

**Attachment Insecurity Moderates Emotion Responses to Mindfulness and Loving-kindness
Meditation in Adults Raised in Low Socioeconomic Status Households**

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Abstract

Research on attachment theory holds that insecure attachment influences people's daily social and emotional experiences. Mindfulness meditation and loving-kindness meditation have been associated with improvements in physical and mental well-being often through their influence on emotion experience and regulation. Yet, little research has examined how emotional well-being may be improved in insecurely attached individuals through meditation practice. We suspected that the emotion profiles of anxious and avoidant attachment may shift with meditation training, both across time and on a particular day. Improving emotional well-being may be especially consequential for those most at-risk for negative health outcomes in late life. A diverse community sample of midlife adults raised in low-SES homes (N = 113; 55% white, 87.5% female) completed daily emotion reports for 10 weeks, during which they received 6 weeks of meditation training, randomized to either loving-kindness or mindfulness meditation practice. Results from growth curve analyses revealed that individuals with greater attachment anxiety and randomized to mindfulness meditation reported significant increases over time in positive emotions alongside decreases in negative emotions. Those high in attachment avoidance reported significant decreases in negative emotions in both meditation groups. On the daily level, within-person dose-response analyses revealed that individuals with greater attachment anxiety showed the most consistent dose-response relations between the duration of either meditation practice and same-day increases in positive emotions and decreases in negative emotions. These findings highlight how meditation interventions can shift emotion profiles of insecurely attached midlife adults who are at heightened risk for late life chronic illnesses.

Keywords: positive psychology; contemplative science; childhood adversity; emotion; attachment

Attachment Insecurity Moderates Emotion Responses to Mindfulness and Loving-kindness Training in Adults Raised in Low Socioeconomic Status Households

Decades of research link individual differences in attachment style to distinct patterns of emotion experience and regulation (for a review see Mikulincer & Shaver, 2019; Mikulincer, Shaver & Pereg, 2003). Emotion-regulation difficulties characteristic of insecure attachment are known to contribute to poor physical and mental health, directly, and indirectly, through strained relationships (for a review see Stanton & Campbell, 2014; Mikulincer & Shaver, 2019). One-way individuals may learn better ways to regulate emotion experience and cope with stress is by adopting a meditation practice. Thus, meditation is a positive health behavior that can improve emotional well-being, and in turn, have downstream consequences for a variety of physical and psychological health indices (Van Cappellen et al., 2020). For example, mindfulness meditation is often associated with reduced stress and negative affectivity (for a review see Schumer, Lindsay & Creswell, 2018; Creswell & Lindsay, 2014), while both mindfulness meditation and loving-kindness meditation have been associated with enhanced positive affective states (Fredrickson et al., 2017; Lindsay et al., 2019). For insecurely attached individuals who may have emotion profiles characterized by either hyperactive regulation (i.e., anxious attachment) or deactivated, muted emotion experience (i.e., avoidant attachment), meditation may be a particularly useful tool in beneficially shifting these characteristic emotion patterns. While abundant work focuses on emotion-related mechanisms and outcomes of meditation practice, we are unaware of any scientific assessment of how individual differences in attachment influence positive and negative emotions in response to meditation practice, whether it be present-moment focused (i.e., mindfulness) or socially-focused practices (e.g., loving-kindness, compassion). Such evidence may carry important implications for improving health and well-being in

individuals most at risk for negative physical and mental health outcomes. Here, we examine whether the emotion profiles of insecurely attached individuals may improve when randomized to training in either mindfulness meditation or loving-kindness meditation in a sample of midlife adults raised in low-SES households.

Emotional Well-Being & Meditation Training

Mindfulness meditation and loving-kindness meditation are known to carry particular benefits for emotional well-being, in addition to benefits for mental, physical, and relational well-being (Fredrickson et al., 2017; Creswell, 2017; Don et al., 2020; Lindsay et al., 2019). Mindfulness meditation (MM) practice typically involves training in (a) monitoring present moment experiences, while (b) cultivating an accepting, open attitude toward whatever experiences arise. Through training in MM, practitioners aim to become more aware and accepting of their own present-moment experiences, including one's emotions (Lindsay & Creswell, 2017). Evidence from a randomized trial that dismantled the skills taught in MM suggests that increases in acceptance are perhaps the central mechanism that link mindfulness training to emotion benefits, particularly to boosts in positive emotions, possibly by fostering greater appreciation and receptivity to positive experiences (Lindsay et al., 2018; Simone, Raffone & Mirolli, 2021). According to *mindfulness-to-meaning* theory, a decentered stance of awareness facilitated through MM, poises one to readily engage in cognitive reappraisals that serve both to reduce negative emotions and cultivate and savor positive emotions (Garland et al., 2015). Indeed, research demonstrates that the practice of mindfulness meditation enhances positive emotions and reduces negative emotions in two ways: by influencing (a) the longitudinal trajectories of positive and negative emotions with repeated practice over time, and (b) positive

and negative emotion experiences on a particular day that includes meditation practice (Fredrickson et al., 2017; Lindsay et al., 2019; Schumer et al., 2018).

Loving-kindness meditation (LKM) typically involves the intentional cultivation of warm-hearted and compassionate feelings towards a series of individuals, including the self, a loved one, acquaintances, people with whom the meditation practitioner struggles, and ultimately, all beings. Through training in LKM, practitioners intentionally cultivate warmth, compassion, and kindness. Indeed, research demonstrates that the practice of loving-kindness is consistently linked with enhanced positive emotions (Fredrickson et al., 2008, 2017; Hutcherson et al., 2008; Kok et al., 2013; Zeng et al., 2015). Although some studies demonstrate LKM also contributes to reduced negative emotions (Galante et al., 2016; 2014; Carson et al., 2005), other studies find no such effect (Fredrickson et al., 2008, 2017), suggesting the influence of LKM on negative emotions appears to be less robust or perhaps population-dependent. Conceivably, for instance, LKM may reduce negative emotions to a greater degree in sub-populations that typically show elevated negative affectivity, such as those with lower SES or higher attachment insecurity (Gallo & Matthews, 2003; Mikulincer & Shaver, 2019). Researchers have suggested that the cultivation of warmth and compassion may be useful even during challenging times, so that practitioners become more likely to approach challenging experiences with warmth and compassion (Shonin et al., 2015). Thus, the limited research on LKM has primarily investigated improvements in well-being by focusing on enhanced positive emotions and compassion toward the self and others (Galante et al., 2014; Zeng et al., 2015). As with the research on MM, prior research has demonstrated LKM influences (a) trajectories of emotions that emerge from repeated practice across time, as well as (b) emotions on a particular day that includes meditation practice (Fredrickson et al., 2008; Fredrickson et al., 2017).

Insecure Attachment and Emotion

Why might individuals with greater insecure attachment particularly reap the emotional benefits of meditation? In early life, people depend on close significant others for the regulation of basic needs and protection from threats. Individuals with warm, responsive and consistent caregiving likely develop secure attachment, or a sense that the world is safe to explore and people can be trusted and depended upon (Mikulincer & Shaver, 2003). Alternatively, those with unresponsive, harsh or inconsistent caregiving are more likely to develop insecure attachment, or a sense that one is vulnerable or unprotected from threats and people cannot necessarily be relied upon for support or comfort when distressed (Mikulincer & Shaver, 2003). According to attachment theory, these early experiences of care lay the groundwork for how individuals experience social relationships and regulate emotions throughout life, and thus may help explain the different trajectories of health and well-being that result from early environmental factors (Bowlby, 1969; Miller, Chen & Parker, 2011).

Attachment insecurity, which is often further conceptualized along the dimensions of attachment anxiety and avoidance, plays an important role in patterns of emotional experience (Brennan, Clark, & Shaver, 1998). Attachment anxiety, characterized by greater fear of being alone or abandoned, has been associated with greater emotion regulation difficulties (Henschel, Nandrino, & Doba, 2020). Specifically, people with higher levels of attachment anxiety tend to experience more intense and frequent negative emotions (i.e., hyperactive regulation), and have difficulty savoring positive emotions, which tend to blend with fear or anxiety (Palmer & Gentzler, 2018; Mikulincer & Shaver, 2005, 2019). Furthermore, people with greater attachment anxiety tend to be reactive and hyper-vigilant to threats, and are thus more likely to perceive conflict or threats, which can trigger negative emotions (Campbell et al., 2005).

Attachment avoidance is characterized by difficulty with closeness and dependency on others, a preference for self-reliance, and general distrust toward others (Mikulincer & Shaver, 2007a). Individuals with this form of attachment insecurity tend to engage in more deactivating emotion regulation strategies, which serve to inhibit both positive and negative emotion experiences, particularly within interpersonal contexts (Brennan & Shaver, 1995; Mikulincer & Shaver, 2003, 2007). In this way, maintaining distance from others allows those with avoidant attachment styles to circumvent potential threats and negative emotions that may arise in response to close others, while avoiding positive emotion experiences helps create barriers to developing intimacy and social closeness, whether with their romantic partners or offspring (Nelson-Coffey, Borelli & River, 2017; Kerr et al., 2019). As such, people with greater attachment avoidance are consistently found to experience fewer positive emotions, particularly in social contexts, and tend to experience more frequent and intense negative emotions (Stanton, Campbell & Pink, 2017; Kerr et al., 2019; Tidwell, Reis & Shaver, 1996; Gentzler, Kerns & Keener, 2010; Nelson-Coffey, Borelli & River, 2017).

