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Mindfulness-related differences in neural response to own infant negative versus positive emotion contexts

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ABSTRACT

Mindfulness is thought to promote well-being by shaping the way people respond to challenging social-emotional situations. Current understanding of how this occurs at the neural level is based on studies of response to decontextualized emotion stimuli that may not adequately represent lived experiences. In this study, we tested relations between mothers' dispositional mindfulness and neural responses to their own infant in different emotion-eliciting contexts. Mothers (n = 25) engaged with their 3-month-old infants in videorecorded tasks designed to elicit negative (arm restraint) or positive (peekaboo) emotion. During a functional MRI session, mothers were presented with 15-s clips from these recordings, and dispositional mindfulness scores were used to predict their neural responses to arm restraint > peekaboo videos. Mothers higher in nonreactivity showed relatively lower activation to their infants' arm restraint compared to peekaboo videos in hypothesized regions—insula and dorsal prefrontal cortex—as well as non-hypothesized regions. Other mindfulness dimensions were associated with more limited areas of lower (nonjudgment) and higher (describing) activation in this contrast. Mothers who were higher in mindfulness generally activated more to the positive emotion context and less to the negative emotion context in perceptual and emotion processing areas, a pattern that may help to explain mindfulness-related differences in well-being.

1. Introduction

Mindfulness—"paying attention on purpose, in the present moment, and nonjudgmentally" (Kabat-Zinn, 1990)—has been shown to predict subjective and neural responses to emotional stimuli that in turn map onto well-being (e.g., Hölzel et al., 2011; Keng et al., 2011). Typically, these stimuli consist of simple, decontextualized emotion representations (i.e., words or unfamiliar adult faces) that may not adequately represent the social-emotional experiences shaping well-being. In particular, emotional exchanges within close relationships represent an under-studied area, despite emerging conceptualizations of mindfulness as an interpersonal process (e.g., Duncan et al., 2009). In this study, we seek to determine how mindfulness may help in coping with an important real-life emotional challenge by testing relations between dispositional mindfulness and mothers' neural responses to their infant in situations that elicit more positive or more negative emotion.

Research on mindfulness has revealed discrepant patterns of neural responsiveness to emotional stimuli. On the one hand, studies have shown that participants higher in dispositional mindfulness exhibit greater prefrontal activation while regulating their response to emotional stimuli (Creswell et al., 2007; Modinos et al., 2010). Similarly, participants instructed to take a mindful approach to emotional stimuli (viewing negative images) have shown heightened activation across several prefrontal areas, including the superior frontal gyrus (SFG) and frontal pole, as well as the insular cortex (Murakami et al., 2015; Smoski et al., 2015). Mapping onto principles of mindfulness, this combination is thought to reflect an experiential awareness of emotion (represented by insula) complemented by a metacognitive awareness (represented by dorsal prefrontal regions). On the other hand, some studies have shown *lower* insula and/or prefrontal reactivity to negative emotion stimuli related to mindfulness (e.g., Farb et al., 2010; Haase et al., 2016; Taylor et al., 2011). Beyond possible differences related to the operationalization of mindfulness as a state, trait, or practice effect, divergent results may reflect contributions of different mindfulness dimensions. For example, Paul et al. (2013) examined dispositional mindfulness measured by the Five Facet Mindfulness Questionnaire (Baer et al., 2006) and found that one scale in particular—nonreactivity, or the ability to move past difficult experiences without getting caught up in them—predicted lower insula activation to negative images.

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Another potentially important factor shaping divergent findings is the emotional response paradigm involved. Mindfulness cultivates a skillful approach to the demands of the situation, which may mean heightened or attenuated activity depending on the situation. Exemplified by the research cited above, knowledge of when and how mindfulness may influence neural activation to emotion cues has typically been limited by a focus on negative impersonal stimuli (though see Desbordes et al., 2012; Lutz et al., 2016; Taylor et al., 2011 for exceptions). In order to fully appreciate how mindfulness may help people to navigate their emotional landscapes, it is necessary to tap their responses to stimuli from their daily lives that vary in their anticipated and perceived emotional valence. One important emotional context that presents a mix of negative and positive stimuli is parenting an infant.

Mothers respond normatively to positive and negative infant emotional stimuli that serve as attachment signals—i.e., behaviors such as smiling and crying that keep the caregiver close by and responsive to the infant's needs. The nature of this response is complex, encompassing a network of subcortical and cortical brain regions involved in perceptual processing (temporal, parietal, and occipital cortices), emotional responsiveness and empathy (insula, OFC, amygdala), and higher-order attentional and emotion regulation (dorsolateral prefrontal and anterior cingulate cortices) (see Swain, 2011). Recently, the concept of mindful parenting has been introduced to characterize caregivers who bring mindful awareness to the parenting context (Duncan et al., 2009). While behavioral research suggests more mindful parents are able to more skillfully interpret and respond to their child's emotional signals (e.g., Duncan et al., 2015; Lippold et al., 2015), there is no research to date addressing how this plays out at the neural level.

