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Holding the Body in Mind: Interoceptive Awareness, Dispositional Mindfulness and Psychological Well-Being

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Abstract

Objective—Recent dialogue between Western and Eastern traditions has stimulated novel explorations of the relationship between mind and body. Many of these cross-cultural, mind-body dialogues have proven productive in identifying more adaptive forms of embodiment. Prior studies suggest that dispositional mindfulness (DM) and interoceptive awareness (IA) are associated but distinct, key constructs in mind-body approaches that are conceptualized in a variety of ways with imprecisely characterized relationship. The current study is a secondary data analysis that explores the relationship between scores on measures of IA and DM, examining multivariate networks of association between these constructs and addressing their relationship with scores on a measure of psychological well-being.

Method—Participants (n=478) were American adults completing measures of interoceptive awareness (as measured by the Multidimensional Assessment of Interoceptive Awareness; MAIA), dispositional mindfulness (as measured by the Five Facet Mindfulness Questionnaire; FFMQ), and psychological well-being (as measure by the Scales of Psychological Well-Being; SPWB) online. The average participant age was 36.44 ($S.D.$=12.17), and 57% were female.

Results—Correlational results from his study indicated that the IA scales and DM facets form two associative clusters. Canonical correlation analysis supported this finding, revealing that two primary networks of association exist between IA and DM, a Regulatory Awareness cluster and an Acceptance in Action cluster. Finally, hierarchical linear regression demonstrated that the self-

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report measures of IA and DM shared considerable variance, but also explained unique portions of the variance in psychological well-being.

Conclusion—This psychometric investigation demonstrates that IA and DM are tightly interwoven, partly overlapping constructs. Indeed, greater DM is strongly linked with greater IA. Additionally, both IA and DM appear to be independently associated with enhanced psychological well-being. Future research should investigate how mindfulness practices moderate IA for therapeutic implications.

Recent dialogue between Western and Eastern traditions has stimulated novel explorations of the relationship between mind and body [1–3]. Many of these cross-cultural, mind-body dialogues have proven productive in identifying more adaptive forms of embodiment. Mindfulness, as the Western adaptation of Eastern contemplative practice, is central to many of these conversations [4,5] and is frequently defined as the intention to attend to present moment experience without judgment [6]. As such, mindfulness is thought to encourage insight into the relationship between mind and body, encouraging interoceptive awareness [5]. However, these fruitful pursuits are not without challenges. Principally, a universal language and a standardized measurement approach are required for moving the field of mind-body research forward. Yet, efforts towards a common taxonomy and standardization have been complicated by the fracturing of empirical mind-body pursuits across a diversity of academic disciplines [7]. Such disjointed efforts have resulted in a variety of partially overlapping conceptual and operational definitions concerning the relationship between mind and body [5].

Interoceptive Awareness and Psychological Well-Being

A growing field of investigators identified “interoceptive awareness” as the scientific term best capturing the construct commonly pursued in mind-body investigations [8]. This term may have the potential to integrate views from many disciplines. Mehling et al. [4,7] suggested a common conceptual definition for interoceptive awareness (IA): interoception involves awareness of both the body’s physiological condition [9] and the evaluative interpretations arising in tandem with such awareness [7]. Farb and colleagues [5] echo this interpretation, defining interoception as “the process of receiving, accessing and appraising internal bodily signals” (p.1). Despite pockets of convergence, the language of interoception continues to evolve and the discussion about the terminology remains ongoing [5,9–11]. Khalsa and Lapidus [10] provide a detailed review of operational alternatives, identifying 10 distinct definitions of interoception. In an effort to promote conceptual and operational synthesis, Garfinkel et al. [9,11] offered and investigated a three-dimensional model of interoception, including *interoceptive accuracy* (accuracy in detecting bodily sensations, such as heartbeats), *interoceptive sensibility* (self-reported beliefs about interoceptive tendencies), and *interoceptive awareness* (“metacognitive awareness of interoceptive accuracy”, p.67) [11]. Of these three dimensions, interoceptive sensibility can be understood as the closest, conceptual parallel to IA as defined by the developers of the self-report measure used in this study [7].

It is clinically important to distinguish two components of the above definition of IA. The first part, awareness of the physiological body, is a classic topic for neuroscience research

into intertwined bottom-up and top-down neurological processes of perception. The second part, introducing conscious, evaluative interpretation of sensations within the body, reflects more behavioral influences on and reactions to internal body signal perception. This evaluative element emphasizes the affective nature and regulatory aspects of interoception. Importantly, interoceptive awareness is ambiguous and can be associated with both deleterious and beneficial effects [5,8]. Maladaptive forms of IA characterized by hypervigilance and catastrophizing over body sensations are linked with clinical complaints, such as chronic pain [12], anxiety [13,14] and disordered eating [15]. However, healthy forms of IA characterized by appropriate attention regulation and acceptance can also be used to disengage from maladaptive thoughts and improve clinical symptoms, such as with pain and depression [16,17]. Given these conflicting potentials for health, methods to add to our understanding of how these concepts may be related are needed.

