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Effect of a 14-Day Mindfulness Intervention on Daily Desire Experiences and Desire Regulation

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University

by

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Abstract

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A growing body of research suggests that mindfulness, a receptive attentiveness to one's present moment experiences, has the potential to adaptively regulate habitual behaviors. No prior study has tested the effect of mindfulness interventions on people's daily desire experiences to inform the potential for adaptive desire regulation. The present exploratory randomized controlled trial examined the effect of a 14-day smartphone-based mindfulness intervention (versus a coping control intervention) on the frequency, intensity, duration, and enactment of everyday desires in 19 participants. The desire domains included basic need-based desires (i.e., for food, drink, sleep) and secondary desires (e.g., for sex, media, social interactions, work), assessed for 7 days pre- and post-intervention through ecological momentary assessment (EMA). Emotion data collected alongside, also through EMA, permitted examining the role of the mindfulness intervention in altering a potential link between experienced emotion (positive and negative) and desire. Results showed that intervention condition significantly predicted post-intervention desire frequency; those in the mindfulness condition experienced a higher frequency of desires post-training, and specifically, increased secondary desire frequency, but not basic desire frequency. Intervention condition did not predict the other desire outcomes (enactment, strength, or

duration). Results also revealed that intervention significant moderated the association between positive emotion and overall desire frequency; those in the mindfulness condition experienced fewer desires when experiencing increased positive emotion, whereas there was no association between positive emotion and desire after coping training. Intervention condition did not moderate associations between positive emotions and other desire variables, or negative emotions and any desire variables.

Effect of a 14-day Mindfulness Intervention on Daily Desire Experiences and Desire Regulation

Behavior regulation necessitates the presence of awareness (Schultz & Ryan, 2015). In a world with numerous targets of temptations and continual competing desires to give in to them, avoiding and resisting maladaptive desires and adopting those that ensure well-being can be a challenging task. Such a task requires a capacity for attention to experiences rather than acting habitually and impulsively (Schultz & Ryan, 2015). When our thoughts, emotions, and behavior are automatic, they have an ingrained strength that can be hard to counter when a situation calls for a novel response (Ostafin, 2015); for instance, automatic desire and craving for food is natural, but can be quite problematic if turns maladaptive for obese individuals. Practicing the deployment of attention towards regular inner experiences may be the first step towards an awareness of desire states and enacting or counteracting them if and when necessary.

Mindfulness is defined as a receptive non-judgmental attention to and awareness of one's present moment experiences (Brown & Ryan, 2003; Kabat-Zinn, 1990). Such awareness entails that habitual responses are more likely to be noticed, and through practice, to become better able to replace habitual responses and actions with consciously regulated ones in order to enact adaptive behavior. Desire-based habitual responses can often cause suffering, either through negative consequences of enacting the desire (e.g., turning to unhealthy consumption, such as smoking or drinking alcohol), negative consequences of not enacting an adaptive desire (e.g., not sleeping when the body requires and desires sleep), or through dissatisfaction from unfulfilled desire. Buddhist literature has extensively discussed how mindfulness meditation has predominantly been used to help people reduce suffering that is fed and perpetuated by craving (Ostafin, 2015). Such literature suggests that when taking an objective, non-evaluative attentional stance, mindfulness can teach one to notice and disambiguate the physiological and

emotional antecedents and processes associated with craving. Specifically, mindful attention can clarify the distinction between (1) the affective tone related with perceptual representations of a sensory object that gives rise to craving and aversion; and (2) craving itself, making one more aware of the craving's fleeting or lasting nature and strategies that might be deployed to regulate it (Grabovac, Lau, & Willett, 2011). Perceiving such distinctions allows room to activate healthy self-regulation by conscious control.

Mindfulness and Self-Regulation

Mindfulness has been implicated in adaptive self-regulation to ensure well-being in the context of a number of impulses and behaviors (Brown, Creswell, & Ryan, 2015; Ostafin, Robinson, & Meier, 2015). Mindfulness training has thus far been incorporated into several approaches for treatment of conditions that require a high degree of self-regulation, such as in Acceptance and Commitment Therapy (ACT; Hayes, Strosahl, & Wilson, 2011) and Mindfulness Based Relapse Prevention (MBRP; Bowen, Chawla, & Marlatt, 2011) in addiction treatment, and such approaches have seen some preliminary positive effects in reducing addictive behavior (Brewer, Van Dam, & Davis, 2015). For example, Gifford et al. (2004) randomized 76 participants to nicotine replacement treatment or ACT and at 1-year follow-up found 24 hours abstinence of 15% and 35%, respectively. An experimental investigation of a brief mindfulness exercise of body scan with smokers demonstrated that compared to a control group, participants in the body scan condition reported significantly lower desire to smoke for up to 5 min after the intervention (May, Andrade, Willoughby, & Brown, 2011). In a study on cigarette craving, mindfulness instructions led to reduced self-reported cigarette craving and reduced neural reactivity to smoking cues in the brain's craving-related subgenual anterior cingulate cortex (sgACC) region among nicotine-deprived smokers (Westbrook, Creswell,

Tabibnia, Julson, Kober, & Tindle, 2011). Bowen et al. (2009) found significantly lower rates of substance use up to 4 months post-intervention in individuals receiving MBRP compared to those receiving treatment as usual. In a systematic review, mindfulness-driven adaptive self-regulation has also been seen in the context of obesity related eating behavior – and specifically binge eating, emotional eating, and external eating (O'Reilly, Cook, Spruijt-Metz, & Black, 2014). Such effects of mindfulness naturally bring into question how increased mindfulness would affect regular day-to-day desires and the enactment of them.

Daily Desires and Mindful Self-Regulation

Human emotions and behavior are based on cognition and motivation, where motivation is arguably more fundamental than thinking, as the former is rooted in the basic drives to perform life-sustaining activities and avoid life-shortening ones (Hofmann, Baumeister, Förster, & Vohs, 2012). We experience motivation in the form of desires for food, drink, sleep, sex, social interactions, exercise, entertainment, etc. Desire, in this context of being a motivating force, specifically refers to "affectively charged cognitive events in which an object or activity that is associated with pleasure or relief of discomfort is in focal attention" (Kavanagh, Andrade, & May, 2005, pg. 447). Defining characteristics of desire require it to be a conscious urge to "gain pleasure, relieve discomfort, or satisfy a want or to engage in consummatory behavior associated with these outcomes" (Kavanagh, Andrade, & May, 2005, pg. 447).

Although desire might have an affective tone to it, desire and emotions are distinct in nature, as desire additionally involves psychological experiences of appetitive aspects of targets as images or thoughts, and also the motivation to acquire the desired targets. The nature of the motivation might be different for different targets of desire. From a survival perspective, e.g., considering Maslow's Hierarchy of needs (Koltko-Rivera, 2006), certain immediate and

unlearned physiological-need based desires can be more fundamental to survival than others, i.e., hunger, thirst, sleepiness (also called basic needs), compared to learned or pleasure-seeking secondary desires to enhance living experiences (e.g., employment-related or recreational desires), therefore the former may differ in frequency and strength than the latter in everyday life. Despite the fundamental importance of desire experiences in daily survival and flourishing, basic facts about daily desires remain understudied, even in terms of how frequently human beings experience various desires on a daily basis, what proportion of desires are resisted and enacted, and how dispositional qualities or cognitive, affective, or behavioral trainings (e.g., dispositional mindfulness, attention training) may affect the nature and enactment of them (Hofmann et al., 2012).

