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If It All Comes Down to Bodily Awareness, How Do We Know? Assessing Bodily Awareness

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A purported key mechanism of action in most mind–body movement approaches is the maturation and development of bodily awareness. This is an experiential learning process with its own phenomenology, underlying neurological processes, and challenges for scientific study. This report focuses on the assessment of changes in bodily awareness, which is of key importance for the documentation of this learning process for both research and clinical application. Objective assessments requiring lab equipment are briefly reviewed. Qualitative assessments can be performed by interviews, focus groups, and second-person observation of movement performance. In addition, systematically developed self-report questionnaires have become available in recent years, have undergone extensive validation, and are presented here.

Keywords: assessment, body awareness, interoception, questionnaire

It has been suggested that improvement in bodily awareness is a key mechanism of action for many movement therapies (Mehling et al., 2011). Examples of these mind–body therapies include mindful movement, integrative exercise, movement-education approaches named after or by founding teachers (e.g., Feldenkrais [the Feldenkrais method], F.M. Alexander [the Alexander technique], Rosen [the Rosen method], Middendorf [Middendorf breath], and G. Alexander [eutony]; Alexander, 1983), breath therapies (Mehling, 2001), mindful awareness in body-oriented therapy (Price, Wells, Donovan, & Rue, 2012), dance therapies (Marich & Howell, 2015; van Vugt, 2014), and many lesser-known approaches. As this mechanism also appears to be shared with tai chi and yoga, which in turn is part of mindfulness-based stress reduction (Carmody & Baer, 2008), some of the references in the following will come from research on these methods.

Bodily awareness can be—and has been—defined in a variety of ways, which has led to some confusion in the literature. For many decades, physicians associated bodily awareness with somatization and hypochondriasis, body image and self-objectification (Daubenmier, 2005)—a general hypervigilance toward bodily sensations interpreted as threatening and anxiety-provoking in patients. This style of bodily awareness is apparently maladaptive and has traditionally been assessed, due to lack of better instruments, by having patients check a list of anxiety-related symptoms (Porges, 1993). Possibly in part due to the prominence of its author and his polyvagal theory among body-oriented psychotherapists, and despite that fact that his highly popular theory has been seriously questioned, if not thoroughly debunked (Grossman, 2016; Grossman & Deuring, 2020), Porges's questionnaire is still applied in bodily awareness and interoception-related research and has led to considerable confusion in the literature (Mehling, 2016; Trevisan et al., 2019). However, the evenhanded (Williams, 2010), adaptive (salutogenic) style of attention toward bodily sensations, generally labeled "mindful," which is the hallmark of the increasingly popular approaches discussed in this special issue of *Kinesiology Review,* is clearly not captured by this legacy measure and required the development of new instruments (see the systematic review in Mehling et al., 2009). Another legacy measure of bodily awareness is the Body Awareness Questionnaire (Shields, Mallory, & Simon, 1989), which was developed to assess the tendency to focus on bodily sensations that explicitly are unrelated to and exclude emotions. However, if researchers are interested in the interface of physical sensations and emotions, as well as the awareness of their interrelatedness, then for our purposes the usefulness of the questionnaire may be limited.

In order to better define the ambiguous construct of bodily awareness, an expert panel developed the following rather lengthy definition:

> Body awareness is the perception of bodily states, processes and actions that is presumed to originate from sensory proprioceptive and interoceptive afferents and that an individual has the capacity to be aware of. Body awareness includes the perception of specific physical sensations (e.g., awareness of heart activity; proprioception of limb position) as well as complex syndromes (e.g., pain; sense of relaxation; 'somatic markers' of emotions). Body awareness is hypothesized as the product of an interactive and dynamic, emergent process that (a) reflects complex afferent, efferent, forward- and back-projecting neural activities, (b) includes cognitive appraisal and unconscious gating, and (c) is shaped by the person's attitudes, beliefs, experience and learning in a social and cultural context. (Mehling et al., 2009, p. 4)

