



## Brief body-scan meditation practice improves somatosensory perceptual decision making

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### ABSTRACT

We have previously found that attention to internal somatic sensations (interoceptive attention) during a heart beat perception task increases the misperception of external touch on a somatic signal detection task (SSDT), during which healthy participants erroneously report feeling near-threshold vibrations presented to their fingertip in the absence of a stimulus. However, it has been suggested that mindful interoceptive attention should result in more accurate somatic perception, due to its non-evaluative and controlled nature. To investigate this possibility, 62 participants completed the SSDT before and after a period of brief body-scan mindfulness meditation training, or a control intervention (listening to a recorded story). The meditation intervention reduced tactile misperception and increased sensitivity during the SSDT. This finding suggests that the perceptual effects of interoceptive attention depend on its particular nature, and raises the possibility that body-scan meditation could reduce the misperception of physical symptoms in individuals with medically unexplained symptoms.

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### 1. Introduction

Perception of internal bodily sensations (“interoception”) and external touch (“exteroception”, e.g., Sherrington, 1906)<sup>1</sup> contributes to our conscious experience of our bodies. Interoception has been defined as the sense of the physiological condition of the body (Cameron, 2001), including the perception of temperature, itch, muscular and visceral sensations, hunger, thirst, pain and other physical symptoms (Craig, 2002). Research suggests that interoceptive information is processed separately to exteroceptive information, via a dedicated cortical pathway (see Craig, 2002, 2003 for reviews). Interoceptive and exteroceptive perception are not solely based on incoming sensory information, rather they are influenced and potentially distorted by information from other sensory modalities and top-down factors, such as attention. As a result, somatic perception does not always reflect sensory reality. For example, hearing about an insect infestation might cause us to feel itch, or crawling sensations on our skin, in the absence of sensory stimulation. For some people, such somatic misperception can become more extreme and debilitating. People with medically unexplained symptoms (MUS), such as somatoform disorder patients, for example, experience subjectively compelling physical symptoms in the absence of any apparent medical pathology.

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<sup>1</sup> It could be argued that regardless of origin, all bodily sensations are “internal”. Indeed, the perception of external touch involves an interaction between environmental and bodily factors (i.e., an external stimulus contacts the skin). Nonetheless, a distinction can be made between sensations that originate from an external stimulus and sensations that originate within the body (e.g., Cameron, 2002; Leder, 1990).

Using a recently developed paradigm, the somatic signal detection task (Lloyd, Mason, Brown, & Poliakoff, 2008), we have shown that healthy people also report feeling external touch in the absence of tactile stimulation. The SSDT involves detecting a near-threshold vibration presented to the fingertip on 50% of trials. Signal detection analysis is used to analyse the data from this task, to determine sensitivity ( $d'$ ; i.e., the ability to distinguish between vibration and no vibration) and response criterion ( $c$ ; i.e., the propensity to report feeling the vibration). Participants often report feeling the vibration when it was not presented (i.e., make false alarms), particularly when a light flashes next to the fingertip (which also occurs on 50% of trials). Individual differences in the tendency to misperceive the vibration are stable over time (McKenzie, Poliakoff, Brown, & Lloyd, 2010).

It is possible that increased attention towards the hand might contribute to tactile misperception during the SSDT by raising interoceptive awareness, leading to ambiguous internal bodily sensations (such as the feeling of the pulse in the fingertip) being mistakenly identified as vibrations (Lloyd et al., 2008). Consistent with this, subjective ratings of feeling the internal pulse in the fingertip during the SSDT tend to be correlated with false alarm rates (Katzer, Oberfeld, Hiller, & Witthoft, 2011) and tactile decision criteria have been shown to become more liberal following a heart beat perception task designed to increase attention to pulse sensations in the fingertip (Mirams, Poliakoff, Brown, & Lloyd, 2012, Experiment one). This could also account for the finding of increased false alarms in the presence of the light when the hand is visible during the SSDT, compared to when the hand is covered (but the light still visible; Mirams, Poliakoff, Brown, & Lloyd, 2010). When the hand is visible, the light might raise awareness of internal sensations in the finger that are then confused with the vibration. Indeed, recent research has shown that viewing the body raises awareness of 'spontaneous sensations' in the fingertips (Michael & Naveteur, 2011; Michael et al., 2012). False alarm responses on the SSDT are also associated with activity in the right insula and the anterior cingulate cortex (Poliakoff et al., in preparation), which are both associated with bodily attention and interoceptive perception (Craig, 2003; Critchley, Wiens, Rotshtein, Ohman, & Dolan, 2004).

