2016

From Intra- to Inter-personal: Effects of Mindfulness Training on Emotion Regulation in Social Contexts

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FROM INTRA- TO INTER-PERSONAL: EFFECTS OF MINDFULNESS TRAINING ON EMOTION REGULATION IN SOCIAL CONTEXTS

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

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May, 2016

Acknowledgements

To the many mentors here at Virginia Commonwealth University and elsewhere for their clear guidance and sincere support, thank you. I would especially like to thank Dr. Kirk Warren Brown, chair of my committee and primary academic mentor, for his time, dedication, and precision. Thank you to my committee, Drs. Jeff Green, Scott Vrana, Zewe Serpell, and Fadel Zeidan. I am grateful for each committee member's constructive feedback and mentorship. I would also like to thank Drs. Peter Grossenbacher and Rebecca M. Todd for their mentorship on this project and beyond. Thanks to the Mind and Life Institute for the generous grant support that made this project possible. To my fellow graduate students and lab members, thank you for your direct and indirect support on this project, and special thanks to Sarah E. Braun and Alexandra Martelli. To the numerous individuals and research assistants who have provided practical support on this project, I greatly value your time and enthusiasm. Thanks especially to the following: Sara Freeman, David Johnson, Courtney Vaughan, Courtney Tat, Emily Ho, Marsha Wilson, Chris Kilbourn, Paul Drumond, Savannah Clements, Suzanne Merritt, Paul Plonski, Sera Davenport, Sarah Spencer, Elliot Lewis, Jenna Nystrom, and Nicole Robinette. I am also incredibly grateful to my parents for their love and care throughout my educational journey. Thanks also to all the other family members who have supported me throughout this process, and especially my grandparents. There are so many more to thank for their time, understanding, and kindness throughout this process on a personal and professional level. I look forward to thanking each of you personally. Finally, I would like to thank the participants of this study for their very important role in this research project.

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Abstract

FROM INTRA- TO INTER-PERSONAL: EFFECTS OF MINDFULNESS TRAINING ON EMOTION REGULATION IN SOCIAL CONTEXTS

By: Jordan T. Quaglia, MA, MS

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The social and emotional lives of people are highly interdependent. Incipient evidence suggests that attention may also play an essential role in determining one's social and emotional well-being. Mindfulness, as a manner of attending, entails greater moment-to-moment awareness to internal and external events, and is thought to have both intra- and inter-personal benefits. Here a study of mindfulness training (MT) examined whether training mindful attention would improve emotion regulation in social contexts as indexed by neural, behavioral, and experience sampling measures. More specifically, 60 participants in romantic relationships were randomly assigned to either four brief (20 min.) MT sessions or a structurally-equivalent control procedure. Romantic partners of these participants also completed questionnaires and experience sampling measures. Findings across the variety of measures supported hypotheses that MT would benefit social emotion regulation. Relative to control participants, those in MT demonstrated greater early attention to facial expressions on an Emotional Go/No-Go task, as indexed by the N200, a neural marker of conflict monitoring. Response time and accuracy during this task revealed more

sustained efficient discrimination of facial expressions for MT participants. During day-to-day social interactions, MT participants reported more positive and less negative emotion as well as less negative emotion lability from one interaction to the next. A mediation analysis found improved accuracy on the Emotional Go/No-Go task mediated the relation between MT and more positive emotion during daily social interactions. Given that social emotion regulation places unique demands on attention for which mindfulness appears well-suited, research on both topics can build from these findings to better understand both intra- and inter-personal benefits of MT.

From Intra- to Inter-personal: Effects of Mindfulness Training

on Emotion Regulation in Social Contexts

The emotional lives of human beings do not occur in a social vacuum. Ties between emotions and social functioning have been of longstanding interest to behavioral scientists (Darwin, 1872; Fox, 2002; Gross, 2002; Hareli & Hess, 2012; Niedenthal & Brauer, 2012; Mineka & Cook, 1993; Sorce & Emde, 1981; Shiota, Campos, Keltner, & Hertenstien, 2004; Zaki & Williams, 2013). Relatedly, emotion regulation, a term that encompasses *the variety of processes by which individuals modulate the presence, timing, and character of emotions and their expression* (Gross, 1998b; Gross & Thompson, 2007), has been understood to interact dynamically with the social environment (Aldao, 2013; Gross, 2002; Marroquín, 2011; Shiota et al., 2005). Indeed, the interpersonal nature of human emotional experience presents unique challenges and affordances for regulating emotion in social situations (Beckes & Coan, 2011; Zaki & Williams, 2013). Despite this recognition, most empirical research on emotion regulation to date has largely overlooked the social context in which emotion regulation is occurring (Aldao, 2013), and unique features of emotion regulation inherent in various social contexts have been largely of peripheral concern (Gross, 2013).

The Process Model of Emotion Regulation

The *process model of emotion regulation* (Gross, 1998a; 1998b) provides a valuable theoretical starting point for considering unique features of emotion regulation in social contexts. This process model builds upon the *modal model of emotion,* which views emotion generation as an unfolding process triggered by a situation that influences attention, appraisal, and subsequently a coordinated response (see Figure 1; Gross & Thompson, 2007, p. 7). From this perspective, emotion regulation strategies represent a wide range of behaviors that modulate emotional experience in a goal-related manner, including emotions that are anticipated in the distant future, building in strength, or that have developed into full-blown emotional episodes.

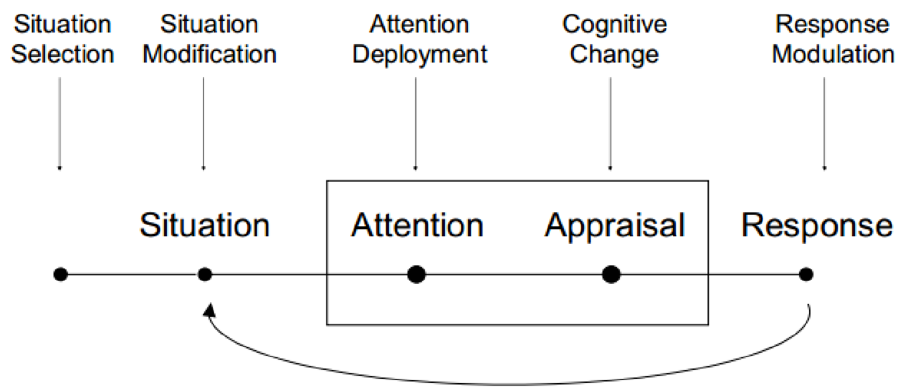

Figure 1. Emotion Regulation Strategies Mapped onto The Modal Model of Emotion. This figure illustrates the five major categories of emotion regulation (top) in a temporal sequence relative to their primary target of influence during emotion generation. Recognizing that responses can dynamically influence situations, the model allows for recursive feedback from emotional response to situation (Gross & Thompson, 2007, p. 7).

Serving as a foundation for a considerable body of emotion regulation research, the process model is a practical theoretical framework for organizing and motivating research on the diversity of emotion regulation processes. This model distinguishes emotion regulation processes across five general categories: situation selection, situation modification, attention deployment, cognitive change, and response modulation (Gross, 1998b; see Figure 1). These five categories represent an elaboration of a more basic distinction between antecedent- and response-focused regulation strategies, which distinguish processes according to their temporal ordering in an emotion generation sequence. Thus, the five general categories of emotion regulation can be illustrated in a temporal chain in relation to this modal model, as depicted in Figure 1.

Consistent with this framework, recent theoretical work has advanced our understanding of the relevance of timing in the operation of a given strategy relative to an emotion's generation. Sheppes and Gross (2011) delineate the divergent consequences of emotion regulation processes that occur earlier or later in the emotion generation sequence. This time-based division appears important for understanding variability in emotion regulation outcomes, as strategies that alter emotional experience very quickly (e.g., within seconds or even less than a second) after an emotional event appear to require less cognitive effort than strategies that occur further "downstream", when emotion generation is already well underway (Sheppes & Gross, 2011). Less effortful regulation strategies require fewer cognitive resources, and by intervening before emotions are well underway, the effectiveness of early strategies may be relatively unchanged according to level of emotional intensity (Sheppes & Gross, 2011). Nonetheless, certain early emotion regulation strategies may bear unique costs that strategies occurring later in the sequence do not.

For example, Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross (2011) compared the neural and subjective consequences of two strategies that represented early and late emotion regulation strategies, namely distraction (an attention deployment strategy involving attention to neutral rather than emotional psychological or situational content) and reappraisal (a cognitive change strategy involving reinterpretation of emotional events as neutral or positive). Consistent with theory (Sheppes & Gross, 2011), Thiruchselvam et al. (2011) found that distraction influenced the Late Positive Potential (LPP), an electrocortical marker of emotion regulation, earlier than reappraisal; however, upon re-exposure to emotion-eliciting stimuli, emotional reactivity to previously reappraised images was lower than for images previously viewed with distraction. Thus, although distraction may be preferable in the short-term because it is less effortful, distraction or similar strategies involving mental avoidance of emotion-eliciting events may be less effective than reappraisal for events that occur repeatedly. Like other regulation strategies that occur relatively late in the emotion generation sequence, however, reappraisal appears to be more effortful than early strategies such as distraction (Sheppes, Catran, & Meiran, 2009), and so appears to deplete cognitive resources important for subsequent self-regulation (Keng, Robins, Smoski, Dagenbach, & Leary, 2013). Thus it remains an important question whether there are other early attention deployment strategies that promote effective emotion regulation without the costs associated with distraction. Such strategies may be especially important for adaptive emotion regulation in social contexts, when the added challenge of accounting for others' emotions may demand more cognitive resources on an ongoing basis than when regulating on one's own.

Individual to Social Emotion Regulation

The value of the process model to emotion regulation research is due in part to the breadth and diversity of regulatory strategies encompassed by it; despite this breadth, the model has primarily motivated research with little attention to context (Aldao, 2013) or social and interpersonal emotion regulation (Gross, 2013). Consistent with the profoundly social nature of emotions and their expression (Tiedens & Leach, 2004), further consideration of unique processes and features of emotion regulation occurring in social contexts seems especially relevant. Indeed, upon examination of the process model literature, one finds many rich examples of emotion regulation in social contexts. Consider this illustration by Gross and

Thompson (2007) regarding the relevance of the process model for understanding emotion regulation in our social lives:

"Standing in a long line at the supermarket check-out counter…further slowed by a gossipy clerk… one prepares a scathing remark for the clerk. But, at the last moment, the thought crosses one's mind that a cutting comment will make a bad situation worse. And so one opts to bite one's tongue and keep one's mouth shut" (Gross & Thompson, 2007, p. 3)

Here we see features of the social context not only eliciting an emotional response, but also guiding emotion regulation. As is evident, emotion regulation in social contexts can require consideration of both one's own and others' emotional experience and regulatory goals. In this example, the individual regulates emotion only at the response modulation stage, after the emotion is already well underway. However, one could just as easily imagine a situation in which the person distracted themselves by thinking about their grocery list, or reappraised the clerk's behavior as stemming from their loneliness, motivating an empathic response. Each strategy may bear corresponding consequences, similar to how each strategy operates outside a social context. On the other hand, unique challenges and affordances of social situations may translate into unique consequences for using each strategy. For example, both distraction and reappraisal during an argument with one's romantic partner could mean missing content critical for conflict resolution.

Building on the process model's ingress into the social side of emotion regulation, and in recognition that most research to date has nevertheless focused on intrapersonal emotion regulation (Gross, 2002; 2013), recent theoretical (Beckes & Coan, 2011; Zaki & Williams,

2013) and empirical (Coan, Schaefer, & Davidson, 2006; Hallam et al., 2014; Mobbs et al., 2007) work has been aimed at more explicitly addressing emotion regulation in social contexts. To provide a distinct construct that broadly encompasses emotion regulation in social situations highlighted by these recent developments, I have adapted Gross' (1998b) definition of emotion regulation to define social emotion regulation as *processes by which individuals modulate the presence, timing, or character of one's own or others' emotion and its expression in a social context*. This approach permits explicit investigation of strategies that may promote effective emotion regulation in social situations, in light of both the unique challenges (e.g., attending and responding adaptively to others' emotions; Cacioppo, 2002; Eisenberg, Fabes, Guthrie, & Reiser, 2000; Eisenberg, Spinrad, & Morris, 2002; Hare et al., 2005) and affordances (e.g., relying on others for regulation; Beckes & Coan, 2011; Zaki & Williams, 2013). Since emotion regulation directly influences behavior generally, the construct of social emotion regulation may also be useful for investigating variation in the quality of social behavior and functioning.

Social Emotion Regulation and Quality of Social Functioning

Effective social emotion regulation may be an important determinant in the quality of social functioning (Gross, 2002; Niedenthal & Brauer, 2012). Ample research, including that addressing the relation between emotion regulation ability and peer-rated social skills (Lopes, Salovey, Coté, & Beers, 2005), the critical role of cognitive and affective empathy in high-quality social functioning (Baron-Cohen & Wheelwright, 2004), and the role of emotion regulation dysfunction in the initiation of interpersonal aggression and violence (Davidson, Putnam, & Larson, 2000; Denson, Pedersen, Ronquillo, & Nandy, 2009), suggests that variation in social emotion regulation may distinguish high- and low-quality social functioning. Effective emotion regulation in social situations can enhance the quality of social experience both directly (i.e., mitigating conflict) and indirectly (i.e., regulating oneself to modulate the emotional tone of interactions; Lopes et al., 2011). The result of better emotion regulation in social contexts might be evident in more effective interaction strategies (Furr & Funder, 1998), less social anxiety (Schmidt, Richey, Buckner, & Timpano, 2009), less distress contagion (Eisenberg & Eggum, 2009), and greater interpersonal sensitivity (Eisenberg et al., 2000; Lopes et al., 2005). Considering the relevance of high-quality social functioning for goal achievement and well-being, these findings underscore the potential wider relevance of investigating factors and strategies that promote effective social emotion regulation.

Disruptions in both emotion regulation and social functioning have been recognized as key features of diverse mental illnesses (American Psychological Association, 2000; Guthiel, 2005; Keltner & Kring, 1998). Many lines of research have shed light on the various ways that cognitive, emotional, and social processes interact, yet social emotion regulation provides a helpful construct for understanding relations between emotion regulation and social dysfunction. For example, deficits in empathy (Henry, Bailey, and Rendell, 2008) and emotional expressivity (Keltner & Kring, 1998) have proven important for understanding the social competence of individuals with schizophrenia; excessive reassurance seeking is a hallmark of depression (Joiner, Metalsky, Katz, & Beach, 1999); interpersonal deficits appear to precede the onset of depression in adolescents (Eberhart & Hammen, 2006); those with borderline personality disorder score higher in interpersonal distress and related problems (Trull, 1995); and maladaptive attention deployment to threat-related faces is thought to underlie the etiology and maintenance of social anxiety disorder (Hakamata et al., 2010; Horley et al., 2004; Bar-Haim et al., 2007). Thus, difficulty regulating emotion in social contexts could be considered an important transdiagnostic target for research, and may even play a causal role in the etiology and maintenance of some forms of mental illness. Accordingly, identifying factors that can promote healthy social emotion regulation could likewise generate knowledge with clinical value.

Mindful Social Emotion Regulation

Many of the unique challenges of social emotion regulation pertain to the presence of others' emotions, and skillful responding to both *one's own* and *others'* emotions is thus a key part of emotion regulation in social contexts (Zaki & Williams, 2013). Stemming primarily from the variety of ways interpersonal events can instigate, maintain, diminish, or amplify affective experience, the unique features of social emotion regulation suggest that effective regulation of this kind may depend critically on ongoing attention to, and awareness of, one's own and others' emotions. Awareness entails conscious experience generally; however, conscious reporting of information in awareness depends on sufficient attentional processing of that information (Lamme, 2003; 2004). Accordingly, previous research has demonstrated that emotion regulation strategies differ according to cognitive demand, including demands on attention, with consequences for awareness of affect-related information (Richards & Gross, 2000; Sheppes et al., 2009; Thiruchselvam et al., 2011).