Building from their synthesized definition of IA, Mehling and colleagues operationalized IA through the construction of the Multidimensional Assessment of Interoceptive Awareness (MAIA) [4]. The MAIA examines five domains of IA by self-report: 1) General awareness of body sensations, measured by the Noticing scale, 2) Emotional and attentional responses to bodily sensations, measured by the Not Distracting and Not Worrying scales, 3) Attention regulation capacity, measured by the Attention Regulation scale, 4) Awareness of mind-body integration, measured by the Emotional Awareness, Self-Regulation and Body Listening scales, and 5) Tendency to trust body sensations, measured by the Trusting scale. These five domains were theoretically derived and confirmed by focus groups. The emergent eight scales were empirically validated as interrelated but distinct constructs [4]. Furthermore, these scales have shown associations with markers of psychological health. Elements of IA, operationalized by the MAIA, appear to be associated with less trait anxiety [4], emotional susceptibility [18] and depression [17]. Broadly, these results suggest that awareness of bodily sensations and the evaluative or regulatory tendencies applied to such sensations are important determinants of emotional health.

Yet, associations between IA and more enduring estimations of well-being remain uncharacterized. While inverse associations have been reported between IA and markers of emotional distress [4,17,18], the absence of emotional distress does not necessarily signal the presence of well-being. Thus, a direct examination of IA and well-being is needed. Psychological well-being is a multidimensional conceptualization of well-being that is grounded in the Aristotelian tradition [19]. A popular conceptualization of psychological well-being proposes the good life to be characterized by autonomy, personal growth, positive relationships, environmental mastery, purpose in life, and self-acceptance [20]. As such, psychological well-being suggests a broad, active and intentional approach to well-being, a more robust form of well-being than just the ratio between positive and negative affect. For example, the desire for personal growth and purposeful living likely entails the presence and use of both positive and negative emotions that both contribute to personally meaningful pursuits. Emotion theory since the time of William James [21,22] has suggested that bodily sensations give rise to emotions and emotions function as the primary motivators of behavior [23]. Thus, it may be that individuals capable of adaptively using IA have the capacity to more actively and intentionally pursue those activities reflecting psychological well-being. It has also been suggested that certain personality characteristics, such as dispositional

mindfulness, may promote more adaptive interoceptive styles [24], which may encourage greater psychological well-being. Indeed, recent evidence suggests that mindfulness moderates the relationship between body awareness and behavior [25].

Interoceptive Awareness and Dispositional Mindfulness

IA as measured by the MAIA appears to be linked with mindfulness [4,5,26,27]. In fact, interoception and mindfulness may be functionally and conceptually yoked [5,27]. For example, many mindfulness practices, such as the body scan and the yoga element in Mindfulness-Based Stress Reduction (MBSR), directly encourage awareness of bodily sensations. Additionally, IA has been proposed as one of the mechanisms of action with mindfulness interventions [5,27,28]. Central to both IA and mindfulness is the capacity to take internal experience as the object of attention. Thus, self-reflection forms the foundation of both constructs. Although IA and DM are both constructs describing attention processes, they are also clearly distinct. Specifically, mindfulness does not distinguish between attention directed to exteroception, interoception or thoughts. Comparatively, IA only focuses on somatic experiences but does not distinguish between different–mindful versus anxiety-driven–attention styles towards internal stimuli. Despite these differences, IA and DM overlap conceptually as mindful body awareness, and instruments measuring IA and DM can be expected to share variance in that field.

Recent research has examined the impact of mindfulness meditation on IA [17,29]. Findings from these studies suggest that mindfulness training improves self-reported interoceptive awareness [17,28,29], which appears to confer psychological health benefits [17]. Bornemann et al. [29] reported that a mindfulness-based intervention targeting body awareness increased aspects of interoception as measured by five of the MAIA scales (Self-Regulation, Attention Regulation, Body Listening, Emotional Awareness and Trusting) compared with a retest control group. Additionally, de Jong et al. [17] found Mindfulness Based Cognitive Therapy to significantly increase the Self-Regulation and Not-Distracting MAIA scales in comparison with treatment as usual. Yet, it is also important to note that while mindfulness training may improve interoceptive awareness as measured by self-report, mixed results have been observed regarding more objective measures of interoceptive accuracy, such as heartbeat detection, following mindfulness training [30,31].

While explicit mindfulness training has been shown to increase dispositional mindfulness [32], people without explicit mindfulness training also report individual differences in dispositional mindfulness, i.e., the tendency to express mindful attitudes and behaviors in everyday life. Though dispositional mindfulness and its correlates have been extensively studied [33,34], the relationship between IA and dispositional mindfulness (DM), remains insufficiently characterized. The Five Facet Mindfulness Questionnaire (FFMQ) [33] is one of the most commonly used self-report measures of DM. It is comprised of five subscales measuring respondents' tendencies to 1) observe experience, 2) use language to describe experience, 3) act with awareness, 4) be non-reactive, and 5) be non-judgmental. Two studies to date have explored the associations between the FFMQ and MAIA [4,29]. In a sample of students and teachers involved with mind-body practices, Mehling et al. [4] observed significant correlations between each of the eight MAIA scales and the five FFMQ

facets. The FFMQ facets of Observing, Non-Reacting and Acting with Awareness evidenced the strongest associations with the MAIA scales in this sample. In a second sample of individuals expressing interest in mind-body training, similar patterns of association were observed between MAIA and FFMQ scales [29]. Again, all significant correlations between the two scales were positive, although the magnitudes of association in Bornemann et al.'s [29] sample were weaker than those observed in Mehling et al. [4].

