindfulness-based instruction set (i.e., urge surfing) compared to a control condition on follow-up CPD found a medium to large effect (d = 0.64; Bowen & Marlatt, 2009). Thus, we used G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) to estimate the sample size needed to detect a medium effect (f^2 = 0.25) with power of 0.80 and an alpha level of .05 for a linear multiple regression analysis using four predictor variables (i.e., baseline CPD, condition, anxiety/depression, and Condition x Anxiety/Depression interaction). According to G*Power (Faul et al., 2007), 48 participants should provide sufficient power to test our primary hypotheses, as this sample size is sufficient to test our primary hypothesis requiring the largest sample size (i.e., moderation hypothesis). Thus, our baseline and follow-up sample sizes are sufficient to test study hypotheses (N = 55, n = 51, respectively).

RESULTS

Sample Descriptives

First, we inspected data for outliers (greater than three standard deviations from the mean). We observed outliers for the following variables: baseline CPD (n = 1), post-intervention AS (n = 1), post-intervention Anh (n = 1), post-intervention BH (n = 1), follow-up anxiety/depression (n = 1), follow-up BH (n = 1), number of minutes participants accessed their materials at follow-up (n = 1), and follow-up CPD (n = 1). We removed outliers for each of these measures prior to conducting study analyses utilizing the measure. Table 2 presents means, standard deviations, skew, and kurtosis values for independent variables, covariates, and dependent variables. Data were not significantly skewed (> 3) or kurtotic (> 10; Field, 2009).

Table 2. Means, Standard Deviations, Skew, and Kurtosis of Study Variables

	M	*SD*	Skew	Kurtosis
Baseline DASS-21	29.53	19.21	0.70	0.28
Baseline CPD	9.02	5.22	0.85	0.10
Baseline AS	22.35	13.38	0.70	-0.40
Baseline DT	3.67	0.96	-0.07	-0.47
Baseline BH	47.25	20.81	0.67	0.51
Baseline PASAT	199.85	129.70	-0.65	-1.51
Baseline Anh	18.93	4.16	0.58	-0.82
Baseline craving	5.04	1.63	-0.72	-0.28
Post-intervention AS	16.65	12.52	0.74	-0.81
Post-intervention DT	3.87	1.01	-0.27	-0.44
Post-intervention BH	44.68	20.63	0.94	1.35
Post-intervention PASAT	171.39	141.13	-0.23	-1.96
Post-intervention Anh	18.19	3.74	0.68	-0.46
Post-intervention craving	4.18	2.07	-0.15	-1.16
Follow-up DASS-21	23.00	18.12	1.20	1.33
Follow-up AS	14.55	12.14	1.12	0.45
Follow-up DT	3.53	0.92	-0.13	-0.54
Follow-up BH	37.42	23.41	1.30	3.40
Follow-up Anh	19.39	5.17	0.70	-0.71
Minutes accessed materials	102.90	81.86	0.42	-0.88
Follow-up craving	3.47	1.90	0.32	-0.97
Follow-up CPD	4.32	3.88	1.27	1.88

At baseline, 60% of participants endorsed depression within the normal range, 14.5% endorsed depression within the mild range, 14.6% endorsed depression within the moderate range, 9.1% endorsed depression within the severe range, and 1.8% endorsed depression within the extremely severe range (Lovibond & Lovibond, 1995). Regarding anxiety at baseline, 50.9% of participants endorsed anxiety within the normal range, 9.1% endorsed anxiety within the mild range, 23.6% endorsed anxiety within the moderate range, 7.3% endorsed anxiety within the severe range, and 9.1% endorsed anxiety within the extremely severe range (Lovibond & Lovibond, 1995). Participants in the current study smoked fewer CPD and had lower levels of nicotine dependence at baseline than participants in prior studies testing the utility of exercise for smoking cessation (Bock et al., 2012; Smits et al., 2016), but smoked more CPD and had greater nicotine dependence than participants in a study testing the efficacy of a brief mindfulness-based intervention (i.e., urge surfing) for smoking reduction (Bowen & Marlatt, 2009). Although all participants endorsed being regular, daily smokers for at least the past year at screening, only 83.6% of participants endorsed past-week daily smoking at baseline.

Conditions did not significantly differ on demographic variables, anxiety, depression, stress, or smoking variables at baseline (Table 1). At baseline, anxiety/depression symptoms were significantly positively associated with AS, Anh, and craving, were significantly negatively associated with perceived DT, and were not significantly correlated with CPD (Table 3). Additionally, nicotine dependence was significantly positively associated with CPD and craving at baseline (Table 3). Further, at baseline, BH and PASAT were not significantly correlated with perceived DT and these two behavioral measures of DT were not significantly correlated with one another (Table 3).

Table 3. Correlations among Baseline Variables

	1	2	3	4	5	6	7	8
1. Anxiety/depression								
2. CPD	.22							
3. FTND	.16	.42**						
4. AS	.48**	.15	.08					
5. DT	-.44**	.09	-.01	-.64**				
6. BH	-.17	.12	-.24	-.17	.19			
7. PASAT	-.06	-.08	.00	.12	-.10	.06		
8. Anh	.42**	.08	.22	.26	-.20	-.18	-.16	
9. Craving	.34*	.10	.52**	.18	-.12	-.11	.09	.21

Note. *$p < 0.05$, **$p < .01$.