If effective social emotion regulation necessitates both attention to and awareness of one's own and others' emotional processing, then those emotion regulation strategies that better afford such processing may be most effective for regulating emotion in social contexts. More specifically, psychological factors and strategies that entail enhanced attentiveness to one's own and others' affective experience may be especially effective in promoting adaptive social emotion regulation. In this manner, *mindfulness* involves a quality of attending to the present moment to promote greater awareness of both internal and external events (Anālayo, 2003; Brown & Ryan, 2003; Teasdale et al., 2000).

There is a rich diversity of conceptual definitions of mindfulness in the current scientific and scholarly literature on the topic. For example, mindfulness has been described as: “An alert but receptive, equanimous observation” (Anālayo, 2003, p. 60); “Watchfulness, the lucid awareness of each event that presents itself on the successive occasions of experience” (Bodhi, 2011, p. 21); “Paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally” (Kabat-Zinn, 1994, p. 4); “Open or receptive attention to and awareness of ongoing events and experience” (Brown & Ryan, 2004, p. 245). Notwithstanding such diversity, only some of which is represented here, most if not all definitions converge on the central importance of attention to moment-by-moment experience that promotes heightened ongoing awareness of inner and outer experience (Quaglia, Brown, Lindsay, Creswell, & Goodman, 2015). It is this quality of present-centered attention that may be most germane to understanding mindfulness as an emotion regulation strategy that could promote adaptive social emotion regulation.

Mindfulness as a Distinct Emotion Regulation Strategy. Incipient research on mindfulness has demonstrated that it can facilitate adaptive emotion regulation. Trait mindfulness has been associated with indices of effective emotion regulation, here understood as the presence and maintenance of positive emotional states and/or the buffering against negative emotions, in light of the fact that individuals generally aim to increase positive, and decrease negative, emotional states (Gross, 2013). Evidence for the relation between trait mindfulness and indices of effective emotion regulation has been found at multiple levels of analysis, including self-reported adaptive use of emotion regulation strategies (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007), ecological momentary assessments of emotional well-being in daily life (Hill & Updegraff, 2012), attenuated cortisol response in the face of social evaluative stress (Brown, Weinstein, & Creswell, 2013), and dampened electrocortical responses of early emotional appraisal (the LPP component) to motivationally salient unpleasant images (Brown, Goodman, & Inzlicht, 2013). Experimental studies on mindfulness interventions of various lengths have found that mindfulness training reduces negative subjective responses to aversive images (Arch & Craske, 2006), decreases emotional interference on cognitive tasks (Ortner et al., 2007), lowers the intensity and frequency of negative emotions (Chambers, Lo, & Allen, 2008), and decreases anxiety, negative affect, and rumination (Shapiro, Brown, & Biegel, 2007). A meta-analysis of both cross-sectional and intervention studies found small-to-medium effect sizes for mindfulness training-related decreases in anxiety and negative emotion, and for increases in positive emotion (Sedlmeier et al., 2012).

Despite a rich body of research on numerous emotion regulation strategies, new perspectives on processes that constitute emotion regulation (e.g., Todd, Cunningham, Anderson, & Thompson, 2013) indicate the importance of considering additional strategies that can broaden, and perhaps even challenge, theoretical models of emotion regulation. Thus, although mindfulness by definition concerns a quality of attention, ample mindfulness research on emotion regulation and emotional benefits generally has motivated broader consideration of mindful attention to emotional experience as a distinct emotion regulation strategy (Brown et al., 2013; Chambers, Gullone, & Allen, 2009; Chiesa, Serretti, & Jakobsen, 2013; Teper, Segal, & Inzlicht, 2013). This line of investigation includes incipient evidence demonstrating comparable or more effective emotion regulation through mindfulness compared to the commonly investigated cognitive change strategy of reappraisal (Keng et al., 2013; Opialla et al., 2014).

Conceptualizing Mindful Emotion Regulation. How does mindful emotion regulation fit within existing models of emotion regulation? Despite the growing literature on mindful emotion regulation, less work has focused on conceptualizing what this entails. Notwithstanding unique features of mindfulness as an emotion regulation strategy (cf. Chiesa et al., 2013; Teper et al., 2013), mindful emotion regulation thus far appears to fit best within the process model of emotion regulation (Gross, 1998b; see Figure 1). Specifically, mindful emotion regulation appears to be an attention deployment strategy (Arch & Landy, 2015; Brown et al., 2013). Like distraction, the most researched attention deployment strategy, the modulation of emotion through mindfulness occurs via attention. However, unlike distraction, which entails attentional avoidance of emotional experience, mindful emotion regulation appears to involve turning attention toward affective events and experiences (Arch & Craske, 2010; Arch & Landy, 2015; De Raedt, Baert, Demeyer, & Goeleven, 2012). It is thus *greater* attentiveness to emotion-related experience that may account for the regulatory benefits of mindfulness. In a theoretical account of mindful emotion regulation, Teper et al. (2013) suggest that enhanced receptive attention facilitates executive control of emotion by heightening sensitivity to internal (e.g., visceral cues) and external (e.g., angry facial expression) affective experience, supporting efficient deployment of cognitive resources. Thus mindful emotion regulation may be construed as an *ongoing process*, rather than a discrete, strategic intervention like reappraisal; accordingly, mindfulness may promote ongoing monitoring of environmental and psychological events in the present, and so facilitate efficient deployment of attentional resources to emotional (and perhaps other goal-relevant) events and experience as needed for early emotion regulation.

Construing mindfulness as an attention deployment strategy is important because, as noted earlier, regulatory strategies that occur further "upstream" in the emotion generation sequence may be highly adaptive, in that they require less cognitive effort, fewer cognitive resources, and their effectiveness is relatively unchanged with high relative to low levels of emotional intensity (Sheppes & Gross, 2011). On the other hand, the primary attention deployment strategy studied to date, distraction, has clear costs. Specifically, distraction and other sorts of attentional avoidance of emotion-related experience may not help if situations demand repeated contact with such experience or engagement with emotional information to guide context-sensitive, goal-relevant behavior. To the extent that social contexts are characterized by such demands on attention and awareness, the costs of distraction may be amplified, and so the benefits of this form of early emotion regulation may be outweighed by its costs. Mindful emotion regulation provides an alternative attention deployment strategy, with the potential benefits ascribed to early emotion regulation (Sheppes & Gross, 2011), but perhaps uniquely, without the costs associated with attentional avoidance.

Mindful Attention in Socioemotional Contexts. As a relatively less effortful, more experientially-engaged regulation strategy, mindful emotion regulation could afford availability of mental resources needed to attend to one's own and others' emotional experience dynamically in social contexts. Ongoing monitoring of experience for regulation-relevant events could promote efficient deployment of top-down (i.e., goal-driven; cf. Todd et al., 2013) attention when and as needed (Teper et al., 2013). Thus, mindful emotion regulation could afford timely, context-sensitive social emotion regulation and behavior. To examine whether mindfulness is an adaptive form of attention deployment in socioemotional contexts, Quaglia, Goodman, and Brown (2015) measured participants' dispositional mindfulness and recorded electrocortical event-related potentials (ERPs) while participants completed an Emotional Go/No-Go task (EGNG; Hare, Tottenham, Davidson, Glover, & Casey, 2005) involving happy, neutral, and fearful faces. As a neurophysiological approach with high temporal precision, ERPs allow for examination of cognitive processes occurring very early after the onset of discrete events (e.g., image onset). As such, ERPs are well-suited to investigate early neural correlates of top-down attention deployment theorized to underlie mindful emotion regulation.

Every day we come face-to-face with others' emotions, and ample research has demonstrated that facial expressions are a primary route by which others' emotions can rapidly influence one's own emotional processing (Cacioppo, Hatfield, & Rapson, 1993). Moreover, others' emotional expressions can guide behavior; happy or other pleasant facial expressions tend to result in approach-oriented behavior, whereas fearful or other threat-related facial expressions tend to result in withdraw-oriented behavior (Hare et al., 2005). Perhaps by virtue of this relevance to our own emotions and behavior, the efficient discrimination of others' facial expressions (affective social stimuli) appears important to effective social emotion regulation and behavior (Hare et al., 2005; Schmidt et al., 2009; Tottenham, Hare, & Casey, 2011). The EGNG task used by Quaglia et al. (2015) demands rapid and accurate discrimination of facial expressions, since participants are instructed to attend to a serial visual presentation of facial expressions, discern each expression, and respond with the corresponding behavior (a button press or no response). For a given block of trials in the EGNG used in Quaglia et al. (2015), participants were asked to press a button for all target (go) facial expressions, which occurred on the majority of trials, and to refrain from pressing the button on nontarget (no-go) facial expression trials. Prior research has demonstrated that during such Go/No-Go tasks, participants habituate to pressing the button when it is the correct response for most trials (e.g., Donkers & Van Boxtel, 2004). As such, efficient (i.e., timely and accurate) discrimination performance on the EGNG depends on attentiveness to facial expressions alongside executive monitoring of one's own habituated tendencies. The EGNG therefore provides a lab-based proxy for several unique challenges to attention that may be found in daily social contexts.

Quaglia et al. (2015) found, as expected, that dispositional mindfulness predicted neural indices of efficient top-down attention very early after the onset of facial expressions, as well as behavioral indices of more efficient discrimination of facial expressions. Specifically, mindfulness predicted larger (more negative) N100 and N200 ERP components to both target and nontarget stimuli, as well as marginally more positive No-Go P300. These neural markers have been previously related to top-down attention (Coull, 1998; Ruz et al., 2012; Zhang & Lu, 2012), and occur within 600 ms after stimulus onset. Additionally, dispositional mindfulness predicted faster discrimination of facial expressions, without any corresponding decrement in accuracy. Thus, these preliminary findings support theory that mindfulness may facilitate social emotion regulation and behavior via early top-down attention to goal-relevant features of experience, as well as more efficient discrimination of facial expressions.

From Mindful Attention to Daily Social Emotion Regulation. While mindfulness-related differences on lab-based measures of attention to, and discrimination of, facial expressions may indicate adaptive social emotion regulation, the study just discussed did not directly assess indices of emotion regulation in social contexts. In a subsequent study, Quaglia, Goodman, and Brown (2014b) aimed to bridge these laboratory-based findings on mindfulness with participants' actual affective and social experience during *in vivo* social interactions. They recruited romantic couples to sample their personal affective and social experience across a range of social situations, from interactions with intimate partners, to friends, to complete strangers. Each romantic partner's trait mindfulness and EGNG performance was assessed prior to a week of event-sampling of emotional and social experience during daily social interactions. Specifically, participants were instructed to report, following each substantive (> 5 min.)

interaction, their experience of positive and negative emotions, perceived connection with the primary interaction partner, and the social role of their primary interactant.

Foremost, this study found that those scoring higher in trait mindfulness reported greater positive and less negative emotion during social interactions, less negative affective lability, and greater perceived connection with interaction partners. Thus mindfulness predicted indices of effective social emotion regulation as well as differences in the quality of social experience. Further analyses revealed that mindfulness-related differences in the efficiency of performance on the EGNG predicted positive emotion during daily social interactions generally, suggesting that differences in the attention to, and discrimination of, others' emotions are indeed important for effective social emotion regulation (Quaglia et al., 2014b). This EGNG performance also mediated the relation between mindfulness and more positive emotion during social interactions. Relating effective social emotion regulation and the quality of social experience, three variables (positive emotion, negative emotion, and negative emotion lability) each mediated the relation between actor mindfulness and perceived social connection. In contrast, neither trait tendencies toward cognitive reappraisal nor suppression emotional regulation strategy use predicted EGNG performance or experience during social interactions, and all mindfulness relations held when controlling for these individual differences in reappraisal and suppression use.

Together these dispositional mindfulness results across two studies, spanning lab-based neurophysiological responses and daily life social interactions, suggest that mindfulness may distinctively facilitate emotion regulation in social contexts. Moreover, these findings support a more general, tractable framework for considering relations between attention, emotion regulation, and behavior in socioemotional contexts (see Figure 2). This framework holds that mindfulness-related variation in social emotion regulation may be key to understanding how mindful attention translates into higher-quality social functioning. Extending the theoretical and applied value of these findings on dispositional mindfulness, experimental research is needed to understand whether *mindfulness training* positively impacts social emotion regulation and thereby the quality of social experience and functioning. As an experimental manipulation of mindful attention, mindfulness training can be used to assess whether mindfulness leads to changes in social experience and behavior.

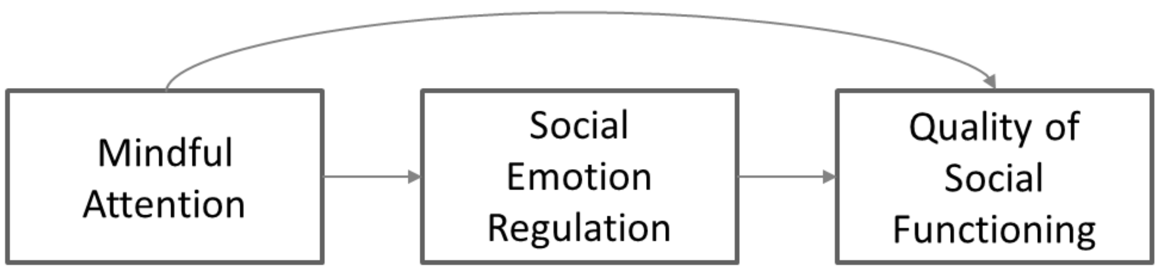

Figure 2. A model of mindful social emotion regulation proposing that variation in social emotion regulation mediates the effects of mindfulness on quality of social functioning.

The Present Research

This randomized controlled study used lab-based neural and behavioral measures, as well as trait and state self-report measures, to examine the value of mindfulness training to enhance emotion regulation and thereby the quality of social functioning in interpersonal contexts. To assess effects of training on individuals' social experience across various social situations, this study recruited participants in romantic relationships. Though some data was collected from each member of the couple, only one person per couple completed all measures and was randomized to an intervention. The study used 1st-, 2nd-, and 3rd-person measures to compare Mindfulness

Training (MT) to a structurally-equivalent Book Listening Control (BLC) to account for nonspecific effects of expected benefits (e.g., reduction in stress, increased well-being), social setting, instructor time, demand characteristics, and processes of learning (cf. Allen et al., 2012). Both ERPs and behavior was assessed during an Emotional Go/No-Go task to index early top-down attention to, and discrimination of, facial expressions. Beyond the laboratory context, ecological momentary assessment-based (EMA-based) event sampling (Shiffman, Stone, & Hufford, 2008) was used to examine the effects of MT on markers of effective social emotion regulation and perceived social connection in real-world social interactions. Lastly, EMA-based measures from each participant's primary romantic partner during couple interactions allowed for assessment of participants' interpersonal responsiveness toward their romantic partners, as well as exploratory analyses of the effects of mindfulness training on close others.

Research Question 1: Does MT, compared with BLC, result in greater pre-post changes in top-down attention to and discrimination of facial expressions, as indexed by ERPs and behavior on the Emotional Go/No-Go task? The temporal precision of ERPs makes them well-suited for examining the effects of MT on processes of early (< 1 sec.) top-down attention during the Emotional Go/No-Go task. ERP components of interest were selected to assess whether MT affects top-down attention for goal-relevant sensory information as well as attentional monitoring of psychological events pertinent to goal-relevant regulation of emotion and behavior. Thus, the N100, N200, and No-Go P300 served as markers of top-down attention in the proposed study (cf. Quaglia et al., 2015).

The visual N100 is a negative-going ERP component occurring less than 200 ms after stimulus onset in tasks of visual discrimination between two or more stimuli (Vogel & Luck, 2000), and may thus reflect pattern recognition processes essential to visual discrimination between stimuli (Luck & Kappenman, 2011). Studies have also found that the capacity of the N100 discrimination process may be limited, such that the N100 is not present for discrimination tasks involving a more rapid serial visual presentation (Heinze et al., 1990; Luck et al., 1990). Though not directly assessed, this limited capacity account suggests that individuals could differ in the extent to which N100-related attentional resources are available in each successive moment. Relatedly, the N100 appears sensitive to differences in early deployment of top-down, goal-relevant attention (Coull, 1998; Hamilton, Baskin-Summers, & Newman, 2014; Ruz et al., 2012). Importantly, the N100 has been found to operate in tasks involving both simple and complex stimulus discrimination (Vogel & Luck, 2000), and has also been previously studied within the context of discrimination tasks involving facial expression stimuli (Luo et al., 2010). Thus, the visual N100 is well-suited as a marker of early top-down attention to task-relevant sensory information that is critical for discerning between facial expressions.