As IA and DM are associated but distinct, key constructs in mind-body interactions and approaches, further examination of this relationship is warranted. Moreover, the extant investigations of IA and DM have only used participants with prior interest in mind-body training. Thus, the reported results may have limited generalizability to the general population. Furthermore, previous analyses of the MAIA and FFMQ scales have concentrated primarily on bivariate relationships. Yet, these multidimensional scales are likely linked by multivariate networks of association. Finally, the MAIA scales' potential differential associations with explicitly positive markers of emotional health, such as psychological well-being, have not yet been investigated.

The current study seeks to address each of these points by: 1) contributing to better understanding the nature of the relationship between IA and DM, 2) expanding the investigation of the relationship between IA and DM to a more general sample of adults, including those with and without interest in mind-body training, 3) examining multivariate networks of association between IA and DM using canonical correlational analysis, and 4) addressing the relationship between IA, DM and psychological well-being, specifically exploring the potential incremental validity of the MAIA.

Method

Participants and Procedures

Participants were recruited from Amazon's crowdsourcing website, Mechanical Turk (MTurk). Compensation was 50¢ for completing the study. Surveys were presented in a randomized order to reduce ordering effects. All surveys were completed online in a single administration session lasting at average 21 minutes. This study is a secondary data analysis, using only a subsection of a larger survey battery designed to examine the psychometric properties of a new self-report survey instrument.

Measures

Interoceptive Awareness was assessed with the Multidimensional Assessment of Interoceptive Awareness (MAIA) [4], a 32-item instrument measured on a 6-point Likert scale (1=Never, 6=Always). The MAIA is comprised of eight scales: Noticing ("I notice where in my body I am comfortable"), Not Distracting ("I distract myself from sensations of discomfort" – reverse scored), Not Worrying ("I can notice an unpleasant body sensation without worrying about it"), Attention Regulation ("I can return awareness to my body if I am distracted"), Emotional Awareness ("I notice how my body changes when I am angry"), Self-Regulation ("When I bring awareness to my body I feel a sense of calm"), Body Listening ("I listen to my body to inform me about what to do"), and Trusting ("I feel my

body is a safe place"). Factor analysis indicates that an 8-factor model is preferred, to either a single factor or hierarchical factor structure [4]. As such, a total score is not calculated for the MAIA.

Dispositional Mindfulness was assessed with the Five Facet Mindfulness Questionnaire (FFMQ) [33], a 39-item instrument measured on a 5-point Likert scale (1=Never or very rarely true, 6=Very often or always true). The FFMQ is comprised of five subscales: Observing ("I pay attention to sensations, such as the wind in my hair or sun on my face"), Describing ("My natural tendency is to put my experiences into words"), Acting with Awareness ("I find myself doing things without paying attention" – reverse scored;), Non-reacting ("I perceive my feelings and emotions without having to react to them"), and Non-judging ("I tell myself I shouldn't be feeling the way I'm feeling" – reverse scored). The full scale score is interpretable for the FFMQ as well as the scores for each subscale.

Psychological Well-Being was assessed with the Scales of Psychological Well-Being (SPWB) [20], an 18-item instrument measured on a 7-point Likert scale (1=Strongly Agree, 7=Strongly Disagree). The SPWB is comprised of six, 3-item subscales: self-acceptance, purpose in life, environmental mastery, positive relationships, personal growth, and autonomy. The full scale score was used in this study.

Mindfulness Practice Experience was measured with a single, dichotomous item: "Do you currently, or have you ever had a mindfulness practice (e.g., meditation, yoga)?"

Statistical Approach and Analyses

Three distinct analytic approaches were utilized in this study to examine the relationships between IA, DM and psychological well-being. First, Pearson correlations were used to explore the bivariate relationships between each component of IA, DM, the five facets of DM, and psychological well-being. Second, a canonical correlation analysis (CCA) was used to examine multivariate networks of association existing between the components of IA and the facets of DM. CCA creates a series of orthogonal, synthetic variable pairs that maximize the relationship between the two variable sets. A correlation term represents the shared variance between each synthetic variable, and each synthetic variable pair represents an independently interpretable function [35]. Third, regression analysis was used to investigate whether both scores on the MAIA and FFMQ scales were unique predictors of psychological well-being.

Power analysis [36] indicated that 431 participants were needed for a linear multiple regression using 15 predictor variables, hypothesizing a small effect size ($f^2 = .05$), setting power at .80, and selecting an alpha level of $p<.05$.