Participants in the hatha yoga condition reported using their study materials for significantly more minutes and on significantly more days than participants in the wellness control condition during the follow-up period (Table 4). At follow-up, number of minutes participants accessed their materials was significantly negatively correlated with craving, $r(48) = -.32$, $p = .023$, but not CPD, $r(47) = -.09$, $p = .532$. Consistent with their intentions to reduce or quit smoking, participants (regardless of condition) smoked significantly less CPD at follow-up ($M = 4.63$, $SD = 4.43$) than at baseline ($M = 9.39$, $SD = 5.93$), $t(50) = 6.75$, $p < .001$, $d = 0.91$. Regarding descriptive information about our sample at follow-up, nine participants reported they used an electronic nicotine delivery system during the past week, with the mean number of use days being 4.33 ($SD = 2.40$). Number of days participants used an electronic nicotine delivery system did not differ by condition (Table 4). Seven participants endorsed having used methods other than those provided in the context of the study to help them quit smoking (e.g., nicotine gum). Conditions did not significantly differ on the number of participants who endorsed having used additional methods during the follow-up period (Table 4). Three participants in the hatha yoga condition reported using yoga other than that provided by the study during the follow-up period. Six participants in the wellness control condition reported reading wellness materials other than participants provided by the study during the follow-up period.

Table 4. Follow-Up Characteristics of Sample by Condition

	Total (N = 51)	Yoga (n = 25)	Control (n = 26)	F or χ^2	p	d or Cramer's V
DASS-21 total	23.00 (18.12)	19.00 (12.26)	26.69 (21.81)	2.31	.135	0.43
DASS-21 depression	6.68 (7.67)	5.00 (5.18)	8.23 (9.25)	2.27	.138	0.43
DASS-21 anxiety	5.28 (5.87)	4.33 (4.82)	6.15 (6.67)	1.21	.277	0.31
DASS-21 stress	9.52 (6.60)	8.50 (5.45)	10.46 (7.49)	1.11	.298	0.30
Minutes accessed materials	102.96 (82.69)	136.68 (79.28)	69.24 (72.84)	9.81	.003	0.89
Days accessed materials	4.63 (2.48)	5.52 (1.96)	3.77 (2.66)	7.12	.010	0.75
Use of additional methods (%)	13.73	8.00	19.23	1.36	.244	0.16
Electronic nicotine use (%)	17.65	12.00	23.08	1.08	.300	0.15
Past-week cannabis use (%)	19.61	20.00	19.23	0.01	.945	0.01
Past-week alcohol use (%)	52.94	44.00	61.54	1.57	.210	0.18

Note. Means and standard deviations are presented unless noted otherwise.

Acute Impact of Condition on Craving and the Role of Anxiety/Depression

Consistent with prediction, the hatha yoga condition was significantly associated with less post-intervention craving (M = 3.40, SD = 2.10) than the control condition (M = 4.83, SD = 1.84), $F(1, 53) = 7.27$, $p = .009$, $d = 0.72$. Contrary to hypothesis, anxiety/depression symptoms did not moderate this relationship (Table 5).[3] Condition remained significantly associated with post-intervention craving after accounting for the variance attributable to pre-intervention craving and anxiety/depression (Table 5).

Table 5. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Post-Intervention Craving

	ΔR^2	ΔF	B	t	p	sr^2
Step 1	.51	55.32			< .001	
Baseline craving			0.91	7.44	< .001	.51
Step 2	.06	3.50			.038	
Anxiety/depression			0.01	0.49	.625	.00
Condition			-1.00	-2.60	.012	.06
Step 3	.01	0.53			.469	
Condition x Anxiety/Depression			-0.02	-0.73	.469	.00

Note. B = unstandardized coefficient; sr^2 = squared part (i.e., semipartial) correlations.

Impact of Condition on Follow-up Smoking and the Role of Anxiety/Depression

Contrary to hypothesis, participants in the hatha yoga condition (M = 4.19, SD = 4.08) did not report smoking significantly fewer CPD at follow-up than participants in the control condition (M = 4.44, SD = 3.77), $F(1, 48) = 0.05$, $p = .823$, $d = 0.06$. Further, anxiety/depression did not moderate this relationship (Table 6).[3] Also counter to prediction, participants in the hatha yoga condition did not evidence increased odds of attaining seven-day PPA compared to the control condition (12.5 % vs. 16.00%, respectively), OR = 0.75, 95% CI [0.15, 3.87], $p = .732$.[3]

Table 6. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Follow-Up Cigarettes per Day

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.20	11.90			.001	
Baseline cigarettes per day			0.32	3.45	.001	.20
Step 2	.01	0.32			.726	
Anxiety/depression			-0.01	-0.43	.673	.00
Condition			0.65	0.65	.519	.01
Step 3	.01	0.50			.483	
Condition x Anxiety/Depression			-0.04	-0.71	.483	.01