In contrast to the externalized focus of attention toward facial expressions indexed by N100 during the Emotional Go/No-Go, both the N200 and No-Go P300 components reflect cognitive processes involving self-regulation of behavior. Specifically, the N200 is a negative-going deflection that occurs approximately 200 ms post-stimulus onset. This component is theorized to index attentional monitoring of the discrepancy between internally-generated intended behavior and external task demands (Donkers & Van Boxtel, 2004; Nieuwenhuis et al., 2003). Thus, the N200 tends to be larger (more negative) on No-Go than Go trials (e.g., Bruin & Wijers, 2002; Nieuwenhuis et al., 2003; Zhang & Lu, 2012). Reflecting ongoing monitoring of internal and external goal-relevant events, the N200 served as a neural index of the sort of up-regulation of top-down attention to both intero- and extero-ceptive processing thought to characterize mindfulness meditation training (Cahn, Delorme, & Polich, 2012).

The No-Go P300 component is a positive-going waveform found in the context of Go/No-Go tasks (Polich, 2007). Whereas the N200 reflects a conflict monitoring process, the No-Go P300 has been associated with actual inhibition of task-inappropriate behavior on No-Go trials (Donkers & Van Boxtel, 2004; Polich, 2007). This component is found for trials that demand inhibitory control of the prepotent behavioral Go response to No-Go stimuli (Donkers & Van Boxtel, 2004). Although there has been some debate regarding the functional dissociation of No-Go P300 from No-Go N200, research suggests that the No-Go P300 may be more directly related to response inhibition of task-inappropriate behavior (Albert et al., 2010; Bruin & Wijers, 2002). Although Go P300 on target trials may reflect goal-relevant top-down attention, there is some evidence that amplitude of Go P300 could reflect, in part, motivated attention to affective facial expressions (Zhang & Lu, 2012). Therefore, the No-Go P300, but not the Go P300, served as the third neural index of top-down attention during the Emotional Go/No-Go task. Regarding behavior, combined analyses of response time (RT) and errors of commission (false alarms; FAs) were used to assess whether MT influences the speed and accuracy of discrimination of facial expressions.

Hypotheses 1-4: Consistent with prior research on dispositional mindfulness and the Emotional Go/No-Go (Quaglia et al., 2014b), I expected that relative to BLC, MT would result in greater pre-post increases in N100 (hypothesis 1), N200 (hypothesis 2), and No-Go P300 (hypothesis 3) amplitudes generally, reflecting up-regulation of early top-down attention. Additionally, I expected that MT participants would demonstrate a greater increase in efficient performance on the Emotional Go/No-Go task, as indexed by combined analyses of RT and FA rate that accounts for any speed/accuracy tradeoff (hypothesis 4).

Research Question 2: Does MT, relative to BLC, impact day-to-day (event sampled) interaction-based positive and negative affect (intensity and lability) during interactions with others in various social roles (e.g., romantic partner, friend, co-worker)? The presence and intensity of both positive and negative emotion have been considered key markers of emotion regulation (Gross, 2002; Hill & Updegraff, 2012), and less negative affective lability has likewise been related to more adaptive emotion regulation (Kuppens, Oravecz, & Tuerlinckx, 2010). Thus, within the context of event-sampled emotional experience during social interactions, more positive and less negative affect as well as less negative affective lability served as indices of effective social emotion regulation.

Hypothesis 5-7: Following from findings on dispositional mindfulness (Quaglia et al., 2014b), I expected that the MT condition would demonstrate greater gains in positive emotion intensity (hypothesis 5) as well as decreases in both negative emotion intensity (hypothesis 6) and negative emotion lability (hypothesis 7) relative to the BLC condition.

Research Question 3: Are effects of MT, relative to BLC, evident in first-person reports of the quality of social experience, and are differences in the quality of social functioning observable and consequential to others? Specifically, relative to BLC, does MT result in greater pre-post training changes in: a) intervention participants' perceived connection with others; b) romantic partners' interaction-based positive and negative affect; c) romantic partners' perceived connection during interactions with the intervention participant; and d) romantic partner ratings of the interpersonal sensitivity of intervention participants?

Hypotheses 8-12: Consistent with findings on dispositional mindfulness, I hypothesized that the MT condition, relative to BLC, would demonstrate greater increases in social connection with others generally (hypothesis 8), and more strongly during romantic partner interactions (hypothesis 9). I expected that higher-quality social functioning among MT participants would also be evident in partner-rated interpersonal sensitivity during romantic partner interactions (hypothesis 10). Finally, I conducted exploratory analyses to see whether, compared to BLC, MT resulted in higher EMA-reported positive affect (question 1) and lower negative affect (question 2) among the participants' romantic partners during couple interactions.

Research Question 4: Do changes top-down attention to facial expressions mediate the expected relations between training condition (MT versus BLC) and indices of effective social emotion regulation (intensity and lability of interaction-based positive and negative affect)? Fast and accurate discrimination of others' emotional facial expressions, which depends on attention, can afford effective behavior in social contexts that balance rapid responding while maintaining adequate governance of behavior to avoid inappropriate responses (Tottenham et al., 2011). Thus, more efficient performance on the Emotional Go/No-Go task should correspond with more effective social emotion regulation. At the same time, variation in behavioral markers during the Emotional Go/No-Go are not likely to capture all the ways that mindfulness can facilitate more effective social emotion regulation, since social emotion regulation depends on many distinct behaviors. Therefore, when relevant, I also examined mediation by ERP markers of top-down attention.

Hypothesis 11-12. As with dispositional mindfulness (Quaglia et al., 2015), I expected that pre-post training changes in the efficiency of discrimination on the Emotional Go/No-Go would partially mediate the relation between MT and indices of effective social emotion regulation (hypothesis 11). I also expected pre-post changes in ERP markers of top-down attention (N100, N200, and No-Go P300) would mediate any relations between MT and effective social emotion regulation (hypothesis 12).

Research Question 5: Do changes in indices of effective social emotion regulation (presence, intensity, and lability of interaction-based positive and negative affect) mediate the relation between MT and perceived connection, as well as between MT and partner EMA-based self-reports of emotional and social experience during couple interactions? As noted above, social emotion regulation depends on many processes and behaviors, only some of which will be assessed by laboratory-based measures of top-down attention and discrimination of facial expressions. Therefore, there is likely to be additional variation in the degree to which MT improves emotion regulation during social interactions.

Hypotheses 13-15. Rather than MT-related differences in attention and discrimination fully accounting for changes in the quality of social functioning, I expected the variation in MT-related improvements in effective social emotion regulation to be key to understanding how mindfulness enhances the quality of social functioning. Consistent with findings for trait mindfulness (Quaglia et al., 2015), I therefore anticipated that changes in multiple indices of effective social emotion regulation, namely EMA-based positive emotion (hypothesis 13), negative emotion (hypothesis 14), and negative emotion lability (hypothesis 15), would mediate the relation between MT and higher-quality social functioning.

Methods

Participants

A power analysis (Cohen, 1992) of moderate effect sizes for brief MT across subjective and objective measures in randomized controlled studies was conducted to determine the appropriate sample size. Specifically, to detect a Cohen's *d* effect size of 0.62 (average effect size obtained from similar prior research using the same brief MT used here (Zeidan, Johnson, Diamond, David, & Goolkasian, 2010; Zeidan, Johnson, Gordon, & Goolkasian, 2010), with statistical power of 0.80, it was determined that a sample size of 66 couples (33 per condition) would be needed.

Participants were recruited using paper and electronic advertisements for a free mindfulness meditation training course, plus monetary incentive. Each participant was screened for age (18 to 60 years old), ownership of appropriate smart phone (for EMA records), presence of a long-term romantic relationship (together for > 12 months and currently cohabitating; Carson, Carson, Gil, & Allen, 2004), lack of previous experience with meditation (no minutes reported), and English as a native language. Three additional screening criteria were applied to account for pre-existing characteristics known to affect electrocortical, behavioral, or self-report results, namely that participants have no prior or current neurological, psychiatric, substance abuse, or significant medical condition; have a body mass index (BMI) < 32 to account for potential cognitive deficits of obesity (Gunstad, Paul, Cohen, Tate, Spitznagel, & Gordon, 2007); and are primarily right-handed to account for potential differences in electrocortical outcomes between left- and right-handed individuals (Propper, Pierce, Geisler, Christman, & Bellorado, 2012). All qualifying participants were randomly assigned to MT or BLC using a computer software-based randomizer.

Intervention

The present study followed intervention guidelines for MT used in previous research by Zeidan and colleagues (Zeidan, Johnson, Diamond, David, & Goolkasian, 2010; Zeidan, Johnson, Gordon, & Goolkasian, 2010; Zeidan, Martucci, Kraft, McHaffie, & Coghill, 2014). This brief MT intervention involves four, 20-minute sessions of instructor-facilitated mindfulness meditation, with progressively more self-directed practice each session. Every group session of no more than six participants ended with a question and answer period. Meditation instruction was presented in a secular format, and as with common approaches to MT, participants were trained in key skills of focused attention – specifically, bringing voluntary attention to a subset of localized sensations pertaining to breathing, noticing when their attention wandered away from their intended meditation object, and disengagement of attention from any distracting thoughts and experiences by returning their focus to the meditation object (respiratory sensations).

Participants randomly assigned to the BLC condition underwent a structurally-equivalent procedure: four sessions of listening to a book read aloud by an instructor on a neutral topic. Introductory remarks provided participants the same benefit expectancy, and so BLC participants were advised that such book listening can reduce stress and promote well-being (see Appendix C for introductory remarks given to both intervention groups). A similar control condition, except involving an audiobook rather than a live reader, has been used as a comparison condition in prior mindfulness research (e.g., Zeidan, Johnson, Diamond et al., 2010). As noted earlier, this control condition was chosen to account for various nonspecific effects, including the engagement of active cognitive processes involved in learning through listening comprehension (cf. Allen et al., 2012). All participants in the BLC condition were invited to participate in MT after study debriefing.

Materials

Self-Report Measures. Both the intervention participant and their romantic partner completed the following multi-item self-report measures (see Appendix A):

Mindfulness. The Freiburg Mindfulness Inventory (FMI; Walach, Buchheld, Buttenmüller, Kleinknecht, & Schmidt, 2006) was used to assess the effect of MT on self-reported dispositional mindfulness. The 14-item FMI has high internal consistency ($\alpha = .86$;

Walach et al., 2006), and has been used in prior mindfulness training research (sample item: "When I notice an absence of mind, I simply return to the experience of here and now"). This dispositional mindfulness measure was chosen specifically because of its use in similar research (Zeidan, Johnson, Diamond, et al., 2010), which has indicated its sensitivity to changes in mindfulness resultant from brief MT. Higher scores reflect higher mindfulness on a Likert Scale (1= *Rarely* to 4 = *Almost always*). This measure was used primarily as a manipulation check to assess whether participants in the MT condition used mindfulness practice skills more in daily life than BLC participants. Cronbach's alpha for the FMI was .86 in this sample.

Nonjudgment. The Five Factor Mindfulness Questionnaire (FFMQ; Baer et al., 2006) assesses dispositional mindfulness across five subscales. The FFMQ is a well-validated, 39-item measure of trait mindfulness, which uses a 5-point scale from 1 ('never or very rarely true') to 5 ('very often or always true'). For the present analyses, only the FFMQ's 8-item Nonjudgment subscale was used, as prior research suggests that a nonjudgmental attitude may be particularly relevant in the context of relationship functioning (cf. Peters, Eisenlohr-Moul, & Smart, 2015). Again, this measure was included primarily as a manipulation check to assess whether participants in the MT condition used mindfulness practice skills more in daily life. Cronbach's alpha for FFMQ-Nonjudgment was .94 in this sample.

Quality of Social Functioning. The Network of Relationships Inventory-Relationships Quality Version (NRI-RQV; Buhrmester & Furman, 2008) was used to examine the quality of social behavior, according to a variety of relationship characteristics, between intervention participants and their romantic partners. This measure was included primarily to test the success of randomization, namely the absence of between-condition differences in quality of relationship at baseline. This 30-item measure, which has shown high internal reliability (all subscale α's >

.70; Furman & Buhrmester, 2009), assessed relationship quality for the following five positive qualities: companionship, disclosure, emotional support, approval, and satisfaction. Additionally, five negative relationship qualities were assessed: conflict, criticism, pressure, exclusion, and dominance. Participants responded to each item on a scale from 1 (Never or hardly at all) to 5 (Always or extremely much). An example item for a positive quality, emotional support, is "When you are feeling down or upset, how often do you depend on this person to cheer things up?" An example for a negative quality, conflict, is "How often do you and this person get mad at or get in fights with each other?" Cronbach's alpha for the NRI-RQV subscales ranged from .76 - .96 in this sample.

Relationship Satisfaction. The Quality of Marriage Index (Norton, 1983) was adapted to measure the overall satisfaction of romantic partnership (Quality of Relationship Index; QRI) across both married and non-married romantic couples in the present study. This measure was also included primarily to test the success of randomization, namely the absence of between-condition differences in relationship satisfaction at baseline. This 6-item scale has demonstrated high internal consistency ($\alpha = .97$; Heyman, Sayers, & Bellack, 1994), and has been previously shown to be sensitive to mindfulness training (Carson et al., 2004). Cronbach's alpha for the QRI was .96 in this sample.

Expected Benefits. To assess and account for any differences in expected benefits between intervention conditions, participants completed the Credibility/Expectancy Questionnaire (CEQ; Devilly & Borkovec, 2000) post-randomization after a thorough description of the intervention (see Appendix A). The scale assesses participants' cognitively-based credibility as well as more affectively-based expectancy. Prior research indicates high internal consistency for these subscales as well as test-retest reliability (Devilly & Borkovec, 2000). Cronbach's alphas for this sample were .90 for cognitively-based credibility and .92 for affectively-based expectancy.

Ecological Momentary Assessment (EMA). EMA-based event sampling was performed using a cloud-based application for Android and iOS mobile devices that was developed in our laboratory and tested over several years. Cloud-based applications have the advantages of allowing study personnel to monitor compliance in real time, and of storing participant data in a secure database, rather than locally on participants' devices. Event sampling collected data for face-to-face or voice-to-voice interactions of more than 5 min. in duration, and included questions regarding the social role of interaction partner(s) (e.g., romantic partner, close friend, coworker) and interaction-based positive and negative affect (Eid & Diener, 1999). The experienced degree of positive affect (4 items; example item, "Pleased"; sample $\alpha = .94$) and negative affect (5 items; example item, "Frustrated"; sample $\alpha = .85$) were rated on a scale from 0 "Not at all" to 6 "Extremely". Additionally, concerning the primary interactant, all participants completed a single-item measure of perceived connection (Eisenberger, Gable, & Lieberman, 2007) and responsiveness of the interaction partner (Debrot, Cook, Perez, & Horn, 2012). Each selected EMA measure has been previously associated with validated and objective measures as expected. Restricting EMA assessment to a small number of items is important for promoting EMA recording compliance (Nezlek, 2012). Appendix B contains the EMA items.

Participants downloaded the cloud-based application to their smartphones and were instructed to complete the EMA survey immediately (or if unable to – for example, driving - as soon as possible) after each substantive (> 5 min.) social interaction for the next 6 days, starting on that day that they made their initial lab visit. To account for an ecologically representative range of social interaction experience, participants were asked to complete EMA measures following interactions with any person, rather than solely with their romantic partner. Compliance was checked on an ongoing basis by daily monitoring of the EMA database. All participants received three reminder emails and text messages per day at standard times (10:00 AM, 3:00 PM, 8:00 PM).