Insecure Attachment & Emotion Responses to Meditation

Given that affective experiences in daily life are shaped by individual differences in attachment insecurity, both attachment anxiety and attachment avoidance may influence affective outcomes associated with the practice of mindfulness meditation or loving-kindness meditation. In light of the *hyperactivating style* associated with attachment anxiety, these individuals may particularly benefit from MM. With MM, people are encouraged to see their thoughts and emotions as mental objects, rather than “fusing” with them, or viewing them as the absolute truth (Hayes, 2019; Hayes et al., 2006). For those wary of rejection or frequently anxious, MM may help them to monitor their hypervigilant thoughts and emotions, accept them

non-judgmentally, and let them pass, and thereby disarm their affective power and reduce the frequency, intensity, and/or duration of negative emotions (Hayes, 2019; Lindsay & Creswell, 2017). Indeed, when comparing the effects of training in Mindfulness-Based Stress Reduction (MBSR) on perceived stress between those with secure versus insecure attachment styles (either anxious or avoidant), results suggested that MBSR may provide greater stress-reducing benefits for insecurely attached individuals (Cordon, Brown, & Gibson, 2009). Additionally, just as this type of present-focused and accepting attention may reduce negative emotions, MM may also reduce the extent to which hypervigilance restricts or impedes the experience of positive emotions. By monitoring experience with an orientation toward acceptance, anxiously attached individuals may be more likely to notice positive experiences in daily life and find greater positive meaning, resulting in increased positive emotions (Lindsay et al., 2018; Garland et al., 2015). Additionally, with a reduced evaluative stance, anxiously attached individuals may be better able to savor and appreciate positive emotions with less interference from perceived threats. Accordingly, MM may carry larger benefits for people higher (versus lower) in attachment anxiety both for reducing negative emotions and increasing positive emotions. Considering the *deactivated emotion profile* associated with attachment avoidance, these individuals may also benefit from MM, albeit for different reasons. Specifically, for them, monitoring present moment experiences may lead to greater awareness of and clarity in daily emotions, subverting habits of emotion suppression (Lindsay & Creswell, 2019). Furthermore, as avoidance reflects a non-acceptance of present moment experience, for those higher (versus lower) in attachment avoidance, the combined effect of training in MM to both *monitor* and *accept* emotions may improve well-being, perhaps by increasing the frequency, intensity and/or duration of positive emotions (Lindsay et al., 2013; Lindsay & Creswell, 2019).

With the explicit emphasis in loving-kindness practice on interpersonal relations, we suspected that its influence on daily positive and negative emotions may also be moderated by attachment insecurity, although the direction of this effect is debatable. Although the social focus of LKM could be particularly beneficial for those with strained social relationships, research has also suggested that this focus may be more emotionally challenging, especially for individuals with histories of interpersonal trauma or poor care in childhood (Gilbert, 2009; Boellinghaus et al., 2013). People higher in attachment anxiety, for instance, have been found to be more vigilant to social signals of care, attention, and warmth in their relationships (Campbell et al., 2005; Fraley et al., 2006). Accordingly, those higher (versus lower) in anxious attachment may find their initial training in LKM to be aversive or frightening, leading to increased negative emotions and decreased positive emotions. Alternatively, through repeated LKM practice, individuals high in anxious attachment may first develop warmth and positive emotions toward themselves, allowing for greater social warmth and the development of social resources (Fredrickson et al., 2008), which might ultimately reduce anxiety and interpersonal vigilance. Additionally, as anxiously attached individuals learn to self-generate positive emotions, they may engage in more affiliative smiling, which could spread to others via facial mimicry, resulting in reduced perceptions of interpersonal threat (Niedenthal et al., 2016). In this way, the emotion profiles of anxiously-attached individuals who practice LKM might improve. By contrast, individuals high in attachment avoidance tend to shy away from vulnerability and openness in relationships by avoiding shared positive emotion experiences, because doing so allows them to avoid the hurtful and rejecting experiences they have historically come to expect from close relationships. Learning to self-generate warm, positive emotions towards the self and others, then, may especially benefit those higher (versus lower) in avoidant attachment, who typically experience

muted positive emotion experience, most notably in social contexts (Palmer & Gentzler, 2018). Cultivating positive emotions in social contexts may also reduce negative emotions in avoidant individuals, as they become more comfortable and receptive to imagined intimacy. Although individuals with avoidant attachment styles may have the most to gain from the social warmth of LKM, they may also be most resistant to it, approaching it with ambivalence, skepticism, or indifference. It should also be noted that some have theorized attachment *security* is necessary and foundational for cultivating compassion and kindness toward the self and others, suggesting LKM may not be as effective for those with greater insecurity (Shaver, Mikulincer, Sahdra & Gross, 2017). Thus, as with those high in anxious attachment, those high in avoidant attachment may find LKM practice to be challenging, potentially resulting in greater negative emotions or even lower positive emotions. These divergent possibilities led us to develop competing hypotheses on whether loving-kindness meditation improves or worsens emotional well-being as a function of individual differences in attachment style.

Low-SES Childhood & Well-being: The Role of Attachment Style

Decades of evidence link habitual emotions to health outcomes (Kubzansky & Kawachi, 2000; Gross & Muñoz, 1995; Salovey et al., 2000; Denson, Spanovic & Miller, 2009). Improving emotional well-being is therefore particularly important for individuals most at risk for poor physical and mental health. Currently, people raised in low socioeconomic status (SES) households hold greater risk for negative health outcomes later in life, independent of adult socioeconomic status (Galabordes et al., 2006; Cohen et al., 2013; Miller, Chen & Parker, 2011). Those raised in low SES households are more likely to be raised in environments which may be characterized by chronic stress (e.g., social, financial), lack of access to resources (e.g., food, health care, education), or exposure to environmental risks (e.g., pollution, toxins), all of which

are known contributors to poor physical and mental health (for a review see Chen & Miller, 2013). Importantly, some adults are spared the negative health consequences associated with early life low-SES, and this divergence in health outcomes is thought best explained by attachment theory, as attachment theory is closely tied to how individuals experience and regulate their emotions (Murdock & Fagundes, 2017; Miller, Chen & Parker, 2011). Specifically, those who experienced high maternal warmth, responsive parenting and/or had positive, supportive role models do not tend to show the same negative health outcomes, suggesting that close and secure interpersonal relationships may serve as a buffer to early life stress, likely through the development of successful emotion regulation strategies (e.g., drawing on felt security in times of stress; Chen et al., 2011; Chen, Brody & Miller, 2017; Dagan et al., 2018; Chen & Miller, 2012; Murdock et al., 2018; Johnson et al., 2018). On the other hand, attachment insecurity is regularly associated with poor emotion regulation and strained social relationships, and therefore may explain or exacerbate negative health outcomes associated with early life low SES (Miller, Chen & Parker, 2011; Murdock & Fagundes, 2017). Taken together, this evidence suggests those at greater risk for negative late life health outcomes may include the subset of those raised in low socio-economic households who *also* lacked warm, responsive parenting or other supportive role models (Miller, Chen & Parker, 2011).

Both theory and evidence suggest that those raised in low-income households are at greater risk of developing insecure attachment (Szepeswol & Simpson, 2019; Johnson et al., 2018; Murdock & Fagundes, 2017). Higher rates of insecure attachment may also explain why those with low SES backgrounds are also more likely to report lower positive affect and higher negative affect compared to those higher in SES (Gallo & Mathews, 2003; Chiang et al, 2015; Gallo, Bogart & Vranceanu, 2005). With heightened stress and less access to a range of

economic, social and psychological resources to cope, lower SES individuals may be more sensitive to the negative health consequences of attachment insecurity, just as they have been found to be more sensitive to the relative presence of social support (Miller, Chen & Parker, 2011). While both dimensions of insecure attachment have been associated with poor health outcomes via poor emotion regulatory strategies (for a review see Pietromonaco & Beck, 2019), attachment anxiety is more consistently linked to higher rates of stress and negative health outcomes, compared to attachment avoidance (Puig et al., 2013; Murdock & Fagundes, 2017; Murdock et al., 2017; Stanton & Campbell, 2014). One cross-sectional survey study ($N = 213$) found that low childhood SES was associated with poor adult health, serially through attachment anxiety and stress (Murdock & Fagundes, 2017). Furthermore, this same study found that childhood SES was directly associated with anxious attachment but not avoidant attachment. Thus, greater attachment anxiety in particular may drive poor health outcomes in mid-life adults raised in low SES households, likely due to difficulties in emotion regulation. Accordingly, these individuals may benefit most from meditation interventions found to improve people's abilities to down-regulate negative affect and up-regulate positive affect.

Current Study

Abundant work has separately investigated the relationships between (a) attachment style and emotions, and (b) meditation and emotions. The present study is the first to our knowledge to examine how dimensions of attachment insecurity contour emotion changes, both longitudinally and daily, stemming from meditation training. The overarching aim of this work is to examine how dimensions of attachment insecurity moderate shifts in positive and negative emotions in response to two distinct meditation practices (MM and LKM). We hypothesized that, among participants randomized to learn MM, those higher (versus lower) in anxious attachment will

show significantly greater reductions in negative emotions alongside significantly greater elevations in positive emotions (H1). We expected these differences to be evident both across the weeks of meditation training and on a given day that included meditation practice. Past literature can motivate two competing and mutually exclusive predictions for participants randomized to learn LKM. Conceivably, as we predicted for those who practice mindfulness meditation, those higher (versus lower) in anxious attachment may show emotional benefits from LKM training (i.e., larger reductions in negative emotions and larger boosts in positive emotions; Competing H2a). Alternatively, in line with past speculation that safety and attachment security are preconditions for LKM benefits, when first learning this practice, those higher (versus lower) in anxious attachment may show worsened emotion profiles (i.e., smaller reductions or increases in negative emotions and smaller boosts or decreases in positive emotions; Competing H2b). Patterning hypotheses for MM, we examined how LKM relates to shifts in emotions both across the weeks of meditation training and on a given day. We followed the same pattern of hypotheses for avoidant attachment. Specifically, we hypothesized that those higher (versus lower) in avoidance attachment and randomized to learn MM will show significantly larger reductions in negative emotions alongside larger boosts in positive emotions (H3). For those randomized to learn LKM, those higher (versus lower) in avoidance attachment may either especially show improved emotion profiles (Competing H4a; patterned after H2a) or worsened emotion profiles (Competing H4b; patterned after H2b). To test these hypotheses, we drew on archival data from a randomized intervention study of diverse, midlife adults raised in low SES households¹ and use multilevel growth curve and daily diary analyses to examine whether

¹ The present study is a secondary analysis of a 6-week randomized trial designed to test whether the biological impact of childhood low SES, indexed by leukocyte gene expression (Cole, 2014), might be reversed in mid-life through loving-kindness meditation (West et al., under review), and whether increases in positive emotions across the intervention mediated this effect. The study targeted the conserved transcriptional

attachment anxiety and avoidance moderated the emotional responses to MM and LKM across weeks and within days. As such, this work has important implications for whether, when, and for whom meditation practice may improve emotional well-being for those most at-risk for negative late-life health outcomes.