Results

Participants were 478 American adults. Only those participants completing the entire survey battery were retained in the final sample, resulting in the exclusion of 246 respondents. Participant demographics are reported in Table 1. The average participant age was 36.44 (*S.D.* = 12.17), and 57% were female. Previous experience with a mindfulness practice, such

as mindfulness meditation or yoga, was reported by 305 (64%) participants. Basic statistics for the primary variables of interest are reported in Table 2.

Bivariate Correlations

Relationships between the MAIA scales and the FFMQ total score were positive and in the expected direction. Similar moderate correlations were observed between seven of the eight MAIA scales and the FFMQ total score. Only MAIA Not Distracting showed no substantial correlation with the FFMQ total score (r=.15).

Broad patterns of relationship between the MAIA scales and the FFMQ facets suggest two associative groupings. First, the FFMQ facets of Acting with Awareness and Non-Judging were principally associated with the MAIA scales of Not Distracting and Not Worrying. Second, the FFMQ facets of Observing, Describing and Non-Reacting were principally associated with MAIA scales of Noticing, Attention Regulation, Emotional Awareness, Self-Regulation, and Body Listening. In general, the Observing and Non-Reacting FFMQ facets demonstrated stronger relationships with the identified MAIA scales than Describing. Additionally, Non-Reacting and Describing demonstrated moderate correlations with Not Worrying. The MAIA Trusting scale demonstrated significant, positive correlations with all five FFMQ facets.

Relationships between the MAIA scales, FFMQ scores and psychological well-being were predominately positive and in the expected direction. However, in general, the FFMQ facets demonstrated stronger associations with psychological well-being than the MAIA scales. With respect to the MAIA scales, Trusting evidenced the strongest relationship with psychological well-being. With respect to the FFMQ facets, Non-Judging, Acting with Awareness and Describing, each demonstrated distinct relationships with psychological well-being.

Canonical Correlation Analysis

Canonical correlation analysis was conducted using the eight MAIA scales as predictors of the five FFMQ facets to evaluate the multivariate shared relationship between the two sets of variables. The full model (Figure 1) was statistically significant using Wilk's λ = .30, F(40,2029.68)=16.17, p<.001., The full model explained 70% of the shared variance between the two variable sets. Five functions were identified with squared canonical correlations corresponding to each: 1) R_c^2 =.50, 2) R_c^2=.31, 3) R_c^2=.10, 4) R_c^2 =.03, and 5) R_c^2=.002. The first three functions were statistically significant, but only the first [50%; F(40,2029.68)=16.17, p<.001] and second [31%; F(28,1681.61)=9.08, p<.001)] functions explained substantial portions of the variance between the variable sets. In the first function, two of the FFMQ facets, Non-Reacting and Observing, were associated with six of the eight MAIA scales: Attention Regulation, Self-Regulation, Trusting, Emotional Awareness, Body Listening, and Noticing. In the second function, the FFMQ facets Non-Judging and Acting with Awareness were principally associated with the MAIA scale Not Worrying.

Incremental Validity of MAIA Scales

Having demonstrated significant bivariate and multivariate associations between the MAIA and the FFMQ as well as significant associations between both constructs and psychological well-being, hierarchical multiple regression was used to determine whether incremental validity could be established for the FFMQ and the MAIA. Two separate two-step hierarchical multiple regression analyses were performed, exploring IA and DM as predictors of psychological well-being. In the first step of the first analysis, the five FFMQ scales were simultaneously entered. In the second step of the first analysis, all eight MAIA scales were entered in one step. The order in which the questionnaires were entered was reversed in the second analysis, with the MAIA scales entered first and then the FFMQ.

Regression models explained a substantial portion of the variance in psychological well-being (R^2 = .49). MAIA and FFMQ scores were both found to be unique predictors. Each step in each model contributed significantly to the model's predictive ability regardless of the order in which the scales were entered. Specifically, MAIA Attention Regulation and Trusting were significant predictors of psychological well-being beyond FFMQ scores, and all FFMQ scores except Observing were predictive beyond MAIA scores. All of the significant predictors were positively associated with psychological well-being except MAIA Attention Regulation. A sensitivity analysis including gender and education in the models did not change the significance or valence of the observed associations.

Discussion

The overarching purpose of this study was to investigate associations between self-report measures of interoceptive awareness (IA), as measured by the MAIA, and dispositional mindfulness (DM), as measured by the FFMQ. Relationships between both constructs and psychological well-being were also examined. Definitions for IA and DM are still debated among researchers and practitioners, remaining somewhat controversial. Although the FFMQ and MAIA are now widely used as proxy measures for these constructs, associations between these self-report measures in this study are solely based on the definitions proposed by the scale developers and are therefore limited to their understanding of the construct. Bivariate correlations suggested a general pattern of positive associations between IA and DM in a general sample of American adults. These findings are similar to the associations reported by Bornemann et al., [29] and Mehling et al., [4] in samples of individuals interested in mind-body practices. Examined collectively, correlational results from his study indicated that the MAIA scales and FFMQ facets formed two associative clusters. Canonical correlation analysis supported this finding, revealing that two primary networks of association exist between IA and DM. Finally, hierarchical linear regression demonstrated that MAIA and FFMQ scores shared considerable variance, but also explained unique portions of the variance in psychological well-being.