Regarding experience sampling, participants completed an average of 3.17 (SD = 1.98) interaction logs per day during the baseline sampling period, and 3.03 (SD = 2.33) at posttest. This average is comparable to prior research (Eisenberger et al., 2007; Hill & Updegraff, 2012). Composite scores for each of positive and negative affect were created for each interaction (Diener & Emmons, 1984). Finally, emotion lability was computed using mean squared successive difference (MSSD), which represents the extent of fluctuation in emotional intensity (i.e., emotion lability) between time points; higher lability, particularly in negative emotion, is related to poorer emotion regulation (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009).

Task-Based Behavior. For the Emotional Go/No-Go task, social stimuli were selected from the NimStim Face Stimulus Set (Tottenham et al., 2009) according to those previously used in an Emotional Go/No-Go task (Hare et al., 2005; Quaglia et al., 2014b). Twelve models from the NimStim Set (6, 8, 11, 14, 15, 16, 25, 27, 36, 39, 43, and 45) included African American, Asian, and Caucasian males and females expressing happy, neutral, or fearful facial expressions. Prior to use they were grayscaled and normalized for luminance.

Following Hare et al.'s (2005) procedure, with minor technical adjustments for an ERP context, a fixation cross was presented for a random interval between 1000 and 3000 ms on a 19'' flat-screen LCD monitor at a distance of approximately 34", with a vertical visual angle of 20°. The cross was followed by a face stimulus for 500 ms. Participants were instructed to press a response key with their dominant hand on a button box to only one type of facial expression per block. Half the participants (randomly assigned) first responded to fearful targets, presented randomly on 70% of trials (30% of the stimuli were happy or neutral faces; alternating blocks, counterbalanced). After eight blocks of 60 trials each, these participants responded to eight blocks of happy targets/fearful nontargets and neutral targets/fearful nontargets. The other half of participants received the same conditions in reverse order. Thus all participants completed 336 fearful, 168 happy, and 168 neutral target (Go) trials, and 144 fearful, 72 happy, and 72 neutral nontarget (No-Go) trials. Consistent with Hare et al.'s (2005) study, a larger number of Go and No-Go trials involving fearful faces allows for separate comparisons of RT and FAs to fearful faces when paired with happy or neutral facial expressions. This difference in the number of No-Go trials per condition was accounted for in all FA analyses by examining FA rate as a percentage rather than raw score. Participants completed 20 practice trials before each condition, and blocks were separated by short rest breaks. Only RTs for correct trials were included in analyses. Before averaging, RTs reflecting anticipatory or delayed responding (< 200 ms or >1500 ms, respectively) were removed (cf. Vago & Nakamura, 2011).

Neural recording. The high temporal resolution of ERPs makes them well-suited for examining differences in early (< 1 sec.) attentional processes during the Emotional Go/No-Go task.

Electrocortical recording, artifact rejection, and component specification. All electrocortical signals were acquired using a Neuroscan (El Paso, TX) NuAmps Express 40 channel system. Electrode positions were based on the 10-20 international system with a forehead ground and two monopolar mastoid references. The electro-oculogram (EOG) was recorded with monopolar electrodes located below and on the outer canthus of each eye. Offline, the monopolar EOG channels were combined into bipolar channels. EEGs and EOGs were acquired at a gain of 20K (3.75 μV/mm equivalent) for a frequency bandwidth of 0.3-100Hz (24dB/octave). EMGs were acquired at a gain of 20K for an initial bandwidth of 30-1000Hz. The digital band-pass filter settings were as follows: EOGs at 0.3-4Hz, EEGs at 0.3-20Hz, and EMGs at 30-250Hz. The timing, presentation, and synchronization of stimulus presentation and the continuous EEG recording were controlled by Stim2 software (Neuroscan; El Paso, TX). The continuous EEG signal was time-locked to the visual presentation of task stimuli.

EEGLAB 12.0 (Delorme & Makeig, 2004) and Matlab (Mathworks, www.mathworks.com) were used for offline EEG processing, which followed standard guidelines (Delorme, Serby, & Makeig, 2006). Bad channels were detected and removed with the automatic detection algorithms provided by EEGLAB, after which all electrodes were re-referenced to the common average. Continuous EEG were locked to feedback stimuli and data epochs were extracted using a -500 ms to 1500 ms window. Epochs containing nonstereotypical artifacts were detected and rejected using native EEGLAB artifact detection algorithms sensitive to abnormal values, distributions, spectra, and linear trends. After rejecting epochs contaminated with paroxysmal artifacts, Independent Components Analysis (ICA) was conducted using the infomax algorithm. Visual inspection of component scalp maps, power spectrum, and raw activity was used to identify exemplar ICA components representing stereotypical artifacts (eye-blinks, EKG, eye movements). Exemplar artifactual components were passed to CORRMAP, an EEGLAB plugin that identifies clusters of highly correlated ($r > .80$) ICA components sample-wide. Component clusters representative of stereotypical artifacts were pruned from the raw EEG signal (Viola et al., 2009), and then epochs were baseline corrected by subtracting the average amplitude between -500 ms and 0 ms.

N100. The N100 was indexed by the peak amplitude at Cz (Campanella et al., 2002; Kubota & Ito, 2007; Rossignol et al., 2005) in a 50 ms window (Vogel & Luck, 2000), approximately 100 to 150 ms post-stimulus, according to visual inspection. Peak amplitudes for Go and No-Go trials and for each stimulus valence were computed separately.

N200. This component was defined as the peak amplitude in a window from approximately 200 to 350 ms post-stimulus (according to visual inspection) at FCz (Bruin & Wijers, 2002; Donkers & van Boxtel, 2004; Nieuwenhuis et al., 2003; Zhang & Lu, 2012). The N200 was computed for Go and No-Go trials for comparison, to determine whether the component identified behaved consistently with prior research (i.e., larger for No-Go trials; Nieuwenhuis et al., 2003; Amodio et al., 2008).

P300. The P300 was indexed by the peak amplitude at Pz (Donkers & van Boxtel, 2004; Hagen et al., 2005; Katayama & Polich, 1998; Polich, 2007) approximately 350 to 600 ms (following visual inspection). The P300 was computed for Go and No-Go trials; however, only trials involving correct rejection of No-Go stimuli constituted the No-Go P300.

Procedure

The proposed study used a 2 x 2 (time x condition) mixed design. An initial online screening assessed eligibility (see Participants section for screening criteria). As potential participants were informed during initial screening that only one member of the couple could participate, each couple was responsible for deciding who would be the primary participant. Primary participants were asked to bring their romantic partners to an initial lab visit, during which they were provided an overview of the study procedure, consented in writing, completed baseline dispositional measures, and then were instructed on how to download and use a smartphone application designed for EMA-based data collection.

As indicated earlier, to record experience following each substantial (> 5 min.) social interaction, a cloud-based, smartphone application was used. Event sampling data was collected within a window 6 days prior to and 6 days after the intervention. Following an initial data collection session for electrocortical and behavioral measures, participants were randomly assigned to an intervention (MT or BLC). To accommodate multiple participants per weekly intervention, randomization occurred at the level of training week. Within a week following their third training session, participants returned to the lab for their fourth training session as well as follow-up data collection of electrocortical and behavioral measures. Subsequently, the second (post-intervention) week of EMA-based assessment began, and finally, participants completed post-test online questionnaires for dispositional mindfulness. After debriefing, all participants originally assigned to the BLC condition were invited to complete MT, though no further data was collected.

Results

Figure 3 presents the participant flow through the study. Of the 304 couples screened, 104 qualified to participate and were sent schedules; 71 consented and completed questionnaires during an initial lab visit; 65 couples attended their baseline laboratory session, including EEG and behavioral measures. From these, 62 participants were randomized and attended their initial intervention session. Randomization occurred by week, and weeks randomly assigned to MT had a higher number of participants than weeks for BLC. As such, the total number of participants randomized into MT was 36, with one participant unable to complete the study because of scheduling conflicts (retention 97.2%); for BLC, the total randomized into this condition was 26, with one participant unable to continue due to scheduling conflicts (retention 96.2%). Of these 60 couples, 35% of primary participants were male and 65% were female. The race/ethnicity breakdown was as follows: 2.7% Asian or Pacific Islander, 4.1% Asian Indian, 6.8%

Black/African American (non-Hispanic), 75.7% Caucasian/White, 2.7% Latino/Hispanic, 1.4% Native American, and 4.1% more than one race. Ages ranged from 20-59 years old, with more than 75% of participants between the ages of 20 and 35.

For reasons other than attrition, including technical problems, scheduling constraints, or lack of participant reporting, the number of participants included for some analyses is lower than 60. Specifically, for ERP analyses, there were four participants without EEG data at both time points because of equipment failures during their scheduled lab visits and four others excluded due to extreme artifact at the electrodes of interest (30 MT, 22 BLC analyzed). For EMA-based analyses, 10 were excluded from EMA-based analyses for lack of sufficient data at pre- and/or posttest (29 MT, 21 BLC analyzed), and 11 excluded from emailed post-test follow-up questionnaire analyses because they did not complete the questionnaires (30 MT, 19 BLC analyzed).

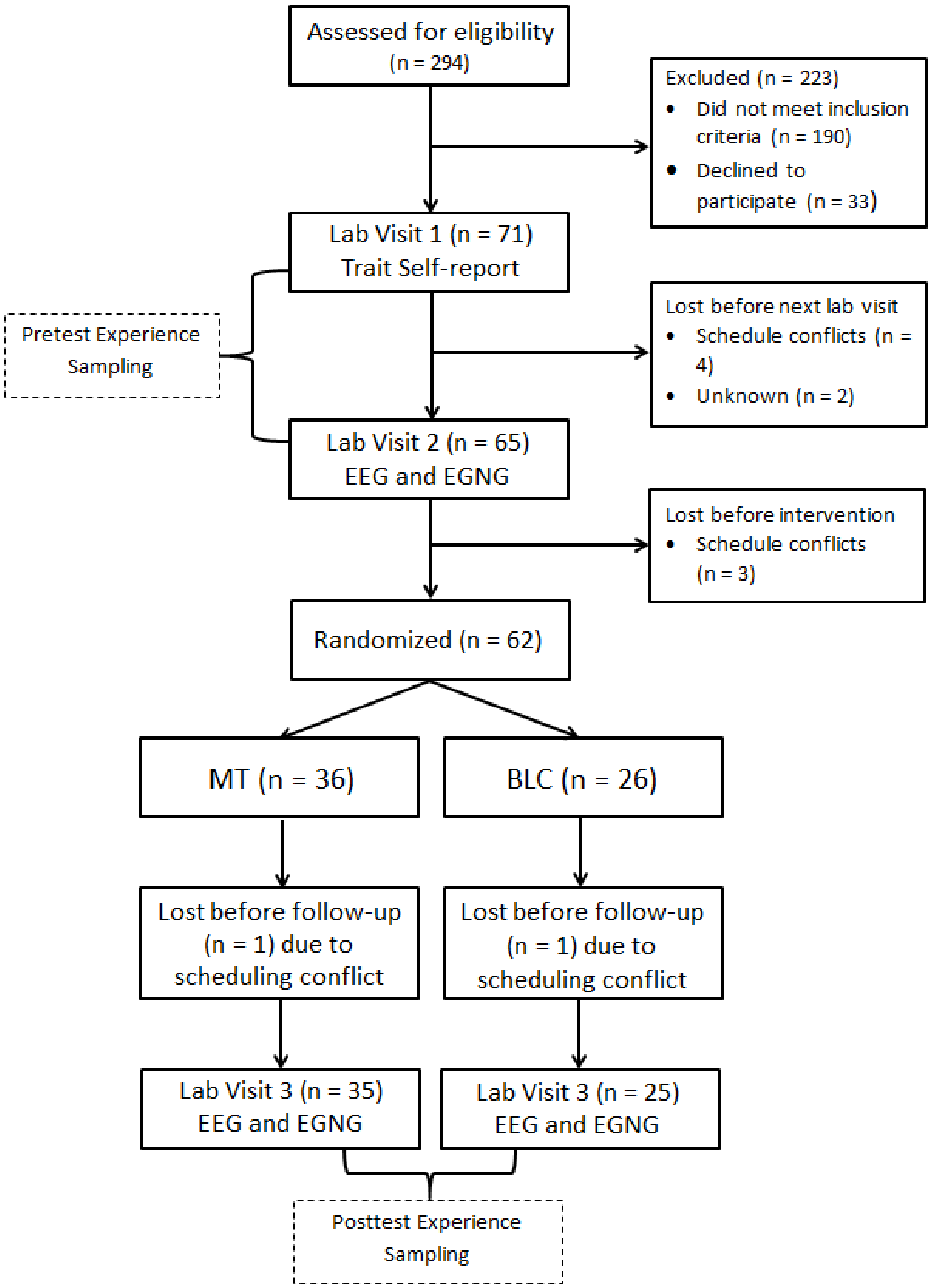

Figure 3. Flow of participants through the study, starting from those assessed for eligibility. Although 60 participants completed the intervention and Lab Visit 3, the total number of participants included in analyses varied according to available data.

Preliminary Self-report Analyses

A number of analyses were conducted on self-report questionnaires prior to examining Research Questions 1-5. Randomization occurred after all baseline measurements. To ensure no preexisting differences between participants who were subsequently assigned to each intervention condition on self-report measures of key mindfulness-related and relationship variables at baseline assessment, we examined whether intervention condition predicted scores on the FMI, FFMQ-Nonjudgment, NRI-RQV, and QRI. One-way ANOVAs on questionnaires and their subscales confirmed no preexisting differences between conditions at baseline on these self-report measures (all *p*s > .14).

Intervention Credibility and Expectancy

Next, scores on the CEQ were examined to test whether the two conditions differed at post-randomization regarding expected benefits of their respective interventions. Two one-way ANOVAs revealed that MT participants scored significantly higher than BLC post-randomization on both the cognitively-based credibility subscale [$F(1, 57) = 18.29$, $p < .001$] and the affectively-based expectancy subscale [$F(1, 57) = 11.98$, $p = .001$]. The CEQ subscales were highly correlated, $r(1, 58) = .84$, $p < .001$. Thus, CEQ subscales were combined and included as a covariate in models testing intervention effects to account for influence such expectation differences may have had on intervention outcomes.

Change in Dispositional Mindfulness Scales

Between-condition differences at posttest on the FMI and FFMQ-Nonjudgment questionnaires were examined in ANCOVAs, using pretest scores as covariates. Of the total sample, 49 primary participants completed follow-up questionnaires. Although FMI scores were higher at posttest for MT ($M = 2.72$, $SE = .50$) than BLC ($M = 2.54$, $SE = .48$), this difference was not significant (*p* = .718). Similarly, FFMQ Nonjudgment scores were higher for MT (*M* = 3.89, *SE* = .83) than for BLC (*M* = 3.75, *SE* = .97) at posttest, but this difference was not significant (*p* = .164). These results indicate that brief MT did not significantly increase dispositional mindfulness scale scores in this subsample.

Research Question 1

Multilevel modeling (MLM) using Restricted Maximum Likelihood estimation (REML; Bryk & Raudenbush, 1992) was used to examine all specific research questions. Each variable was assessed according to assumptions of normality and the predictors were zero-centered. For Research Question 1, a three-level multilevel model was specified for examining effects of MT on ERPs and EGNG performance. At Level 1, the level of repeated-measures, Stimulus Condition (fearful, happy, or neutral facial expression) and Task Time (first versus second half of Emotional Go/No-Go) were included, and for ERPs, also stimulus type (Go vs. No-Go). There were no specific hypotheses pertaining to these repeated-measures predictors, except for an expectation of larger N200 and P300 amplitudes to No-Go versus Go trials. Level 2 was the level of individual participant, in which repeated measures were nested to account for between-person variation within each intervention condition. Finally, participants were nested within training intervention condition (MT vs. BLC). Controlling for baseline assessment, hypothesized effects of MT on ERPs and task-based behavior would be evident in more efficient performance and larger component amplitudes at post-test for the MT condition. However, I expected an intervention condition x stimulus type interaction for my hypothesis regarding the No-Go P300 component, reflecting larger No-Go (but not Go) P300 in the MT condition at post-test.