Method

Participants

As part of a larger study on health in midlife adults who were raised in low SES households, participants were recruited to participate in a study about how to best reduce health risks. Prospective participants were assessed for eligibility through a pre-screening survey. To be eligible, participants must have been between the ages 30-69, had little to no meditation experience, be fluent in English, and have home internet access for nightly survey completion. In addition, low childhood SES was determined by a score of 39 or below on the Hollingshead Four-factor Index, a widely used measure of SES which considers the gender, marital status, occupation and education of the respondents' parents during childhood (Hollingshead, 1975). This number represented the highest score before entering mid-range occupations based on 1970's US census data. Through this process, 113 midlife adults were recruited from 9 counties within a 50-mile radius of a large university in the Southeastern United States via paper, television and online advertisement. Participants could earn up to \$235 for full participation in

response to adversity (CTRA), which represents a pattern of gene expression thought to arise following prolonged life adversity, and characterized by increased expression of proinflammatory genes and decreased expression of antiviral and antibody-related genes (for a review see Cole, 2019). Contrary to our prediction, only those randomized to learn mindfulness meditation showed significant reductions in CTRA gene expression. Furthermore, there were no differences in trajectories of positive or negative emotions over time by meditation condition, so mediation by emotions was not pursued. For transparency, these emotion analyses are reported again here and flagged in the analyses section. The biological findings suggested that individuals in this at-risk sample responded positively to mindfulness practice yet did not particularly benefit from the socially-focused loving-kindness practice.

the study (Data from this larger NIH-supported study [5R01AG048811] have been reported elsewhere (West et al., under review).

The hypotheses for the study were not preregistered. For analysis, all participants who completed baseline self-report surveys (Week 0) and baseline daily emotion reports (Week 2) were included in data analysis ($N = 112$). Participants were randomized to one of two meditation workshops: loving-kindness meditation (LKM; $n = 57$) or mindfulness-meditation (MM; $n = 55$). In the final sample, the mean age was 47.10 years ($SD = 10.49$). The majority of participants were female (83.93%). Participants primarily identified as either White (55%) or Black (34%). The remaining participants either identified as more than one race 5%, Asian 5%, or Native Hawaiian or Pacific Islander >1%. Of the sample, 6% of participants indicated Hispanic or Latino. Descriptive statistics confirm that the analysis sample represents those raised in low-SES households. Specifically, the mean Hollingshead Four-Factor Index Score was 26, well-below the cut-off of 39 (Hollingshead, 1975). Sample size was determined based on *a priori* power analyses for the primary grant study aims from which these data are derived. More information on these power analyses can be found in (West et al., under review).

Procedure

The Institutional Review Board of the University of North Carolina at Chapel Hill approved all procedures for the study (Study #14-1938). Data collection took place across two waves between February 2015 and May 2016. Prospective participants were directed to a website which detailed the study purpose and procedures and invited them to complete a pre-screening questionnaire. Participants indicated consent during pre-screening and were assigned a numeric identification code. Those who met the inclusion/exclusion criteria were invited to participate in the study. Participants were then scheduled for an initial lab visit, where they were allocated (via

a random number generator) to either the loving kindness meditation group or the mindfulness meditation group. All study personnel involved in lab visits were blind to participants' condition. The study lasted 12 weeks, with the 6-week meditation workshops occurring from Week 3 through Week 8. Baseline psychological measures were collected at Week 1. Daily emotion reports were collected throughout the study. Data from the second week (baseline measures), the weeks during the meditation intervention (Weeks 3-8), and immediately following the intervention period (Weeks 9-11) were analyzed here.

Meditation Interventions

The MM and LKM workshops were designed with small group of meditation experts not involved in data collection (see Fredrickson et al., 2017 for further details on workshop development and procedures). The MM and LKM workshops were designed with the identical attitude of open and non-judgmental awareness, while their respective intention and attention components differed. For MM, practitioners were guided to attend and de-identify with the contents of consciousness in the present moment, progressively expanding across targets over a six-week course, first toward breathing and hearing (Week 3), the body (Week 4), emotions (Week 5), thoughts (Week 6), and choiceless awareness (Week 7), with Week 8 being review and integration. For LKM, with the same open and non-judgment attitude, practitioners were guided to self-cultivate warm and friendly feelings progressively expanding to various social targets, first directed toward a loved one (Week 3), oneself (Week 4), an acquaintance (Week 5), a difficult person (Week 6), and all beings (Week 7), with Week 8 being review and integration. The hallmark meta mechanism of LKM was taught as a fundamental shift toward warmth, kindness, and social connection. Both meditation workshops were designed in a secular health-based format that used six progressive, small-group sessions, each lasting 1 hour. Participants also received homework assignments and five 20-minute audio-recorded guided meditations,

along with additional resources and encouragement for daily individual meditation practice, both formal and informal (Fredrickson et al., 2019)

Measures

Positive and Negative Emotions

Positive and negative emotions were computed from nightly assessments with the modified Differential Emotions Scale (Fredrickson, 2013). This scale measures the degree to which participants experienced, in the targeted time period, 10 distinct positive emotions (amusement, awe, gratitude, hope, inspiration, interest, joy, love, pride, and serenity) and 10 distinct negative emotions (anger, contempt, disgust, embarrassment, fear, guilt, hate, sadness, shame, and stress). Specifically, participants were asked “*Please think back to how you felt during the past twenty-four hours...indicate the greatest amount that you've experienced each of the following feelings*” using a 5-point Likert scale (0 = Not at all, 4 = Extremely). Positive (PE) and negative (NE) emotion scores were computed by averaging the 10 scale items in each category for each participant. The first week of daily emotion reports were excluded to avoid the elevation bias (Shrout et al., 2018). Reliabilities for PE and NE were assessed for daily reports completed during baseline (Week 2) through the intervention (Weeks 3-8) by calculating McDonald’s omega using the multilevel confirmatory factor analysis procedure described in Bolger and Laurenceau (2013; p. 138-140, calculated in Mplus version 8; Muthén and Muthén, 2017). The omega estimates indicated good reliability of within-person and between-person changes in emotions over time (within person: $\omega_{PE} = .892$, $\omega_{NE} = .833$; between person: $\omega_{PE} = .962$, $\omega_{NE} = .906$).

Adult Attachment

Participants completed the 18-item Revised Adult Attachment Scale in the baseline pre-intervention surveys (Collins & Read, 1990; Collins, 1996). On a scale from 1 (not at all

characteristic of me) to 5 (very characteristic of me), participants were instructed: “The following questions concern how you *generally* feel in *important close relationships in your life*. Think about your past and present relationships with people who have been especially important to you, such as family members, romantic partners, and close friends. Respond to each statement in terms of how you *generally* feel in these relationships.” The dimensions anxiety (6-items; e.g., “*In relationships, I often worry that my partner will not want to stay with me*”) and avoidance (12-items; e.g., “*Often, partners want me to be closer than I feel comfortable being*”) were assessed by taking the average of their corresponding items (Brennan, Clark & Shaver, 1998). Cronbach's alpha was .85 for the avoidance dimension and .76 for the anxiety dimension.

Meditation Practice

Participants provided daily reports of their engagement in meditation practice. Participants first indicated whether they had meditated at all that day. If they reported that they had meditated that day, they were then asked to report how many minutes they engaged in meditation practice. These two items were then used to create a daily minutes of meditation variable, whereby participants who reported they had not meditated on a particular day received a 0, and all other participants received the number of minutes they reported meditating each day.

Analysis Strategy

We analyzed the data in two steps. In the first step, we examined how attachment insecurity (anxiety H1, Competing H2a, b; avoidance H3, Competing H4a, b) influenced participants trajectories of positive and negative emotions across the course of the meditation interventions by utilizing growth curve analyses. To do so, we followed the recommendations of Bolger and Laurenceau (2013) for conducting growth curve analyses using multilevel modeling with the mixed procedure in SPSS. We specified these models to test two key parameters. First,

we examined whether attachment insecurity (either anxiety or avoidance) predicted participants' trajectories of emotions across the course of the study by specifying an interaction between the attachment variables and the continuous indicator variable for time (the day that the participant provided each nightly report). Second, we examined whether attachment anxiety (H1, Competing H2a, b) and attachment avoidance (H3, Competing H4a, b) had a differential influence on participants' trajectories of emotion experience across time depending on the type of meditation they practiced (MM; H1 & H3 vs. LKM; Competing H2a,b & Competing H4a,b). To do so, we specified a three-way interaction between day, attachment insecurity (either anxiety or avoidance), and meditation condition. As per recommendations for growth curve analyses (Bolger & Laurenceau, 2013; Grimm et al, 2016), each model was specified with random intercepts, and a random slope for time (i.e., the day in which participants provided their nightly report of emotion).

In the second step, we examined whether attachment insecurity influenced the dose-response relationship between daily engagement in meditation and participants' emotions on a particular day. To do so, we used multilevel, within-subjects, daily analyses in SPSS, again according to the recommendations of Bolger and Laurenceau (2013). We partitioned the variance in participants' self-reports of engagement in meditation each day (specifically, the number of minutes they meditated each day) into between- and within-person components (Bolger & Laurenceau, 2013; Hofman, 2015).² As per the recommendations of Bolger and Laurenceau

² To do so, we first calculated a grand mean-centered version of the daily engagement in meditation variable. Next, based on this grand-mean centered variable, we calculated a person-specific average of daily minutes meditated across the course of the intervention period, which provides an indicator of whether the individual tended to generally engage in a higher or lower amount of daily meditation as compared to other people across the course of the study. This was the between-person variable. Then, we subtracted the individual's between-person score (their average daily engagement in meditation across the entire intervention) from their daily meditation on a particular day to calculate the within-persons variable. As such, the within-person variable represents the individual's engagement in meditation on a particular day, as compared to their own, person-specific average. When a person has a high score on the within-person variable on a particular day, it

(2013), we specified these models to include (a) random intercepts, and (b) a random slope for the primary within-person predictor variable – in this case the within-person minutes meditating variable. Finally, because our goal was to establish that daily engagement in meditation influenced daily positive and negative emotions (and not the reverse direction of association), we controlled for the influence of prior day positive or negative emotions in all daily dose-response models (Bolger & Laurenceau, 2013).

