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Embodiment and Body Awareness in Meditators

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Abstract Mindfulness practice consists of focusing attention in an intentional way on the experience of the present moment, including bodily sensations, thoughts or feelings, and the environment, with an attitude of acceptance and without judging. The body and, especially, body awareness are key elements in mindfulness. Embodiment or the feeling of being located within one's physical body is a related concept, and it is composed of the sense of ownership, location, and agency of the body. The rubber hand illusion (RHI) is an experimental paradigm that has been used to understand the mechanisms of embodiment, and evidence shows that body awareness modulates this illusion. To our knowledge, no studies have analyzed embodiment processes in meditators. The aim of this study is to use the RHI to analyze the mechanisms of embodiment and its relationship with body awareness and mindfulness in meditators and non-meditators. The sample was composed of long-term meditators ($n = 15$) and non-meditators ($n = 15$). Objective and self-report measures for embodiment with the RHI and self-report questionnaires of body awareness and mindfulness were administered. One-way ANOVA revealed significant differences between groups in sense of agency in the rubber hand. Meditators experienced less sense of agency in the rubber hand than non-meditators. Pearson's correlations showed that this lower sense of agency in the rubber hand was associated with higher body awareness and mindfulness. Results highlight the role of body awareness and mindfulness in embodiment mechanisms. This study has clinical implications, especially in psychopathological disorders that can be influenced by disturbances in these processes.

Keywords Mindfulness · Embodiment · Sense of agency · Body awareness · Rubber hand illusion · Meditation

Introduction

Mindfulness practice consists of focusing attention in an intentional way on the experience of the present moment, including bodily sensations, thoughts or feelings, and the environment, with an attitude of acceptance and without judging

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(Bishop et al. 2004). Mindfulness-based interventions (MBIs) have shown promise in the treatment of several disorders, including those where the body experience is altered, such as somatoform disorders (Lakhan and Schofield 2013), fibromyalgia (Grossman et al. 2007), hypochondria (McManus et al. 2012), or unexplained medical symptoms (Van Ravesteijn et al. 2013). Body awareness has emerged as one of the key mechanisms for understanding the effectiveness of the practice of mindfulness (Hölzel et al. 2011; Quezada-Berumen et al. 2014). Thus, mindfulness meditation training has been related to an increase in the sensitivity to perceiving bodily sensations (e.g., Mirams et al. 2013; Parkin et al. 2014) or introspective accuracy (Fox et al. 2012). Therefore, the body and, especially, body awareness are key elements in the practice of mindfulness. In fact, MBI frequently uses techniques that are specifically designed to observe the whole body, such as the body scan (Dreeben et al. 2013).

Body awareness can be defined as the dynamic and interactive process through which the body's psychological states, processes, actions, and functions are perceived, at both interoceptive and proprioceptive levels. It includes the individual's appraisal, and it is shaped by attitudes, beliefs, and experiences in his/her social and cultural context (Mehling et al. 2009). Amplified body awareness has mainly been investigated as a maladaptive cognitive process associated with exaggerated attention to physical symptoms, magnification or "somatosensory amplification," rumination, and catastrophic thoughts (Cioffi 1991). However, body awareness that promotes the practice of mindfulness, based on the present without judging, could be considered adaptive (Farb et al. 2015; Mehling et al. 2012). For example, this adaptive body awareness was related to fewer depressive symptoms, greater awareness, and less propensity to judge (Quezada-Berumen et al. 2014); better affect regulation (Mehling et al. 2012) and decision making (Dunn et al. 2010); or higher coherence between subjective and cardiac aspects of emotion (Sze et al. 2010).

The relationship between mindfulness and body awareness has also been studied in research on brain changes, as mindfulness practice has been associated with morphological changes in the insula (Hölzel et al. 2008; Lazar et al. 2005), a brain area that is activated during interoceptive body awareness tasks (Craig 2009). Mindfulness also seems to play an important role in embodiment processes, especially in the sense of ownership and agency of one's body (Karnath and Baier 2010).