The reasons for expecting any mindfulness-based impact on regular daily desires lie in research findings that targeted and focused on different components of daily desires, e.g., food consumption, sleep, sex, social interaction. In the domain of eating, a group of investigators found across four studies that trait mindfulness correlated with less impulsive eating, reduced calorie consumption, and healthier snack choices, while a manipulation of state mindfulness also caused fewer calorie intake in a spontaneous eating task, even when eating behavior was not specifically targeted in the manipulation (Jordan, Wang, Donatoni, & Meier, 2014). Mindfulness was also found to be associated with more constant body weight in general population (Van De Veer, Van Herpen, & Van Trijp, 2015). A literature review examining the effectiveness of mindfulness-based interventions for treating obesity-related eating behaviors found 18 of the reviewed studies (86%) reported improvements in the targeted eating behaviors (O'Reilly et al., 2014). In the domain of sexual desire, mindfulness interventions have been shown to improve sexual desire and sexual arousal in women seeking treatment for low sexual desire (Brotto &

Basson, 2014). In the context of sleep-related behavior, research evidence consistently suggests a positive role for mindfulness in sleep regulation, especially in the context of insomnia (Howell, Digdon, Buro, & Sheptycki, 2008; Howell, Digdon, & Buro, 2010; Winbush, Gross, & Kreitzer, 2007). Mindfulness also likely affects daily social desires, as studies have reported that mindfulness interventions promote greater social connectedness and positive affect compared to control participants (Aspy, & Proeve, 2017). Dispositional mindfulness has been linked with greater self-esteem and reduced social anxiety (Rasmussen & Pidgeon, 2011), findings that are likely to impact daily desires related to social interactions and social media use. Given all such research, taking initiative to directly explore the influence of mindfulness on a variety of common daily desires by implementing a mindfulness intervention and collecting real-world desire data could be worthwhile. Such exploration could inform how mindfulness training affects the desire-related aspects of individuals' daily lives, the findings from which could inform the implementation of mindfulness to promote healthy day-to-day desires.

Mindfulness Based Desire-Regulation: Decoupling of Emotion and Desire

Research studies suggest that mindfulness skills increase the ability to abstain from maladaptive impulsive behavior in the presence of stress or negative affect (Peters, Erisman, Upton, Baer, & Roemer, 2011), indicating that mindfulness may play a role in decoupling the emotion-impulsivity link. Studies involving eating disorders report that those suffering from such disorders frequently admit using eating to manage negative emotions and stress, and regardless of the presence of a disorder, a majority of people can often be detached from internal experience and instead follow patterns of "mindless" eating (Kristeller, 2015), and in the absence of mindfulness, the affect-desire link can be strong. In two smoking cessation studies, participants given mindfulness instructions showed a weaker association between negative affect and

smoking urges than those in a control condition (Bowen & Marlatt, 2009; Adams et al., 2012). In the domain of alcohol use, studies show that mindfulness and executive control decouple the relation between automatic affective responses and difficulty in disengaging attention from alcohol-related thoughts (Adams et al., 2015). Higher trait mindfulness also has been seen to weaken the relation between perceived stress and quantity of alcohol use (Ostafin, Kassman, & Wessel, 2013). All such work suggests that mindfulness causes the decoupling of emotion from desire experience and desire enactment by making one adopt an approach-oriented coping towards emotions that may prevent subsequent temptation experiences and enactment tendencies. Here, approach-oriented coping refers to a cognitive, emotional and behavioral engagement with stressful situations rather than mental and behavioral disengagement that is characteristic of avoidant coping (Weinstein, Brown, & Ryan, 2009). Elliott, Zahn, Deakin, & Anderson (2011) theorize that mindfulness targets previously developed affective biases that may prevent individuals from accurately assessing what is happening in the present moment and acting accordingly; thus, mindfulness functions to decouple pleasant and unpleasant experience from habitual reactions of desire and aversion. By overcoming affective biases ingrained in memory and perpetuated by previous attentional tendencies, a mindful approach to experience allows individuals to feel and know more clearly the pain of perpetuating emotional craving and aversion (Elliott et al., 2011). Practice sitting with affective experiences thus may promote decoupling between certain emotions and desire-related reactions. No prior study has tested the effect of a mindfulness training on the link between concurrent everyday state emotions and desires. Therefore, exploring whether a mindfulness intervention can moderate the link between emotion and desire can be useful to inform the nature of daily self-regulation that mindfulness training may promote.

Does Mindfulness Necessarily Promote Self-Regulation?

When it comes to motivation and behavior regulation, the question remains as to whether mindfulness always promotes restraint of desire enactment. As secular mindfulness training is composed of several aspects, the different aspects may impact self-regulation differentially. On the one hand, acting with awareness, rather than habitually and impulsively, clearly seem to promote conscious restraint and regulation (Friese & Hofmann, 2016). On the other hand, greater attention towards inner experiences may increase awareness of the degrees and nuances of temptation, making them more salient in the attentional field, potentially making it more difficult to restrain fulfillment. Another crucial aspect of secular mindfulness training, the non-judgmental acceptance of one's inner experiences of emotions and desires, may promote indulgence rather than restraint. An attitude of acceptance towards experiences implies less cognitive conflict between experienced desire and goals, thus reducing incentive for self-control, regardless of ability (Friese & Hofmann, 2016). Therefore, different aspects of mindfulness training, namely, inward-directed attention, awareness of behavior, and non-judgmental acceptance towards events and experiences may have differential self-regulatory effects, with the possibility of both promoting and reducing restraint of desire and activation depending on which training feature is more salient and consistently utilized.

Research findings provide support for the assumption that mindfulness may not always promote restraint. Several studies have shown that trait mindfulness and mindfulness interventions were associated with increased rather than decreased smoking craving, binge drinking, and chocolate craving and consumption (Jenkins & Tapper, 2014; Leigh, Bowen, & Marlatt, 2005; Szasz, Szentagotai, & Hofmann, 2012). These studies mostly focused on brief interventions (<30 minutes). Certain longer acceptance-based interventions of several weeks

have shown to be more successful in regulating craving for food and chocolate (Alberts, Mulkens, Smeets, & Thewissen, 2010; Lacaille, Ly, Zacchia, Bourkas, Glaser, & Knäuper, 2014). Therefore, the length of intervention alongside the degree of practice of different aspects of mindfulness may also be a contributing factor in determining whether an intervention promotes self-regulation.

Due to these apparently distinct effects of different mindfulness training aspects on desire regulation, the effect of a mindfulness training containing all such aspects on daily desire experiences can be an important area of exploration to investigate desire experiences and restraint behavior. However only one prior study examined the link between (state) mindfulness and everyday desire experiences, and it showed that state or current mindfulness fostered lower self-restriction for enacting overall daily desires, and decreased negative emotions (e.g., guilt) associated with the fulfillment of desires (Friese & Hofmann, 2016). No prior studies have explored the effect of a mindfulness intervention on daily desires, which is the goal of the present pilot study.

Ecological Momentary Assessments (EMA)

Outside of the context of addictive and problematic desire and behavior, the effect of mindfulness intervention has not been examined in the context of normal daily life desires, including desires for food and drink, caffeine, sex, media use, etc. Capturing daily life desires could be best done by taking measurements in people's natural environments using ecological momentary assessment (EMA), a process involving repeated sampling of current experiences and behaviors in participants' day-to-day contexts (Shiffman, Stone, & Hufford, 2008). EMA seeks to decrease recall bias and improve ecological validity and allows us to observe processes in real-world environments. Only two studies (Hofmann, Baumeister, Förster, & Vohs, 2012;

Friese & Hofmann, 2016) have attempted to capture daily life desires using ecological assessments in a variety of domains as they occur in the moment. One of these studies investigated the effect of state self-reported mindfulness on desire. Examining how a mindfulness intervention could affect the nature, frequency, intensity, duration, resistance to, and enactment of different common everyday desires could inform its potential in changing people's habitual responses and daily functioning, as well as give us insight into mindfulness's role in common maladaptive desires and responses to them. Additionally, assessing concurrent emotion experiences would allow the exploration of the desire-emotion link and the role of mindfulness intervention in altering this link. A particularly effective ecological approach would be the delivery of a mindfulness intervention and pre- and post-intervention EMA through a smartphone, which many people carry and use in their day-to-day environments. Alongside convenience, this intervention and assessment approach would also be practical to improve compliance by reducing the participant burden of having to travel to receive interventions (classes). The current study deploys a cell phone-based intervention and EMA approach.

Current Study

The current study examines the effect of a 14-day smartphone-based mindfulness training intervention on the nature, frequency, intensity, duration, and enactment of people's everyday desires, which are assessed pre- and post-intervention through EMA, also using a smartphone. Because literature suggests that mindfulness might affect desire through emotion regulation, emotion data collected alongside the desire data through EMA is also assessed to examine a potential emotion-desire link and the role of mindfulness intervention in altering this link. Due to the novelty of the current study, in terms of the questions and methodological approach, the

study is exploratory, and hypotheses will not be proposed. Rather the following questions will be investigated:

1) Does a 14-day smartphone-based mindfulness training (MT), compared to a coping training (CT) control condition, change the overall or general a) frequency, b) intensity, c) duration, and d) enactment of everyday desires pre- to post-training?