We focused on two parameters for each dose-response analysis. First, to examine the possibility that greater daily engagement in either type of meditation may have had a differential influence on positive or negative emotions depending on a participants' attachment anxiety (H1, Competing H2a, b) or avoidance (H3, Competing H4a, b), we examined whether attachment anxiety or avoidance interacted with the within-person indicator of daily engagement in meditation. Second, to examine the possibility that greater daily engagement in a particular type of meditation may have a differential influence depending on attachment anxiety or avoidance, we tested for a three-way interaction among within-person daily engagement in meditation, meditation condition, and attachment anxiety or avoidance. Although they were not the focus of our hypothesis tests, we did include all the analogous interactions between attachment insecurity and the between-persons meditation variables (e.g., attachment insecurity x between-persons daily meditation in predicting positive and negative emotions; Bolger & Laurenceau, 2013). We examined four dose-response models in total: attachment anxiety interacting with daily engagement in meditation to predict positive and negative emotions (separately), and attachment avoidance interacting with daily engagement in meditation to predict positive and negative emotions (separately).

means the individual engaged in greater than usual meditation on that day, as compared to their own typical daily meditation practice.

Finally, because our sample was racially and ethnically diverse, we wanted to account for the possibility of group differences in emotion responses to meditation. As most research on meditation consists of white, female and middle to upper class individuals, little work has explored how demographic factors influence meditation outcomes. Thus, we also conducted ancillary analyses to examine whether our primary findings of interests were altered when controlling for race.

Statistical Power. Although power was considered a priori, prior to collection of data for the original study upon which these data are derived, we also conducted post-hoc power analyses to determine whether these specific multilevel analyses were adequately powered. To do so, we followed recommendations for conducting Monte Carlo simulations in MPlus for multilevel analyses (Bolger & Laurenceau, 2013). In particular, we utilized the sample size, the overall number of surveys completed by participants, and the estimates of fixed effects in the results below to calculate observed power for the analyses of interest.³ Here, we focus on power for focal effects only (i.e., the key two- and three-way interactions in the growth curve and dose response analyses predicting positive and negative emotions). With respect to attachment anxiety, in the growth curve analyses, the two-way interaction between attachment anxiety and time was well-powered when predicting both positive (observed power = .94) and negative (observed power = .99) emotions. Moreover, the three-way interaction between time, condition, and attachment anxiety was well powered when predicting both positive (observed power = 1.00) and negative (observed power = 1.00) emotions. In the dose-response analyses, the two-way interactions between attachment anxiety and daily minutes of meditation were well-powered

³ For the sake of parsimony given our highly complex models (i.e., testing three-way interactions in the context of multilevel models), all Monte Carlo simulations were conducted assuming random intercepts and fixed slopes.

when predicting both positive (observed power = .96) and negative emotions (observed power = 1.00), yet (likely reflecting the smaller fixed effects), the three-way interactions between daily minutes of meditation, attachment anxiety, and meditation condition were underpowered when predicting both positive (observed power = .64) and negative emotions (observed power = .51). With respect to attachment avoidance, reflecting their small and non-significant effects, nearly all of the two- and three-way interactions were underpowered in both the growth curve and dose-response analyses. That is, with the exception of the two-way interaction between attachment avoidance and Time in predicting negative emotions in the growth curve analyses (where observed power was .99), observed power for all other two- and three-way interactions between attachment avoidance and the other outcome variables was .68 or below.

Study materials used here, along with a data set that includes computed study variables and our analysis code are available on the Open Science Framework (URL tbd).

Results

Descriptive statistics and bivariate correlations for primary study variables are presented in Table 1.

Anxious Attachment and Meditation Training

We first examined the effect of anxious attachment on emotion responses in MM (H1) and LKM (Competing H2a, b). Results of growth curve analyses examining whether attachment anxiety influences trajectories of positive and negative emotions across the course of the intervention period are presented in Table 2. The coefficient for day was significant ($B = 0.004$, $p = .001$), indicating participants experienced positive changes in positive emotions across the course of the study (reported previously in West et al., under review). Specifically, the unstandardized coefficient demonstrated participants experienced a 0.004 increase in positive

emotions each day, or an increase of 0.31 points across the 70 days in which participants provided nightly reports. While no main effects emerged for attachment anxiety or avoidance, and the two-way interaction between day and attachment anxiety was not statistically significant, a significant three-way interaction emerged among day, condition, and attachment anxiety ($B = -0.003$, $p = .038$, effect size $r = .22$), and this interaction is plotted in Figure 1. To decompose the interaction, we conducted simple slopes analyses to examine participants' changes in positive emotions across the intervention in each meditation condition (MM vs. LKM) at low and high levels ($\pm 1SD$) of attachment anxiety. With respect to participants in the MM condition, results demonstrated that when attachment anxiety was high, participants reported significant positive changes in positive emotions across the course of the study ($B = .008$, $p < .001$). When attachment anxiety was low, participants in the MM condition did not report changes in positive emotions across the course of the study ($B = .001$, $p = .55$). However, participants at *average* levels of attachment anxiety in the MM condition reported significant positive changes across the course of the study in positive emotions, $B = .004$, $p = .004$. In the LKM condition, regardless of whether their attachment anxiety was low ($B = .004$, $p = .08$) or high ($B = .001$, $p = .52$), participants did not demonstrate statistically significant changes in positive emotions across the course of the study, supporting neither competing hypotheses (H2a, b).⁴ Thus, those with *moderate* or *high levels* attachment anxiety appeared to especially benefit in terms of their positive emotions from training in mindfulness meditation in particular, supporting H1.

Turning our attention to negative emotions and attachment anxiety, results in Table 2 demonstrate that day was a significant predictor of negative emotions ($B = -0.003$, $p < .003$), such that participants tended to decrease in negative emotions across the course of the study

⁴ Participants at average levels of attachment anxiety also did not report statistically significant changes in positive emotions across the course of the study, $B = .002$, $p = .08$.

(reported previously in West et al., under review). Participants higher in attachment anxiety also reported generally greater levels of negative emotion during the study ($B = 0.10, p = .02$). The two-way interaction between day and attachment anxiety was statistically significant ($B = -0.002, p = .009$), however this interaction was qualified by a significant three-way interaction between day, condition, attachment anxiety ($B = 0.002, p = .004$, effect size $r = .29$). We plot the three-way interaction in Figure 2, and decomposed it using simple slopes analyses. Specifically, we examined whether participants reported changes in negative emotions across time depending on (a) their attachment anxiety, and (b) meditation condition. As shown in Panel A of Figure 2, when participants were higher in attachment anxiety and in the MM condition, they experienced significant decreases in negative emotions across the course of the intervention ($B = -.007, p < .001$), whereas when participants were lower in attachment anxiety and in the MM condition, they did not experience decreases in negative emotions across the course of the intervention ($B = -.0001, p = .92$). Participants at average levels of attachment anxiety also reported decreases in negative emotions when they were in the MM condition ($B = -.003, p < .001$). As shown in Panel B of Figure 2, regardless of whether their attachment anxiety was high ($B = -.001, p = .19$) or low ($B = -.002, p = .11$), participants in the LKM condition did not experience significant changes in their negative emotions.⁵ Thus, with respect to negative emotions, participants only statistically significantly benefited when they (a) reported moderate to high attachment anxiety, and (b) engaged in mindfulness meditation practice, again supporting H1 with no support for

⁵ Surprisingly, however, participants at *average* levels of attachment anxiety did experience significant decreases in negative emotions across time, $B = -.002, p = .034$. Because of this, we conducted an additional analysis in which we tested whether there was a curvilinear link between attachment anxiety and negative emotions across the course of the interaction, and whether this depended on meditation condition. Results of this analysis are presented in Ancillary Table S1 in the OSM. In this analysis, the three-way interaction between time, condition, and the quadratic component for attachment anxiety was statistically significant, suggesting that there was a curvilinear link between attachment anxiety and negative emotions across the course of the study depending on condition. As such, it appears that people at average levels of attachment anxiety, but not at low or high levels of attachment anxiety, are especially likely to experience decreases in negative emotions when they are in the loving kindness condition.

either competing hypotheses (H2a, b). (with the exception of people at *average* levels of attachment anxiety, who also experienced decreases in negative emotions in the LKM condition, partially supporting competing hypothesis H2a, see Footnote 5).

Results of analyses examining whether attachment anxiety moderated the association between daily meditation practice and daily positive and negative emotions are presented in the Table 3. With respect to positive emotions, even after controlling for prior day positive emotions ($B = 0.02, p = .046$), the within-persons coefficient for daily meditation practice was significant ($B = 0.01, p < .001$), suggesting when people engaged in greater than usual meditation on a particular day, it was associated with greater positive emotion on that day. While the between-person coefficient was not statistically significant ($B = 0.02, p = .16$), a significant two-way interaction emerged between the within-person daily meditation variable and attachment anxiety in predicting daily positive emotions ($B = 0.005, p = .01$, effect size $r = .28$). This interaction is plotted in Panel A of Figure 3. Simple slopes analyses at low and high levels of attachment anxiety demonstrated that when attachment anxiety was high, greater than usual engagement in meditation on a particular day was associated with greater positive emotions on that day ($B = 0.01, p < .001$). This same effect emerged for individuals with average levels of attachment anxiety ($B = 0.01, p < .001$). When attachment anxiety was low, however, greater than usual daily meditation was not associated with positive emotions on that day ($B = 0.002, p = .30$). No three-way interaction emerged among condition, attachment anxiety, and daily meditation (either between or within persons), suggesting that the daily positive emotional benefit that people higher in attachment anxiety experience as a result of greater engagement in meditation does not depend on the type of meditation they practice, supporting both H1 and Competing H2a.