Embodiment can be defined as the sense of being located within one's physical body (Arzy et al. 2006). Longo et al. (2008) pointed out that the recognition of the importance of embodiment has not been accompanied by theoretical clarity about what it is. In an attempt to clarify this concept, Longo et al. (2008) conducted a study using a psychometric approach to explore the process of embodiment. They concluded that embodiment is a complex experience with three components: (a) sense of ownership ("the feeling that the rubber hand was part of one's body, the feeling of looking directly at one's hand, and the rubber hand taking on the characteristics of one's own hand"), (b) sense of location ("the feeling that the rubber hand and one's own hand were in the same place, and also to sensations of causation between the seen and felt touches"), and (c) sense of agency ("the feeling of being able to move the rubber hand, and control over it"). It is noteworthy that these embodiment processes can be altered, as occurring in several pathological disorders where body experiences can be distorted, such as eating disorders (Eshkevari et al. 2012; Keizer et al. 2014; Mussap and Salton 2006) or fibromyalgia (Calsius et al. 2015).

The rubber hand illusion (RHI) is an experimental paradigm used to understand what the embodiment processes are and how they work (e.g., Ehrsson et al. 2004; Longo et al. 2008; Tsakiris et al. 2011). It consists of generating the illusionary experience that a rubber hand (a fake hand) is one's own hand (Botvinick and Cohen 1998). To do this, the person receives a synchronous tactile stimulation of both hands (the rubber hand and the own hand), while he/she can only see the rubber hand. The integration of visual, tactile, and proprioceptive sensory information is related to the generation of this illusion, and it can help to identify the cognitive processes that make us feel that we own a physical body or have control over it.

One of the variables that could modulate the experience of embodiment is body awareness. In fact, adults with greater interoceptive body awareness are more resistant to the experience of the RHI (Tsakiris et al. 2011), and children with autism spectrum disorder, who have shown an increased ability to maintain attention on internal signals for a longer time (Schauder et al. 2015), show a lower susceptibility to experiencing the RHI (Cascio et al. 2012). By contrast, individuals with a negative body image and/or an eating disorder diagnosis, who show a deficit in interoceptive body signal attention, have an increased susceptibility to experiencing the RHI (Eshkevari et al. 2012; Mussap and Salton 2006; Pollatos et al. 2008).

Regarding the relationship between embodiment and mindfulness, some authors (Cebolla et al. 2015; Farb et al. 2015) suggest that mindfulness practice and movement-based practices (e.g., yoga and tai chi) may be well-suited to cultivate agency. In this sense, Naranjo and Schmidt (2012) studied whether visuomotor performance and agency of body were modulated by mindfulness meditation. To do so, they compared the performance during a perceptual motor conflict task in three groups with different levels of training in mindfulness (short-term meditators, long-term meditators, and non-meditators). Participants were asked to perform movements based exclusively on proprioception, without the visual reference of the body, and results showed that mindfulness training significantly improved motor control during the task.

Moreover, speed and precision movements of meditators were superior to controls.

Evidence shows that mindfulness practice increases body awareness (Bornemann et al. 2015). Therefore, we would expect that it may affect individuals' disposition to experiencing the RHI and to maintaining embodiment processes unaltered. However, to our knowledge, no studies have analyzed embodiment processes in a sample of long-term meditators. Therefore, the main objective of this study is to compare the performance on the RHI in meditators and compare the results on a RHI experience with non-meditators. The secondary objective is to analyze the relationship between the performance on the RHI and self-reported body awareness and dispositional mindfulness. We expected that (a) meditators would show lower proprioceptive drift and lower scores on self-reported embodiment in the RHI compared to non-meditators and (b) lower embodiment scores in the rubber hand would be associated with greater body awareness and dispositional mindfulness.

Method

Participants

The total sample was composed of 30 Caucasian participants (15 women) with a mean age of 38.07 (SD = 11.49). For all the participants, their right hand was the dominant one. None of the participants reported psychological or medical problems, such as neurological disorders or a history of drug or alcohol addiction. All participants were informed about the study and signed the informed consent documents before beginning the experiment. The study was approved by the Institutional Review Board at the University of Valencia (Spain).

Meditator participants ($n = 15$) had at least 5 years of experience in meditation, practiced mindfulness regularly, and were recruited from different research groups on mindfulness from several Spanish universities. Non-meditator participants ($n = 15$) were recruited using advertisements posted at the Faculty of Psychology (University of Valencia, Spain). No participants had to be excluded from the study.