Acute Impact of Condition on Transdiagnostic Factors and the Role of Anxiety/Depression

Contrary to prediction, the hatha yoga condition (*M* = 14.83, *SD* = 11.35) did not evidence significantly less post-intervention AS than the control condition (*M* = 18.10, *SD* = 13.40), *F*(1, 52) = 0.91, *p* = .346, *d* = 0.26. Further, anxiety/depression symptoms did not moderate this relationship (Table 7).[3] Similarly, the hatha yoga condition (*M* = 3.46, *SD* = 1.03) was not significantly associated with greater post-intervention perceived DT compared to the control condition (*M* = 3.10, *SD* = 0.97), *F*(1, 53) = 1.83, *p* = .182, *d* = 0.36, and anxiety/depression did not moderate this relationship (Table 8).[3] Contrary to hypothesis, the hatha yoga condition (*M* = 41.50, *SD*= 19.32) was not associated with greater post-intervention BH than the wellness control condition (*M* = 47.41, *SD* = 21.66), *F*(1, 52) = 1.10, *p* = .298, *d* = 0.29, nor did anxiety/depression moderate this relationship (Table 9).[3]

Table 7. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Post-Intervention Anxiety Sensitivity

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.81	220.63			< .001	
Baseline anxiety sensitivity			0.89	14.85	< .001	.81
Step 2	.04	5.97			.005	
Anxiety/depression			0.14	3.28	.002	.03
Condition			1.80	1.27	.212	.00
Step 3	.00	0.40			.528	
Condition x Anxiety/Depression			-0.05	-0.64	.528	.00

Table 8. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Post-Intervention Perceived Distress Tolerance

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.89	441.44			< .001	
Baseline distress tolerance			0.99	21.01	< .001	.89
Step 2	.01	1.51			.230	
Anxiety/depression			0.00	-1.61	.114	.01
Condition			0.06	0.68	.503	.00
Step 3	.00	0.16			.688	
Condition x Anxiety/Depression			0.00	-0.40	.688	.00

Table 9. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Post-Intervention Breath-Holding

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.80	205.41			< .001	
Baseline breath-holding			0.92	14.33	< .001	.80
Step 2	.01	1.77			.181	
Anxiety/depression			-0.05	-0.79	.433	.00
Condition			-4.49	-1.77	.083	.01
Step 3	.00	0.62			.435	
Condition x Anxiety/Depression			-0.11	-0.79	.435	.00

Counter to prediction, the hatha yoga condition (M = 151.16, SD = 146.65) was not significantly associated with greater post-intervention PASAT than the control condition (M = 188.25, SD = 136.54), $F(1, 53) = 0.94$, $p = .337$, $d = 0.26$, nor did anxiety/depression symptoms moderate this relationship (Table 10).[3] Similarly, the hatha yoga condition (M = 17.80, SD = 3.35) was not significantly associated with less post-intervention Anh than the wellness control condition (M = 18.52, SD = 4.07), $F(1, 52) = 0.49$, $p = .487$, $d = 0.19$. Anxiety/depression symptoms did not moderate this relationship (Table 11).[3]

Table 10. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Post-Intervention PASAT

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.77	177.57			< .001	
Baseline PASAT			0.96	13.33	< .001	.77
Step 2	.00	0.50			.607	
Anxiety/depression			0.49	0.99	.325	.00

(Table 10 continued)

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Condition			-1.45	-0.08	.939	.00
Step 3	.00	0.26			.610	
Condition x Anxiety/Depression			-0.51	-0.51	.610	.00

Table 11. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Post-Intervention Anhedonia

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.80	206.33			< .001	
Baseline anhedonia			0.81	14.36	< .001	.80
Step 2	.00	0.20			.822	
Anxiety/depression			0.01	0.62	.535	.00
Condition			-0.03	-0.05	.957	.00
Step 3	.00	0.06			.810	
Condition x Anxiety/Depression			-0.01	-0.24	.810	.00

Impact of Condition on Follow-up Transdiagnostic Factors and the Role of Anxiety/Depression

Consistent with our hypothesis, the hatha yoga condition (M = 11.04, SD = 8.14) was significantly associated with less follow-up AS than the wellness control condition (M = 17.92, SD = 14.39), F(1, 49) = 4.38, p = .042, d = 0.59. Also consistent with prediction, anxiety/depression symptoms moderated the relationship between condition and follow-up AS (Table 12).[3] Baseline AS accounted for 64% of the variance in follow-up AS, the main effects of condition and anxiety/depression accounted for an additional 3% of the variance, and the Condition x Anxiety/Depression interaction accounted for an additional 6% of unique variance.