N100. To test Hypothesis 1 that participation in MT would predict greater increases in N100 amplitude, an initial multilevel model tested the main effect of Stimulus Condition, Stimulus Type, and Task Time on the N100 amplitude, controlling for baseline N100 amplitude. There were no specific hypotheses pertaining to repeated measures variables, but Stimulus Condition significantly predicted N100 [F(2, 101) = 4.88, *p* = .0095], as did prettest N100 amplitudes [F(1, 249) = 8.20, *p* = .0046]. Tukey-Kramer post-hoc tests revealed that the amplitude of the N100 was significantly more negative for happy than fearful or neutral stimuli (*p*s < .05). However, neither Stimulus Type [F(1, 51) = .02, *p* = .89] nor Task Time [F(1, 51) = .03, *p* = .87] significantly predicted N100. Subsequently, a multilevel model tested Intervention Condition as a predictor of N100, retaining baseline amplitude and Stimulus Condition as covariates. Additionally, CEQ scores were included to account for intervention condition differences in intervention expectancy and credibility. Although N100 was larger for MT (*M* = -2.48, *SE* = .35) than BLC (*M* = -1.85, *SE* = .43), this difference was not significant [F(1, 49) = 1.60, *p* = .21], nor was there an interaction between Intervention Condition and baseline N100 at Cz [F(1, 244) = .43, *p* = .514]. Figure 4 presents topographic maps and grand average waveforms for BLC and MT conditions at posttest, and Table 1 summarizes N100 and other ERP results. CEQ scores also did not significantly predict N100 amplitude (*p* = .89). Thus, results did not support the hypothesis that MT would result in significantly larger N100 amplitude.

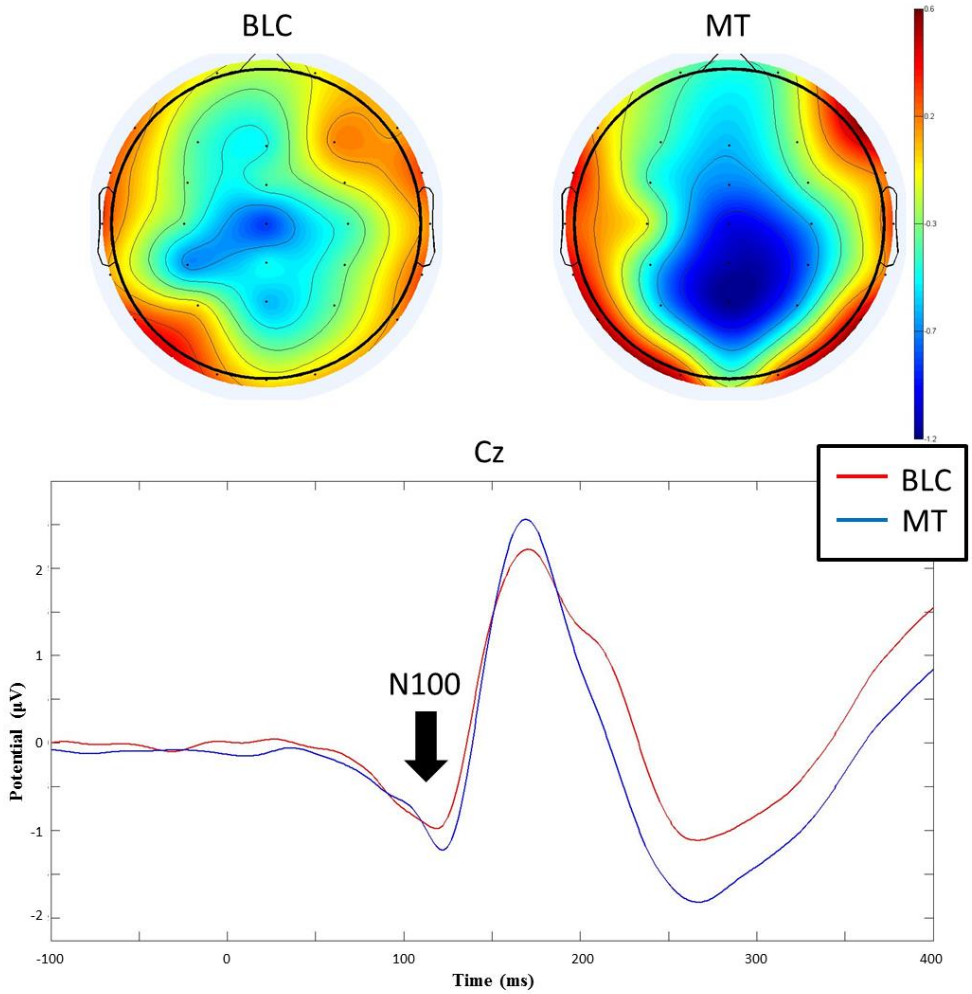

Figure 4. Top: Scalp topographies at posttest for BLC (left) and MT (right) for 100-130 ms following stimulus onset during the Emotional Go/No-Go Task. Darker blue indicates more negative activation. Bottom: Grand average waveform at Cz for BLC (red) and MT (blue) from -100 and 400 ms following all conditions and stimulus types at posttest.

Table 1. *Event-related Potentials (ERPs) Findings*

	b(SE)	95% CI	p-value	Effect size (R^2)
N100				
Intervention Condition	-.43 (.62)	-1.69, .81	.21	--
Stimulus Condition	.14 (.31)	-.19, .17	.11	--
Baseline N100	.01 (.09)	-.16, .19	.82	--
Intervention x Stimulus Cond.	-.47 (.36)	-1.17, .24	.16	--
Intervention x Baseline N100	-.04 (.09)	-.22, .14	.51	--
CEQ	-.003 (.03)	-.06, .05	.89	--
N200				
Intervention Condition	-1.32 (.62)	-2.56, -.07	.011	.084
Stimulus Condition	.12 (.20)	-.28, .53	.40	--
Baseline N200	.05 (.08)	-.11, .21	.34	--
Intervention x Stimulus Cond.	-.61 (.27)	-1.15, -.07	.046	.047
Intervention x Baseline N200	-.04 (.08)	-.12, .19	.08	--
CEQ	.04 (.03)	-.02, .09	.15	--
P300				
Intervention Condition	-.45 (.52)	-1.49, .59	.15	--
Stimulus Type	.57 (.43)	-.30, 1.44	.20	--
Baseline P300	.23 (.09)	.04, .42	.002	.022
Intervention x Stimulus Type	-.42 (.54)	-1.52, .68	.44	--
Intervention x Baseline P300	-.26 (.09)	-.45, -.07	.002	.027
CEQ	-.02 (.02)	-.06, .02	.36	--

Note. CEQ = Credibility/Expectancy Questionnaire. Coefficient values are unstandardized estimates. Effect sizes obtained using a *t*-to-*r* transformation: $R^2 = t^2 / (t^2 + DF)$ (Kashdan & Steger, 2006).

N200. To test Hypothesis 2 that participation in MT would predict greater increases in N200 amplitude generally, an initial multilevel model tested the main effect of Stimulus Condition, Stimulus Type, and Task Time on the N200 amplitude, controlling for baseline N200 amplitude. Stimulus Condition significantly predicted N200 [F(2, 101) = 3.26, p = .0426], but Stimulus Type did not [F(1, 51) = .22, p = .64]. Amplitudes for No-Go stimuli (M = -2.12, SE =

.31) were slightly larger than for Go stimuli (*M* = -2.03, *SE* = .28), but the fact that Stimulus Type did not predict N200 is consistent with a more general role of this component in conflict monitoring during both target and nontarget trials (cf. Nieuwenhuis et al., 2003). Tukey-Kramer post-hoc tests revealed that the amplitude of the N200 was significantly more negative for happy than fearful stimuli (*p* = .042), and marginally more negative relative to neutral stimuli (*p* = .08). This is consistent with prior research that happy faces result in approach-oriented responses that may require greater inhibitory control, whereas fearful faces demand less inhibitory control (Hare et al., 2005). Baseline amplitudes significantly predicted posttest N200 [F(1, 249) = .6.87, *p* = .0093], but Task Time did not (*p* = .81). Subsequently, a multilevel model tested Intervention Condition as a predictor of N200, retaining Stimulus Condition and baseline amplitude as covariates. Additionally, CEQ scores were included to account for Intervention Condition differences in intervention expectancy and credibility.

Results revealed a main effect of Intervention Condition on N200 [F(1, 49) = 6.98, *p* = .011]. Figure 5 presents topographic maps and grand average waveforms for BLC and MT conditions at posttest. There was also a marginally significant interaction between Intervention Condition and baseline N200 at FCz [F(1, 244) = 3.03, *p* = .083]. Participants in MT (*M* = -2.59, *SE* = .37) had more negative N200 amplitude at posttest relative to BLC (*M* = -1.24, *SE* = .46). Further, there was a significant Intervention Condition x Stimulus Condition interaction [F(2, 99) = 3.16, *p* = .046]. Tukey-Kramer post-hoc tests revealed that the difference in N200 amplitude between conditions was significant for fearful faces (*p* = .021; MT: *M* = -2.56, *SE* = .38; BLC: *M* = -1.00, *SE* = .49) and happy faces (*p* = .042; MT: *M* = -2.75, *SE* = .38; BLC: *M* = -1.43, *SE* = .47), but only marginally significant for neutral faces (*p* = .054; MT: *M* = -2.46, *SE* = .35; BLC: *M* = -1.29, *SE* = .44). CEQ scores did not significantly predict N200 amplitude (*p* = .15). Thus, results generally supported the hypothesis that MT would increase conflict monitoring as indexed by N200 amplitude, with effects most evident for emotional facial expressions.

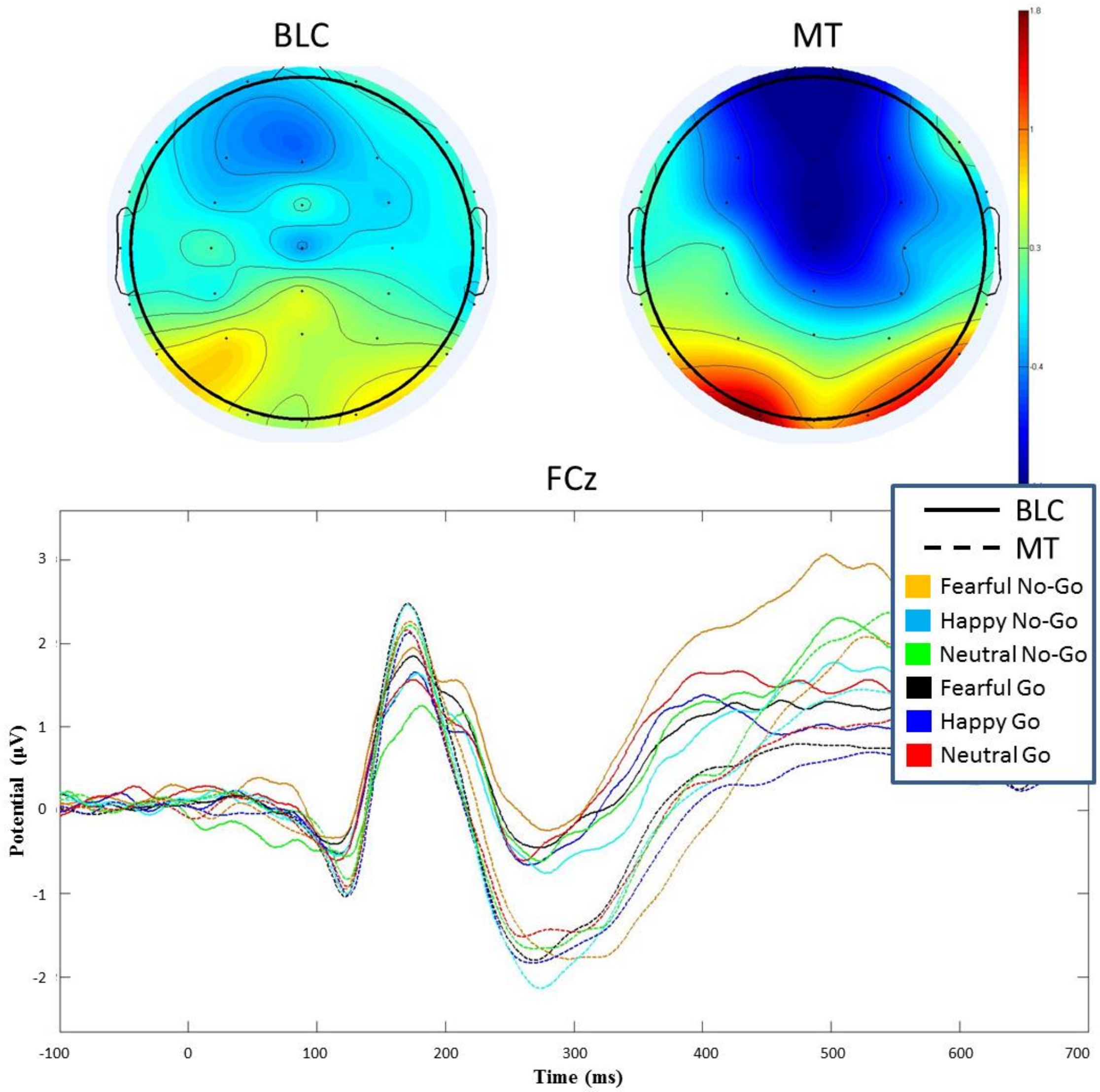

Figure 5. Top: Scalp topographies at posttest for BLC (left) and MT (right) for 200-350 ms following stimulus onset during the Emotional Go/No-Go Task. Darker blue indicates more negative activation. Bottom: Grand average waveform at FCz for BLC (solid) and MT (dashed) from -100 and 700 ms following all conditions and stimulus types at posttest.

P300. To test Hypothesis 3 that participation in MT would predict greater increases in No-Go P300 amplitude, an initial multilevel model tested the main effect of Stimulus Condition, Stimulus Type, and Task Time on the P300 amplitude, controlling for baseline P300 amplitude. I expected larger P300 for No-Go stimuli, and although P300 was larger for No-Go than Go stimuli, there was no significant effect of Stimulus Type [$F(1, 51) = .73$, $p = .39$]. There was, however, a marginally significant main effect of Stimulus Condition [$F(2, 101) = 2.86$, $p = .062$], and baseline P300 amplitudes predicted posttest P300 [$F(1, 249) = 4.03$, $p = .046$]. Task Time did not predict posttest P300 [$F(1, 51) = 1.25$, $p = .26$]. Considering the hypotheses that MT would result in larger increases in No-Go P300 specifically, a multilevel model tested Intervention Condition as a predictor of P300, retaining Stimulus Type, Stimulus Condition, and baseline amplitude as covariates. Additionally, CEQ scores were included to account for intervention condition differences in intervention expectancy and credibility. Results revealed no main effect of Intervention Condition [$F(1, 49) = 2.18$, $p = .15$]. However, there was a significant interaction between baseline P300 and Intervention Condition [$F(1, 246) = 9.59$, $p = .002$], revealing that BLC predicted larger P300 at posttest relative to MT for participants with larger baseline P300. There was no interaction between Stimulus Type and Intervention Condition ($p > .40$). CEQ scores also did not significantly predict P300 amplitude ($p = .36$). Figure 6 presents topographic maps and grand average waveforms for BLC and MT conditions at posttest. Thus, results did not support the hypothesis that MT would result in larger No-Go P300, and instead indicated that P300 was larger for BLC participants when baseline P300 was larger.