Bodily awareness has also been a topic for philosophers at least since Merleau-Ponty (Barsalou, 1999; Bermudez, 2018; Leder, 1990; Merleau-Ponti, 1945; Shusterman, 2008). What may be of importance for our discussion is that bodily awareness is conceived of as a developmental process unfolding not only during childhood (Oldroyd, Pasupathi, & Wainryb, 2019) but also—most important—throughout adulthood (Gadow, 1980). Gadow (1980) proposed a model of four stages of this development, from taking the body for granted, having an aversive relationship to uncomfortable sensations (e.g., pain), accepting physical symptoms as valid information from one's body, to appreciating the wisdom of the body for decision making. Meditators and contemplatives might add a fifth stage: a nonconceptual, nondual experience of

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mind and body as one. Although conceptualizing this development as a linear progression may be an oversimplification, capturing any individual development along that axis for research appears quite challenging, to say the least.

Neurologically, bodily awareness is the part of proprioception and interoception of which one can be aware. Proprioception is defined here as the perception of joint angles and muscle tensions, of movement, posture, and balance. Interoception, more narrowly defined, is the perception of physical sensations from inside the body and includes sensations related to internal organ function, such as heartbeat, respiration, satiety, and autonomic nervous system activity related to emotions (Craig, 2003; Sherrington, 1906). More broadly defined, it can include any perception that originates inside the body (Cameron, 2001; Farb et al., 2015). In the last decade, research interest in interoception has virtually exploded (Khalsa et al., 2018). This construct is now deeply anchored in neuroscience (Farb et al., 2015; Khalsa et al., 2018; Seth, 2013) and has caught the interest of the National Institute of Health (NIH; Chen, 2019).

As neuroscience has provided deep insight into the mostly unconscious processes involved in and underlying interoception and interoceptive awareness (Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004; Schmalzl & Kerr, 2016), it has conducted its first studies of the claims of the Feldenkrais Guild that the effectiveness of Feldenkrais training may be based on "rewiring your brain" (i.e., neuroplasticity; Myers, 2016; Verrel, Almagor, Schumann, Lindenberger, & Kuhn, 2015). What is needed are clinical studies to show that changes in brain activities help patients with medical conditions.

The goal of this article is to provide an overview of methods for capturing the changes that may occur with mind–body movement interventions. Objective measures generally require relatively expensive technology primarily available at academic institutions. First-person reports can provide qualitative data on the phenomenology of the experience when undergoing the approaches discussed in this volume, as this phenomenology is hard to capture with objective measures. An innovative interview technique in this field is based on microphenomenology (Petitmengin & Lachaux, 2013). Standardized second-person observations are commonly used in Scandinavian studies of body-awareness approaches. A brief overview of quantitative assessment methods using questionnaires will follow and provide more details about the current state of measurement development, using the Multidimensional Assessment of Interoceptive Awareness (MAIA) as an example.

Methods

The method for this article is an eclectic narrative review presenting a broad array of currently applicable assessment methods. These methods may enable clinicians and researchers to capture processes presumably involved in the therapeutic-movement approaches discussed in this journal issue. It must be noted that the field has expanded in the last decades in such a way that it is impossible to pay respect to all elements and provide a complete review here. Self-report measures that are freely available in the public domain for clinical work and research are highlighted.

Results

First, a brief overview of objective measures for bodily awareness should be provided. Beginning with measures for proprioception and postural and motor control, the literature on that topic is extensive (Clark, Roijezon, & Treleaven, 2015), and here only a few feasible examples are mentioned. One is the joint-repositioning error (Feipel et al., 2003; Newcomer, Laskowski, Yu, Larson, & An, 2000) assessed by wearable motion sensors. These electronic sensors have been miniaturized and have become increasingly sophisticated (Weston, Le, & Marras, 2017). People with higher bodily awareness are expected to be able to more closely repeat a given positioning joint angle at the spine or peripheral joints. Tactile sensory discrimination (Flor, Denke, Schaefer, & Grusser, 2001) and acuity (Kerr et al., 2008) should be mentioned, as the latter has been used to demonstrate improved bodily awareness in a study of tai chi. Motion labs use cameras and body markers (e.g., for assessing body-awareness-based exercise form in chi-running; Kumar et al., 2015). Force plates have been used for the assessment of changes from Alexander-technique or Middendorf-breath therapy (Cacciatore, Horak, & Henry, 2005; Mehling, 2004).