Bivariate Relationships between Interoceptive Awareness and Dispositional Mindfulness

The FFMQ Observing and Non-Reacting facets evidenced the strongest associations with the MAIA scales. Being both mindfully observant and non-reactive appears closely linked with the capacity to sustain and control attention on bodily sensations. The mindful tendency

to observe internal and external phenomena is primarily connected with a general awareness of bodily sensations, awareness of the connection between bodily sensations and emotional states, and the tendency to listen to the body for insight. In short, being mindfully observant is connected with greater body awareness. The mindful disposition to be non-reactive towards internal experience is primarily connected with the ability to attend to bodily sensations as a method of regulating emotional distress and the tendency to experience the body as safe and trustworthy. Thus, non-reactivity is associated with using IA for emotion regulation. This finding is consistent with the notion that mindfulness can facilitate interoceptive recovery from emotional perturbations [37,38]. Indeed, Farb et al. [37] found that mindfulness training was associated with increased activation of insula cortex, generally viewed as the brain's hub for interoception [9,24,39], following experimental sadness induction among depressives. In turn, this activity in the insula predicted improvements in negative affect.

The Non-Judging and Acting with Awareness FFMQ facets appear to be primarily associated with only two MAIA scales, Not Worrying and Not Distracting. Non-Judging was most closely associated with Not Worrying, suggesting that the tendency to accept internal experience manifests as less emotional distress in response to unpleasant bodily sensations. Acting with Awareness was most closely associated with Non Distracting, suggesting that the tendency to act intentionally (e.g., without distraction) is linked with a greater willingness to consciously attend to unpleasant bodily sensations. However, Not Distracting was the MAIA scale least associated with FFMQ scores. Curiously, the FFMQ Describing facet evidenced roughly equivalent magnitudes of weak association with most scales of the MAIA. This may suggest that translating emotions into words may not be central to IA. This finding adds to prior studies identifying an inverse relation between alexithymia, the inability to express emotions in words, and interoceptive accuracy [40].

Networks of Relationship between Interoceptive Awareness and Dispositional Mindfulness

The networks of relationship between the IA scales and DM facets suggested by the bivariate correlation analysis were reflected in the canonical correlation analysis (CCA). The two CCA functions captured two broad associative clusters. The first cluster paired the FFMQ Non-Reacting and Observing facets with the bodily *awareness* (noticing, emotional awareness and body listening) and bodily *regulation* (attention regulation, self-regulation and trusting) elements measured by the MAIA. This function could be interpreted as the *Regulatory Awareness cluster*. The second cluster paired the Non-Judging and Acting with Awareness FFMQ facets with the primary emotional reactivity MAIA scale, Not Worrying. Given the prominence of the Non-Judging FFMQ facet, this function could be interpreted as the *Acceptance in Action cluster*.

Regulatory Awareness Cluster

The Regulatory Awareness cluster indicates that more observant and less reactive individuals may be more likely attend to their bodily sensations and use their bodily sensations for regulation purposes. These relationships appear intuitive. A baseline level of self-observation would seem necessary for bodily awareness. And, awareness of the body would seem requisite for focusing attention on the body. Finally, being non-reactive to both internal

and external events would seem to support sustained attention on the body, particularly when uncomfortable somatic sensations are present. These attentional and regulatory tendencies are reported to be calming, as indicated by the prominent position of the MAIA Self-Regulation element in this associative cluster. Interestingly, the six MAIA scales identified in the Regulatory Awareness cluster were also found to be the MAIA scales longitudinally impacted by a mindfulness based intervention [29].

In reviewing these findings, it is also interesting to consider the role IA is believed to play in motivating behavior [8]. Internal signals of hunger or pain are evolutionarily conserved, reflexive motivators of action. Additionally, the ability to satiate hunger and avoid pain confers adaptive advantages. However, selectively reacting to hunger or pain cues in a context-dependent manner may be even more advantageous. Indeed, mindfulness is believed to de-automatize behavior, increasing the intentionality of behavior [41,42]. In interpreting the Regulatory Awareness cluster, it is important to emphasize that the FFMQ Non-Reacting does not suggest a general non-responsiveness. Non-reacting in this context may be better understood as the ability to selectively respond according to one's goals with less affective interference. For instance, recognition of hunger introduces the motivation to eat. Noticing this cue and mindfully observing the bodily sensations without reflexive, emotional reactions may prove the difference between grabbing a donut readily at hand or an apple down the hall.

Acceptance in Action Cluster

The Acceptance in Action cluster indicates that less judgmental individuals may likely worry less about their unpleasant bodily sensations, which may allow them to act in more intentional ways. Being inclined to accept bodily sensations without judgment may reduce the emotional impact of unpleasant sensations. Evaluating a given sensation as "bad" is likely to provoke concern that something is wrong with the body. Judging the body to have a problem is likely to elicit emotional distress, as problems with the body may have implications for survival. Thus, discriminating between unpleasant bodily sensations that are of legitimate concern and those not requiring attention is an adaptive skill. It may be that mindfulness encourages better discriminative capacities with respect to bodily sensations. Better discriminating between bodily sensations also appears to have a behavioral component as suggested by the inclusion of the primary mindful behavior facet in this cluster, Acting with Awareness. This is in line with the finding that mindful body awareness is linked with authentic behavior [25]. Nevertheless, continued exploration is needed to better understand the associations between mindful interoceptive awareness, emotion and behavior.