Procedure

This study was conducted in a single session where participants filled out an informed consent, RHI was applied, proprioceptive drift was measured, and questionnaires (embodiment questionnaire; the Five Facet Mindfulness Questionnaire (FFMQ) and Multidimensional Assessment of Interoceptive Awareness (MAIA)) were answered.

To carry out the RHI, participants sat in a comfortable position in front of a table and the researcher, and they put their non-dominant hand and forearm inside a box (80 cm × 35 cm × 48 cm) covered with a dark cloth. Next, a fake hand/forearm was placed in front of the participant, and the rest of the arm was covered (from the shoulder to the forearm) with a black cloth. The fake hand/forearm was in line with the person's own hidden hand, at a distance of 15 cm (taking into account the distance between the middle fingers of both hands). A left or right and male or female hand/forearm was used depending on the characteristics of each participant.

Once participants were in a comfortable position, proprioceptive drift was measured before starting the experiment, by asking them to point at the center of their own hidden hand with the index finger of their dominant hand. Then, the following instruction was given: "Please, focus your attention on the rubber hand and try to feel it as part of your body, as if it were yours." Later, the researcher started to stimulate both hands with two brushes (the rubber hand and the person's own hand) synchronously for 2 min, with strokes lasting approximately 1 s in the same direction. Then, proprioceptive drift was measured again in the same way as at the beginning of the experiment. Finally, participants answered the embodiment questionnaire, the FFMQ, and the MAIA. Three participants ($n = 3$ non-meditators) did not answer the FFMQ, and seven participants ($n = 3$ non-meditators and $n = 4$ meditators) did not answer the MAIA.

Measures

The performance on the RHI (primary outcome) was assessed using an objective measure (proprioceptive drift) before and after the procedure and an embodiment self-report measure after the procedure. We also used self-report measures once to assess body awareness and dispositional mindfulness.

Proprioceptive Drift It is a quantitative objective perceptual measure of the RHI that has been used in several studies (e.g., Tsakiris and Haggard 2005), and it is taken at the beginning and end of the experiment. Participants are asked to close their eyes and to point to the center of their real hand (which is hidden under a dark box) with the index finger of the other hand. Later, with the help of a ruler that participants cannot see, the difference (in centimeters) in the perception of the center of the hidden hand in both moments is calculated, that is, the distance between perception of one's hand and the real location of one's own hand. Bias toward the rubber hand in these proprioceptive judgements due to the visuotactile stimulation is taken as a measure of the visual dominance of the perception of the rubber hand over the proprioception of the participant's own hand. A higher positive value (Proprioceptive drift = Proprioceptive drift post − Proprioceptive drift pre) means that the participant has experienced a greater illusion, as there is a tendency to consider

that the center of the real hand is closer to the rubber hand after the RHI.

Embodiment Self-Report Measure The embodiment questionnaire (Longo et al. 2008) is a self-report questionnaire that provides a subjective measure of the experience of embodiment in the rubber hand. It consists of 10 items that assess the three components of embodiment: sense of ownership (items 1–5) (e.g., "It seemed like the rubber hand belonged to me"), sense of location (items 6–8) (e.g., "It seemed like my hand was in the location where the rubber hand was"), and sense of agency (items 9 and 10) (e.g., "It seemed like I could have moved the rubber hand if I had wanted"; "It seemed like I was in control of the rubber hand"). Participants have to answer on a Likert scale ranging from −3 ("strongly disagree") to +3 ("strongly agree"). Cronbach's alpha coefficient was .91 for the present sample.

Body Awareness The Multidimensional Assessment of Interoceptive Awareness (MAIA, Mehling et al. 2012) is a 32-item questionnaire answered on a Likert scale ranging from 0 ("never") to 5 ("always"). It assesses eight dimensions of body awareness: *noticing* (awareness of uncomfortable, comfortable, and neutral body sensations), *not-distracting* (tendency not to ignore or distract oneself from sensations of pain or discomfort), *not-worrying* (tendency not to worry or experience emotional distress about sensations of pain or discomfort), *attention regulation* (ability to sustain and control attention to body sensations), *emotional awareness* (awareness of the connection between body sensations and emotional states), *self-regulation* (ability to regulate distress by paying attention to body sensations), *body listening* (active listening to the body for insight), and *trusting* (experiencing one's body as safe and trustworthy). Cronbach's alpha was .95 for the present sample.