Table 12. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Follow-Up Anxiety Sensitivity

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.64	85.63			< .001	
Baseline anxiety sensitivity			0.72	9.25	< .001	.64
Step 2	.03	1.81			.175	
Anxiety/depression			-0.01	-0.15	.883	.00
Condition			-3.89	-1.87	.067	.03
Step 3	.06	10.69			.002	
Condition x Anxiety/Depression			-0.34	-3.27	.002	.06

We examined the form of the significant interaction (Figure 2) and among participants with higher anxiety/depression symptoms, the simple slope was significant, B = 10.07, t = 3.77, $p < .001$, sr^2 = 0.08, indicating that condition was related to follow-up AS, such that participants in the hatha yoga condition endorsed lower levels of AS than participants in the wellness control condition. Among participants with lower anxiety/depression, the simple slope was not significantly different from zero, B = 2.22, t = 0.84, p = .408, sr^2 = 0.00, indicating that condition was not associated with follow-up AS. Among participants in the hatha yoga condition, the difference between baseline (M = 22.20, SD = 12.75) and follow-up (M = 11.04, SD = 8.14) AS represents a large effect, $t(24)$ = 4.93, $p < .001$, d = 0.86.

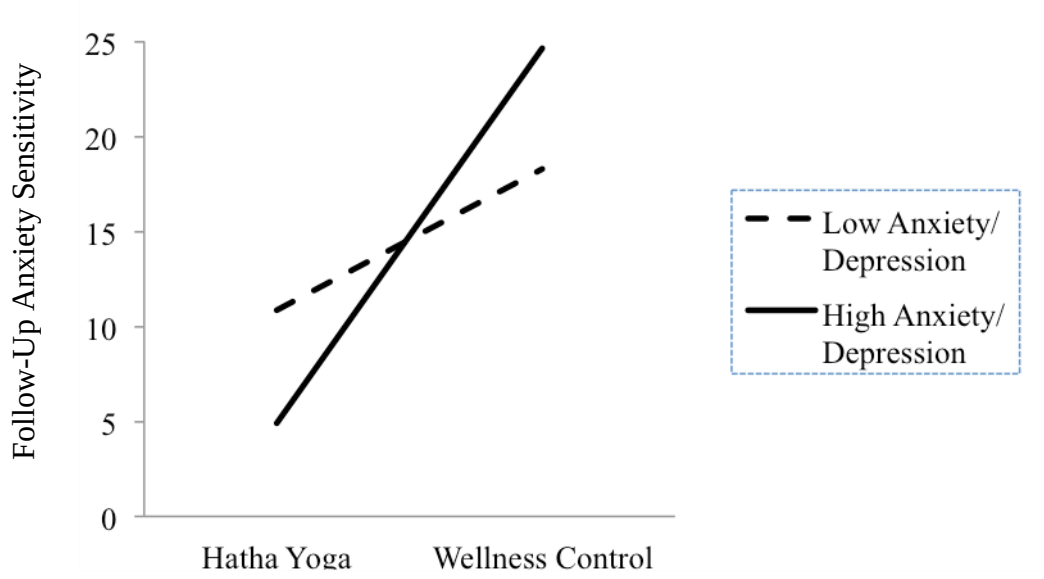

Figure 2. Significant Condition x Anxiety/Depression interaction predicting follow-up anxiety sensitivity

Contrary to prediction, the hatha yoga condition (M = 3.49, SD = 0.90) was not significantly associated with greater follow-up perceived DT than the control condition (M = 3.19, SD = 0.93), $F(1, 49)$ = 1.28, p = .264, d = 0.32, nor did not anxiety/depression moderate this relationship (Table 13).[3] Also counter to prediction, the hatha yoga condition (M = 36.04, SD = 22.55) was not associated with greater follow-up BH than the control condition (M =

38.79, *SD* = 24.62), *F*(1, 48) = 0.17, *p* = .682, *d* = 0.12. Additionally, anxiety/depression did not moderate this relationship (Table 14).[3] Similarly, the hatha yoga (*M* = 19.16, *SD* = 5.17) condition was not associated with less follow-up Anh than the control condition (*M* = 19.62, *SD* = 5.20), *F*(1, 49) = 0.10, *p* = .757, *d* = 0.09, nor did anxiety/depression moderate this relationship (Table 15).[3]

Table 13. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Follow-Up Perceived Distress Tolerance

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.68	104.34			< .001	
Baseline distress tolerance			0.78	10.22	< .001	.68
Step 2	.00	0.02			.985	
Anxiety/depression			0.00	0.04	.967	.00
Condition			0.03	0.16	.872	.00
Step 3	.01	1.81			.185	
Condition x Anxiety/Depression			-0.01	-1.35	.185	.01

Table 14. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Follow-Up Breath-Holding

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.42	34.44			< .001	
Baseline breath-holding			0.71	5.87	< .001	.42
Step 2	.02	1.01			.373	
Anxiety/depression			-0.21	-1.41	.165	.02
Condition			-0.70	-0.14	.891	.00
Step 3	.00	0.04			.845	
Condition x Anxiety/Depression			-0.06	-0.20	.845	.00

Table 15. Hierarchical Linear Regression of the Condition x Anxiety/Depression Interaction on Follow-Up Anhedonia

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.46	41.19			< .001	
Baseline anhedonia			0.86	6.42	< .001	.46
Step 2	.02	1.03			.366	
Anxiety/depression			0.05	1.42	.162	.02
Condition			0.13	0.12	.902	.00
Step 3	.01	0.52			.476	
Condition x Anxiety/Depression			-0.04	-0.72	.476	.01