With respect to daily meditation practice and negative emotions, after controlling for prior day negative emotion ($B = 0.36, p < .001$), the within-person meditation variable was negatively associated with negative emotions, such that people who engaged in greater than usual meditation on a particular day reported fewer negative emotions on that day ($B = -0.003, p = .03$). As with positive emotions, the two-way interaction between within-persons daily engagement in meditation and attachment anxiety was statistically significant in predicting negative emotions ($B = -0.005, p = .002$, effect size $r = .30$), and results of this interaction are plotted in Figure 3, Panel B. Results of simple slopes analyses demonstrated that when people were higher in attachment anxiety, they reported fewer negative emotions on days in which they reported greater than usual engagement in meditation ($B = -.007, p < .001$). This same effect emerged for individuals with average levels of attachment anxiety ($B = -0.003, p = .03$). When participants were lower in attachment anxiety, however, greater than usual meditation on a particular day was not associated with their negative emotions on that day ($B = .001, p = .48$). The three-way interaction among meditation condition, within-person daily meditation, and attachment anxiety was not significant ($B = .002, p = .24$), suggesting that the interaction between attachment anxiety and daily engagement in meditation did not depend upon condition, again supporting H1 and Competing H2a.

Avoidant Attachment and Meditation Training

Next, we examined the effect of avoidant attachment on emotion responses in MM (H3) and LKM (Competing H4a, b). Results of growth curve analyses examining how attachment avoidance predicted positive and negative emotions across the course of the intervention period are presented in Table 4. With respect to positive emotions, attachment avoidance did not moderate the association between day and positive emotions ($B = 0.001, p = .55$), and no three-

way interaction emerged among day, attachment avoidance, and condition ($B = -0.001, p = .43$). Thus, greater attachment avoidance did not influence the extent to which people experienced positive emotions as a result of meditation across time. With respect to negative emotions, the two-way interaction between attachment avoidance and day was statistically significant ($B = 0.001, p = .047$, effect size $r = .20$), however no three-way interaction emerged among day, attachment avoidance, and condition ($B = 0.001, p = .32$). The interaction between day and attachment avoidance in predicting negative emotions is presented in Figure 4. When attachment avoidance was high, participants reported significant decreases in negative emotions across the course of the study ($B = -.004, p < .001$), however when attachment avoidance was low, participants did not report decreases in negative emotions across the course of the study ($B = -.001, p = .13$). These results suggest that while avoidant individuals may not experience longitudinal shifts in positive emotions, they may experience reduced negative emotions, regardless of the type of meditation they practice, providing support for H3 and Competing H4a.

Results of dose-response analyses examining whether attachment avoidance moderated the association between daily meditation and daily positive and negative emotions are presented in Table 5. The two-way and three-way interactions were all not statistically significant, for both positive and negative emotions. Thus, these analyses suggest that, regardless of whether participants meditated (a) to a greater extent than other people in the study (between-persons), or (b) greater than usual on a particular day (within-persons), the emotional benefit of this meditation did not depend on attachment avoidance, providing no support to H3, H4a or H4b.

Ancillary Analyses

After conducting these primary analyses, we re-examined each model to test whether the primary findings of interest were altered when including race as a covariate. Results of these

analyses are presented in the Online Supplemental Materials for this manuscript (OSM), in Tables S2-S5. Although some mean level differences in emotional experiences emerged across the intervention period between Black participants and White participants, all of the substantive findings of interests were comparable when controlling for of race. For example, with respect to the growth curve analyses for attachment anxiety (H1 & Competing H2a,b), even when controlling for race, the three-way interaction between day, attachment anxiety, and condition in predicting both positive and negative emotions over time remained statistically significant (Table S2).⁶

Discussion

Extensive research on insecure attachment has documented its relationship to difficulties regulating emotion, as well as associated downstream consequences for physical, psychological and social health and well-being. Yet, prior research has scarcely examined whether meditation practice, a relatively common health behavior utilized for improving emotional well-being, leads to beneficial shifts in emotion profiles of those who struggle most with emotion regulation (i.e., anxious or avoidantly attached individuals). Here, we provide the first evidence to our knowledge that initiating a practice of mindfulness meditation or loving-kindness meditation is especially likely to improve emotion profiles for individuals with greater attachment insecurity.

⁶ In addition to including race as a covariate in our primary analyses, we also conducted analyses to ensure that participants of different racial and ethnic backgrounds did not have different affective responses to the meditation interventions more generally. To do so, we conducted a series of growth curve and dose response analyses in which we specified race as a moderator of the (a) the influence of time on positive and negative emotions (in the growth curve analyses), and (b) the influence of daily minutes meditated on daily positive and negative emotions (in the dose-response analyses). In both sets of analyses, participants who identified as Black or African-American and participants who identified as another non-white race demonstrated no statistically significant differences from participants who identified as White in terms of their affective experiences in response to meditation, and this was true regardless of meditation condition. Thus, in sum, prior to considering attachment orientation, results suggested that participants had a similar affective response to the meditation interventions regardless of their racial identity

In line with Hypothesis 1, our findings suggest those with greater attachment anxiety particularly benefit from meditation practice. Specifically, with respect to longitudinal changes in emotion across the course of ten-weeks, relative to others, adults with moderate to high attachment anxiety experienced significantly larger improvements in positive emotions and reductions in negative emotions over the course of the study when randomly assigned to receive training in mindfulness meditation for six-weeks (supporting H1), but *not* when randomly assigned to receive training in loving-kindness meditation (failing to support either Competing H2a or H2b). Relative to other individuals, participants lower in attachment anxiety did not experience changes across the intervention in either positive or negative emotions regardless of which meditation training they received. Concerning same-day emotion changes, those with moderate to high attachment anxiety who meditated more than usual on a given day relative to other days, experienced significant boosts in positive emotions and significant reductions in negative emotions in *both* mindfulness meditation and loving-kindness meditation conditions, supporting H1 & Competing H2a. In concordance with the longitudinal findings, regardless of condition, those lower in attachment anxiety did not experience same-day changes in emotion experience when meditating more than usual. Together, this evidence suggests those with greater attachment anxiety particularly experience beneficial shifts in emotion profiles over time with mindfulness meditation training, and experience same-day emotional benefits when engaging in either meditation practice. Concerning attachment avoidance, we found less evidence that attachment avoidance moderated the influence of meditation training on emotions across time or in daily life in this particular sample (H3 & H4a,b). Specifically, the one instance where higher attachment avoidance moderated the influence of meditation was in reducing negative emotions across the course of ten-weeks and this did not depend on whether individuals were practicing MM or

LKM, providing partial support for H3 and H4a. We note, however, that this analysis was underpowered, and it was the only instance in which attachment avoidance contributed to the influence of meditation on affective outcomes. As such, while we discuss this finding below, we interpret it with caution.

Attachment Anxiety, Avoidance, and Emotion Responses to Meditation

A clear and prominent finding of this research is that individuals with moderate to high attachment anxiety were especially likely to experience affective benefits in response to meditation training. In dose-response analyses, participants with moderate to high levels of attachment anxiety experienced same-day emotion benefits from either mindfulness meditation or loving-kindness meditation. In longitudinal analyses, however, these same participants were especially likely to benefit from mindfulness meditation. Thus, while people with moderate to high levels of attachment anxiety appear to derive greater benefit than those lower in attachment anxiety from meditation in general (i.e., both forms of meditation), our results suggest that mindfulness meditation may carry particular affective benefits for people with moderate to high levels of attachment anxiety. Why might this be the case? Mindfulness meditation has consistently been linked to greater regulation of positive and negative emotions (for a review see Roemer et al., 2015; Fredrickson et al., 2017; Eberth & Sedlmeier, 2012), and thus may be particularly suited for anxiously attached individuals, who tend to struggle most with emotion regulation. Our findings suggest that mindfulness meditation training may dampen the hyperactive regulation style characteristic of anxious attachment, possibly through cultivating equanimous and decentered states of conscious experience, thereby reducing negative reactivity or ruminating thought patterns (Feldman et al, 2010). A direct test of these speculations in future work would provide evidence and understanding for how mindfulness meditation may be having

such potent effects on anxiously attached individuals. Furthermore, those low in attachment anxiety did not experience changes in emotion across the intervention, likely due to already effective emotion regulation characteristic of secure attachment (Shaver & Mikulincer, 2007; Henschel et al., 2020). Indeed, as evident in the correlations between attachment styles and baseline emotions presented in Table 1, individuals lower in attachment anxiety also report fewer negative emotions even before their meditation workshop began. A possible avenue for future research is to investigate whether these shifts in emotion for anxiously attached individuals also predict shifts in social outcomes or improve attachment insecurities.

Concerning those with greater attachment avoidance, little evidence emerged that these individuals benefited any more or less than those lower in avoidance, or compared to those with greater anxious attachment. While greater attachment avoidance did predict significant reductions in negative emotions over time, this did not depend on whether or how much they practiced mindfulness meditation or loving-kindness meditation. We note, however, that absent a no-meditation control group, we cannot determine whether either meditation (or both) caused these reductions, or, instead whether these reductions would have emerged with time regardless for extraneous reasons (e.g., due to providing daily self-reports of emotions). Additionally, neither meditation style improved positive emotions or influenced same-day emotion experiences for individuals higher in attachment avoidance. Because highly avoidantly attached individuals may already have dampened emotion experiences, fostering greater detached awareness through mindfulness meditation may not lead to noticeable changes in emotion, while the purposeful cultivation of positive emotions during loving-kindness may either be met with resistance or potentially backfire by making individuals feel worse, as can happen when inauthentically forcing positive feelings (Mauss et al., 2011). Perhaps by focusing on first reducing negative

emotions, as we observe in our sample, individuals higher in attachment avoidance may later be more open to, or cultivate with more ease, positive, warm emotion states. Although some work has investigated improving positive experiences and emotions for avoidantly attached individuals within romantic relationships (Stanton, Campbell, & Pink, 2017), individuals higher in attachment avoidance without close partners may particularly benefit from improved positive emotions so that they may be more open to entering into a close, intimate relationship in the first place.