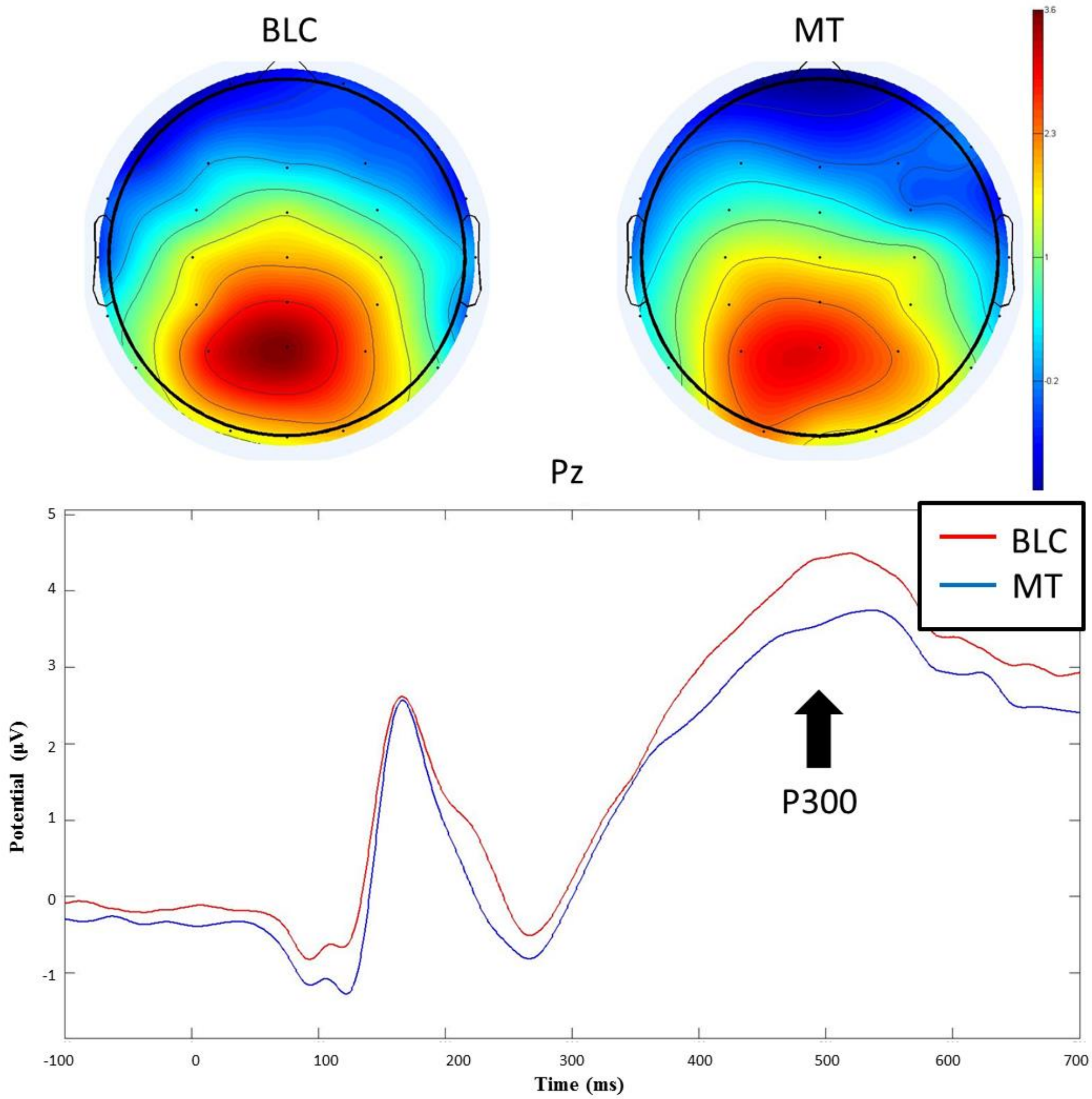

Figure 6. Top: Scalp topographies at posttest for BLC (left) and MT (right) for 350-600 ms following stimulus onset during the Emotional Go/No-Go Task. Darker blue indicates more negative activation. Bottom: Grand average waveform at Pz for BLC (red) and MT (blue) from -100 and 700 ms following all conditions and stimulus types at posttest.

Summary of ERP Results. Overall, results partially supported the hypothesis that MT would improve early attention during the EGNG as indexed by electrocortical response. Training effects were only found for the N200, with larger N200 amplitude for MT participants compared with BLC at posttest, controlling for baseline N200. These differences between conditions were most pronounced for emotional facial expressions. Contrary to hypotheses, there were no effects of MT on the N100 nor No-Go P300.

Task-based Behavior. Multilevel models tested Hypothesis 4 that mindfulness training would predict faster RT at posttest, accounting for FA rate, with Stimulus Condition and Task Time (first versus second half of Emotional Go/No-Go) as repeated measure factors. Baseline RT was also included as a covariate to control for baseline scores, and FA rate was included as an individual level predictor to account for any speed/accuracy tradeoff. Regarding RT, an initial model found a marginally significant effect of Stimulus Condition [$F(2, 113) = 2.83$, $p = .063$], with Tukey-Kramer post-hoc tests revealing that RT was marginally faster for happy relative to fearful faces ($p = .053$), though there was no difference for neutral and happy faces (ps > .10). RT at pretest also significantly predicted posttest RT [$F(1, 113) = 80.30$, $p < .0001$]. Further, FA rate at posttest predicted RT [$F(1, 113) = 4.15$, $p = .044$], with higher FA rate related to faster RT**.** Slower RT during the second half of the task was also found, with Task Time a significant predictor of RT [$F(1, 58) = 7.79$, $p = .007$]. All variables were retained in the model to test effects of MT on RT. Additionally, CEQ scores were included to account for intervention condition differences in intervention expectancy and credibility.

To test the primary hypothesis that MT would predict greater general decreases in RT than BLC, a multilevel model assessed whether Intervention Condition predicted faster RT while controlling for the variables mentioned above, including pretest RT. There was no significant main effect of Intervention Condition [$F(1, 57) = 1.61$, $p = .21$], but there was a significant interaction between Intervention Condition and Task Time [$F(1, 57) = 10.09$, $p = .002$]. Tukey-

Kramer post-hoc tests revealed that RT became significantly slower for the BLC group from this first (BLC: *M* = 461.90, *SE* = 12.65) to the second half (*M* = 495.38, *SE* = 14.65), while the change was not significant for the MT group (first half: *M* = 474.21, *SE* = 12.19; second half: *M* = 486.40, *SE* = 10.68). Importantly, RT was not significantly different between groups during either the first or second half of the EGNG (*ps* > .20). Thus, MT seems to have buffered against a time-related decrement in performance, and the pattern of findings may reflect more sustained, efficient top-down attention with MT at posttest. RT at pretest continued to predict posttest RT (*p* < .0001), and there was a significant three-way interaction between Intervention Condition, Task Time, and pretest RT [F(1, 95) = 12.55, *p* = .001], with slower baseline RT strengthening the relation between MT and faster RT during the second half of the EGNG. CEQ scores did not predict RT (*p* > .40). Results for RT and other task-based behavioral measures are summarized in Table 2.

Table 2. *Task-based Behavioral Findings*

	b(SE)	95% CI	p-value	Effect size (R^2)
EGNG Response Time (RT)				
Intervention Condition	-175.10 (128.61)	-82.44, -432.64	.21	--
Stimulus Condition	105.95 (119.46)	-343.12, 257.07	.002	.008
Task Time	143.33 (118.31)	-93.59, 380.25	.90	--
Baseline RT	.65 (.17)	.31, .99	< .0001	.127
FA Rate	-107.46 (.69)	-284.81, 69.89	.23	--
Intervention x Task Time	-234.79 (164.22)	-563.64, 94.07	.002	.034
Intervention x Task Time x Baseline RT	.51 (.32)	-.14, 1.15	.001	.025
CEQ	-.48 (.69)	-1.85, .90	.49	--
EGNG False Alarm (FA) Rate				
Intervention Condition	-.05 (.04)	-.03, .13	.07	.024
Stimulus Condition	-.004 (.05)	-.09, .08	.52	--
Task Time	.02 (.03)	-.04, .08	.03	.008
Baseline FA Rate	.78 (.19)	.41, 1.15	.002	.158
RT	-.0001 (.0001)	-.0003, -.0001	.01	.068
Intervention x Baseline FA	-.81 (.19)	-.20, .05	.004	.057
CEQ	.0003 (.0005)	-.0008, .0014	.56	--
Inverse Efficiency Score (IES)				
Intervention Condition	310.72 (95.56)	119.36, 502.09	.01	.156
Task Time	128.79 (75.36)	-22.10, 279.69	.82	--
Baseline IES	.93 (.16)	-.62, 1.24	< .0001	.241
Intervention x Task Time	-236.99 (94.19)	-425.60, -48.38	.01	.100
Intervention x Baseline IES	-.62 (.18)	-.97, -.26	.009	.093
Intervention x Task Time x Baseline IES	.49 (.18)	-.15, .85	.006	.065
CEQ	-.18 (.77)	-1.72, 1.36	.81	--

Note. CEQ = Credibility/Expectancy Questionnaire. Effect sizes obtained using a *t*-to-*r* transformation: $R^2 = t^2 / (t^2 + DF)$ (Kashdan & Steger, 2006).

For FA rate, a preliminary multilevel model found that Stimulus Condition predicted FA rate [F(2, 113) = 5.18, p = .007]. Tukey-Kramer post-hoc tests revealed that FA rate was significantly lower for neutral relative to both fearful and happy nontargets (*ps* $< .02$). FA rate at pretest also predicted posttest FA rate [$F(1, 113) = 16.60$, $p < .0001$]. Faster RT predicted a higher FA rate [$F(1, 113) = 6.69$, $p = .011$], consistent with a speed/accuracy tradeoff. Task Time predicted FA rate [$F(1, 58) = 9.17$, $p < .004$], but unlike RT, performance in terms of accuracy was improved during the second half of the EGNG. All variables were retained in the model to test effects of MT on FA. Additionally, CEQ scores were included to account for intervention condition differences in intervention expectancy and credibility.

To test the primary hypothesis that MT would predict greater improvement in accurate inhibition to No-Go stimuli generally, a multilevel model assessed whether intervention condition predicted FA rate while controlling for RT at posttest and baseline FA rate. Intervention Condition marginally predicted FA rate at posttest [$F(1, 57) = 3.40$, $p = .071$], with a lower FA rate for MT ($M = .082$, $SE = .007$) than BLC ($M = .098$, $SE = .009$). There was also a significant interaction between pretest FA rate and Intervention Condition [$F(1, 95) = 8.51$, $p = .004$], such that MT was a stronger predictor of posttest FA rate when pretest FA rate was higher. Task Time continued to predict FA rate ($p < .03$), but there was no interaction with Intervention Condition. Faster RT also continued to predict higher FA rates ($p < .05$), but CEQ scores did not predict FA rate ($p > .60$).

Given this pattern of findings regarding effects of MT on both RT and FA rate, an additional model was run to test the effect of MT on a variable that combined both RT and FA rate. The inverse efficiency score (IES; RT/(1 – FA rate); Bruyer & Brysbaert, 2011) accounts for speed/accuracy tradeoffs to index efficient performance (wherein higher scores indicate less efficiency) in a single dependent measure that is still expressed in terms of milliseconds (Bruyer & Brysbaert, 2011). Although IES may warrant interpretative caution in some contexts, it can provide additional relevant analysis, and especially when examined in the context of RT and FA rate, with a large number of trials, and when error rate is relatively low (< 10%; Bruyer, & Brysbaert, 2011). Consistent with the hypothesis that MT would predict more efficient performance on the EGNG, Intervention Condition significantly predicted IES at posttest [F(1, 57) = 6.67, *p* = .012], with more efficient performance in MT (*M* = 526.10, *SE* = 9.99) than BLC (*M* = 529.58, *SE* = 12.01). There was also a significant interaction between pretest IES and Intervention Condition [F(1, 112) = 7.12, *p* = .009], such that MT was a stronger predictor of more efficient (lower) posttest IES rate when pretest IES rate was higher. An interaction between Intervention Condition and Task Time [F(1, 57) = 6.33, *p* = .012] supported that MT predicted greater efficiency than BLC in the second half of the EGNG (MT: *M* = 521.75, *SE* = 10.70; BLC: *M* = 539.78, *SE* = 13.77), but not the first half of the EGNG (MT: *M* = 530.94, *SE* = 11.39; BLC: *M* = 520.23, *SE* = 12.55). Finally, a three-way interaction between Intervention Condition, Task Time, and pretest IES [F(1, 112) = 7.89, *p* = .006] indicated that less efficiency among those in the MT condition at pretest was related to larger condition differences at posttest during the second half of the EGNG. CEQ scores did not predict IES (*p* > .80).

Summary of Task-Based Behavioral Results. Results generally supported the hypotheses that brief MT would increase the efficiency of facial expression discrimination on the EGNG, as indexed by FA rate and RT. However, interactions between Intervention Condition and Task Time revealed that the effects of MT were evident during the second half of the EGNG, suggesting that MT improves sustained, goal-driven attention over time (i.e., better attention regulation). In the context of significant findings for both RT and FA rate, analysis of a combined marker of efficiency (IES) gave further support that, relative to BLC, MT led to greater improvements in attention regulation of goal-driven attention on the EGNG.

Research Question 2

Multilevel models were specified for examining effects of MT on day-to-day (event sampled), interaction-based positive and negative affect (intensity and lability). Separate models assessed effects of MT on positive emotion, negative emotion, and negative emotion lability. The models for both positive and negative emotion were as follows: At Level 1, the level of repeated-measures, the diary events were numbered sequentially within and across days and included the social role of the interactant (e.g., romantic partner, friend). Level 2 was the level of individual participant. At Level 3, participants were nested within training intervention condition (MT vs. BLC). Following prior research on emotion regulation (Kuppens et al., 2010), negative emotion lability was computed as the MSSD, which represents the degree of fluctuation in emotional intensity (i.e., emotion lability) between event-sampled time points, for each participant, pre- and post-test. Therefore, the model for negative emotion lability tested the factor of intervention condition and covariate of baseline emotion lability. Hypothesized effects of MT (Hypotheses 5-7) on positive and negative emotion intensity, and on negative emotion lability, were expected as a main effect of intervention condition on covariate-adjusted posttest scores, reflecting greater gains in effective emotion regulation from pre- to posttest for the MT condition relative to BLC.

Preliminary models found that baseline negative and positive emotion scores strongly predicted emotional experience at posttest (ps < .0001). Additionally, Diary Time accounted for some variability in negative ($p = .02$), but not positive ($p > .50$), emotion. Finally, social role of the interaction partner significantly predicted both negative and positive emotion (ps < .0001). Considering both negative and positive emotion, participants felt best during social interactions with close friends and worst during interactions with coworkers. These variables were retained in subsequent models for testing study-specific hypotheses. Additionally, CEQ scores were included.

Experience sampling data supported the hypothesized effect of MT on effective social emotion regulation. Regarding emotions during day-to-day social interactions, Intervention Condition was a significant predictor of both negative [$F(1, 45) = 6.44$, $p = .015$] and positive emotion [$F(1, 45) = 6.54$, $p = .014$]. Specifically, participants in the MT condition reported less negative ($M = 3.33$, $SE = .60$) and more positive emotion ($M = 13.82$, $SE = .66$) than BLC (negative, $M = 4.48$, $SE = .74$; positive, $M = 12.11$, $SE = .79$). There was no interaction with baseline day-to-day emotional experience. For negative emotion lability, there was a significant effect of Intervention Condition [$F(1, 44) = 4.20$, $p = .046$], with less negative emotion lability for MT ($M = 37.55$; $SE = 8.13$) than BLC ($M = 47.61$; $SE = 9.63$). This effect was qualified by a significant interaction between Intervention Condition and baseline emotion lability such that MT more strongly predicted posttest emotion lability for those participants with more baseline negative emotion lability [$F(1, 44) = 4.09$, $p = .049$]. Regarding day-to-day measures, CEQ scores did not significantly predict daily socioemotional experience (ps > .50). Table 3 presents a summary of results regarding day-to-day socioemotional experience.