Moderating Role of Time Spent Using Intervention Materials

Contrary to prediction, number of minutes participants accessed their materials did not moderate the relationship between condition and follow-up CPD (Table 16).[3] Also inconsistent with prediction, number of minutes participants accessed their materials did not moderate the relationship between condition and follow-up AS (Table 17).[3] Similarly, number of minutes participants accessed their materials did not moderate the relationships between condition and follow-up perceived DT (Table 18),[3] follow-up behavioral DT (i.e., BH; Table 19),[3] or follow-up Anh (Table 20).[3]

Table 16. Hierarchical Linear Regression of the Condition x Minutes Participants Accessed Their Materials Interaction on Follow-Up Cigarettes per Day

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.28	18.28			< .001	
Baseline cigarettes per day			0.40	4.28	< .001	.28
Step 2	.02	0.75			.478	
Minutes			-0.01	-1.12	.269	.02
Condition			0.93	0.91	.370	.01
Step 3	.02	1.22			.275	
Condition x Minutes			0.01	1.11	.275	.02

Table 17. Hierarchical Linear Regression of the Condition x Minutes Participants Accessed Their Materials Interaction on Follow-Up Anxiety Sensitivity

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.64	86.14			< .001	
Baseline anxiety sensitivity			0.72	9.28	< .001	.64
Step 2	.03	2.29			.113	
Minutes			0.01	0.47	.641	.00
Condition			-4.74	-2.09	.042	.03
Step 3	.00	0.12			.726	
Condition x Minutes			-0.01	-0.35	.726	.00

Table 18. Hierarchical Linear Regression of the Condition x Minutes Participants Accessed Their Materials Interaction on Follow-Up Perceived Distress Tolerance

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.68	104.34			< .001	
Baseline distress tolerance			0.78	10.22	< .001	.68

(Table 18 continued)

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 2	.00	0.02			.986	
Minutes			0.00	-0.04	.970	.00
Condition			0.03	0.17	.866	.00
Step 3	.00	0.23			.631	
Condition x Minutes			0.00	-0.48	.631	.00

Table 19. Hierarchical Linear Regression of the Condition x Minutes Participants Accessed Their Materials Interaction on Follow-Up Breath-Holding

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.40	31.40			< .001	
Baseline breath-holding			0.75	5.60	< .001	.40
Step 2	.00	0.04			.961	
Minutes			-0.01	-0.13	.894	.00
Condition			-0.98	-0.17	.868	.00
Step 3	.00	0.08			.775	
Condition x Minutes			0.02	0.29	.775	.00

Table 20. Hierarchical Linear Regression of the Condition x Minutes Participants Accessed Their Materials Interaction on Follow-Up Anhedonia

	ΔR^2	ΔF	*B*	*t*	*p*	sr^2
Step 1	.45	39.57			< .001	
Baseline anhedonia			0.85	6.29	< .001	.45
Step 2	.02	0.65			.527	
Minutes			-0.01	-1.14	.262	.01
Condition			0.70	0.57	.573	.01
Step 3	.00	0.04			.843	
Condition x Minutes			0.00	0.20	.843	.00

Mediating Role of Transdiagnostic Factors

As described above, condition was not associated with post-intervention AS, perceived DT, behavioral DT, or Anh. Thus, the mediating role of these transdiagnostic factors in the relationship between condition and post-intervention craving was not tested. Given that condition was associated with follow-up AS, but not follow-up perceived DT, behavioral DT, or Anh (as described above), we tested the direct and indirect effects of condition on follow-up CPD through follow-up AS (Table 21).[3] The total effect model (with condition and covariates as independent variables) did not account for significant variance in follow-up CPD, though baseline CPD did account for significant variance. The full model,

including follow-up AS, also did not account for significant variance in follow-up CPD. The direct effect of condition on follow-up CPD (controlling for covariates and follow-up AS) was not significant. The indirect effect of condition on follow-up CPD craving via follow-up AS was also nonsignificant (Figure 3).

Table 21. Direct and Indirect Effects of Condition on Follow-Up Cigarettes per Day via Follow-Up Anxiety Sensitivity

	R^2	F	B	t	p	95% CI
Total effect model	.22	1.51			.224	
Condition			0.47	0.46	.645	[-1.56, 2.50]
Baseline cigarettes per day			0.34	2.11	.041	[0.01, 0.66]
Baseline AS			-0.03	-0.93	.358	[-0.10, 0.04]
Full model	.23	1.22			.318	
Condition			0.35	0.27	.786	[-2.22, 2.92]
Baseline cigarettes per day			0.34	1.91	.062	[-0.02, 0.70]
Baseline AS			0.01	0.05	.961	[-0.26, 0.27]
Follow-up AS			-0.05	-0.37	.711	[-0.32, 0.22]
Direct effect			0.35	0.27	.786	[-2.22, 2.92]
Indirect effect						
Follow-up AS			0.03			[-0.12, 0.36]