While loving-kindness meditation may lead to same-day boosts in positive emotions and reductions in negative emotions for individuals higher in attachment anxiety, our findings suggest this practice may be less beneficial over time for these individuals compared to mindfulness meditation. Surprisingly, however, a curvilinear effect on negative emotions emerged for anxious attachment among those who practiced loving-kindness meditation (see Footnote 5). Whereas for those low and high in attachment anxiety loving-kindness meditation did not alter negative emotions over time, those with average levels showed significant reductions. We speculate that this suggests that for individuals high in attachment anxiety, purposefully cultivating warm, positive emotions states does not reduce negative feelings (or improve positive emotions for that matter), yet those with *moderate* levels of attachment anxiety may be soothed by the practice, leading to reduced negative emotions over time. However, given that the observed curvilinear effect was unexpected and did not emerge in other analyses, replication is needed.

Based on our findings, it does not appear that people who have attachment insecurities, often stemming from childhood experiences, benefited more from a social-focused meditation (i.e., LKM), yet neither did they respond particularly negatively to it. In fact, while positive

emotion gains in the mindfulness meditation condition were associated with insecure attachment, it could be the case that the purposeful cultivation of warmth and compassion during loving-kindness meditation may come easier, and lead to greater gains in positive emotions, for those more securely attached. In this particular sample, those low and moderate in attachment anxiety who practiced loving-kindness meditation showed marginally significant trends ($p = .08$) toward increased positive emotions over the course of the study. While we hesitate to interpret marginally significant findings, we note that this trend is consistent with theory suggesting attachment security, like positive emotions, fosters a broaden-and-build cycle (Mikulincer & Shaver, 2007b; Fredrickson, 2013). In other words, individuals who feel safer in their relationships may be more inclined to experience positive emotions, which allow for greater exploration, expanded perspectives, and building of consequential resources. Attachment security is also thought to be foundational for being open, kind, and generous to the self and others (Shaver, Mikulincer, Sahdra & Gross, 2017). Thus, future research should test whether attachment security predicts greater gains in positive emotions in a larger and more general sample, one not restricted by low early life SES.

In a similar vein, we speculate that reaping the potential emotional benefits from training in loving-kindness meditation may depend on having previously built a foundation of mindfulness skills. Indeed, dispositional mindfulness is regularly associated with attachment security (Goodall et al., 2012; Mikulincer & Shaver, 2007a; Pepping & Duvenage, 2016). Although many meditation training programs teach MM and LKM together, we are unaware of any work that has investigated optimal ways to deliver and combine training in MM and LKM. For example, research could test whether training in MM followed by training in LKM carries more benefit than training in MM or LKM alone. Whereas other research has found greater

effects of LKM on health-related biomarkers, relative to MM or waitlist controls (Le Nguyen et al., 2019), subpopulations with greater difficulties cultivating positive emotions, such as those with early life adversity or attachment insecurities, may benefit more from a training format that combines LKM with MM.

Implications for Research on Relationships and Attachment

One contribution of the current work is to demonstrate how individuals with moderate to high levels of attachment anxiety may influence their own affective experiences via meditation. Prior research has often focused on the role of relationship partners -- such as intimate partners -- in beneficially influencing an individual's attachment style (e.g., Arriaga et al., 2018; Arriaga et al., 2014), or in buffering the deleterious influence of attachment on key outcomes (e.g., Park et al., 2019). Because attachment theory posits that individuals' models of attachment are forged within significant relationships, it makes logical sense that prior research has largely focused on how a partner's behavior can beneficially influence a target individual's outcomes. Our research addresses a novel and previously underexplored question: do people high in attachment insecurity need to rely solely on other people to regulate their affective responses? Our results suggest not, and point to meditation as one solo pursuit (i.e., an activity that does not rely on the presence of another person) that people high in attachment anxiety can use to enhance their own affective experiences.

Implications for Mid-life Adults Raised in Low-income Households

Whereas the present study tests attachment insecurity and emotion responses to meditation in a unique sample of at-risk adults, replication in broader samples is necessary to test the generalizability of these findings. Yet, for this specific sample, the present findings on the emotional benefits of meditation are particularly promising in light of evidence linking higher

rates of attachment anxiety and/or greater sensitivity to its effects among those raised in low SES homes, both of which are associated with greater risk of poor late-life health (Murdock & Fagundes, 2017; Miller, Chen & Parker, 2011; Johnson et al., 2018). Because all people across SES levels may develop attachment insecurities, we would still expect anxiously attached individuals with higher SES to emotionally benefit from meditation training, particularly mindfulness meditation, although effects of meditation training as a function of attachment insecurity may be weaker, when compared to those with a low SES background. Adults raised in lower SES households have been described as more sensitive to the effects of insecure attachment, and tend to have lower baseline positive emotions and greater negative emotions (Chiang et al., 2015; Murdock, LeRoy & Fagundes, 2016). Thus, we suspect that because a higher SES population may have less variability in rates and magnitude of insecure attachment, they may accordingly have less room for improvement in their emotion profiles. Furthermore, we might expect a higher SES population to have greater responses to loving-kindness meditation over time, to the extent they exhibit a weaker influence of attachment insecurities and consequently fewer potential threats. Beyond replication in a broader sample, future work is needed to link beneficial shifts in emotion profiles to improved biological outcomes and to tease apart whether increased positive emotions or decreased negative emotions, both or neither, drive any observed biological changes. One study, for example, found evidence that after exposure to a rhinovirus, low early life SES predicted greater cold incidence as mediated by lower positive emotions (Murdock, LeRoy & Fagundes, 2017). This suggests that increasing positive emotions may play a greater role in improving health outcomes than is typically assumed.

Strengths & Limitations

The present study has several notable strengths. For one, participants completed daily emotion reports for a total of 10 weeks. Having densely-repeated assessments of emotions allows for powerful tests of change over time, as well as the ability to assess within-person changes. Whereas some research has raised the concern that the assignment to provide daily emotion reports may act as an intervention in itself by increasing awareness of one's emotion states (for example see Conner & Reid, 2012), other research has not found daily reporting to impact emotion experiences (De Vuyst et al., 2019). In our own past work that compared a similar LKM intervention to a randomized no-intervention monitoring control condition, we have also not found daily self-reports of emotion to influence respondents' emotions over time (Fredrickson et al., 2008). Thus, the effect of reporting daily on one's emotions is likely small, if any. Another strength of the present study is successfully recruiting a unique sample of midlife adults raised in low-income households, a subgroup who may carry higher rates of insecure attachment, or greater sensitivities to the consequences of insecure attachment, and thereby face elevated health risks. The sample recruited was also racially diverse. As low-income households are disproportionately Black or Hispanic, whereas meditation interventions tend to attract White and higher SES participants, our findings extend the emotional benefits of meditation to groups typically underrepresented in well-being research.

This study also has several limitations. First, this research was not preregistered. We call for preregistered replication attempts by independent research teams. Plus, although we randomized participants to conditions, we did not have a no-intervention control group, which limits our ability to draw causal conclusions. For instance, one recent study (Karremans et al., 2020) demonstrated that mindfulness training did not improve relationship well-being above and beyond an active control (relaxation training). Although the current research is concerned with

different outcomes, we note here that future research is needed to replicate our findings with an active control that does not involve meditation of any sort. Additionally, while we test dose-response relationships between meditation engagement and emotion experience, we did not manipulate the dosages of meditation practice. That is, participants were allowed to freely choose how much time they engaged in meditation outside of class. Thus, we cannot support causal claims about the frequency of meditation on emotion experience, as a number of factors and choices may lead participants to engage in meditation at varying frequencies or durations. These unaccounted factors may also partly explain, for example, why same-day effects of daily loving-kindness meditation for those higher in anxious attachment emerged, yet did not translate to significant improvements in emotion profiles over the course of the intervention. We do, however, attempt to mitigate this concern by statistically controlling for previous-day emotions. Lastly, we note that a potential limitation of the intervention is the absence of any effort to tailor the intervention to be accessible to a racially and socio-economically diverse demographic. For example, several researchers have called for greater consideration in developing culturally relevant mindfulness meditation interventions, such as greater representation of Black and Brown individuals in reading materials and instructors, as well as connecting material to culturally relevant religious or spiritual principles (Woods-Giscombé & Gaylord, 2015; Proulx et al., 2018). Such efforts stand to optimize the benefits of MM to address health disparities based on differences in race or social class.

Conclusion

The present study investigated how the emotion profiles of individuals with anxious and avoidant attachment shift, both across time and on a particular day, as these individuals undertake formal training in either mindfulness meditation or loving-kindness meditation. In a

sample of midlife adults raised in low socio-economic status households, which may exhibit higher rates of attachment insecurity and/or greater sensitivities to the consequences of attachment insecurity, we find that individuals with average to high levels of attachment anxiety particularly benefit from mindfulness meditation in terms of longitudinal boosts in positive emotions and reductions in negative emotions. However, both meditation practices improved same-day positive emotions and reduced same-day negative emotions for those greater in attachment anxiety. Additionally, both meditation practices appeared to reduce negative emotions over time for those greater in attachment avoidance. These findings carry important implications for improving emotional health and well-being among those most at risk for negative mental and physical health outcomes in late-life. Future research is needed to replicate and extend these findings in broader samples

Table 1*Descriptive statistics and bivariate correlations for major study variables*

	<i>M</i>	<i>SD</i>	<i>p</i>	1	2	3	4	5
1. Baseline PE	1.64	0.82	.698	-				
2. Baseline NE	0.59	0.51	.355	.33**	-			
3. Attachment Anxiety	2.50	0.94	.804	-.18 [†]	.35**	-		
4. Attachment Avoidance	2.98	0.76	.567	-.14	.20*	.43**	-	
5. Meditation Minutes	10.0	7.71	.061	.21*	.04	-.08	.11	-

Note. Baseline positive (PE) and negative (NE) emotions reflects the average of week 2 daily reports. Meditation Minutes reflects the average minutes a day that participants engaged in meditation practice. Major study variables did not significantly differ by condition, as indicated by Independent sample t-tests. $p = .06^{\dagger}$ $p < .05$ * $p < .001$ **

Table 2

Results of Multilevel Growth Curve Analyses Examining Trajectories of Positive and Negative Emotions During the Intervention Period for Anxious Attachment

<i>Predictor</i>	Positive Emotions					Negative Emotions				
	<i>B</i>	<i>p</i>	95% CI		<i>r</i>	<i>B</i>	<i>p</i>	95% CI		<i>r</i>
			<i>Lower</i>	<i>Upper</i>				<i>Lower</i>	<i>Upper</i>	
Intercept	1.76	<.001	1.61	1.91	-	0.481	<.001	0.41	0.54	-
Day	0.004	.001	0.002	0.01	.34	-0.003	<.001	-0.004	-0.002	.42
Condition	0.06	.45	-0.09	0.20	.07	-0.002	.95	-0.070	0.06	.01
Attachment Anxiety	-0.04	.63	-0.21	0.13	.05	0.100	.02	0.019	0.18	.24
Attachment Avoidance	-0.12	.27	-0.32	0.09	.11	-0.012	.81	-0.112	0.09	.02
Day * Condition	0.00	.39	0.00	0.00	.09	0.001	.17	0.000	0.002	.14
Day * AttAnx	0.00	.35	0.00	0.00	.10	-0.002	.009	-0.003	-0.001	.26
Condition * AttAnx	0.08	.29	-0.07	0.24	.10	-0.007	.84	-0.081	0.066	.02
Day * AttAnx * Condition	-0.003	.038	-0.005	-0.001	.22	0.002	.004	0.001	0.004	.29

Note. AttAnx = Attachment Anxiety. Statistically significant focal predictors are presented in bold. Attachment anxiety was mean centered. Condition was coded as -1 = mindfulness, +1 = loving-kindness. Effect sizes here and in all subsequent tables were calculated according to the method used by Kashdan and Steger (2006; a t to r transformation): $r = \sqrt{(t^2/t^2 + df)}$.