Interoceptive Awareness and Psychological Well-Being

This study is the first to directly investigate the relationship between IA and psychological well-being. Yet, findings from this study are consistent with previously reported negative associations between IA, as measured by the MAIA, and markers of emotional distress [4,29]. Bivariate relationships revealed that seven of the eight MAIA scales were positively associated with psychological well-being. This broad pattern of association suggests that IA, as assessed by the MAIA, may be linked with a broad conceptualization of well-being,

characterized by self-acceptance, purpose in life, environmental mastery, positive relationships, personal growth, and autonomy. Specifically, the MAIA Trusting scale showed the highest zero-order correlation with psychological well-being, a result resonant with theoretical and empirical evidence that uncertainty engenders distress [43,44]. Taken together, these findings may suggest that experiencing the body as a safe and predictable space may reduce uncertainty at an immediate, physical level, with greater certainty linked with decreased symptoms of anxiety and depression [43] and increased well-being [44]. However, associations were mild to moderate and less strong between the remainder of the IA elements and psychological well-being than the associations between DM and psychological well-being. This is not surprising as IA—as explained above—is contingent on the style of IA attention being applied, either mindful or anxiety driven. Nevertheless, individuals that experience their bodies as safe and their bodily sensations as trustworthy are also more likely to report greater psychological well-being. Secondarily, Not Worrying and Self-Regulation evidenced stronger relationships with psychological well-being relative to the remaining IA elements. These two IA elements both appear to reflect emotionally adaptive methods of coping with bodily sensations. Not worrying suggests the withholding of negative interpretations in response to unpleasant sensations. Self-Regulation suggests that bodily sensations can be interpreted as emotional anchors, capable of providing a sense of calm stability.

Considerable shared variance appears to exist between IA and DM with respect to the prediction of psychological well-being. Nevertheless, aspects of IA were found to predict psychological well-being above and beyond dispositional mindfulness using multivariate, hierarchical linear regression. Specifically, two of the MAIA scales, Trusting and Attention Regulation, remained significant predictors of psychological well-being after controlling for DM.

The MAIA Trusting scale appears to capture a component of interoception not reflected in the FFMQ. These results indicate that individuals who trust their bodies are more likely to report greater psychological well-being, irrespective of their dispositional mindfulness. That trusting the body has implications for well-being appears intuitive. However, the nature of this relationship requires elaboration. Future exploration is needed to clarify this study's suggested link between interoceptive awareness and higher order eudaimonic processes such as meaning-making, personal growth and environmental mastery [20]. Better understanding the process of translating momentary bodily sensations into a durable form of well-being deserves continued investigation.

The MAIA Attention Regulation scale also remained a significant, but negative predictor of psychological well-being. Given that the bivariate correlation between Attention Regulation and psychological well-being was positive, this may be due statistical suppression. Yet, this result is also consistent with Mehling et al. [4], who found that Emotional Awareness, Attention Regulation and Body Listening MAIA scales were positive predictors of trait anxiety in multivariate models with shared variance removed, but were negative predictors of trait anxiety in bivariate analysis. Furthermore, as IA is ambiguous and can be beneficial or maladaptive for psychological health depending on its context, studies have demonstrated hypervigilance and exaggerated interoception among patients with anxiety [13]. Our data

seem to confirm the findings of Tsur et al. [25], who showed than the use of body awareness for adaptive behavior was conditioned by mindfulness. Such complexity suggests that continued exploration is needed to better understand the individual contributions of IA elements to markers of psychological health.

Limitations

Despite offering novel analyses detailing the relationship between IA and DM, limitations in this study should also be noted. First, it should be acknowledged that various theorists offer competing definitions of "interoceptive awareness" [5,7,10,11], yet this study drew upon an operationalization of interoceptive awareness consistent with belief in one's interoceptive tendencies (Mehling, c.f. interoceptive sensibility as discussed in Garfinkel). And, although the debate surrounding the operationalization of interoception is still open, we felt justified to apply one of the most widely used measures of interoception in this study and note that our definition is the definition proposed by the developer of the questionnaire. Second, similarities in the wording of the MAIA and FFMQ, particularly the MAIA's Noticing scale and the FFMQ's Observing Facet, may undermine the meaningfulness of the observed correlations. Continued psychometric work and replication is needed to support the findings from this study. Third, a general limitation of self-report measures is that they reflecting what people claim they do and feel, as opposed to their actual behaviors and feelings. Thus, additional research employing observational designs or reports from individuals knowledgeable about participants' feelings and behaviors is needed to triangulate these self-report results. Fourth, two of the IA scales, Not Worrying and Not Distracting, showed low internal reliability, rendering the conclusions drawn about the constructs tentative. Similarly, lower internal reliability was observed for these two scales in MAIA validation studies [4,29]. Further refinement of the MAIA may be warranted given the consistency of these measurement concerns [5]. Finally, recruitment of this sample from an online crowdsourcing website may limit the generalizability of these results. While evidence suggests that samples derived from MTurk provide valid and useful data [45,46], continued investigation of the IA and DM among a variety of healthy and clinical populations is needed.