Table 3. *Event-based Ecological Momentary Assessment (EMA) Emotion Findings*

	b(SE)	95% CI	p-value	Effect size (R^2)
Negative Emotion				
Intervention Condition	-3.05 (1.12)	-5.29, -.80	.009	.142
Baseline Negative Emotion	4.57 (4.88)	-5.03, 14.16	< .0001	.120
Diary Time	.52 (.21)	.09, .94	.03	.011
Interactant Role	-1.61 (1.09)	-3.75, .54	< .0001	.094
CEQ	.004 (.02)	-.05, .05	.87	--
Positive Emotion				
Intervention Condition	6.02 (2.37)	1.24, 10.79	.014	.127
Baseline Positive Emotion	1.02 (.14)	.74, 1.29	< .0001	.544
Diary Time	-5.85 (5.40)	-16.46, 4.76	.41	--
Interactant Role	5.00 (1.18)	2.66, 7.35	< .0001	.203
CEQ	-.02 (.02)	-.07, .04	.59	--
Negative Emotion Lability				
Intervention Condition	-39.17 (19.11)	-77.70, -.65	.046	.087
Baseline Lability	-.06 (.18)	-.42, .29	.13	--
Intervention Condition x Baseline Lability	.53 (.26)	.002, 1.06	.049	.084
CEQ	.17 (.59)	-1.01, 1.35	.77	--

Note. Interactant role = Social Role of Primary Interactant. Effect sizes obtained using a *t*-to-*r* transformation: $R^2 = t^2 / (t^2 + DF)$ (Kashdan & Steger, 2006).

To summarize, MT significantly improved emotional experience within social interactions. Results supported hypotheses that, relative to BLC, brief MT would increase positive, and decrease negative, emotion during daily social interactions. Moreover, MT participation predicted greater stability in negative emotion experience between different social interactions, particularly for those starting with higher emotion lability. These findings suggest that brief MT enhanced effective emotion regulation in day-to-day social interactions.

Research Question 3

Multilevel models were specified for examining effects of MT on participants' perceived social connection with others (Hypothesis 8-9), romantic partners' ratings of interpersonal responsiveness (Hypothesis 10), and to explore indirect effects of MT on the participants' romantic partners' self-reported emotions and perceived connection during couple interactions (Questions 1-2). These models were specified as were those outlined above for Research Question 2. Regarding perceived connection, Intervention Condition was not a significant predictor of connection [$F(1, 46) = .02$, $p = .87$], nor was there any interaction with baseline scores. Similarly, analyses on romantic partner data did not support an indirect effect of MT on negative [$F(1, 34) = .03$, $p = .86$] nor positive emotion [$F(1, 34) = .21$, $p = .65$], perceived connection during romantic partner interactions [$F(1, 33) = 1.48$, $p = .23$], or perceived responsiveness [$F(1, 33) = .44$, $p = .51$]. Thus, hypothesized effects of MT on perceived social connection, partner-rated interpersonal responsiveness, and as an exploratory examination, on partners' emotions and perceived connection during couple interactions were not supported by these models. Thus, brief MT did not affect the social outcomes assessed, beyond the effects on social emotion regulation.

Research Question 4

To test Hypotheses 11 and 12 that expected changes in top-down attention to facial expressions on the Emotional Go/No-Go task would mediate the relation between MT and expected improvements in day-to-day social emotion regulation, mediational tests followed a procedure outlined for assessing multilevel mediation (Zhang, Zyphur, & Preacher, 2009). As with all mediational analyses, significant relations must be found between the mediator and dependent variable(s). Thus, preliminary models assessed the relation between improvements in attentional efficiency on the EGNG and experience sampling measures through analysis of RT and FA rate change scores. As a neural index of top-down attention during the EGNG, changes in N200 were also examined. Results demonstrated that FA rate change predicted posttest positive emotion during social interactions [F(1, 44) = 4.54, $p = .038$], but not negative emotion [F(1, 44) = .69, $p = .41$]. However, neither RT nor IES change scores predicted emotion intensity at posttest (*p*s > .20). Changes in N200 also predicted positive emotion during social interactions [F(1, 41) = 1.82, $p = .034$], but not negative emotion [F(1, 41) = 1.00, $p = .32$].

Given these findings, mediation analyses assessed the role of within-person changes in FA rate on the EGNG as a mediator of more positive emotion during day-to-day social interactions. Following MacKinnon, Lockwood, Hoffman, West, and Sheets (2002) product of coefficients mediational procedure, each regression coefficient (Intervention Condition predicting Mediator; Mediator predicting day-to-day positive emotion) was converted into a *z* score through division by its standard error. Subsequently, these terms were multiplied and their product (*P*) was compared to critical values from a theoretical distribution of the product of two normal variables (Craig, 1936). Results revealed that changes in FA rate significantly mediated the relation between Intervention Condition and positive emotion ($P = 6.039$, $p < .01$), while the N200 did not ($P = -.282$, $p > .40$). In summary, partial support for the hypothesis that top-down attention would serve as a mechanism for MT's effects on daily social emotion regulation was found. Specifically, improvements in FA rate (controlling for RT), but not N200, significantly mediated the relation between participation in MT and increases in positive emotion.

Research Question 5

Given that no significant differences between intervention conditions were found for Research Question 3, no further analyses were conducted to assess Hypotheses 13-15 that effective emotion regulation would mediate the expected relations between MT and perceived connection with and responsivity to interactants.

Discussion

In the present study, findings from a variety of measures and levels of analysis are consistent with and build upon prior mindfulness research (Barnes et al., 2007; Hill & Updegraff, 2012; Quaglia et al., 2014). Relative to a structurally-equivalent control condition, a brief 4-session intervention involving focused attention mindfulness meditation training predicted changes in neural, task-based behavioral, and daily life indices of more effective social emotion regulation. Combined, these results add further support to theory regarding benefits of mindful emotion regulation (Teper et al., 2013), including the relevance of mindfulness to unique features of social emotion regulation (Quaglia et al., 2014b). Findings could inform advances in MT research in several ways. Foremost, these findings are among the first to demonstrate effects of MT on attention and emotion regulation in a social context specifically, an important step in extending research on mindfulness beyond its chief focus on intrapersonal benefits. This shift in research emphasis toward consideration of social context mirrors, and is in part motivated by, recognition of the importance of social factors in emotion regulation research more generally (Aldao, 2013; Gross, 2002; Marroquín, 2011; Shiota et al., 2005). Relatedly, findings across laboratory and daily life measures help to bridge our understanding of neural and cognitive mechanisms of mindfulness and attention with *in vivo* changes in daily socioemotional experience. More generally, the present findings add to a growing number of studies (e.g., Zeidan, Johnson, Diamond, et al., 2010; Zeidan, Johnson, Gordon, et al., 2010) indicating effects of a brief MT (< 100 minutes), which has both applied and basic research-related advantages over longer-term interventions (most commonly, 8 weeks in MT research).

Investigating effects of MT on neural responses during the EGNG revealed greater N200, a neural index of conflict monitoring, for MT than BLC participants. Conflict monitoring involves ongoing attention to discrepancies between internally-generated intended behavior and external task demands (Donkers & Van Boxtel, 2004; Nieuwenhuis et al., 2003). Such monitoring is critical for inhibitory control over prepotent responses, and may thus reflect a more general skill of overriding habitual behaviors when they are not in service of one's goals. In the context of mindfulness meditation, the cognitive skill of conflict monitoring may be trained through the repeated practice of noticing task-unrelated events (e.g., mind wandering), disengaging attention from such events, and reengaging intended attention on the meditative object (cf. Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012). Results further indicated an interaction with stimulus condition, with larger relative increases in N200 for emotional (fearful and happy) versus neutral social stimuli. This affective sensitivity is consistent with theory that mindfulness enhances sensitivity to emotion-related cues that may require regulatory resources (Teper et al., 2013). In social contexts, such conflict monitoring may facilitate timely and effective regulatory control since social situations demand awareness not only for one's own emotions and goals, but also for the emotional responses and goals of others. Thus, greater conflict monitoring may help balance goal pursuit and context-sensitivity in a dynamic socioemotional environment.

Results did not support the hypotheses for larger increases in N100 nor No-Go P300 among MT participants. This contrasts with previous findings showing that dispositional mindfulness predicted larger N100 and No-Go P300, though the latter finding was exploratory (Quaglia et al., 2015). In the context of those findings, lack of support for the influence of brief MT on N100 suggests that effects of MT on visual discrimination processes may manifest only through more durable, trait-like changes in mindfulness. Here, changes in trait mindfulness as assessed by the FMI were not significantly different at post-test between intervention conditions. Similarly, lack of significant findings concerning the No-Go P300 may only emerge alongside more robust increases in mindfulness. Alternatively, support for the effects of brief MT on only the N200 could reflect a more focused effect of this style of MT on top-down attention to discrepancies between goal-driven intentions and context cues (i.e., conflict monitoring). Said differently, specific effects of MT may be driven not only by differences in duration of training, but also specific qualities of the MT instructions.

Task-based behavioral results supported hypotheses that MT would increase the efficiency of facial expression discernment, a process that involved both facial expression discrimination and inhibitory control on the EGNG. Importantly, however, these effects of MT on task performance were more strongly evident in the second half of EGNG, suggesting that MT helps buffer against time-related decrements in the efficiency of cognitive performance (e.g., better attention regulation). MT predicted less decrement in RT from the first the second half of the EGNG, regardless of facial expression type, compared to BLC when controlling for FA rate (to account for any speed/accuracy tradeoff). Similarly, MT marginally predicted improvements in accuracy generally when controlling for RT. Finally, MT predicted increased efficiency on a combined index of RT and accuracy. Because the most effective emotion regulation is flexible and sensitive to individual goals and context (Eisenberg et al., 2000; Gross & Thompson, 2007), the various combinations of happy, neutral, and fearful faces as either target or nontarget stimuli on the EGNG affords insight about whether MT improves attention and performance across differing socioemotional contexts (i.e., facilitates performance across divergent task parameters). That mindfulness increased efficient performance on the EGNG generally, rather than for specific types of targets/nontargets, suggests that MT facilitates adaptive attention deployment across varying socioemotional contexts. For example, responding quickly to emotion-related targets that evoke either avoidance or approach behavioral tendencies may be facilitated by more or less inhibition, respectively. This adaptive feature of mindful attention, evident in timely and context-sensitive goal-driven behavior on the EGNG, may map onto skillful navigation of complex socioemotional situations in daily life.

In that vein, event sampling of emotion during day-to-day social interactions revealed larger increases in positive emotion as well as decreases in negative emotion for MT participants relative to control participants. These findings may reflect more effective emotion regulation since individuals generally aim to decrease negative and increase positive emotional states (Gross, 2013). MT training was also a significant predictor of changes in negative emotion lability, particularly for those who had more lability at baseline, and so MT improved effective emotion regulation as expressed within social interactions and in stability of negative emotion across different social interactions.

Regarding effects of MT on social experience beyond emotion, MT did not lead to greater increases in perceived connection with others, nor did romantic partners' event sampling outcomes reveal greater increases in emotional well-being, perceived connection, or responsiveness of their respective primary participant partner. The lack of a significant finding regarding primary participants' perceived connection does not support the hypothesis that MT would improve social connection with others, whereas lack of support for questions regarding indirect effects of MT on romantic partner emotions and social experience is less surprising given their exploratory nature. Given findings that dispositional mindfulness predicts both higher emotional well-being and perceived social connection (Quaglia et al., 2014b), it could be that more durable changes in mindfulness accrued through longer training are needed before shifts in attention and emotion regulation translate into these other social outcomes. An alternative explanation is that, as noted earlier, qualities of the MT intervention itself could affect what domains are affected. A more focused approach to cultivating mindfulness with an intention to benefit relationships may more strongly drive social effects of MT (cf. Carson et al., 2004).

Given effects of MT on both laboratory and daily life measures, further analyses investigated relations between changes on these measures. However, preliminary results established significant relations only between changes in FA rate and N200 and experience sampled positive emotion during social interactions. Though we expected relations between behavioral and neural markers and EMA-based measures of effective emotion regulation more generally, attention performance on the EGNG may only capture some of the variation in mental performance resulting from MT. As such, FA rate, but not N200, significantly mediated MT-related increases in positive emotion during day-to-day social interactions. In addition to such partial empirical support for mediation by top-down attention, there is a compelling theoretical rationale for considering changes in attention as mechanisms of MT's effects on social emotion regulation more broadly, and this topic deserves further investigation.

Mechanisms of Brief Mindfulness Meditation Training

Most neuroscience research to date on mindfulness involves efforts to localize neural processing regions pertinent to mindfulness-related differences in cognition. Here we used both task-based behavioral and electrophysiological measures to consider differences in mindful attention from a fine-grained temporal perspective. Studying mindfulness from this perspective affords insight specifically regarding early attention and awareness-related processes that are central to questions about mindfulness. In the present study, findings support a perspective that greater early (< 350 ms) goal-driven attention with mindfulness may afford more timely and flexible behavior. As noted, regulatory strategies that occur further "upstream" in the emotion generation sequence may require less cognitive effort, fewer cognitive resources, and support effective regulation that is relatively unchanged by level of experienced emotional intensity (Sheppes & Gross, 2011). The present results offer some support for a perspective that mindful emotion regulation is relatively less effortful, given its rapidity of effect (approximately 250 ms), and more experientially-engaged, promoting efficient deployment of top-down attention when and as needed (Teper et al., 2013).

Given the growing number of studies demonstrating effects of brief MT, the present study adds to a call for understanding how brief MT works, and specifically, how its mechanisms may compare with those observed for longer-term MT. Findings from the present research shed light on this question in a manner that could inform more targeted research on the topic. Specifically, effects of MT on neural and task-based behavioral indices of early top-down attentional efficiency could be broadly interpreted in at least two ways: First, brief MT may improve the efficiency of attention-related processes in a manner consistent with longer-term training, such as through more efficient prefrontal cognitive control due to structural changes in neurophysiology (cf. Tang, Hölzel, & Posner, 2015). Just as plausible, however, is that functional changes in the process configuration and deployment of cognitive mechanisms of attention occur largely independent from substantial structural changes in the brain. Brief MT may provide learning of new mental regulatory techniques and skills. In novices, for example, mindfulness meditation instructions (e.g., noticing and disengaging mind wandering) may introduce personally novel cognitive behaviors that individuals can employ to support better regulation of attention, emotion, and behavior. Ultimately, it may be impossible to disentangle structural from functional changes that underlie effects of brief MT, but considering each perspective in turn could yield complementary understanding.

From Mindfulness Mechanisms to Social Effects

Effects of brief MT on laboratory and daily life measures of social emotion regulation are consistent with an emerging theoretical framework for understanding effects of mindfulness on the quality of social functioning. Social emotion regulation may be key to such effects given that effective emotion regulation appears critical for high-quality social functioning (Baron-Cohen & Wheelwright, 2004; Lopes et al., 2005; Lopes et al., 2011). Although results in the present study did not directly support the theoretical model that MT would increase participants' quality of social functioning (in this study, perceived social connection with others), findings did corroborate the importance of social emotion regulation for understanding the social relevance of mindfulness meditation, namely the effects of MT on emotional experience during social interactions and the stability of emotional experience from one interaction to the next. Furthermore, links between improvements in top-down attention to facial expressions on the EGNG and positive emotion during social interactions underscores the germaneness of attention regulation in socioemotional contexts.

The present findings suggest that mindfulness meditation provides a means for effectively training attention to function more adaptively in social situations by improving context-sensitive regulation of emotion and behavior. As noted earlier, a more explicit training focus on bringing mindfulness into interpersonal life may increase its effects on social outcomes. Considering that a relational focus is a part of many traditional approaches to MT (Williams, 2008), further investigation of MT with an interpersonal focus is warranted. The brief MT intervention used in the present research focused primarily on development of mindful attention for individuals' own benefit (reducing stress and promoting well-being), whereas traditional approaches to MT emphasize the importance of, and cultivate intentions for, bringing such attention into social interactions not only for personal benefit, but also for the benefit of others. A similar brief MT intervention could, for example, explicitly encourage participants to bring mindfulness into their social lives (e.g., into stressful interpersonal interactions; Carson et al., 2004). More generally, these findings highlight the potential for interventions targeting attention to also improve emotional and social well-being.