Table 3

Results of Multilevel Analyses Examining the Association of Daily Engagement in Meditation on Daily Emotions for Anxious Attachment

<i>Predictor</i>	Positive Emotions					Negative Emotions				
	<i>B</i>	<i>p</i>	95% CI		<i>r</i>	<i>B</i>	<i>p</i>	95% CI		<i>r</i>
			<i>Lower</i>	<i>Upper</i>				<i>Lower</i>	<i>Upper</i>	
Prior Day Emotion	0.02	.046	0.001	0.04	.04	0.36	<.001	0.33	0.39	.43
Condition	0.06	.46	-0.09	0.21	.08	-0.01	.71	-0.06	0.04	.05
Day	0.004	<.001	0.002	0.005	.19	-0.002	<.001	-0.003	-0.002	.22
Daily Meditation – BP	0.02	.16	-0.01	0.04	.14	0.005	.17	-0.002	0.01	.17
Daily Meditation - WP	0.01	<.001	0.003	0.01	.45	-0.003	.03	-0.01	0.000	.23
Attachment Anxiety	-0.08	.39	-0.26	0.10	.09	0.08	.01	0.03	0.14	.34
Attachment Avoidance	-0.17	.12	-0.37	0.04	.16	-0.01	.81	-0.07	0.06	.03
COND * AttAnx	0.06	.47	-0.11	0.23	.07	0.005	.86	-0.05	0.06	.02
COND * Daily Med BP	0.02	.12	-0.004	0.04	.16	-0.004	.28	-0.01	0.003	.13
COND * Daily Med WP	0.00	.79	-0.003	0.003	.03	0.001	.82	-0.002	0.003	.02
Daily Med BP * AttAnx	-0.01	.68	-0.03	0.02	.04	0.001	.95	-0.01	0.01	.01
Daily Med WP * AttAnx	0.005	.01	0.001	0.01	.28	-0.005	.002	-0.01	-0.002	.30
Cond * AttAnx * Daily Med WP	-0.003	.11	-0.01	0.00	.18	0.002	.24	-0.001	0.005	.12
Cond * AttAnx * Daily Med BP	0.02	.21	-0.01	0.04	.13	-0.003	.39	-0.01	0.004	.10

Note. BP = between-persons, WP = within persons. AttAnx = attachment anxiety. Attachment anxiety was grand mean centered. Statistically significant focal predictors are presented in bold.

Table 4

Results of Multilevel Growth Curve Analyses Examining Trajectories of Positive and Negative Emotions During the Intervention Period for Avoidant Attachment

<i>Predictor</i>	Positive Emotions					Negative Emotions				
	<i>B</i>	<i>p</i>	95% CI		<i>r</i>	<i>B</i>	<i>p</i>	95% CI		<i>r</i>
			<i>Lower</i>	<i>Upper</i>				<i>Lower</i>	<i>Upper</i>	
Intercept	1.75	<.001	1.61	1.90	-	0.480	<.001	0.412	0.547	
Day	0.004	.001	0.001	0.006	.33	-0.003	<.001	-0.004	-0.002	.39
Condition	0.05	.51	-0.10	0.19	.07	-0.002	.963	-0.069	0.066	.00
Attachment Anxiety	-0.06	.52	-0.23	0.11	.06	0.095	.02	0.014	0.176	.23
Attachment Avoidance	-0.11	.32	-0.32	0.11	.10	-0.013	.80	-0.112	0.087	.02
Day * Cond	0.001	.41	-0.003	0.001	.09	0.001	.19	0.000	0.002	.13
Day * AttAv	0.001	.55	-0.002	0.004	.06	-0.002	.047	-0.004	-0.001	.20
Condition * AttAv	-0.12	.20	-0.32	0.07	.13	-0.060	.19	-0.149	0.030	.13
Day * AttAv * Condition	-0.001	.43	-0.004	0.002	.08	0.001	.32	-0.001	0.003	.10

Note. AttAv = Attachment avoidance. Statistically significant focal predictors are presented in bold. Attachment avoidance was mean centered. Condition was coded as -1 = mindfulness, +1 = loving-kindness.

Table 5

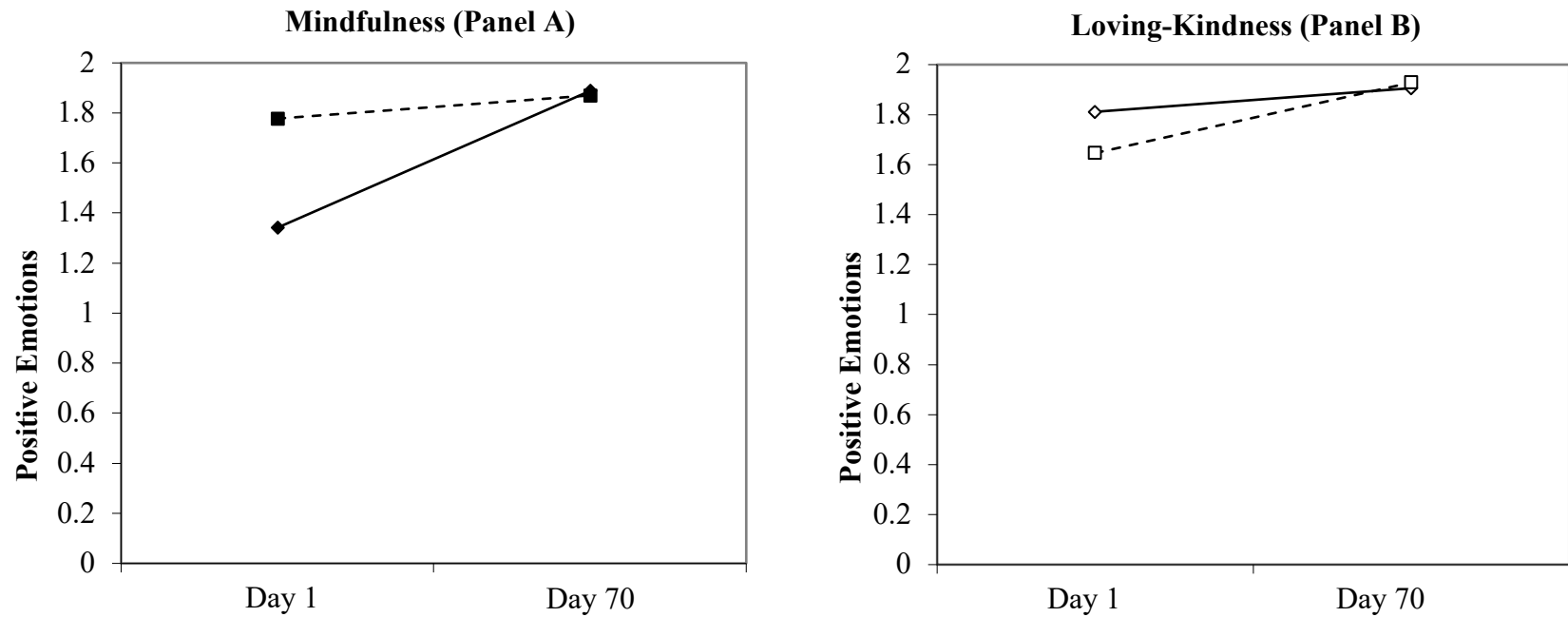
Results of Multilevel Analyses Examining the Association of Daily Engagement in Meditation on Daily Emotions for Avoidant Attachment

<i>Predictor</i>	Positive Emotions					Negative Emotions				
	<i>B</i>	<i>p</i>	95% CI		<i>r</i>	<i>B</i>	<i>p</i>	95% CI		<i>r</i>
			<i>Lower</i>	<i>Upper</i>				<i>Lower</i>	<i>Upper</i>	
Prior Day Emotion	0.02	.04	0.001	0.04	.04	0.36	<.001	0.33	0.39	.44
Condition	0.04	.60	-0.11	0.19	.05	-0.01	.57	-0.06	0.03	.07
Day	0.004	<.001	0.002	0.01	.19	-0.002	<.001	-0.003	-0.002	.22
Daily Meditation – BP	0.02	.09	-0.003	0.04	.17	0.01	.08	-0.001	0.01	.21
Daily Meditation - WP	0.01	<.001	0.003	0.01	.41	-0.003	.04	-0.01	0.000	.21
Attachment Anxiety	-0.07	.45	-0.24	0.11	.08	0.06	.02	0.01	0.12	.28
Attachment Avoidance	-0.16	.15	-0.37	0.06	.15	-0.001	.97	-0.07	0.07	.01
COND * AttAv	-0.17	.09	-0.37	0.03	.17	-0.05	.12	-0.11	0.01	.20
COND * Daily Med BP	0.01	.18	-0.01	0.04	.14	-0.004	.26	-0.01	0.003	.14
COND * Daily Med WP	0.000	.84	-0.004	0.003	.02	0.001	.83	-0.003	0.003	.02
Daily Med BP * AttAv	0.001	.94	-0.03	0.03	.01	0.004	.32	-0.004	0.01	.12
Daily Med WP * AttAv	0.001	.69	-0.003	0.01	.04	-0.001	.52	-0.005	0.002	.07
Cond * AttAv * Daily Med WP	-0.002	.26	-0.01	0.002	.12	0.002	.38	-0.002	0.01	.09
Cond * AttAv * Daily Med BP	-0.006	.65	-0.03	0.02	.05	-0.002	.68	-0.01	0.01	.05

Note. BP = between-persons, WP = within persons. AttAv = attachment avoidance. Attachment anxiety and attachment avoidance were grand mean centered.