2) Does the mindfulness training (MT), compared to the coping training (CT) control condition, change the a) frequency, b) intensity, c) duration, and d) enactment of desires specifically related to primary (basic) needs (i.e., food, drink, sleep) and secondary needs (e.g., sex, media, social interactions, work, hygiene) pre- to post-training?

3) Does training condition moderate the association between emotion (in terms of frequency and intensity of positively vs. negatively valanced emotions) and overall desire (frequency, intensity, duration, and enactment frequency)? From the discussion above on mindfulness's possible ability to decouple emotion and desire, mindfulness training may moderate the association between emotion and overall desire frequency, intensity, duration, and enactment frequency, such that the correlation between emotion and desire variables is reduced for the MT condition compared to the CT condition.

Methods

Participants

Data for this study were collected from adult participants from the Richmond, Virginia (USA) community who took part in a study that primarily aims to assess whether mindfulness meditation training predicts lab-based and daily life-based behavioral outcomes indicative of reduced retaliatory aggression and associated anger and interpersonal conflict, through survey, EMA, and fMRI methods. EMA of daily life desires was included alongside daily conflict

measures for exploration purposes of mindfulness training's effect on various daily life desires for 7 days pre- and post-intervention and collected 3 times/day at quasi-random times (more on this below). Prospective participants contacted the study by using the phone number or e-email listed on the online advertisements on Craigslist, clinical trials.org, the VCU Telegram, and the VCU graduate student email listserv. Flyers were also placed at local libraries, gyms, coffee stores, etc., around Richmond, VA. In order to participate, participants must have met the following inclusion criteria: English speaking, 21-55 years of age, owning a personal smart-phone, and naïve to meditation practice. Exclusion criteria included: 1) report of a new diagnosis of a non-acute medical or psychiatric condition within the last 3 months; 2) report of hospitalization within the last 3 months; 3) report of current drug use (e.g., recreational drug use, smoking more than 1⁄2 pack per day, alcohol intake in excess of 2 drinks per day); 4) left-handed; 5) major, uncorrected sensory impairments and cognitive deficits; 6) present fMRI safety risks (e.g., ferromagnetic implants, body weight > 300 lbs); 7) prisoners or pregnant women; or 8) unwillingness or inability to complete study assessments or treatments. Participants were compensated based on their completion of each part of the study: baseline measures, lab visits, fMRI completion, MT/CT training completion, and EMA completion. Funding for the current pilot study limited enrollment to 20 participants. See Figure 1 showing the participant flow through the study.

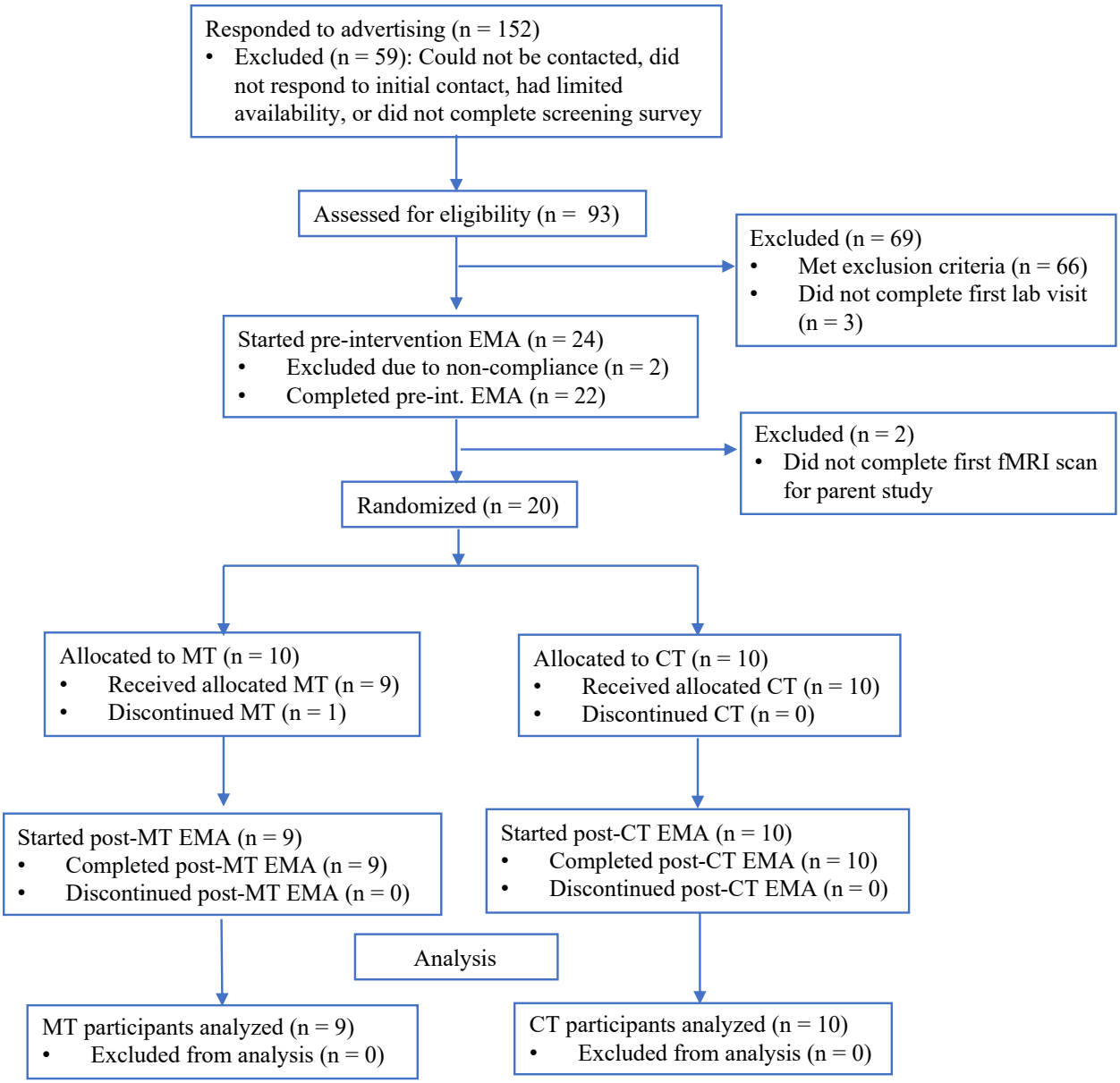

Figure 1: CONSORT flow diagram

Participants with complete data (N=19; female =15 and male = 4) had a mean age of 36.2 years, and they described themselves as White (n=10, 52.6%), Black or African American (n=7, 36.8%), Hispanic or Latino(a) (n=1, 5.3%), and Asian Indian (n=1, 5.3%). Nine participants (47.3%) endorsed having a post-graduate degree, six participants (31.6%) endorsed having a bachelor's degree, three participants (15.8%) reported having some college education but no

college degree, and one participant did not provide any response about their education. Participants' relevant demographic information is provided in Table 1.

Table 1. Participant Demographic Characteristics.

Characteristic	*n*	*Percent*
Age		
Mean 36.2 yr (range 22-51)	-	-
Gender		
Female	15	78.9
Male	4	21.1
Race/Ethnicity		
White or Caucasian	10	52.6
Hispanic or Latino(a)	1	5.3
Black or African American	7	36.8
Asian Indian	1	5.3
Education		
Some college, no degree	3	15.8
Bachelor's degree	6	31.6
Post-graduate degree	9	47.3
Income		
Less than $25,000	1	5.3
$25,000 to $39,999	6	31.6
$40,000 to $54,999	6	31.6
$55,000 to $69,999	2	10.5
$100,000 to $114,999	1	5.3
$130,000 to $144,000	1	5.3
$160,000 or more	2	10.5

Notes. Gender was coded 0 = male, 1 = female; Race was coded 0 = White, 1 = non-White; Education was coded 0 = some college, no degree, 1 = bachelor's degree, 2 = post-graduate degree; income was coded 0 = less than $25,000, 1 = $25,000 to $39,999, 2 = $40,000 to $54,999, 3 = $55,000 to $69,999, 6 = $100,000 to $114,999, 8 = $130,000 to $144,000, 10 = $160,000 or more.