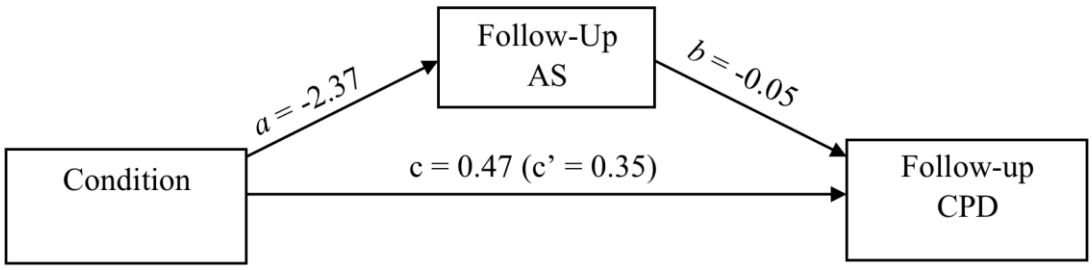

Figure 3. Direct and indirect effects of condition on follow-up cigarettes per day via follow-up anxiety sensitivity.

DISCUSSION

The current study tested whether hatha yoga (versus a wellness control condition) reduced craving acutely and aided in smoking reduction or cessation over the course of one week. The current study also tested whether the presence of anxiety/depression symptoms impacted the utility of hatha yoga for reducing craving and smoking. Additionally, informed by a recent theoretical model that proposed that anxiety/depression symptoms are linked to smoking-related risk factors and poorer smoking cessation outcomes via transdiagnostic reactive factors, AS, DT, and Anh (Leventhal & Zvolensky, 2015), we tested whether hatha yoga impacted AS, DT, and Anh and whether these factors mediated the relationship between condition and smoking-related outcomes.

Consistent with our hypothesis and prior research finding that hatha yoga reduced craving among nicotine-deprived smokers not attempting to change their smoking (Elibero et al., 2011), on intervention day, hatha yoga was associated with less craving than the control condition, even after accounting for the variance attributable to participants' baseline craving. Yet, anxiety/depression did not moderate the relationship between condition and post-intervention craving. These results suggest hatha yoga is associated with a reduction in craving among smokers attempting to reduce or quit smoking, regardless of whether they have elevated anxiety/depression symptoms.

Our results do not support the hypothesis that hatha yoga exerts its effects on smoking-related factors through changes in AS, DT, or Anh. In light of our sample endorsing relatively low levels of anxiety/depression, and consistent with Leventhal and Zvolensky's model (2015), it is possible that hatha yoga impacts smoking outcomes through these transdiagnostic factors among smokers with clinical levels of anxiety/depression, as these individuals would also likely have higher levels of AS (e.g., Otto et al., 1995; Taylor et al., 2007) and Anh (e.g., Kashdan, 2004; Lewinsohn, 1974), and lower DT (e.g., Keough et al.,

2010; Williams et al., 2013). It is also possible that hatha yoga impacts smoking outcomes through other mechanisms, such as smoking-specific self-efficacy (i.e., one's confidence in ability to quit smoking; Loprinzi, Wolfe, & Walker, 2015). Exercise, including hatha yoga, may expand individuals' abilities to cope with craving, leading them to feel more efficacious in abstaining from smoking. In support of hatha yoga potentially being related to smoking outcomes through smoking-specific self-efficacy, Mindfulness-Based Addiction Treatment (versus usual care) was associated with increases in smoking-specific self-efficacy and increases in smoking-specific self-efficacy mediated the relationship between condition and abstinence four weeks post-quit (Spears et al., 2017).

Hatha yoga was not associated with less smoking at follow-up relative to control. These findings are in contrast to prior work finding that hatha yoga was efficacious as an aid to CBT for smoking cessation (Bock et al., 2012). These findings are also inconsistent with findings of a study evaluating the efficacy of a brief mindfulness-based intervention on craving and seven-day follow-up smoking (Bowen & Marlatt, 2009). However, participants in that study were taught a different mindfulness technique (urge surfing) in response to smoking cues, whereas we did not tell participants to use hatha yoga in response to smoking cues or to help manage craving. Another possible explanation for this discrepancy is that participants in Bowen and Marlatt's study smoked fewer CPD and had less severe nicotine dependence than participants in our study, suggesting brief, mindfulness-based interventions may only be efficacious for very low-level smokers. When considered with Elibero and colleagues' study (2011), our results suggest hatha yoga is helpful for reducing craving among smokers attempting to reduce or quit smoking but is not an efficacious stand-alone intervention for smoking reduction or cessation, at least in the short-term. An important next step in this line of research will be to test whether encouraging individuals to use hatha yoga in response to smoking cues (including craving) reduces craving and CPD more long-term.

Further, future research is necessary to test whether hatha yoga could aid in smoking reduction or cessation among smokers with clinical levels of anxiety/depression.

In contrast to previous research (for review see Leventhal & Zvolensky, 2015), AS, DT, and Anh were not associated with CPD in the current study. Again, differences in smoking rates may account for these discrepant findings given that smokers in the current study generally smoked fewer CPD than participants in studies finding these relationships. It is also possible that these factors are more strongly related to smoking among those with clinically elevated symptoms (e.g., Brown et al., 2001; Cook et al., 2010).