Figure 1

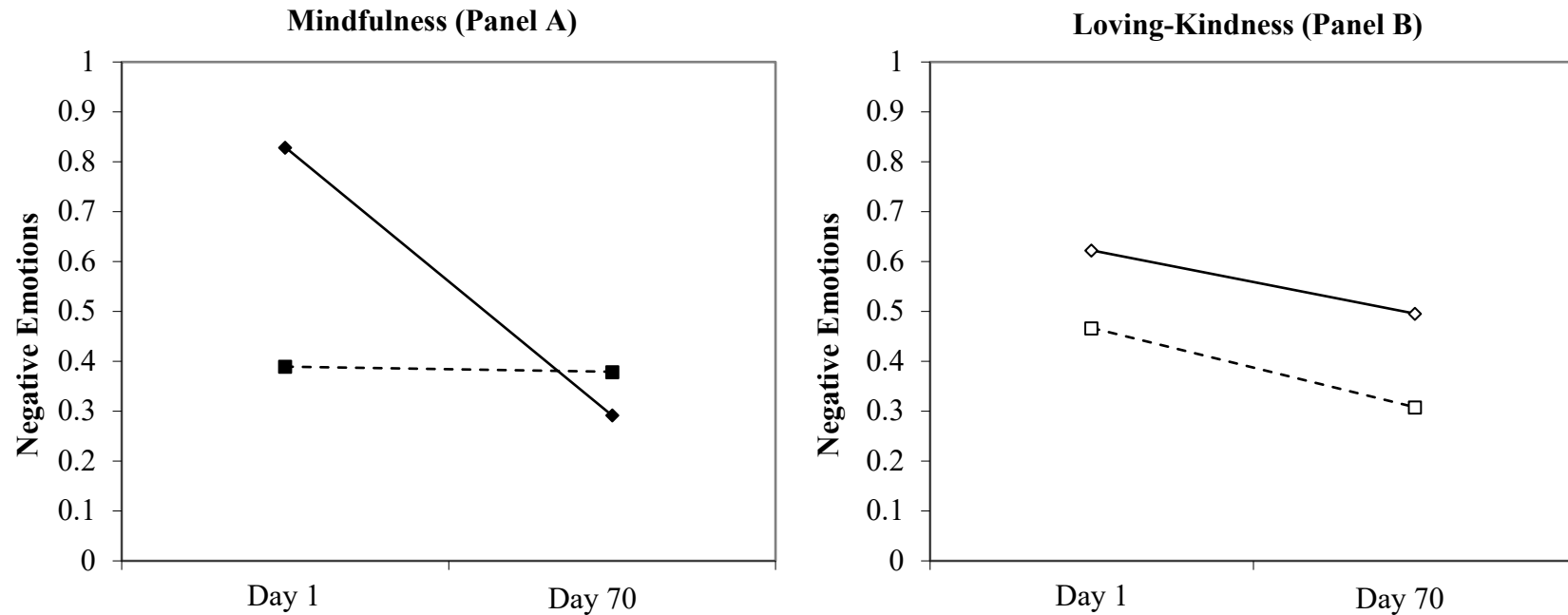
Trajectories of Positive Emotions Depending on Meditation Condition and Attachment Anxiety



Note. Solid lines refer to participants 1 *SD* above the mean in attachment anxiety, whereas dashed lines refer to people 1 *SD* below the mean in attachment anxiety. Day 1 was the first day participants reported their positive emotions (pre-intervention), and Day 70 was the last day people reported their positive emotions.

Figure 2

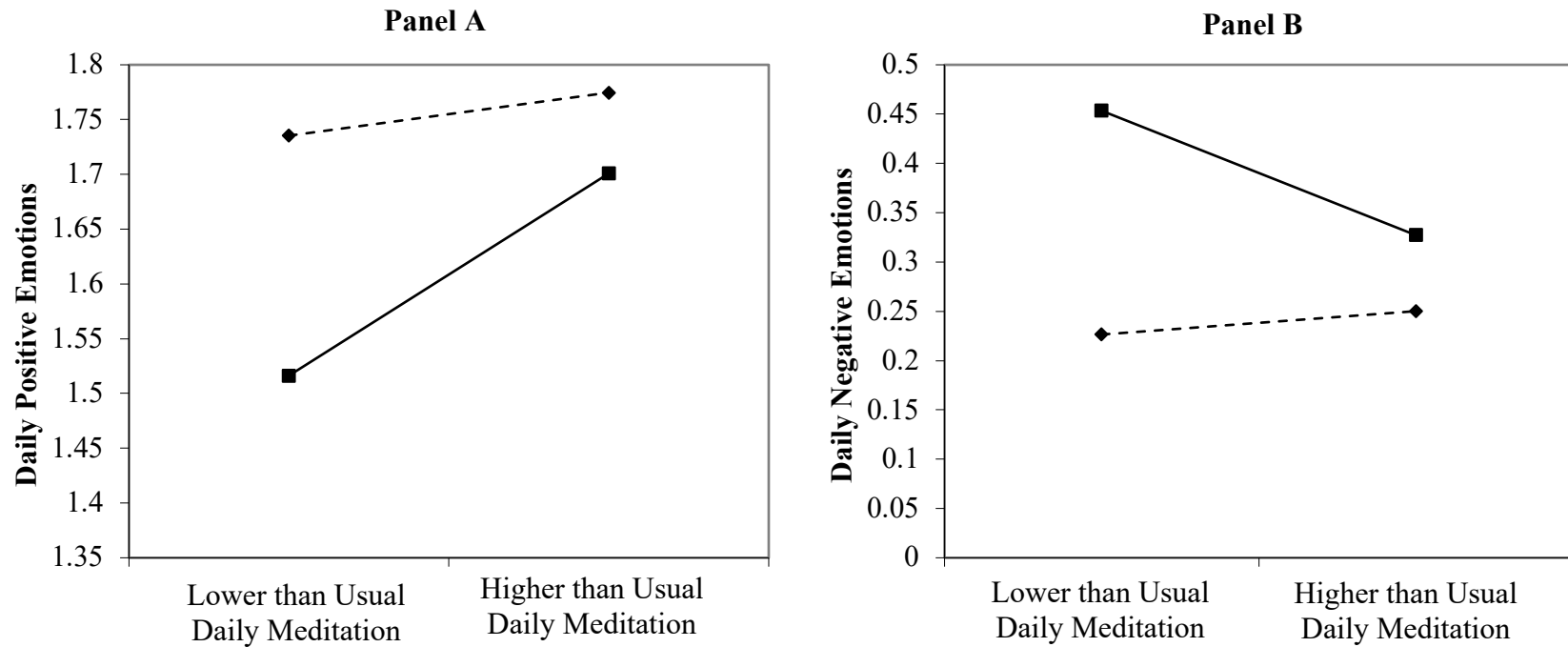
Trajectories of Negative Emotions Depending on Meditation Condition and Attachment Anxiety



Note. Solid lines refer to participants 1 *SD* above the mean in attachment anxiety, whereas dashed lines refer to people 1 *SD* below the mean in attachment anxiety. Day 1 was the first day participants reported their negative emotions (pre-intervention), and Day 70 was the last day people reported their negative emotions.

Figure 3

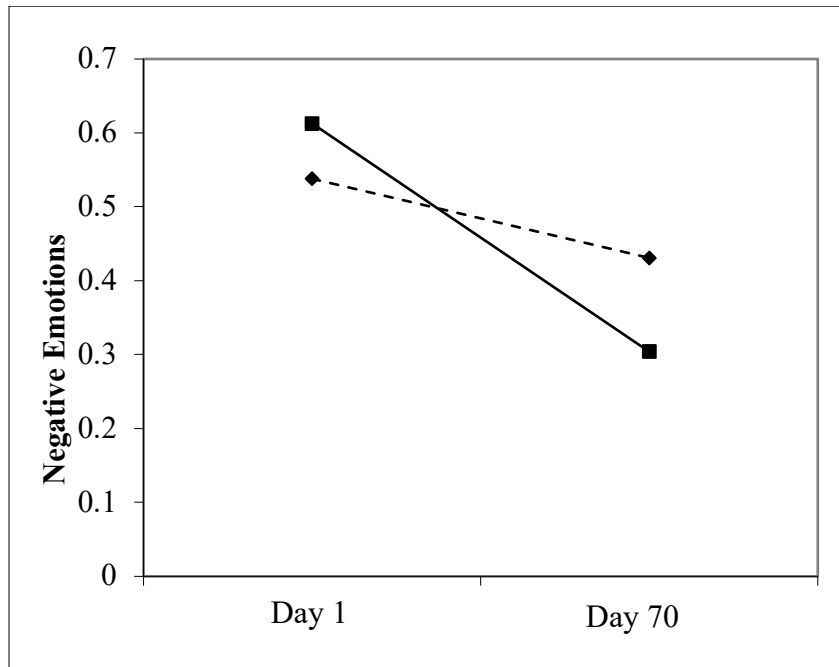
Daily Emotions Depending on Engagement in Meditation and Attachment Anxiety



Note. Solid lines refer to participants 1 *SD* above the mean in attachment anxiety, whereas dashed lines refer to people 1 *SD* below the mean in attachment anxiety.

Figure 4

Trajectories of Negative Emotions Depending on Attachment Avoidance



Note. The solid line refers to those high in attachment avoidance, whereas the dashed line refers to those low in attachment avoidance

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