Procedures

The study used a 2-arm randomized controlled trial design, with EMA, and specifically experience sampling-based measures collected pre- and post-training of a 14-day Mindfulness training or Problem-Focused Coping control training. A CITI-certified and study-trained undergraduate Research Assistant (RA) or Graduate Research Assistant (GRA) responded via phone to introduce the study to prospective participants to determine interest and eligibility. Then participants were emailed an online consent form and the screening survey. Each eligible participant was then telephoned to determine interest and commitment and to set up the first (baseline) lab visit, where the participants were introduced to the study and the procedures in more detail. To test whether MT vs CT altered anger, conflict, and desires (desire is the focus of the current study) in daily life, participants completed 3 times/day experience sampling of anger, conflict, and desires for 7 days both before and after their 14-day smartphone-based training. Experience sampling is a form of EMA for studying the in-the-moment content of people's thoughts, feelings, or behavior (Shiffman, Stone, & Hufford, 2008; Larson & Csikszentmihalyi, 2014).

Participants were randomly assigned to one of two training conditions: a 14-day smartphone-based mindfulness training (MT; n=9) or a 14-day, structurally equivalent coping control training (control condition) (CT; n=10) (description in the section below). As with the experience sampling, participants were required to use their own smartphone for intervention delivery. Participants received a link to a website, created a username and password, and completed the daily intervention lessons and homework via the internet. During the 14-day intervention period, participants completed one 20-minute audio lesson (MT or CT) each day, and a brief homework practice involving mental exercises (3-10 minutes/day), all of which were

included in the intervention software. Each lesson trained specific techniques through didactic explanation, audio guided practice, and self-guided practice. To assess compliance with intervention lesson completion, date- and time-stamps were collected indicating when each segment of each lesson was played. A project GRA contacted all participants by phone on days 3 and 9 of the intervention program to answer training-specific questions, address difficulties, and encourage program adherence. Participants also received standardized study reminder texts throughout the training period and were given access (through call or text) to a study hotline to ask questions or resolve technical issues.

During the first lab visit, alongside introduction to the MT or CT training websites, participants were trained on experience sampling using their own smartphone and asked to answer some short surveys with their smartphone immediately after receiving a signal on their phone, which happened 3 times per day for 7 days. Participants were told that the purpose of doing this is to capture their lived experience as it happens in the real world and that participants in the past studies have not reported to find it too burdensome, as the process takes only about 2 minutes per log, totaling 6 minutes of their day. The signals were sent at quasi-random times, with 2 hours of minimum and 6 hours of maximum gaps between consecutive signals. When not able to log data immediately (e.g., driving, in a meeting), participants were asked to complete the log as soon as they could do so safely and according to their current experience, not their experience at the time of the signal; participants were asked not to log all experiences at one time. The window of response for a signal closed after 4 hours of receiving the signal, at which point participants no longer were able to respond to the prompt. To customize the delivery of signals for experience sampling, participants' waking time and bed time were recorded to determine the earliest starting and the latest ending times of the signals. All data in these surveys

were collected using Department of Psychology-licensed Qualtrics software, a secure online web survey service. All data was identified by the participant study ID number only.

Interventions

Both of the MT and CT intervention programs were developed in collaboration with leading mindfulness teacher Shinzen Young and are based on his Unified Mindfulness system (Young, 2016). To maximize experimental control in isolating the effects of mindfulness instruction from problem-focused coping instructions, both MT and CT interventions were delivered by the same female voice and matched on attentional demand, length, structure, and delivery tone.

Mindfulness Training (MT): Participants in the MT condition learned foundational attentional skills that enable them to (a) monitor their present-moment body experience (referred to as 'sensory clarity') while (b) welcoming and accepting each experience (referred to as 'equanimity'). Stable attention is placed on the intended target, which in the case of the current training was physical and emotional body experience; e.g., physical sensations on the skin, temperature changes, sensations in the muscles, ongoing physiology, sleepiness, etc., as well as body sensations related to emotions, such as impatience, joy, anger, enthusiasm, fear, anxiety, sadness, etc. Monitoring ('sensory clarity') was explained in terms of two dimensions: resolution and sensitivity. Resolution refers to discriminating types of experiences, e.g., pleasant, unpleasant, neutral, physical vs. emotional, level of intensity, locations, and movement patterns of sensations. Sensitivity refers to detecting subtle sensations, e.g., subtle weak sensations related to pleasant/unpleasant activities and emotions, and fleeting waves of emotions. Acceptance or 'equanimity' was trained through encouraging participants to (a) maintain a state of global body

relaxation, (b) mentally welcome all physical and emotional body experiences, and (c) use a gentle, matter-of-fact tone of inner voice while labeling these experiences.

Coping Training (CT): The Coping control program was designed to be useful for managing stress by reinforcing common reappraisal and coping strategies (Ochsner & Gross, 2005) without training mindfulness, and here was used to control for nonspecific effects of the MT program (e.g., treatment expectancies, daily time and effort toward the goal of reducing stress). The CT program, called 'MyTime' was developed to parallel the structure of MT without encouraging focus on or acceptance of present moment experience. Instead, participants were instructed to freely reflect and let their minds drift and reappraise past and future events. Here, the past and future emphasis contrasts the present-focused monitoring in mindfulness, and the reappraisal and analysis emphasis contrasts with the attitude of acceptance towards current experience in the mindfulness training. Although positive reappraisal may be a downstream consequence of practicing mindfulness, reappraisal is a change-based strategy that is not trained in mindfulness interventions (Hayes, 2004) and is therefore appropriate as part of a comparison training program.

Adherence. Participants' spent time on the Qualtrics link that embedded the lesson audio and their responses to questions about the lesson were checked daily by trained research assistants to ensure that participants participated in the training of the day. If a participant did not seem to have completed a lesson, they were re-sent the lesson and requested through text messaging to complete the lesson before moving onto the next one. All participants except two have shown to have completed all of the 14 lessons either on time (the same day) or by making up the lesson the next day. Out of the two participants who missed one or more lessons, one participant completed 12 lessons (missed 2 lessons) and the other completed 11 lessons (missed

3 lessons). 7 participants never needed any lessons to be resent for make-up and completed all of their lessons on time. Among the rest, 8 participants needed 3 or fewer lessons to be resent, 1 participant needed 4 lessons to be resent and 1 participant needed 5 lessons to be resent before they completed them.

Measures

Experience sampling of desires and their enactment. Desire experience and enactment of desire were assessed using measures taken from Hofmann, Baumeister, Förster, & Vohs (2012) using experience sampling (see Appendix, p. 45). At the delivery of each software-controlled signal, participants first indicated whether they were currently experiencing a desire or whether they had just been experiencing a desire within the last 30 min. If they indicated no desire, the assessment was over. If they indicated a desire, they next indicated the content of the desire from a list of 15 domains - food, nonalcoholic drinks, alcohol, coffee, tobacco, other substances, sex, media, spending, work, social, leisure, sleep, hygiene-related, and 'other' that further branched into a total of 76 subdomains (e.g., under desire for food, subdomains are: fast food as main dish, healthy main dish, fast food as snack, sweets, healthy snack).

Next, participants indicated the strength of the desire on a scale from 0 (*no desire at all*) to 7 (*irresistible*) and the duration they have been experiencing the desire on a 10-point scale (0 – 5 min, 6 –10 min, 11–15 min, 16–20 min, 21–30 min, 31–60 min, 1–2 hr, 2–3 hr, 3–5 hr, and >5 hr). After that participants indicated whether they had attempted to resist the desire (*yes* vs. *no*). Participants then reported (*yes* vs. *no*) whether they had enacted the behavior suggested by the desire (even at least to some extent; e.g., eating some of a chocolate bar without eating the entire bar would count) (see Appendix, p. 45).