As outlined in the mindfulness-emotional response literature above, greater dispositional mindfulness could predict higher or lower neural activation to emotional situations. In keeping with theorizing about mindfulness more broadly, we would expect a mindful mother to respond flexibly to what the situation demands. For example, even though the maternal brain should allocate resources to processing acute distress signals signaling pain or need, mindful mothers may be less reactive to lower-level expressions of negative emotion and instead may focus more attention on positive exchanges. Mindfulness-related activity may also depend on the aspect of mindfulness under consideration, with some dimensions (such as nonreactivity) playing a more important role in social-emotional responses. The present study was designed to shed light on how mindfulness shapes parent-infant emotional exchanges by relating maternal mindfulness to neural activation to her own infant in situations designed to elicit more negative vs. more positive emotion.

We assessed dispositional mindfulness and functional brain responses to infant videos at 3 months postnatal in a sample of mothers recruited for a larger longitudinal study of mother-infant stress regulation. Videos were taken in the home during tasks designed to elicit low-level frustration (arm restraint) and joy (peekaboo). Based on the theoretical and empirical literature discussed above, we hypothesized that maternal mindfulness—in particular, nonreactivity—would relate to differences in insula and prefrontal activation to the videos. Directional hypotheses were tentative, given conflicting findings in previous mindfulness research, but we generally expected that as mindfulness increased, mothers would show lower activation to the arm restraint emotion video compared to the peekaboo video.

2. Method

2.1. Participants

Mothers (n = 25) of 3-month-old infants were recruited from the Women Infants Children program and other community agencies serving low-income women in a mid-size Pacific Northwest city. Mothers' ages ranged from 1 to 33 (M = 26.4, SD = 3.8). The majority of mothers were Caucasian (72%; 12% Latina; 8% Asian American; 8% Other) and married or living with a romantic partner (88%). Although most reported some education past high school (84%), only 24% had completed college or received a graduate degree, and the median household income was in the $20,000–$29,999 range. For more than half of mothers (56%) this was their first child (36% second child; 8% third child).[1] Most infants were born on time (4% before 37 weeks and 8% after 41 weeks of pregnancy), and none had serious health problems. A vaginal delivery was reported by 56% of mothers, with 88% breastfeeding and 67% bed-sharing with their infant at the time of assessment. Over half of mothers (52%) reported having engaged in a form of contemplative practice (mostly yoga—only 8% indicated some form of meditation), and 31% reported currently engaging in that practice. All women gave informed consent prior to participation, and all study procedures were approved by the University of Oregon Institutional Review Board.

2.2. Dispositional mindfulness

Prior to the home visit described below, mothers completed a number of self-report questionnaires online using Qualtrics, including the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The FFMQ measures dispositional mindfulness traits and is based on a factor analysis of existing mindfulness measures and comprises scales for Observing (e.g., "I pay attention to sensations, such as the wind in my hair or the sun on my face"), Describing (e.g., "Even when I'm feeling terribly upset, I can find a way to put it into words"), Acting with Awareness (e.g., "When I do things, my mind wanders off and I'm easily distracted" [reversed]), Nonjudging (e.g., "I tell myself I shouldn't be feeling the way I'm feeling" [reversed]), and Nonreactivity (e.g., "When I have distressing thoughts or images, I am able to just notice them without reacting"). Internal consistencies for the scales were adequate (alphas = .79–.93).

2.3. Stimulus collection and presentation

During a home visit scheduled at approximately 12 weeks postnatal, a graduate research assistant conducted a clinical structured interview with the mother and videorecorded her infant during two mother-infant interaction tasks: peekaboo and arm restraint. The infant was placed so that s/he was face to face with the mother for both tasks, and the video focused on the baby's face with as little background in the shot as possible. For peekaboo, the mother was told to cover her face with her hands and say "baby," then open her hands and say "peekaboo" (see Montague and Walker-Andrews, 2001). This continued for up to 3 min, or until the infant showed expressions of joy (i.e., smiling, laughing). For the arm restraint task, the mother was asked to change the infant's diaper and then hold his/her arms to their side for up to two minutes (see Moscardino and Axia, 2006). During that time, the mother was instructed to maintain a neutral expression and not talk to her baby. The same protocol was followed with an additional mother-infant dyad who did not participate in the rest of the study to generate unfamiliar infant peekaboo and arm restraint videos.

The 15 s video segment showing maximum positive (for peekaboo) or negative (for arm restraint) infant emotion was selected for presentation in the scanner. Presentation® software (Version 14.7, Neurobehavioral Systems, Inc. Berkely, CA, www.neurobs.com) was used to present video and rest blocks (each 15s) in counterbalanced order during two 7.5 min runs; each run contained 6 cycles of own infant positive, own infant negative, unfamiliar infant positive, unfamiliar infant negative, and rest. Participants were simply instructed to

[1] Although parity has been shown to impact neural response in previous research, we found no evidence that activation differences reported below were related to number of children in this sample.