Dispositional Mindfulness The Five Facet Mindfulness Questionnaire-Short Version (FFMQ, Aguado et al. 2015; Cebolla et al. 2012; Tran et al. 2013) is the short version of the 39-item questionnaire by Baer et al. (2006), and it consists of 20 items that assess five facets of mindfulness. Items are rated on a Likert scale ranging from 1 ("never or very rarely true") to 5 ("very often or always true"), with higher scores indicating higher self-reported mindfulness skills. The five facets are as follows: *observing* (to notice or attend to internal and external experiences such as sensations, thoughts, or emotions), *describing* (to label internal experiences with words), *acting with awareness* (to focus on one's activities at a given moment as opposed to behaving mechanically), *non-judging of inner experience* (to take a non-evaluative stance toward thoughts and feelings), and *non-reactivity to inner experience* (to allow thoughts and feelings to come and go, without getting caught up in or carried away by them). Cronbach's alpha was .74 for the present sample.

Data Analyses

The statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) for Windows, version 20. First, descriptive statistics were calculated to analyze the characteristics of the meditator sample (length of meditation sessions, frequency of practice, and average years of practice). Subsequently, several statistical procedures were performed to assess differences between meditators and non-meditators on proprioceptive drift and embodiment scores (sense of ownership, location, and agency). An independent-samples *t* test was performed to verify that there were no significant differences in the average age of the two groups. A chi-square test was also performed to analyze differences between the groups in sex proportions. Next, to check for differences between the two groups in proprioceptive drift, an independent-samples *t* test was conducted. A multivariate analysis of variance (MANOVA) was performed to test the difference between the groups across the three components of embodiment (sense of ownership, location, and agency). Components of embodiment were analyzed separately because some studies show that the sense of ownership and agency can be dissociated, representing different cognitive processes (Kalckert and Ehrsson 2012). Subsequently, bivariate analyses with Pearson's correlations were performed to analyze the relationships between proprioceptive drift and the embodiment component scores and the other measures related to body awareness (MAIA) and dispositional mindfulness (FFMQ). Finally, dimensions of body awareness (MAIA) and dispositional mindfulness (FFMQ) were used in a stepwise multiple regression analysis to predict the performance on the RHI (proprioceptive drift, sense of ownership, sense of location, and sense of agency).

Results

Regarding the frequency of the meditation practice in terms of days per week, 60 % practiced "daily," 26.7 % practiced "3–4 times a week," and 13.3 % practiced "once a week." Moreover, the average time they had been practicing was $M = 9.0$ years (SD = 5.86). Finally, the average length of their meditation sessions was $M = 36.4$ min per session (SD = 26.10).

Differences in Age and Sex

An independent-samples *t* test showed that there were no significant differences between meditators ($M = 40.60$, SD =

9.16) and non-meditators ($M = 35.53$, SD = 13.26) in age ($t(24.88) = 1.22$, $p = .235$, $d = 0.44$). Regarding sex differences, a chi-square test revealed that the proportion of women in meditators was 33.3 %, whereas the proportion of women in non-meditators was 66.7 %, but the difference was not significant ($X^2(1, N = 30) = 3.33$, $p = .068$). The descriptive statistics of age and sex in each group are shown in Table 1.

Effect of the RHI: Proprioceptive Drift and Embodiment

An independent-samples t test showed that scores on proprioceptive drift were marginally lower for the meditators ($M = 0.15$, SD = 0.82) than those for the non-meditators ($M = 1.27$, SD = 2.20) ($t(28) = -1.86$, $p = .074$, $d = -0.67$).