Experience sampling of discrete emotions. An adopted version of the Discrete Emotions Questionnaire (DEQ) by Harmon-Jones, Bastian, & Harmon-Jones (2016) was used to assess present moment emotion through experience sampling (see Appendix, p. 47), and on the same schedule as the assessment of desires. The full-version DEQ is sensitive to eight distinct state emotions: anger, disgust, fear, anxiety, sadness, happiness, relaxation, and desire. Each emotion is assessed with a collection of emotion items, e.g., items in the anger subscale are anger, mad, pissed off, rage; items in the happiness subscale are happy, enjoyment, satisfaction, liking. Published reliability of the subscales is in the 0.82-0.96 range (Harmon-Jones et al., 2016).

The current study asked participants to what degree they are experiencing just the following emotions "right now" on a 7-point scale ("not at all" to "extremely"): anger, fear, sad, mad, calm, scared, relaxation, lonely, enjoyment, and liking (see Appendix, p. 47). Anger and mad fall under the anger subscale, fear and scared fall under the fear subscale, calm and relaxation fall under the relaxation subscale, sad and lonely fall under the sadness subscale, and enjoyment and liking fall under the happiness subscale. For the purpose of this current project, emotions were categorized based only on positive and negative valence, and composite scores were calculated for each of these two categories.

Demographic questionnaire. This questionnaire collected data on participant age, gender, race, ethnicity, current income, and occupation.

Statistical Analyses

Prior to performing analyses, normality of the data was checked by examining skewness and kurtosis statistics, so that any deviations from normality could be corrected through data transformations or winsorizing, as appropriate (Tabachnick & Fidell, 2007). To address study

question 1, 2, and 3 (see p. 12), hierarchical ordinary least squares multiple regression was used. Performing multiple regression allows us to assess the combined effects of a set of multiple predictor variables on a criterion variable, the predictor variables being 1) relevant demographic variables, 2) pre-intervention desire (frequency, intensity, duration, enactment frequency) and 3) intervention condition (MT and CT), and the criterion variable being post-intervention desire (frequency, intensity, duration, enactment frequency). Hierarchical multiple regression permits entry of a set of predictor variables in a particular order when predicting a criterion variable in order to determine a moderation effect or any incremental variance in the dependent variable attributable to a predictor above and beyond other predictors. The relevant equations are as follows:

$$\hat{Y} = B_1X + B_2Z + B_0 + e \text{ (Step 1)}$$

$$\hat{Y} = B_1X + B_2Z + B_3XZ + B_0 + e \text{ (Step 2).}$$

Due to the small sample size, exploring effect sizes will be the primary concern, which in this case will be standardized regression coefficients. All analyses were performed with an alpha level of .05 and conducted using SPSS software version 25 (Armonk, NY: IBM Corp.).

Desire and emotion data were aggregated across the pre-intervention and post-intervention weeks for each participant. For desire frequency, the total number of experienced desires for each of the pre- and post-intervention weeks (in each of the domains explored for Questions 1, 2, and 3) was divided by the total responses (both ‘yes’ and ‘no’ responses for the ‘Are you experiencing a desire?’ question) to obtain a continuous variable representing the proportion of desire experience. For desire enactment, the total number of enactment instances (in each of the domains explored for Questions 1, 2, and 3) for each of the pre- and post-intervention weeks was divided by the total desire reported that week. For desire strength, desire

duration, positive emotion strength, and negative emotion strength, mean values on these continuous variables were calculated for each of the pre- and post-intervention weeks.

All desire and emotion variables were tested for assumptions of multiple regression and all variables except negative emotion strength were found to have met the assumptions of normality, linearity, multicollinearity, and homoscedasticity. The negative emotion variables were transformed using a square-root transformation to meet the multiple regression assumptions. The assumption of normality of the residuals was violated for several variables, but as multiple regression is robust to violations of these assumptions, the results should still be valid. No univariate or multivariate outliers were found.

Results

Preliminary Analyses

Preliminary analyses were conducted using multiple regressions with the demographic variables of age, race, education, and gender entered as predictors simultaneously into the model for each of the dependent variables. Age, race, and education were found to be significantly related to one or more of the desire- and emotion-related dependent variables, and therefore these demographic variables were retained for subsequent analyses.

Main Analyses

Question 1. The first question of the study concerned whether the 14-day smartphone-based mindfulness training (MT), compared to a coping training (CT) control condition, changed the overall a) frequency, b) intensity, c) duration, and d) enactment of everyday desires pre- to post-training. The descriptive information related to the overall desire variables (frequency, enactment, intensity, and duration) during each of the pre- and post- intervention weeks is presented in Table 2.

Table 2: *Mean and Standard Deviation Values for Desire Variables*

Variables	Pre-intervention Week		Post-intervention Week	
	Mean	SD	Mean	SD
Number of All Responses (Over a Week)				
MT	20.78	1.92	18.33	4.53
CT	20.80	1.14	20.10	1.66
Overall Desire				
Number of All Desires (Over a Week)				
MT	10.89	4.01	10.11	4.86
CT	10.10	5.72	6.70	5.33
Proportions: Total Desires/Total Responses				
MT	0.53	0.19	0.54	0.22
CT	0.48	0.26	0.32	0.26
Number of All Enactments (Over a Week)				
MT	6.22	3.27	4.89	2.93
CT	4.20	2.90	3.30	3.53
Proportions: Total Enactments/Total Desires				
MT	0.57	0.13	0.51	0.20
CT	0.39	0.22	0.46	0.29
Desire Intensity				
MT	4.99	0.64	5.04	0.58
CT	5.25	0.87	4.98	0.80
Desire Duration				
MT	3.80	1.08	4.02	1.54
CT	3.51	1.38	3.25	2.07

To explore question 1, two stage hierarchical multiple regressions were conducted with each of the overall post-intervention desire variables (i.e., post-intervention frequency, intensity,

duration, and enactment frequency) as the dependent variable. Pre-intervention desire variables corresponding to each dependent variable (i.e., pre-intervention frequency, intensity, duration, and enactment frequency) and the relevant demographic variables were entered at stage one of the regression model to control for their contribution to the dependent variable. Intervention condition was entered at stage two to examine whether it contributed incrementally to the prediction of the dependent variable above and beyond the prediction by the pre-intervention desire values and the demographic variables.

Results from the hierarchical multiple regression with pre-intervention desire frequency and race entered into the first stage and intervention condition entered into the second stage revealed that at stage 1, the model was significant, $F(2, 16) = 7.74$, $p = 0.004$, and accounted for 42.8% of the variance in post-intervention desire frequency. Adding intervention condition in stage two significantly accounted for an additional 15.2% of the variance in post-intervention desire frequency, $\Delta R^2 = 0.152$, $\Delta F(1, 15) = 6.41$, $p = 0.02$, above and beyond the variance accounted for by pre-intervention desire frequency and race. Therefore, it is inferred that the intervention condition significantly accounted for incremental variance in post-intervention desire frequency after accounting for pre-treatment desire frequency and relevant demographic variables (i.e., race) in the population. Exploring the standardized coefficients revealed that higher pre-treatment desire frequency predicted higher post-treatment desire frequency, $\beta = 0.57$, $t(15) = 3.63$, $p = .002$, and MT predicted higher post-treatment desire frequency compared to CT, $\beta = 0.39$, $t(15) = 2.53$, $p = .02$. Race did not significantly predict post-treatment desire frequency.

For desire enactment, hierarchical multiple regression with pre-intervention desire enactment frequency and education level entered into the first block and intervention condition entered into the second block revealed that block 1 variables predicted post-intervention desire

enactment significantly, $F(2,14) = 8.05$, $p = 0.005$, and accounted for 43.5% of the variance in post-intervention desire enactment. Adding intervention condition in block 2 did not significantly account for additional variance in post-intervention desire enactment beyond the variance accounted for by pre-intervention desire enactment and education, $\Delta R^2 = 0.005$, $\Delta F(1, 13) = 0.135$, $p = 0.72$. Therefore, desire enactment was not significantly predicted by intervention condition. Exploring the standardized coefficients revealed that higher pre-treatment desire enactment predicted higher post-treatment desire enactment, $\beta = 0.49$, $t(13) = 2.28$, $p = .04$, and higher education level predicted lower post-treatment desire enactment $\beta = -0.55$, $t(13) = 2.93$, $p = .01$.

For desire strength, neither block 1, with pre-intervention desire strength and education level entered as predictors, nor block 2, with intervention condition entered as a predictor in addition to the block 1 variables, significantly predicted post-intervention desire strength, $F(3, 13) = 1.90$, $p = 0.18$ (block 2), and $\beta = 0.122$, $t(13) = 0.51$, $p = .62$ (treatment condition). Thus, intervention condition did not predict desire strength.