The rubber-hand illusion (Cacciatore et al., 2005; Valenzuela Moguillansky, O'Regan, & Petitmengin, 2013) is a traditional objective measure for what is commonly termed "body ownership" and assesses proprioceptive bias (Longo, Schuur, Kammers, Tsakiris, & Haggard, 2008). It has been studied qualitatively (Valenzuela Moguillansky et al., 2013) and takes notice of the common deficit in bodily awareness by testing a subject's connection to a visible fake hand versus their own invisible hand. Intriguingly, as a side note, temperature and blood supply to the hand diminish to the degree that the real hand is disowned, lost to momentary bodily awareness, in favor of a fake hand (Moseley et al., 2008).

Measurements for dimensions of interoception, interoceptive accuracy (or sensitivity), interoceptive awareness (or sensibility) are based on a terminology that is unfortunately somewhat confusing and that underwent several changes since its operationalization (Ceunen, Van Diest, & Vlaeyen, 2013; Ceunen, Vlaeyen, & Van Diest, 2016; Farb et al., 2015; Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015; Khalsa et al., 2018). Interoceptive accuracy is measured separately for cardiac, respiratory, and gastrointestinal interoception (Ferentzi et al., 2018). The most frequently used heart-rate-detection/-counting tasks have been shown to have considerable limitations (Desmedt et al., 2020; Knapp-Kline & Kline, 2005; Ring & Brener, 1996; Zamariola, Maurage, Luminet, & Corneille, 2018) and are only poorly related—if at all—with self-reported interoceptive awareness or sensibility (Cali, Ambrosini, Picconi, Mehling, & Committeri, 2015). As this is not the space to comprehensively review the available objective measures (see overviews in Khalsa et al., 2018; Pace-Schott et al., 2019), a few references will have to suffice: Respiratory interoception has been assessed with detection thresholds and discrimination of inspiratory loads placed into the air flow of breathing (Daubenmier, Sze, Kerr, Kemeny, & Mehling, 2013; Paulus et al., 2012; Rieger, Stephan, & Harrison, 2020), and gastrointestinal interoception has used intestinal distension (e.g., with water loads; Boeckxstaens, Hirsch, van den Elzen, Heisterkamp, & Tytgat, 2001; Dudley & Stevenson, 2016; Kanazawa et al., 2008). These objective measures assess one dimension of interoception, namely its accuracy. Other aspects such as regulatory aspects (Bornemann, Herbert, Mehling, & Singer, 2014), different styles of attention (Mehling, 2016), the degree of mind–body integration with emotions (Khoury, Lutz, & Schuman-Olivier, 2018), and trusting one's body (Velten & Brotto, 2017) are not captured by measures of interoceptive accuracy. These measures, to use an analogy, test the

equivalent of your visual acuity when looking at modern art in a museum, rather than how you process what you see and feel.

Neuroscience on interoception has widely employed fMRI (functional magnetic resonance imaging; Critchley, Mathias, & Dolan, 2001; Haase et al., 2016), EEG (electroencephaolography; Kerr, Sacchet, Lazar, Moore, & Jones, 2013). and heartbeat-evoked potentials (Baranauskas, Grabauskaite, & Griskova-Bulanova, 2017) to study interoception. Physiological feelings related to emotions have been extensively studied (Barrett, 2017a, 2017b; Pace-Schott et al., 2019; Seth & Critchley, 2013; Wiens, 2005). Again, it is important to note that objective assessments of interoceptive accuracy only poorly correlate with self-reported interoceptive awareness or sensibility. For our field of neuroscience in mindful-movement practices, the NIH has conducted intriguing brain research on yoga and its effect on pain and the insula cortex, which is the brain's hub for interoception (Villemure, Ceko, Cotton, & Bushnell, 2014). But to my knowledge, although currently underway, little *clinical* research has been completed and published on brain imaging with mindful-movement practices and interoceptive bodily awareness. An exception is a recent study on tai chi and depression (Xu et al., 2020). Although bodily awareness was not assessed directly, the authors found connectivity changes indicating "a shift towards processing experience according to sensory rather than cognitive aspects . . . attention toward sensations as they arise without changing them." They labeled this "changed communication between brain regions involved with bodily processing" as "interoceptive shift" (p. 7).