Moreover, a MANOVA revealed that, using Pillai's trace, there was a significant effect of group on the three components of embodiment ($V = 0.36$, $F(3,26) = 4.92$, $p = .008$, $\eta^2_p = .36$). According to Cohen's (1988) indications, the effect size was large ($\eta^2_p > .14$). However, separate univariate ANOVAs of the three components of embodiment only revealed significant group effects on the sense of agency in the rubber hand ($F(1,28) = 8.26$, $p = .008$, $\eta^2_p = .23$), with a large effect size ($\eta^2_p > .14$). Scores on the sense of agency in the rubber hand were lower for the meditators ($M = -1.07$, SD = 1.51) than those for the non-meditators ($M = 0.57$, SD = 1.60). By contrast, there were no significant differences between the meditators ($M = 0.57$, SD = 1.42) and non-meditators ($M = 0.68$, SD = 1.55) on the sense of ownership of the rubber hand ($F(1,28) = 0.04$, $p = .846$, $\eta^2_p = .00$) or between meditators ($M = 1.02$, SD = 1.18) and non-meditators ($M = 0.82$, SD = 1.43) on the sense of location of the rubber hand ($F(1,28) = 0.18$, $p = .679$, $\eta^2_p = .01$). The results are shown in Table 1 and Fig. 1.

Relationships Between Embodiment, Body Awareness, and Dispositional Mindfulness

The descriptive statistics of body awareness and dispositional mindfulness in each group are shown in Table 1. Pearson's

Table 1 Descriptive statistics of age, sex, body awareness (MAIA), dispositional mindfulness (FFMQ), proprioceptive drift, and embodiment self-report measures with the rubber hand in each group

	Meditators	Non-meditators
Sex (% of women)	33.3	66.7
Age	40.60 (9.16)[a]	35.53 (13.26)
MAIA		
Noticing	4.39 (0.38)	3.67 (0.86)
Not-distracting	3.21 (0.79)	2.78 (0.94)
Not-worrying	3.27 (0.84)	3.06 (0.71)
Attention regulation	4.25 (0.56)	2.83 (1.18)
Emotional awareness	4.58 (0.38)	3.17 (0.81)
Self-regulation	4.16 (0.38)	2.83 (1.23)
Body listening	4.12 (0.48)	2.28 (1.20)
Trusting	4.33 (0.49)	2.92 (1.12)
FFMQ		
Observing	13.07 (2.02)	9.58 (3.87)
Describing	12.40 (2.32)	12.00 (1.86)
Acting with awareness	10.27 (3.10)	10.33 (3.98)
Non-judging of inner experience	12.80 (2.78)	10.17 (2.52)
Non-reactivity to inner experience	11.20 (2.51)	9.17 (2.86)
Proprioceptive drift		
Pre-rubber hand illusion	1.14 (2.14)	−0.31 (2.03)
Post-rubber hand illusion	1.29 (2.11)	0.97 (3.37)
Change in proprioceptive drift (post-pre)	0.15 (0.82)	1.27 (2.20)
Embodiment self-report measures		
Location	1.02 (1.18)	0.82 (1.43)
Ownership	0.57 (1.42)	0.68 (1.55)
Agency	−1.07 (1.51)	0.57 (1.60)

MAIA Multidimensional Assessment of Interoceptive Awareness, *FFMQ* Five Facet Mindfulness Questionnaire-Short Version