Conclusions

The MAIA and the FFMQ represent important self-report measurement tools for elucidating mind-body relationships related to interoception and the disposition to exhibit mindfulness in daily life. Our findings demonstrate that IA and DM as measured by these instruments are tightly interwoven, partly overlapping constructs. Indeed, greater DM is strongly linked with greater IA. Indeed, A scale specifically measuring this overlapping domain of mindful body awareness could have theoretical and clinical utility [47]. Additionally, both IA and DM appear to be independently associated with enhanced psychological well-being, defined as "the striving for perfection that represents the realization of one's true potential" [48]. Though the present study assessed IA and DM in individuals with and without contemplative practice, our findings suggest that future research should further investigate how mindfulness practices moderate IA for therapeutic implications in various clinical contexts.

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Highlights

- This study examined Interoceptive awareness (IA) and Dispositional mindfulness (DM)
- IA was measured by the Multidimensional Assessment of Interceptive Awareness
- DM was measured by the Five Facet Mindfulness Questionnaire
- The IA scales and the DM facets formed two, primary networks of association
- Elements of IA and DM were unique predictors of psychological well-being

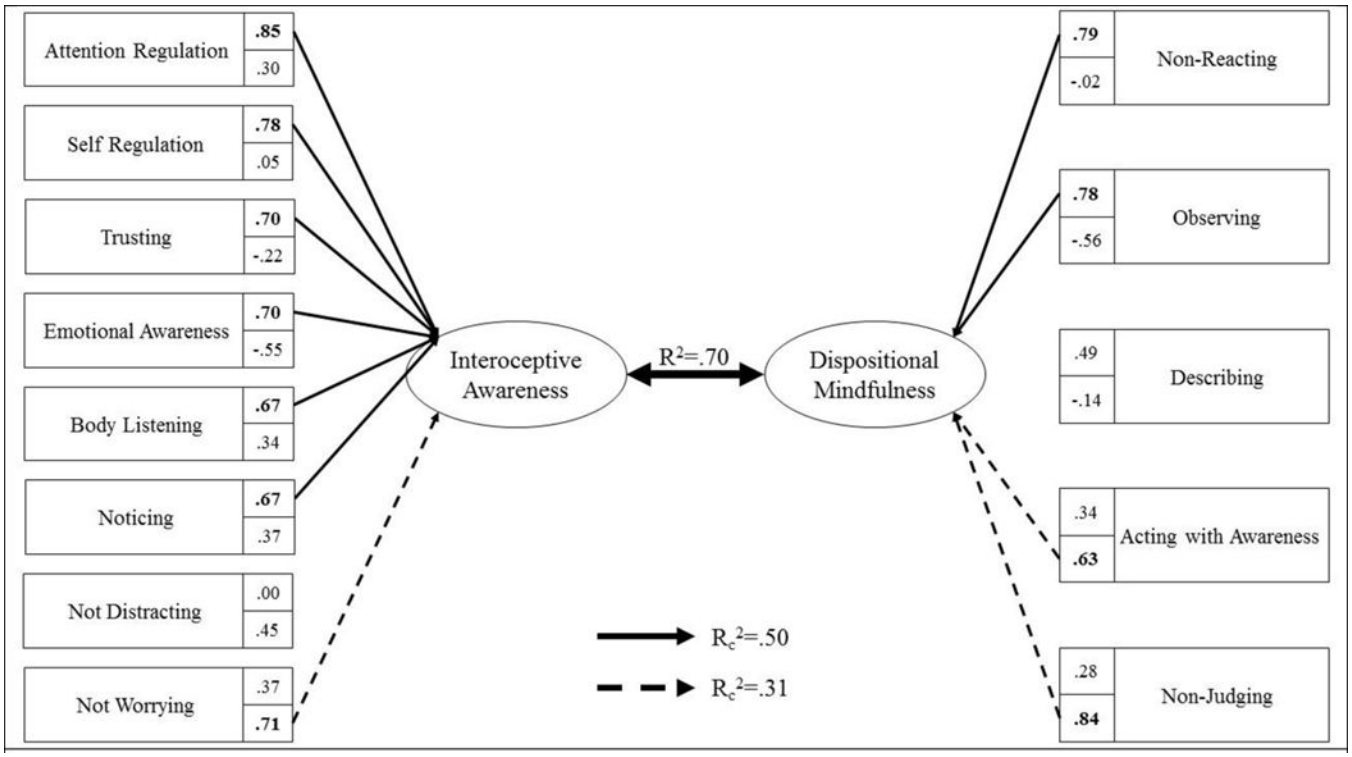

Figure 1.