For desire duration, pre-intervention desire duration entered in block 1 as a predictor significantly predicted post-intervention desire duration, $F(1, 16) = 12.07$, $p = 0.003$, and accounted for 43% variance in the outcome variable. But adding treatment condition to the next block did not contribute significant incremental variance in the outcome variable beyond what was predicted by pre-treatment desire duration, $\Delta R^2 = 0.015$, $\Delta F(1, 15) = 0.406$, $p = 0.53$.

Therefore, it was found that overall desire frequency was significantly predicted by intervention condition, such that the mindfulness intervention training predicted higher post-training desire frequency than the coping training condition. Training condition did not predict overall desire enactment, intensity, or duration.

Question 2. Question 2 explored whether the mindfulness training (MT), compared to the coping training (CT) control condition, changed the a) frequency, b) intensity, c) duration, and d) enactment of desires specifically related to primary (basic) needs (i.e., food, drink, sleep) and secondary needs (e.g., sex, media, social interactions, work) pre- to post-training. The descriptive information related to the basic and secondary desire variables pre- and post-intervention is presented in Table 3.

Table 3: *Mean and Standard Deviation Values for Basic and Secondary Desire Variables*

Variables	Pre-intervention Week		Post-intervention Week	
	Mean	SD	Mean	SD
Basic Desires				
Number of Basic Desires (Over a week)				
MT	6.56	2.24	5.22	3.23
CT	5.30	3.92	3.70	3.06
Proportions: Total Basic Desires/Total Responses				
MT	0.31	0.10	0.28	0.17
CT	0.25	0.18	0.18	0.15
Number of Basic Desire Enactments (Over a Week)				
MT	3.89	1.54	2.56	1.33
CT	2.20	1.75	1.60	1.84
Proportions: Total Basic Desire Enactments/Total Desires				
MT	0.36	0.07	0.30	0.18
CT	0.21	0.17	0.25	0.22
Basic Desire Intensity				
MT	1.08	0.26	0.85	0.37
CT	0.89	0.46	0.89	0.57

Variables	Pre-intervention Week		Post-intervention Week	
	Mean	SD	Mean	SD
Basic Desire Duration				
MT	0.81	0.25	0.61	0.29
CT	0.54	0.35	0.52	0.43
Secondary Desires				
Number of Secondary Desires (Over a Week)				
MT	3.22	2.11	4.33	2.74
CT	3.40	4.01	2.30	2.21
Proportions: Total Secondary Desires/Total Responses				
MT	0.16	0.10	0.23	0.13
CT	0.16	0.19	0.11	0.11
Number of Secondary Desire Enactment (Over a Week)				
MT	1.78	1.56	2.22	1.99
CT	1.40	1.58	1.00	1.63
Proportions: Total Secondary Desire Enactments/Total Desires				
MT	0.16	0.12	0.20	0.16
CT	0.11	0.12	0.13	0.16
Secondary Desire Intensity				
MT	0.18	0.06	0.26	0.11
CT	0.17	0.17	0.22	0.16
Secondary Desire Duration				
MT	0.13	0.07	0.24	0.17
CT	0.12	0.14	0.15	0.15

Similar to question 1, to answer question 2 hierarchical multiple regression was conducted with pre-intervention variables entered into block1 and the intervention condition

entered into block 2. The resulting statistics related to the basic desire and secondary desire variables are given in Table 4 and Table 5 respectively.

Table 4. *Summary of Hierarchical Regression Analysis for Variables predicting Basic Desire*

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	β	p (Sig. t)
DV: Post-Int. Basic Desire Frequency						
Block 1	0.24	0.24	5.40	0.03		
Pre-Int. Basic Desire Frequency					0.49	0.03
Block 2	0.28	**0.04**	**0.96**	**0.34**		
Pre-Int. Basic Desire Frequency					0.45	0.06
Intervention Condition					**0.21**	**0.98**
DV: Post-Int. Basic Desire Enactment						
Block 1	0.34	0.34	8.07	0.01		
Pre-Int. Basic Desire Enactment					0.58	0.01
Block 2	0.38	**0.05**	**1.13**	**0.31**		
Pre-Int. Basic Desire Enactment					0.72	0.01
Intervention Condition					**-0.26**	**0.31**
DV: Post-Int. Basic Desire Strength						
Block 1	0.22	0.22	4.41	0.05		
Pre-Int. Basic Desire Strength					0.47	0.05
Block 2	0.25	**0.03**	**0.68**	**0.42**		
Pre-Int. Basic Desire Strength					0.52	0.04
Intervention Condition					**-0.19**	**0.42**
DV: Post-Int. Basic Desire Duration						

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	β	p (Sig. t)
Block 1	0.13	0.13	2.31	0.15		
Pre-Int. Basic Desire Duration					0.36	0.15
Block 2	0.13	**0.001**	**0.02**	**0.90**		
Pre-Int. Basic Desire Duration					0.37	0.19
Intervention Condition					**-0.03**	**0.90**

Note. *N = 19;* contributions in DV variance relevant to intervention condition are bolded.

Results in Table 4 indicated that pre-intervention variables of frequency, enactment, and strength of basic desires for food, drink, and sleep predicted post-intervention basic desire frequency, enactment, and strength significantly and accounted for 24%, 34%, and 22% respectively of the variance in the outcome. But adding intervention condition in block 2 did not significantly account for any additional variance in post-intervention basic desire variables beyond the variance accounted for by pre-intervention basic desire. In the case of basic desire duration, neither pre-intervention duration nor intervention condition predicted post-intervention duration. Therefore, the intervention condition was not found to account for any incremental variance in post-intervention basic desire frequency, enactment, strength, or duration.

Table 5. *Summary of Hierarchical Regression Analysis for Variables predicting Secondary Desire*

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	β	p (Sig. t)
DV: Post-Int. Secondary Desire Frequency						
Block 1	0.28	0.28	1.93	0.17		
Pre-Int. Secondary Desire Frequency					0.32	0.24
Age					-0.27	0.27

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	β	p (Sig. t)
Race					0.22	0.43
Block 2	0.48	**0.21**	**5.56**	**0.03**		
Pre-Int. Secondary Desire Frequency					0.34	0.16
Age					-0.16	0.45
Race					0.21	0.40
Intervention Condition					**0.47**	**0.03**
DV: Post-Int. Secondary Desire Enactment						
Block 1	0.41	0.41	4.83	0.03		
Pre-Int. Secondary Desire Enactment					0.18	0.41
Education					-0.57	0.02
Block 2	0.49	**0.09**	**2.18**	**0.16**		
Pre-Int. Secondary Desire Enactment					0.09	0.67
Education					-0.62	0.01
Intervention Condition					**0.31**	**0.16**
DV: Post-Int. Secondary Desire Strength						
Block 1	0.003	0.003	0.04	0.84		
Pre-Int. Secondary Desire Strength					-0.053	0.84
Block 2	0.03	**0.03**	**0.41**	**0.53**		
Pre-Int. Secondary Desire Strength					-0.04	0.88
Intervention Condition					**0.16**	**0.53**
DV: Post-Int. Secondary Desire Duration						
Block 1	0.18	0.18	3.62	0.08		

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	β	p (Sig. t)
Pre-Int. Secondary Desire Duration					0.43	0.08
Block 2	0.27	**0.09**	**1.75**	**0.21**		
Pre-Int. Secondary Desire Duration					0.44	0.07
Intervention Condition					**0.29**	**0.21**

Note. *N = 19;* contributions in DV variance relevant to intervention condition are bolded.

Table 5 summarizes the statistical findings related to the predictors of post-intervention secondary desire variables, where secondary desire refers to desire for social interactions, sex, leisure, work, etc. Results showed that intervention condition predicted post-intervention secondary desire frequency, such that those receiving mindfulness training reported significantly more secondary desires compared to those in the coping training condition, $\beta = 0.47$, $t(14) = 2.36$, $p = .03$. Intervention condition accounted for 21% additional variance on top of the contribution from other predictors, $\Delta R^2 = 0.21$, $\Delta F(1, 14) = 5.56$, $p = 0.03$. Intervention condition did not significantly predict post-training secondary desire enactment, strength, and duration.