Notably, the hatha yoga condition was associated with reduced AS compared to the control condition at follow-up, especially among participants with higher anxiety/depression. Number of minutes participants accessed their materials during the follow-up period did not moderate the relationship between condition and follow-up AS. However, on average, participants in the hatha yoga condition reported practicing hatha yoga on more than five days during the follow-up period, suggesting AS may be malleable in response to repeated hatha yoga practice. This finding is in line with emotional processing theory (Foa & Kozak, 1986), such that hatha yoga may decrease AS via repeated exposure to anxiety-related symptoms produced by hatha yoga, thereby promoting habituation to these symptoms. This finding is also consistent with the mindfulness component of hatha yoga, which teaches individuals to focus on present moment experiences, such as anxiety-related sensations (e.g., increased heart rate) produced by hatha yoga, in a nonjudgmental and curious way, thereby promoting acceptance of these sensations (Kabat-Zinn, 2003). Importantly, the difference between baseline and follow-up AS among participants in the hatha yoga condition in our study represents a large effect. Not only is AS implicated in the etiology and maintenance of smoking (Leventhal & Zvolensky, 2015), it is also a risk factor for developing Axis I psychopathology (e.g., anxiety and depressive disorders; Schmidt, Zvolensky, & Maner,

2006). Thus, hatha yoga may serve as an additional tool for prevention and intervention efforts for individuals with high AS.

Contrary to hypothesis, and prior work demonstrating that a single bout of exercise acutely reduced AS (Broman-Fulks et al., 2015; LeBouthillier & Asmundson, 2015), one session of hatha yoga did not acutely reduce AS in the current study. This discrepant finding could be accounted for by differences in participants' baseline AS between studies. To illustrate, participants in past studies that demonstrated acute reductions in AS from one bout of exercise (Broman-Fulks et al., 2015; LeBouthillier & Asmundson, 2015) endorsed lower levels of AS than participants in the current study. Thus, AS may be more acutely malleable via exercise among individuals with lower AS compared to individuals with higher AS.

Current study findings suggest that hatha yoga does not impact perceived DT acutely or over the course of one week, even with continued practice. This finding is consistent with prior research finding that neither aerobic exercise nor resistance training increased DT acutely (e.g., Broman-Fulks et al., 2015). Consistent with prior work indicating hatha yoga increased DT over the course of eight weeks (Medina et al., 2015), it is likely that hatha yoga is unable to impact DT in the short-term but continued practice of hatha yoga over the course of several weeks may increase DT. Although prior research has not examined whether hatha yoga impacts behavioral DT, our finding that hatha yoga does not acutely affect behavioral DT is consistent with the finding that perceived DT is not acutely impacted by other forms of exercise (e.g., Broman-Fulks et al., 2015). Similarly, our findings suggest that hatha yoga does not impact Anh acutely or over the course of one week. Similar to prior research concerning perceived DT (Medina et al., 2015), it may be that hatha yoga would reduce Anh over the course of several weeks or months with continued practice.

Our findings also demonstrated that participants continued practicing hatha yoga during the follow-up period using the instructional video they followed during their

intervention day appointment. On average, participants practiced hatha yoga on 5.5 days during the week following their intervention day. This finding is in contrast to findings from a study evaluating the efficacy of yogic breathing on smoking craving among abstinent smokers, which found that adherence to utilization of yogic breathing to cope with craving during the 24 hours following the laboratory appointment was low (Shahab, Sarkar, & West, 2013). These discrepant findings are likely due to participants in the current study desiring to reduce or quit smoking, whereas participants in Shahab and colleagues' study were not attempting to change their smoking. In contrast to Shahab and colleagues' study, participants in the current study were provided a video to aid them in continued practice of hatha yoga, which may have also contributed to greater adherence in the present study. Although participants in the hatha yoga condition did not report smoking less at follow-up than participants in the control condition, their continued use of hatha yoga during the follow-up period is meaningful given that hatha yoga is associated with numerous physical (e.g., improved strength; for review see Raub, 2002) and mental health (e.g., decreased anxiety and depression; for reviews see Hofmann et al., 2016; Uebelacker, Epstein-Lubow, et al., 2010) benefits.

Limitations and Future Directions

Study findings should be considered in light of the study's limitations. First, the sample comprised relatively light smokers compared to prior smoking cessation studies (e.g., Bock et al., 2012). Second, despite using advertisements to oversample for individuals with elevated anxiety/depression, on average, our participants endorsed depression within the normal range and anxiety within the mild range (Antony et al., 1998). Further, non-completers (i.e., participants who did not complete follow-up) endorsed more severe anxiety/depression symptoms than completers. Although this group difference was not statistically significant, it represented a medium effect size, suggesting clinical significance.