The idea that attention to the body can increase sensory noise and lead to perceptual errors is consistent with clinical models of MUS (e.g., Brown, 2004; Deary, Chalder, & Sharpe, 2007; Rief & Barsky, 2005; Rief & Broadbent, 2007). These models suggest that attention raises awareness of ambiguous interoceptive sensations, which can lead to physical symptom reports if such sensations are misinterpreted as signalling illness. Indeed, people who report experiencing high numbers of physical symptoms also report being highly aware of internal bodily sensations more generally (e.g., Barsky, Brener, Coeytaux, & Cleary, 1995; Duddu, Chaturvedi, & Isaac, 2003; Haenen, Schmidt, Schoenmakers, & Van Den Hout, 1997) and tend to make illness attributions for bodily sensations (Rief, Nanke, Emmerich, Bender, & Zech, 2004; Robbins & Kirmayer, 1991). In addition, both clinical and non-clinical participants reporting a high number of physical symptoms make more false alarms, and have a more liberal response criterion on the SSDT (Brown, Brunt, Poliakoff, & Lloyd, 2010; Brown et al., 2012).

Not all attentional manipulations increase tactile misperception during the SSDT, however. In one recent study, for example, focusing on exteroceptive sensations, in the context of a grating orientation task, led to a more stringent response criterion and a reduction in false alarms on the SSDT (Mirams et al., 2012, Experiment two), perhaps by reducing interference from interoceptive sensory noise. In the current study, we investigated the possibility that changing the nature of interoceptive attention could also reduce the misperception of touch during the SSDT. It has been argued, for example, that the type of interoceptive attention practised during mindfulness meditation should improve the accuracy of somatic perception (e.g., Khalsa et al., 2008). Mindfulness meditation involves paying attention to present moment experience including bodily sensations, thoughts, feelings and environmental stimuli, with an attitude of non-judgemental acceptance. Meditation practice is thought to increase mindfulness (i.e., the ability to focus attention on present moment experience) in everyday life, resulting in enhanced awareness of physical sensations, perceptions, affective states, thoughts and imagery (Grossman, Niemann, Schmidt, & Walach, 2004). Most meditation practices incorporate attention to internal body sensations such as the breath, the position of the joints, muscle tension and the heart beat. Such practice is thought to enhance interoceptive awareness (Khalsa et al., 2008) and improve perceptual clarity (Brown, Ryan, & Creswell, 2007; Grossman et al., 2004; MacLean et al., 2010; Rubia, 2009). As meditation commonly incorporates non-evaluative attention to internal and external stimuli it should result in more veridical perception (Grossman et al., 2004; Khalsa et al., 2008); that is, meditation should result in perceptions that are a more accurate account of sensory reality.

In line with this idea, meditation training has been found to reduce perceptual thresholds in a visual discrimination task (MacLean et al., 2010) and experienced practitioners of Tai Chi (a Chinese slow motion meditative exercise involving mindful attention to interoceptive sensations) show enhanced tactile acuity on grating orientation tasks compared to controls (Kerr et al., 2008). Meditation practice has also been found to reduce physical symptoms in participants with MUS (Eriksson, Moller, Soderberg, Eriksson, & Kurlberg, 2007; Landsman-Dijkstra, van Wijck, Groothoff, & Rispens, 2004) and dispositional mindfulness is negatively correlated with physical symptoms (Baer et al., 2008; Brown & Ryan, 2003) and health care utilisation (Brown & Ryan, 2003). Meditation practice is also associated with structural and functional changes in brain areas associated with attention, interoception and sensory processing (Farb et al., 2007; Lazar et al., 2005) including the right anterior insula. However, experienced meditators do not perform more accurately on heart beat perception tasks compared to controls (Khalsa et al., 2008; Nielsen & Kaszniak, 2006) and brief meditation training has not been found to improve heart beat perception ability (Parkin et al., submitted for publication). While heart beat perception ability may vary naturally between individuals (e.g., Dunn et al., 2010; Pollatos, Traut-Mattausch, & Schandry, 2009; Pollatos, Traut-Mattausch, Schroeder, & Schandry, 2007), it may not be amenable to modulation by training (c.f. Khalsa et al., 2008).

Given that we have previously found performance on the SSDT to be modulated by attention, the aim of the current study was to investigate whether meditation practice might impact on somatic perception during this task. We implemented a

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