[a] Mean and standard deviation (in parenthesis) are reported for each variable

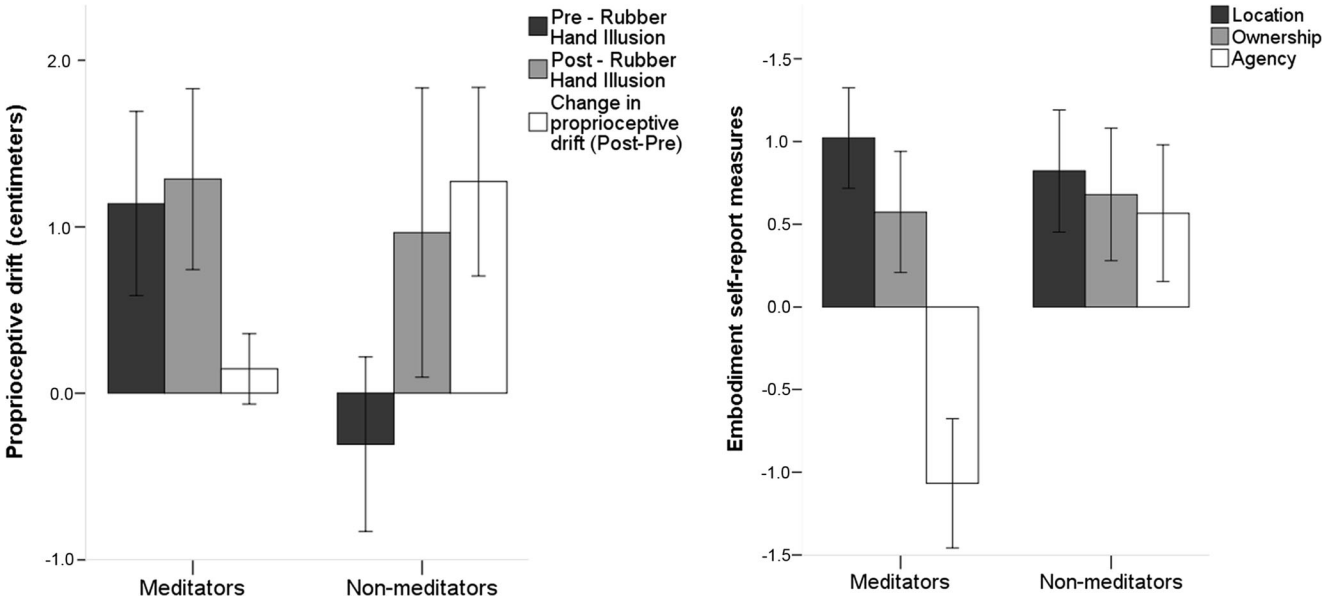

Fig. 1 Mean and standard error of proprioceptive drift and embodiment self-report measures with the rubber hand in each group. *Error bars* represent the mean ± 1 standard error

correlations showed a negatively significant relationship between sense of ownership during the RHI and "acting with awareness" from the FFMQ questionnaire ($r = -.40$, $p = .04$). Moreover, the sense of agency in the rubber hand was negatively associated with the mindfulness total score on the FFMQ questionnaire ($r = -.48$, $p = .01$) and almost all the dimensions of body awareness on the MAIA questionnaire: "noticing" ($r = -.53$, $p = .01$), "attention regulation" ($r = -.65$, $p < .001$), "emotional awareness" ($r = -.62$, $p = .002$), "self-regulation" ($r = -.56$, $p = .005$), "body listening" ($r = -.63$, $p < .001$), and "trusting" ($r = -.65$, $p < .001$) (see Table 2).

Finally, the dimensions of body awareness (MAIA) and dispositional mindfulness (FFMQ) were entered simultaneously in the same step of four separated stepwise multiple regression analyses to determine their capacity to predict embodiment measures with the rubber hand (proprioceptive drift, sense of ownership, sense of location, and sense of agency). However, only one model was statistically significant in predicting the sense of agency in the rubber hand ($F(1,21) = 15.14$, $p < .001$) and accounted for 39.1 % of the variance ($R^2 = .42$; adjusted $R^2 = .39$). Sense of agency in the rubber hand was predicted by lower levels of "trusting" on the MAIA questionnaire ($\beta = -.65$, $t = -3.89$, $p < .001$).

Discussion

The objectives of this study were, first, to analyze embodiment processes through the RHI paradigm in a sample of meditators and, second, to explore the relationships between these embodiment processes and body awareness and dispositional mindfulness.

Results showed that people who practice meditation reported significantly less agency over the rubber hand. However, only a trend was found for differences between meditators and non-meditators on proprioceptive drift. No differences were found on sense of location, and ownership with the rubber hand. Moreover, a lower sense of agency with the rubber hand was associated with higher scores on mindfulness and body awareness. Finally, experiencing one's body as safe and trustworthy significantly predicts a lower sense of agency with the rubber hand. Therefore, both hypotheses in this study were partially supported.

Regarding the first hypothesis, the meditators' low experience of agency in the rubber hand coincides with the results found by Naranjo and Schmidt (2012) or Teper and Inzlicht (2013), where mindfulness training was associated with higher motor control during perceptual motor conflict tasks. According to Farb et al. (2015), this increase in motor control could reflect an increase in the sense of agency of one's own body, which might have an impact on self-representations related to one's ability to control the environment and, therefore, on well-being.