Thus, our participants generally did not resemble a clinical sample, suggesting they may not have faced the same barriers to smoking cessation as clinical samples, and participants who did endorse higher levels of anxiety/depression symptoms were more likely to drop out of the study. Future work would benefit from testing the utility of hatha yoga in smoking cessation among heavier smokers with higher levels of anxiety/depression symptoms as well as strategies to improve retention rates among these smokers. Third, follow-up smoking was assessed via self-report, and though prior studies evaluating brief interventions for smoking have assessed follow-up smoking via self-report (e.g., Bowen & Marlatt, 2009), and in our sample, baseline self-reported smoking was moderately correlated with biochemical verification of smoking status, future work would benefit from assessing follow-up smoking outcomes using multiple methods (e.g., self-report, CO analyses of breath samples, saliva cotinine levels).

Fourth, we chose a relatively short follow-up period (i.e., one week) given that the majority of smokers who underwent an unaided quit attempt smoked within the first week (Langdon, Farris, Øverup, et al., 2016). However, in light of our findings that hatha yoga reduced AS, a risk factor for poorer smoking cessation outcomes (Assayag et al., 2012; Brown et al., 2001; Zvolensky et al., 2009), future research is necessary to test whether hatha yoga is a more useful intervention tool for smoking reduction and cessation over longer follow-up periods. Additionally, future work would benefit from continued study of the mechanisms by which hatha yoga exerts its effects on smoking outcomes (e.g., smoking-specific self-efficacy).

Fifth, although changes in AS from baseline to follow-up among participants in the hatha yoga condition represent a large effect, it remains unknown whether hatha yoga would benefit individuals with higher levels of AS as efficaciously as aerobic exercise (e.g., Broman-Fulks & Storey, 2008). Thus, testing the efficacy of hatha yoga for reducing AS in

comparison to other forms of exercise among individuals with higher levels of AS is an important future direction. Sixth, participants who were deemed possibly unable to safely engage in exercise (e.g., for having "heart troubles"; Chisholm et al., 1975) were excluded from the current study. Although this precaution was taken to avoid potentially harming study participants, it is unknown whether results of the current study would generalize to smokers who have medical comorbidities, such as cardiovascular disease, respiratory disease, or cancer (Centers for Disease Control and Prevention, 2017a).

Conclusions

Results from the current study suggest that hatha yoga on its own is not a sufficient intervention to aid individuals in reducing smoking, at least in the short-term. Yet, hatha yoga may serve as a useful tool to help acutely curb cravings among smokers attempting to reduce or quit smoking. Anxiety/depression symptoms did not impact the relationship between condition and post-intervention craving, suggesting that hatha yoga is efficacious for acutely reducing craving, regardless of whether elevated anxiety/depression symptoms are present. Future research is necessary to test whether clinical levels of anxiety/depression symptoms would impact these relationships. Given poor smoking cessation outcomes among those with clinically elevated anxiety/depression symptoms (Hitsman et al., 2013; Piper et al., 2010; Zvolensky et al., 2009), such research could have important implications for prevention and intervention efforts for an especially high-risk group of smokers.

NOTES

[1]Reasons for being unable to safely engage in exercise at screening included: often feeling faint or having spells of severe dizziness (n = 42), having high blood pressure (n = 40), having chest pains (n = 38), having heart trouble (n = 27), having a bone or joint problem that could be exacerbated by exercise (n = 11), and other physical reasons (n = 4).

[2]The majority of participants (51.2%) who were excluded for smoking less than five cigarettes per day were recruited from the university's psychology participant pool.

[3]Given that study conditions did not significantly differ on any theoretically relevant variables at baseline, we also conducted study analyses without covariates. Patterns of findings were similar with and without inclusion of covariates.

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APPENDIX. IRB APPROVAL FORM

ACTION ON PROTOCOL APPROVAL REQUEST

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
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TO: Julia Buckner
Psychology

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: December 16, 2016

RE: IRB# 3808

TITLE: A Randomized Controlled Trial of Hatha Yoga as an Aid to Smoking Cessation: The Impact of Emotional Disorder Symptoms

New Protocol/Modification/Continuation: New Protocol

Review type: Full ____ Expedited _X_ **Review date:** 12/16/2016

Risk Factor: Minimal ___X___ Uncertain _____ Greater Than Minimal_____

Approved_____X_____ **Disapproved**_____

Approval Date: 12/16/2016 **Approval Expiration Date:** 12/15/2017

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 146

LSU Proposal Number (if applicable):

Protocol Matches Scope of Work in Grant proposal: (if applicable)

By: Dennis Landin, Chairman _____

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

VITA

Emily Jeffries earned a Bachelor of Arts Degree in psychology from University of Cincinnati in 2012 and a Master of Arts Degree in clinical psychology from Louisiana State University in 2016. Ms. Jeffries completed her doctoral work in clinical psychology at Louisiana State University under the mentorship of Dr. Julia Buckner. Ms. Jeffries completed her predoctoral clinical internship at the VA Ann Arbor Healthcare System in Ann Arbor, Michigan and is currently completing a postdoctoral fellowship with an emphasis in trauma and posttraumatic stress disorder at the Edward Hines Jr. VA Hospital in Hines, Illinois. Ms. Jeffries' clinical and research interests focus on anxiety and posttraumatic stress disorders and co-occurring substance use.