Limitations and Future Directions

The following limitations of this study may bear on interpretation of the results and should thus be considered in future research. First, it is important to acknowledge limitations in assessing effects of brief MT in this context. Specifically, although the training was delivered over multiple days, the involvement of meditation just prior to posttest EEG and behavioral assessment does not allow for disentangling trait-like and state-like effects of MT. Future research on brief or longer-term MT may assess whether effects are evident when excluding this final training session just prior to posttest assessment. Alternatively, brief mindfulness booster MT sessions, perhaps even between blocks or trials, could more effectively manipulate mindful attention to assess its effects.

Second, we found significant differences between intervention conditions in expected benefits and credibility post-randomization, with greater benefits and more credibility expected by those in the MT condition. On one hand, a strength of this study was that all participants were recruited through advertisements offering free training in mindfulness meditation, increasing the likelihood they would consciously engage the training. On the other hand, this may have contributed to less enthusiasm for the expected benefits and credibility of the BLC intervention.

More generally, although a number of critical nonspecific effects were controlled via BLC, BLC cannot account for placebo effects due to beliefs about learning mindfulness meditation. Importantly, all analyses testing intervention effects controlled for this variable, such that the effects observed were independent of expectancy and credibility differences. Future research could use a sham meditation condition (e.g., Zeidan, Johnson, Gordon, et al., 2010) to better control for differences in expectancy and credibility.

Third, regarding participants, the sample size resulted in an underpowered study, especially for ERP and EMA-based analyses where the number of participants was lower than 60. However, this sample constitutes a subset of a continuing project and sample sizes for final analyses will be higher. The present sample was also largely homogenous in terms of sex, race/ethnicity, and sexual orientation. I chose to include romantic partners regardless of sexual orientation due to interest in social interaction functioning generally. However, because there was only one homosexual couple, it is not possible to assess potential differences that could be due to sexual orientation.

Fourth, there are a few limitations regarding the EMA measures. Given our focus on romantic partners, we were unable to assess second-person ratings of social responsiveness beyond those reported by the romantic partner. Although the EMA-based event sampling approach used here demonstrated comparable results in terms of number of interaction records per day, the approach relies on participants to report each substantive social interaction. Thus, participants could have been biased regarding which daily social interactions they reported. We therefore followed up with participants regarding the representative nature of interactions, and participants reported an average of 4.18 (SD = .78) on a 5-point scale, with 5 representing “Very Much Representative” in their posttest questionnaire. Fifth and finally, although we measured expected benefits of each intervention for primary participants, we did not assess romantic partners' expectations; we were therefore not able to control for these in partner analyses (Research Question 3).

Conclusion

The ubiquity of emotional experience across varied social contexts, both in oneself and in others, leaves little doubt that people's social and emotional lives are strongly interdependent. The study of MT and its effects on emotion regulation in social contexts suggests the importance of another factor that may be just as embedded in human social life as emotion, namely quality of attention. Indeed for thousands of years, traditional approaches to MT have emphasized the relevance of mindfulness to social life. This study examined effects of four brief (20 min.) MT sessions, relative to a structurally-equivalent control procedure, on neural, task-based behavioral, and experience sampling measures to understand how mindful attention may enhance social emotion regulation. Though not all hypotheses were supported, results were found across the variety of measures that corroborate the theorized benefits of mindfulness for effective emotion regulation in social contexts. Relative to control participants, those in MT demonstrated better goal-driven attention regulation in socioemotional contexts across both neural and behavioral indices. During social interactions in daily life, MT participants reported more positive and less negative emotion during social interactions and less negative emotion lability from one social interaction to the next. Regarding mechanisms of brief MT, a mediation analysis revealed better attention regulation as a possible mediator of the effect of MT on more effective social emotion regulation, specifically concerning more positive emotion during social interactions. Given that social emotion regulation places unique demands on attention for which mindfulness appears well-suited, research on both topics can build from these findings to better understand both intra- and inter-personal benefits of MT.

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Appendix A: Self-report Questionnaire Measures

Freiburg Mindfulness Inventory

The purpose of this inventory is to characterize your experience of mindfulness. Please use the last ___ days as the time-frame to consider each item. Provide an answer the for every statement as best you can. Please answer as honestly and spontaneously as possible. There are neither ‘right’ nor ‘wrong’ answers, nor ‘good’ or ‘bad’ responses. What is important to us is your own personal experience.

1	2	3	4
Rarely	Occasionally	Fairly often	Almost always

1. I am open to the experience of the present moment.
2. I sense my body, whether eating, cooking, cleaning or talking.
3. When I notice an absence of mind, I gently return to the experience of the here and now.
4. I am able to appreciate myself.
5. I pay attention to what’s behind my actions.
6. I see my mistakes and difficulties without judging them.
7. I feel connected to my experience in the here-and-now.
8. I accept unpleasant experiences.
9. I am friendly to myself when things go wrong.
10. I watch my feelings without getting lost in them.
11. In difficult situations, I can pause without immediately reacting.
12. I experience moments of inner peace and ease, even when things get hectic and stressful.
13. I am impatient with myself and with others.
14. I am able to smile when I notice how I sometimes make life difficult.

Five Facet Mindfulness Questionnaire – Nonjudgment Facet

_____ 1. I criticize myself for having irrational or inappropriate emotions.

_____ 2. I tell myself I shouldn't be feeling the way I'm feeling.

_____ 3. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.

_____ 4. I make judgments about whether my thoughts are good or bad.

_____ 5. I tell myself that I shouldn't be thinking the way I'm thinking.

_____ 6. I think some of my emotions are bad or inappropriate and I shouldn't feel them.

_____ 7. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.

_____ 8. I disapprove of myself when I have irrational ideas.

Network of Relationships Inventory-Relationships Quality Version

Instructions: We would like you to answer the following questions about your romantic partner using the following scale.

1	2	3	4	5
Little or none	Somewhat	Very much	Extremely much	The Most

1 How often do you spend fun time with this person?

2 How often do you tell this person things that you don’t want others to know?

3 How often does this person push you to do things that you don’t want to do?

4 How happy are you with your relationship with this person?

5 How often do you and this person disagree and quarrel with each other?

6 How often do you turn to this person for support with personal problems?

7 How often does this person point out your faults or put you down?

8 How often does this person praise you for the kind of person you are?

9 How often does this person get their way when you two do not agree about what to do?

10 How often does this person ***not*** include you in activities?

11 How often do you and this person go places and do things together?

12 How often do you tell this person everything that you are going through?

13 How often does this person try to get you to do things that you don’t like?

14 How much do you like the way things are between you and this person?

15 How often do you and this person get mad at or get in fights with each other?

16 How often do you depend on this person for help, advice, or sympathy?

17 How often does this person criticize you?

18 How often does this person seem really proud of you?

19 How often does this person end up being the one who makes the decisions for both of you?

20 How often does it seem like this person ignores you?

21 How often do you play around and have fun with this person?

22 How often do you share secrets and private feelings with this person?

23 How often does this person pressure you to do the things that he or she wants?

24 How satisfied are you with your relationship with this person?

25 How often do you and this person argue with each other?

26 When you are feeling down or upset, how often do you depend on this person to cheer things up?

27 How often does this person say mean or harsh things to you?

28 How much does this person like or approve of the things you do?

29 How often does this person get you to do things their way?

30 How often does it seem like this person does not give you the amount of attention that you want?

Quality of Marriage Index

	I do not agree at all		*I strongly agree*			*PERFECT!*	
We have a good relationship.	1	2	3	4	5	6	7
My relationship with my partner is very stable.	1	2	3	4	5	6	7
Our relationship is strong.	1	2	3	4	5	6	7
My relationship with my partner makes me happy.	1	2	3	4	5	6	7
I really feel like part of a team with my partner.	1	2	3	4	5	6	7

Circle the point that best describes the degree of happiness in your relationship.

The middle point ('happy') represents the degree of happiness most get from relationship.

Very Unhappy				Happy					Totally Perfect
1	2	3	4	5	6	7	8	9	10

Credibility/Expectancy Questionnaire

Instructions: We would like you to indicate below how much you believe, *right now*, that the course you will receive will help to reduce your stress. Belief usually has two aspects to it: (1) what one *thinks* will happen and (2) what one *feels* will happen. Sometimes these are similar; sometimes they are different. Please answer the questions below.

In the first set, answer in terms of what you *think*. In the second set answer in terms of what you really and truly *feel*. Your course leaders will not ever see these ratings, so please be honest in your responses.

Set I

1. At this point, how logical does the course offered to you seem?

1	2	3	4	5	6	7	8	9
Not At All Logical				Somewhat Logical				Very Logical

2. At this point, how successfully do you think this course will be in reducing your stress?

1	2	3	4	5	6	7	8	9
Not At All Useful				Somewhat Useful				Very Useful

3. How confident would you be in recommending this course to a friend who experiences similar stresses?

1	2	3	4	5	6	7	8	9
Not At All Confident				Somewhat Confident				Very Confident

4. By the end of this course, how much improvement in your stress do you think will occur?

0	1	2	3	4	5	6	7	8	9	10
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Set II

1. At this point, how much do you really *feel* this course will help you to reduce your stress?

1	2	3	4	5	6	7	8	9
Not At All				Somewhat				Very Much

2. By the end of the course, how much improvement in your stress do you really *feel* will occur?

0	1	2	3	4	5	6	7	8	9	10
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Appendix B: Ecological Momentary Assessment Measures

Emotions

During the interaction, to what degree were you experiencing the following emotions?

0 = Not at all, 3 = Somewhat, 6 = Extremely

1) Worried/Anxious
2) Happy
3) Frustrated
4) Pleased
5) Angry/Hostile
6) Enjoyment/Fun
7) Unhappy
8) Joyful
9) Depressed/Blue

Experience

10) Who was present? (Choose as many as apply)
    - Romantic Partner
    - Close friend(s)
    - Friend(s)
    - Parent(s)/Guardian(s)
    - Sibling(s)
    - Other family member(s)
    - Coworker(s)
    - My child(ren)
    - Close friend's child(ren)
    - Acquaintance(s)
    - Stranger(s)
    - Other(s)

11) Primary interaction with: a) Adult; b) Teen; c) Child

12) Primary interaction with:

    a. Romantic Partner
    b. Close friend(s)
    c. Friend(s)
    d. Parent(s)/Guardian(s)
    e. Sibling(s)
    f. Other family member(s)
    g. Coworker(s)

h. My child(ren)
i. Close friend's child(ren)
j. Acquaintance(s)
k. Stranger(s)
l. Other(s)

13) Thinking about the primary person you interacted with: I felt ________ to him/her.

-3	0	3
Very Distant From	Neither distant nor connected	Very connected to

14) Thinking about the primary person you interacted with: They were responsive to me.

0	2	3
Does not apply	Applies somewhat	Applied very strongly

Appendix C: Intervention Introductory Remarks

Mindfulness Meditation Condition

Welcome and thank you for being here. You have been randomly assigned to the mindfulness meditation group. Because it's important to keep things consistent from week-to-week in a scientific study, I'll be referring to a script during our time together. This intervention has been designed to reduce stress and promote well-being, principally by increasing mindfulness in your daily life. There are many scientific reasons to believe that the activities we will engage in over the coming days are beneficial. That being said, this intervention is focused on the practical application of mindfulness meditation, rather than on understanding why and how the intervention can reduce stress and promote well-being. Moreover, the activities we will be doing in this group were selected and motivated by scientific support that learning mindfulness meditation in this format can reduce stress and promote well-being. In other words, we think the activities of this group can reduce stress and promote well-being through certain mechanisms, and we're quite interested in understanding these mechanisms.

Before we get started, I am going to go over what mindfulness is and what it isn't. First what it's not: When practicing mindfulness, you won't be falling asleep, floating, or experiencing any number of the other somewhat common perceptions of what meditation is. When practicing mindfulness meditation, please do not use your cell phone, talk or otherwise interact with others, or fall asleep. In fact, if you do fall asleep during the session, we will unfortunately have to make it up with another session. The expected benefits of mindfulness meditation depend on engaging fully in the practice.

What I am going to be teaching you is the cognitive practice of mindfulness meditation without any of the spiritual or religious affiliations. In other words, what we are going to be talking today is a secular practice. There is no religious or spiritual emphasis whatsoever. You can trust that as I will teach the practice, it does not involve any religious elements.

This is a disciplined practice; you will not experience levels of transcendence or anything like that. We are here to simply cultivate awareness of our sensory environment and ourselves, , as prior neuroscience research indicates this can have stress reducing effects, promoting well-being broadly through brain mechanisms of attention. It may seem hard to believe, but new research shows that even brief cognitive interventions such as the one you will receive can result in structural changes in the brain through neuroplasticity. These structural changes in the brain may affect a host of additional processes, and we will be studying this using highly sensitive laboratory and daily life measures.

During this intervention, we will first develop our attention by focusing on the breath and then learn how to deal with different common experiences people have by learning some emotion regulation strategies. Do you have any questions before we get started?

OK, great, now there's just one last thing we need to do before we get started.

Book Learning Condition

Welcome and thank you for being here. You have been randomly assigned to the book learning group. Because it's important to keep things consistent from week-to-week in a scientific study, I'll be referring to a script during our time together. This intervention has been designed to reduce stress and promote well-being, principally by listening to a book on a new topic. There are many scientific reasons to believe that the activities we will engage in over the coming days are beneficial. That being said, this intervention is focused on the practical application of book learning, rather than on understanding why and how the intervention can reduce stress and promote well-being. Moreover, the activities we will be doing in this group were selected to serve as a viable, alternative approach to reducing stress and promoting well-being, motivated by scientific support that book learning in this format can do so in ways different from mindfulness meditation. In other words, although we advertised this study as pertaining to mindfulness meditation, we think the activities of this group can reduce stress and promote well-being through different learning mechanisms, and we're quite interested in comparing these mechanisms. Of course, we know you are all interested in learning mindfulness meditation, and just to remind you, you will still have an opportunity receive free mindfulness meditation training after completing the study.

Before we get started, I am going to go over what we'll be doing here: Basically, I will be reading from a book, and you will be asked to listen as I read this book aloud. When listening, please do not use your cell phone, talk or otherwise interact with others, or fall asleep. In fact, if you do fall asleep during the session, we will unfortunately have to make it up. Prior research shows that the expected benefits of this book learning depend on listening as I read aloud.

What I am going to be reading to you is a book without any spiritual or religious affiliations. In other words, what we are going to be talking today is a book you might come across in any bookstore. There is no religious or spiritual emphasis whatsoever. You can trust that what I read does not depend on being religious or spiritual.

This is an opportunity to learn about what I will be reading. We are here to simply learn about a new topic through the experience of listening to a book being read aloud, as prior neuroscience research indicates this can have stress reducing effects, promoting well-being broadly through brain mechanisms of learning. It may seem hard to believe, but new research shows that even brief cognitive interventions such as the one you will receive can result in structural changes in the brain through neuroplasticity. These structural changes in the brain may affect a host of additional processes, and we will be studying this using highly sensitive laboratory and daily life measures.

During the intervention, we will learn new things in a very specific way that was chosen intentionally, and your experience will be similar to listening to a book on tape. Each day we will pick up where we left off. Do you have any questions before we get started?

OK, great, now there's just one last thing we need to do before we get started.

Vitae

Jordan T. Quaglia was born in Victoria, TX on October 5, 1985. He earned his B.A. from the University of Richmond in 2008 (Magna Cum Laude), with an interdisciplinary major in Positive Organizational Leadership. In 2011, he graduated with an MA from Naropa University where he studied counseling psychology. In 2010 and 2011, Jordan was invited to present at the United Nations Day of Vesak Conference on scholarly work pertaining to contemplative training, psychology, and neuroscience. In 2012, Jordan was awarded a Francisco J. Varela Award from the Mind and Life Institute to investigate the effect of mindfulness training on neural, behavioral, and real-world indicators of emotion regulation in social contexts. Jordan received an MS in Experimental Psychology in 2013 from Virginia Commonwealth University.