Question 3. The last question explored whether training condition moderated the association between emotion (in terms of frequency and intensity of positively vs. negatively valanced emotions) and overall desire (frequency, intensity, duration, and enactment frequency). From the earlier discussion on the potential of mindfulness training to decouple emotion and desire, mindfulness training may moderate the association between emotion and overall desire frequency, intensity, duration, and enactment frequency, such that the correlation between emotion and desire variables is reduced for the MT condition compared to the CT condition. The descriptive information related to the degree of positive and negative emotions pre- and post-interventions is presented in Table 6 below.

Table 6: *Mean and Standard Deviation Values for Positive and Negative Emotion Intensity*

Variables	**Pre-intervention Week**		**Post-intervention Week**	
	Mean	**SD**	**Mean**	**SD**
Positive Emotion Intensity				
MT	2.13	0.98	2.28	0.76
CT	2.33	0.97	2.65	1.06
Negative Emotion Intensity				
MT	0.24	0.20	0.38	0.42
CT	0.42	0.31	0.32	0.44

Hierarchical regression analysis again evaluated the influence of training condition on the association between emotion and desire variables. Prior to analyses, the independent (overall post-treatment desire frequency, enactment, strength, and duration) and moderator (intervention condition) variables were centered, and from the centered variables a product term was calculated. To assess the contribution of this interaction term to the variance of the dependent variable (post-intervention emotion) above and beyond other predictors, with each of the dependent variables of post-intervention emotion (positive emotion and negative emotion), pre-intervention emotion and relevant demographic variables were entered into block 1, pre-intervention desire into block 2, intervention condition into block 3, post-intervention desire into block 4, and finally the post-intervention desire variable x intervention condition interaction term into block 5. The focus was on the significance of the incremental variance contributed by the interaction term. The statistical findings (relevant to block 5) related to the moderation effect of intervention for the dependent variables of post-intervention positive emotion and post-intervention negative emotion are given below in Tables 7 and 8 respectively.

Table 7. *Moderator Analyses: Intervention Effect on Positive Emotion and Desire link*

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	B	p (Sig. t)
DV: Post-Intervention Positive Emotion						
Desire Frequency						
Block 5	0.80	**0.10**	**6.20**	**0.03**		
Pre-Int. Positive Emotion					1.03	0.00
Pre-Int. Desire Frequency					-0.12	0.56
Intervention Condition					-.07	0.65
Post-Int. Desire Frequency					0.46	0.18
Post-Int. Desire Freq x Int. Condition					**-0.58**	**.03**
Desire Enactment						
Block 5	0.77	**0.04**	**2.14**	**0.17**		
Pre-Int. Positive Emotion					0.89	0.00
Pre-Int. Desire Enactment					-0.26	0.18
Intervention Condition					-0.03	0.83
Post-Int. Desire Enactment					0.33	0.13
Post-Int. Desire Enact x Int. Cond.					-0.27	0.17
Desire Strength						
Block 5	0.78	**0.06**	**2.93**	**0.11**		
Pre-Int. Positive Emotion					0.66	0.005
Pre-Int. Desire Strength					0.12	0.63
Intervention Condition					-0.12	0.41
Post-Int. Desire Strength					-0.39	0.13
Post-Int. Desire Strength x Int. Cond.					**0.30**	**0.11**

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	B	p (Sig. t)
Desire Duration						
Block 5	0.74	**0.02**	**0.71**	**0.42**		
Pre-Int. Positive Emotion					0.67	0.01
Pre-Int. Desire Duration					-0.03	0.87
Intervention Condition					-0.12	0.46
Post-Int. Desire Duration					-0.28	0.34
Post-Int. Desire Duration x Int. Cond.					**0.16**	**0.42**

Note. *N = 19;* contributions in DV variance relevant to interaction term are bolded.

Results in Table 7 suggested that the interaction term significantly predicted the outcome of post-intervention positive emotion only in the case of desire frequency. More specifically, intervention condition was a significant moderator for the association between post-intervention positive emotion and desire frequency, $\Delta R^2 = 0.10$, $\Delta F = 6.20$, $p = 0.03$, $\beta = -0.58$, $p = 0.03$. Simple slope analyses revealed a significant negative association between positive emotion and desire frequency post-intervention in the mindfulness intervention condition, $\beta = -0.45$, $t = -2.58$, $p = 0.049$, but did not find a significant association between positive emotion and desire frequency for the coping training condition, $\beta = 0.48$, $t = 1.48$, $p = 0.19$. Therefore, in the mindfulness condition, higher levels of positive emotion post-training predicted lower desire frequency, while in the coping training condition there was no evidence for a relationship between positive emotion and desire frequency post-intervention. Intervention condition was not found to moderate links between positive emotion and desire enactment, strength, or duration. These results suggest that after mindfulness training, people experiencing higher positive

emotion tend to experience fewer desires, whereas after coping training, level of positive emotional experience is not linked to number of desire experiences.

Table 8. *Moderator Analyses: Intervention on Negative Emotion-Desire link*

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	β	p (Sig. t)
DV: Post-Intervention Negative Emotion						
Desire Frequency						
Block 5	0.74	**0.01**	**0.60**	**0.45**		
Pre-Int. Negative Emotion					0.65	0.01
Age					-0.46	0.03
Pre-Int. Desire Frequency					-0.09	0.67
Intervention Condition					0.20	0.33
Post-Int. Desire frequency					-0.12	0.73
Post-Int. Desire Freq x Int. Condition					**0.18**	**0.45**
Desire Enactment						
Block 5	0.74	**0.002**	**0.09**	**0.77**		
Pre-Int. Negative Emotion					0.50	0.04
Age					-0.50	0.04
Pre-Int. Desire Enactment					-0.15	0.49
Intervention Condition					0.25	0.21
Post-Int. Desire Enactment					-0.04	0.86
Post-Int. Desire Enact x Int. Cond.					**-0.06**	**0.77**
Desire Strength						
Block 5	0.73	**0.002**	**0.084**	**0.78**		

Variable	R^2	ΔR^2	ΔF	p (Sig. ΔF)	β	p (Sig. t)
Pre-Int. Negative Emotion					0.57	0.01
Age					-0.30	0.27
Pre-Int. Desire Strength					-0.14	0.61
Intervention Condition					0.20	0.30
Post-Int. Desire Strength					0.15	0.56
Post-Int. Desire Strength x Int. Cond.					**0.07**	**0.78**
Desire Duration						
Block 5	0.74	**0.01**	**0.39**	**0.55**		
Pre-Int. Negative Emotion					0.46	0.05
Age					-0.39	0.07
Pre-Int. Desire Duration					0.15	0.55
Intervention Condition					0.16	0.38
Post-Int. Desire Duration					0.11	0.64
Post-Int. Desire Duration x Int. Cond.					**-0.13**	**0.55**

Note. *N = 19;* contributions in DV variance relevant to interaction term are bolded.

Table 8 shows the statistical findings regarding the moderation effect of intervention on the post-training negative emotion and desire link. Results in Table 8 showed that none of the interaction terms (post-training desire variable x intervention) significantly predicted the outcome of negative emotion post-intervention. More specifically, the study results do not show mindfulness training to be relevant to any association between post-intervention negative emotion and desire variables.

Discussion

The current exploratory study examined the effect of a 14-day smartphone-based mindfulness intervention on the frequency, intensity, duration, and enactment of everyday desires in 19 participants. The study focus was on basic need-based desires (i.e., for food, drink, sleep) and secondary desires (e.g., for sex, media, social interactions, work). Desire and emotion experience data was collected through ecological momentary assessment (EMA) for seven days pre- and post-intervention. Results revealed that intervention condition significantly predicted post-intervention desire frequency, such that those in the mindfulness condition experienced a higher frequency of desires post-training compared to the coping control condition. Further analyses showed that mindfulness intervention significantly predicted secondary desire frequency (e.g., for sex, media, social interactions, work), but not basic desire frequency (i.e., for food, drink, sleep), revealing that post-training secondary desire frequency was higher in the mindfulness condition. Desire enactment, strength, or duration was not found to be predicted by intervention condition. Daily emotion data was also explored to examine the potential role of mindfulness intervention in altering a link between emotion (positive and negative) and desire. Results revealed that intervention condition was a significant moderator of the association between positive emotion and overall desire frequency. Specifically, those in mindfulness condition experienced fewer desires when experiencing a higher degree of positive emotion, while no association was found between positive emotion and desire in the coping training condition. Intervention condition did not moderate any associations between positive emotion and the other desire variables of desire enactment, strength and duration. Intervention also did not moderation any link between negative emotion and any of the desire variables.