Reported values are standardized canonical coefficients. The top value in each variable box is the standardized canonical coefficient for that variable in the first function. The bottom value is the standardized coefficient for the second function. Solid lines represent the variables in the first function. Dashed lines represent the variables in the second function. R^2 = shared variance between the mindfulness and personality variables across all functions. R_c^2 = squared canonical correlation, shared variance between the MAIA and FFMQ variables for each function.

Table 1

Participant Demographics

Race	*American Indian or Alaskan Native*	*Asian or Soutd Asian*	*African American*	*Native Hawaiian or Pacific Islander*	*Latino or Hispanic*	*Caucasian*	*Multiracial*		
	1%	6%	6%	0%	6%	77%	9%		
Marital Status	*Single*	*Married*	*Divorced*	*Widowed*					
	43%	46%	9%	2%					
Educational Background	*Less than High School*	*High School or equivalent*	*Trade School*	*Associate's Degree*	*Bachelor's Degree*	*Graduate Degree*			
	1%	24%	7%	14%	37%	17%			
Family Income	*Under $25,000*	*$25,000–$49,999*	*$50,000–$74,999*	*$75,000–$99,999*	*$100,000–$149,999*	*$150,000 or more*			
	23%	28%	23%	15%	8%	4%			
Religious Affiliation	*Protestant Christian*	*Roman Catholic*	*Evangelical Christian*	*Jewish*	*Muslim*	*Hindu*	*Buddhist*	*None*	*Other*
	25%	20%	7%	3%	1%	2%	2%	29%	12%

Table 2

Means, Standard Deviations and Internal Consistencies for the Primary Variables of Interest

	$\overline{x}$	*SD*	*α*		$\overline{x}$	*SD*	*α*
Interoceptive Awareness							
Noticing	16.94	4.49	.80	Dispositional Mindfulness	129.01	19.15	.87
Not Distracting	9.74	3.39	.66	Observing	26.88	6.04	.82
Not Worrying	10.68	2.97	.47	Describing	26.99	6.03	.83
Attention Regulation	27.71	7.44	.89	Acting with Awareness	27.40	6.90	.90
Emotional Awareness	21.99	5.49	.88	Non-Reacting	26.46	7.21	.90
Self-Regulation	15.95	4.62	.85	Non-Judging	21.27	5.08	.82
Body Listening	11.49	3.78	.86				
Trusting	13.19	3.69	.91	Psychological Well-Being	87.91	16.06	.83

Table 3

Bivariate Correlations between the MAIA Scales, FFMQ, and FFMQ Facets

	Noticing	Not Distracting	Not Worrying	Attention Regulation	Emotional Awareness	Self-Regulation	Body Listening	Trusting
Dispositional Mindfulness	.34***	.15**	.39***	**.42***	.31***	**.43***	.32***	**.45***
Observing	**.49***	−.10*	−.01	**.55***	**.58***	**.43***	**.47***	.31***
Describing	.24***	.07	.19***	.26***	.22***	.24***	.21***	.25***
Acting with Awareness	.09*	.29***	.34***	.09	.00	.08	.04	.21***
Non-Reacting	.34***	−.10*	.20***	**.51***	.34***	**.50***	.38***	**.43***
Non-Judging	−.05	.22***	**.42***	.01	−.08	.14**	−.03	.23***

Correlations above .40 are bolded.

* $p < .05$,

** $p < .01$,

*** $p < .001$

Table 4

Bivariate Correlations between the MAIA Scales, FFMQ, FFMQ Facets, and SPWB

MAIA Scales	Noticing	Not Distracting	Not Worrying	Attention Regulation	Emotional Awareness	Self-Regulation	Body Listening	Trusting
Psychological Well-Being	.22***	.07	.31***	.23***	.21***	.33***	.19***	**.42***

Dispositional Mindfulness	Total Score	Observing	Describing	Acting witd Awareness	Non-Reacting	Non-Judging
Psychological Well-Being	**.65***	.20***	**.44***	**.46***	.30***	**.53***

* $p < .05$,

** $p < .01$,

*** $p < .001$

Table 5

Hierarchical Multiple Regression Analyses Predicting Psychological Well-Being

	Psychological Well-Being			
	Model 1	**Model 2**	**Model 1**	**Model 2**
Step 1. Dispositional Mindfulness				
Observing	.11**	.06		.06
Describing	.19***	.18***		.18***
Acting with Awareness	.19***	.18***		.18***
Non-Reacting	.18***	.12**		.12**
Non-Judging	.36***	.32***		.32***
Step 2. Interoceptive Awareness				
Noticing		.07	.16**	.07
Not Distracting		−.04	.09*	−.04
Not Worrying		.03	.24***	.03
Attention Regulation		−.17**	−.15*	−.17**
Emotional Awareness		.10	.11	.10
Self-Regulation		.09	.20**	.09
Body Listening		−.08	−.14*	−.08
Trusting		.20***	.31***	.20***
F	74.59***	33.99***	22.13***	33.99***
R^2	.44	.49	.27	.49
ΔF		5.26***		5.26***
ΔR^2		.05		.05