In the Scandinavian countries, and there particularly within the frame of physical therapy and psychiatric care, body-awareness-based interventions have been developed and widely implemented. One example is basic body awareness therapy (Bravo, Skjaerven, Espart, Sein-Echaluce, & Catalan-Matamoros, 2019): Changes in movement patterns and body-awareness-related treatment effects are assessed by trained physical therapists using a standardized semiqualitative observation scale (a method of second-person assessment), often in addition to detailed first-person, qualitative assessments.

Qualitative research assesses first-person subjective experience from interviews and focus groups. In one such study with well-known experts using a variety of mind–body interventions including yoga (Iyengar and Desikachar), tai chi, Feldenkrais, Alexander, breath therapy, eutony, mindfulness-based stress reduction, and somatic experiencing, improving bodily awareness was viewed as a common key mechanism of action (Mehling et al., 2011). Qualitative studies have been conducted on the Feldenkrais method (Connors, Galea, Said, & Remedios, 2010; Pugh & Williams, 2014), although changes in bodily awareness itself were not the main focus of the studies. A more recently developed method of microphenomenology may be particularly useful for in-depth analyses of what happens during mindful-movement interventions (Petitmengin & Lachaux, 2013) and has been used in assessing subtle variations in bodily awareness in the rubber-hand illusion (Valenzuela Moguillansky et al., 2013).

Self-reported bodily awareness has been assessed by numerous scales (see the review in Mehling et al., 2009). For postural awareness, a new scale has been developed very recently (Cramer, Mehling, Saha, Dobos, & Lauche, 2018). One of the oldest (1984), more disease-specific scales, the Eating Disorder Inventory, is a standard measure in patients with eating disorders (Espelage et al., 2003). It specifically includes a subscale for interoceptive deficits. Price and Daubenmier developed scales that attempt to capture the changes involved in body-oriented psychotherapy (Price & Thompson, 2007; e.g., mindful awareness in body-oriented therapy; Price et al., 2012) and yoga (Cramer, Lauche, et al., 2018; Daubenmier, 2005). Both joined a team that systematically developed the MAIA (Mehling et al., 2012), which is now used in an improved second version (MAIA-2; Mehling, Acree, Stewart, Silas, & Jones, 2018). It has now been translated into 30 other languages (see https://osher.ucsf.edu/maia) and is used worldwide, for example, for capturing changes in interoceptive bodily awareness in patients undergoing mind–body interventions. The MAIA has also shown its ability to distinguish between known groups (Brown et al., 2017; Stern et al., 2017; Todd, Aspell, Barron, & Swami, 2019) and to predict treatment outcomes (Vachon-Presseau et al., 2019, 2018). Similar to many other instruments that try to assess learning processes and subtle variations in a complex construct that is difficult to operationalize, this instrument should be viewed as a work in progress, with the limitations of any self-report measure. This is particularly obvious in regard to its translations and cross-cultural adaptations (see the review in Todd et al., 2020). However, since its publication in November 2012, the MAIA has demonstrated its validity and been applied in numerous studies (Bornemann et al., 2014; de Jong et al., 2016; Duncan et al., 2017; Fissler et al., 2016; Mehling, Chesney, et al., 2018; Price & Hooven, 2018; Price, Thompson, Crowell, & Pike, 2019a), including studies of mindful-movement practices (Mehling, Chesney, et al., 2018; Osypiuk et al., 2020).