Prior research has presented mixed evidence on the link between mindfulness and desire. While some studies showed that mindfulness promotes self-restraint (Gifford et al., 2004), some others showed that mindfulness may promote indulgence, possibly due to increased awareness of craving experiences (Jenkins & Tapper, 2014; Leigh, Bowen, & Marlatt, 2005). The current study finding showing that a mindfulness intervention promoted a higher desire frequency may be more consistent with the latter perspective. It is also possible that the practice of mindfulness makes people more aware of their desires without increasing the actual desire frequency; this is, the training merely increased awareness of, and thus the reporting of desire frequency. It is noteworthy though that our study found mindfulness to promote higher desire frequency for secondary desires but not primary or basic desires. One line of reasoning may be that daily basic desires (i.e., drink, sleep, food), when within a necessary or healthy range required for functioning, may be too fundamental for survival to be prone to change by brief interventions. The range of secondary desires that was covered here may have had more room for modification regarding experienced frequency.

Because the targets of desire housed within the secondary desire category in this study were diverse (e.g., hygiene, media, work, sex), without further and closer inspection and analyses, it is difficult to tell which targets contributed to the increased desire frequency for the mindfulness condition. Further research within this category of desire may give a more complete picture. Exploring which domain of secondary desires mindfulness could have the greatest impact on could inform application of the intervention when desire frequency in those specific domains needs to be increased; such knowledge could inform clinical interventions targeting desire enhancement.

Based on prior literature, mindfulness intervention was expected to weaken links between emotion and desire. The current study finding suggested a different picture. The coping condition showed no link between emotion and desire, but the mindfulness condition showed a negative association between positive emotion and desire frequency, linking fewer desires with an increased strength of positive emotion. One interpretation could be that mindfulness makes individuals more aware of their positive emotional states, and the heightened experience of emotional pleasantness counteracts desire experiences and thus decreases desire frequency. Another interpretation could be that mindful awareness of desire experiences increases their frequency and decreases the degree of positive emotion. This interesting moderation effect could be explored further in future studies through experimental methods. The absence of a mindfulness intervention relation to any negative emotion and desire association also warrants further study.

Limitations

One of the primary limitations of this study was the very small sample size. A small sample size reflects low statistical power and thus reduced chance to detect a true effect. As the study was exploratory, the primary goal was to detect effect sizes meaningful enough to inform future research. For such small samples, EMA methods can be ideal as they allow for higher statistical power when sensitive statistical methods (e.g., multilevel modeling) are used. Future research would do well to apply such methods. The study also received a much higher number of female participants (n = 15) than males (n = 4), and thus could not effectively inform any possible gender differences in the outcomes. Moreover, all four male participants were randomized to the coping training condition. Future studies should look deeper into the reasons behind higher female participation in such studies and work to recruit equivalent number of

participants from each gender. Smaller studies could use a stratified randomization technique to ensure equivalent gender proportions in all study conditions.

One of the other weaknesses of the study concerns the possibility of the desire questionnaire evoking some degree of social desirability due to the presence of questions regarding one's current desires related to alcohol, tobacco, other substances, sex, work, media, hygiene, etc. Social desirability refers to the tendency of participants to present themselves in a more favorable light. For example, if individuals from the general population are asked whether they are feeling sexual desires and whether such desires are for committed partner, someone from the friend circle, or a fictitious character or celebrity, the participant might not want to respond honestly and rather respond in a socially desirable fashion; for example if feeling an intense sexual desire for a friend, a participant might not report the desire. The same argument could hold for current desires for alcohol, substances, etc. A participant might also worry about legal implications of reporting their desires and the enactment of them (e.g., about substance use). Putting appropriate incentives in place to encourage participants to report honestly may be useful. To enhance honesty, participants in the current study were assured about the anonymity and privacy of their responses, so desire under-reporting may not have been a serious concern.

Another possible concern was the ease with which an EMA report could be completed by responding 'no' to questions of desire experience, as this immediately ended the desire portion of the survey, as opposed to saying 'yes,' which led to subsequent desire questions. But as answering subsequent questions took only a little more time, it seems reasonable to trust that participants were truthful in their desire reporting. But future studies could add subsequent questions following a 'no' response to match the time lengths and effort following 'yes' responses.

An additional weakness in the desire measure was the mismatch between the way participants were asked about their current desire and their enactment of the desire. More specifically, participants were asked whether they are currently feeling a desire or felt a desire in the last 30 mins. The enactment question then asked them whether they acted on their desire, even if to some extent. If the participant responded "no" to the enactment question, it is not clear what this response entails – whether it means they purposefully did not engage or that they have not gotten the time to engage yet. If their desire was current, it is very much possible that they responded "no" to the enactment question because they have not yet had time to enact, but will. Such issues make questionable any conclusion about the desire enactment findings (and lack thereof). Therefore, researchers must be careful about how to frame these desire questions. If probing current moment desires, asking whether participants have enacted the desires or have the plan or intent to enact the desire may serve the purpose better.

Another limitation concerns the exclusion of participants based on criteria appropriate for an fMRI study but which may have been irrelevant to the aims of the current study. Such exclusion criteria may have limited the diversity of our sample in terms of daily living experiences (e.g., exclusion based on degree of cigarette or alcohol consumption). Future mindfulness and desire studies determining exclusion criteria based on the goals of the relevant study would rectify such problems. The study also excluded people based on the ownership of a smartphone, which could have led to exclusion of individuals from a lower socio-economic background. In future larger studies, lending participants cell phones for the duration of the study may better accommodate participants from lower socio-economic strata.

In sum, future studies exploring similar questions and with similar designs must consider sample size, using proper analysis method to reap the full benefits and richness of EMA data,

social desirability effects, the quickness of survey completion from ‘no’ responses to desire questions as opposed to ‘yes’ responses, and a lack of clarity in desire enactment questions. Nevertheless, the study design had the significant strengths of the effective use of technology for intervention and survey delivery, thereby reducing participant burden and potentially fostering compliance. The study also permitted data collection at multiple daily timepoints for weeks in participants’ natural environments. Finally, the structurally equivalent treatment delivery helped to account for non-specifics effect of the MT condition. The current exploratory investigation could inform the design of larger studies on how a smart-phone-based mindfulness intervention could affect participants’ daily life desire and emotion experiences, and the behaviors that follow from them. Such research could help create technology-based, easily accessible clinical interventions to promote adaptive desires, emotions, and self-regulation.

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Appendix

Experience sampling of desires and their enactment (Hofmann et al., 2012)

Are you currently experiencing a desire or have you experienced desire within the past 30 minutes?

- Yes
- No

Describe the content of the desire.

- Food
- Coffee/Tea
- Other non-alcoholic drink
- Alcohol
- Sleep
- Sex
- Hygiene-Related
- Tobacco
- Other substance
- Media
- Spending
- Work
- Social activity
- Leisure
- Other

Rate the strength of the desire you selected.

- Extremely low
- Very low
- Somewhat low
- Moderate
- Somewhat high
- Very high
- Extremely high

Describe the duration of the desire

- 0-5 minutes
- 6-10 minutes
- 11-15 minutes
- 16-20 minutes
- 21-30 minutes
- 31-60 minutes
- 1-2 hours
- 2-3 hours
- 3-5 hours
- >5 hours

Did you act on this desire (to any extent; e.g. eating part of a chocolate bar without eating the entire bar)?

- Yes
- No

Experience sampling of discrete emotions (adapted from the Discrete Emotions Questionnaire (DEQ) by Harmon-Jones et al. (2016))

To what degree are you experiencing these emotions right now?

Not at all	Slightly	Somewhat	Moderately	Quite a bit	Very much	An extreme amount

Anger	Scared
Fear	Relaxation
Sad	Lonely
Mad	Enjoyment
Calm	Liking