The current version of the MAIA consists of eight scales with a total of 37 items that can be used independently from one another according to researchers' needs and research questions (Mehling, Acree, et al., 2018; Mehling et al., 2012):

- *Noticing* (4 items): the awareness of uncomfortable, comfortable, and neutral body sensations
- *Not-distracting* (6 items): the tendency not to ignore or distract oneself from sensations of pain or discomfort
- *Not-worrying* (5 items): the tendency not to worry or experience emotional distress with sensations of pain or discomfort
- *Attention regulation* (7 items): the ability to sustain and control attention to body sensations
- *Emotional awareness* (5 items): the awareness of the connection between body sensations and emotional states
- *Self-regulation* (4 items): the ability to regulate distress by attention to body sensations
- *Body listening* (3 items): the active listening to the body for insight
- *Trusting* (3 items): the experience of one's body as safe and trustworthy.

The questionnaire is in the public domain and free to use without permission. For the most recent version and any translations, please see https://osher.ucsf.edu/maia.

Discussion

This review has shown that there are numerous ways to assess variations and changes in bodily awareness in research. These measures have also been applied in clinical practice to document the effects of a given therapy (e.g., in physical therapy, psychotherapy, or psychiatry). If we hypothesize that changes in bodily awareness are a key mechanism in mindful-movement practices, these measures can ideally be applied in research that uses mediation analysis. Mediation analysis tests whether the changes in the

main clinical outcome (e.g., improved depression or pain scores) associated with or produced by a mind–body intervention are due, at least partially, to improvements in bodily awareness. For example, it has already been shown in research on mindfulness-based therapeutic approaches, which include present-moment interoceptive attention to yoga movements and postures, that changes in interoceptive bodily awareness assessed by the MAIA mediated the benefits of the intervention on depression in patients with chronic pain with comorbid depression (Fissler et al., 2016). In mindfulness-based classes for mothers preparing for childbirth, improvements in interoceptive awareness—again, assessed by the MAIA—mediated the beneficial effects on postpartum depression. And yoga for women improved women's self-objectification mediated by an improved relationship to their bodies (Daubenmier, 2005). Mediation analyses usually require a sufficient sample size and expert-level knowledge of statistics. Somewhat simpler studies, without that type of mediation analysis, have shown that changes in interoceptive awareness were found in parallel with changes in clinical outcomes. Examples include integrative, body-awareness-focused movement exercises for posttraumatic stress disorder (PTSD; Mehling, Chesney, et al., 2018); mindful awareness in body-oriented therapy for substance-use disorder (Price et al., 2019a, 2019b); Qigong for postsurgical pain in patients with breast cancer (Osypiuk et al., 2020); and other mindfulness-based interventions for women with obesity (Daubenmier et al., 2016) or for hypertension (Loucks et al., 2019). The analyses in the latter studies support the hypotheses that the improvements in clinical outcomes may potentially be associated with improvements in interoceptive bodily awareness, but without mediation analysis, these studies are unable to confirm that this improvement in a clinical outcome occurred *because* of improved bodily awareness.

A limitation of this paper may be the research and study preferences of the author. However, the references are numerous and include a variety of viewpoints, some of which are in respectful disagreement with my own and may counterbalance the admitted selection bias.

Conclusions

This paper aimed to show the many ways to study bodily awareness: from a first-person, qualitative phenomenological perspective; from second-person behavioral observation; quantitatively, by self-report with validated psychological questionnaires; and objectively, with psychophysiological and neuroscientific techniques. This field of research is rapidly expanding (Farb et al., 2015; Khalsa et al., 2018). The scientific journal *Frontiers in Neuroscience* dedicated a special-topic issue to "Neural Mechanisms Underlying 'Movement-Based' Embodied Contemplative Practices" (Schmalzl & Kerr, 2016). The current paper can only scratch the surface and offers further references for deepening the study of bodily awareness. Science has opened up to rigorous studies of mindful-movement practices and body-awareness-enhancing approaches. This is the time.

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