Regarding the proprioceptive drift, meditators obtained marginally significant lower scores than non-meditators. The effect size of the difference between groups was medium-large, but a larger sample may be needed in order for differences of this size to be significant. However, it is necessary to be cautious about the data on proprioceptive drift because this measure is controversial. Some authors suggest that it cannot be a suitable objective indicator of the RHI (e.g., Holmes et al. 2006), while others have found it to be correlated with the sense of ownership of the rubber hand (Tsakiris and Haggard 2005), and even

Table 2 Pearson's correlations between embodiment measures with the rubber hand (proprioceptive drift and embodiment self-report measures), body awareness (MAIA), and dispositional mindfulness (FFMQ)

	Proprioceptive drift	Ownership	Location	Agency
Proprioceptive drift				
Ownership	.46			
Location	.13	.67**		
Agency	.06	.58**	.47**	
Observing (FFMQ)	−.26	−.04	.03	−.20
Describing (FFMQ)	−.06	−.10	.14	−.21
Acting with awareness (FFMQ)	.23	−.40*	−.23	−.35
Non-judging (FFMQ)	.10	.15	.17	−.30
Non-reactivity (FFMQ)	−.17	−.18	−.19	−.32
Total FFMQ	−.05	−.21	−.05	−.48*
Noticing (MAIA)	−.01	−.17	−.09	−.53*
Not-distracting (MAIA)	−.11	.28	.37	.02
Not-worrying (MAIA)	−.09	−.04	.07	−.23
Attention regulation (MAIA)	.24	−.18	−.09	−.65**
Emotional awareness (MAIA)	−.10	−.13	−.07	−.62*
Self-regulation (MAIA)	.18	−.16	−.14	−.56*
Body listening (MAIA)	−.06	−.13	−.12	−.63**
Trusting (MAIA)	.05	−.23	−.06	−.65**

FFMQ Five Facet Mindfulness Questionnaire-Short Version, *MAIA* Multidimensional Assessment of Interoceptive Awareness

*$p < .05$; **$p < .01$

others, such as Rohde et al. (2011), suggest that different multisensory integration mechanisms are responsible for proprioceptive drift and the feeling of ownership.

This study provides partial evidence that a greater resistance to experiencing the RHI is associated with greater body awareness and higher dispositional mindfulness. Thus, a high score on the facet *acting with awareness* from the mindfulness questionnaire was associated with experiencing less sense of ownership of the rubber hand. This facet of mindfulness is related to focusing on one's activities at a given moment and not behaving mechanically. In this sense, Kerr et al. (2013) observed that after body scan training (observation of the whole body), participants learned not only to become aware of bodily sensations but also to increase attention regulation. This mechanism reflects an improvement in top-down modulation, enhancing sensory information processing in the brain. Thus, it is hypothesized that this increased attention to what happens in the body generates a lower self-attribution of a foreign limb to one's own body, that is, less sense of ownership of the rubber hand.

Moreover, the negative relationship between the total score on mindfulness was associated with the sense of agency in the rubber hand, so that people with greater mindfulness experienced less sense of agency in the rubber hand. This result is in line with the studies discussed above by Naranjo and Schmidt (2012) or Teper and Inzlicht (2013).

In addition, other significant negative associations were found between the sense of agency in the rubber hand and the majority of the body awareness dimensions, such as the awareness of uncomfortable, comfortable, and neutral body sensations (noticing); the ability to sustain and control attention to body sensations (attention regulation); the awareness of the connection between body sensations and emotional states (emotional awareness); the ability to regulate distress through attention to body sensations (self-regulation); active listening to the body for insight (body listening); and the experience of one's body as safe and trustworthy (trusting). These results agree with those found by Tsakiris et al. (2011), who observed a negative relationship between interoceptive body awareness and the experience of the illusion.

Moreover, the "trusting" dimension was the only variable that significantly predicted the low sense of agency in the rubber hand. This result coincides with results found by Keizer et al. (2014), where patients with eating disorders that implied dissatisfaction with their bodies had a higher susceptibility to experiencing bodily illusions than healthy females. The significantly negatively association between mindfulness trait and body awareness and agency in the rubber hand could provide a rationale for therapies involving mindfulness to preserve the embodiment processes and body perception, which may have special clinical relevance for the treatment of some

psychopathological disorders that have shown alterations of these processes (e.g., Keizer et al. 2014; Thakkar et al. 2011).

Limitations of the current study should be noted. The most important one is lack of an asynchronous condition. This study only included a synchronous condition, where the rubber hand is stroked in synchrony with the individual's own hidden hand. In this condition, the person feels that both inputs (visual and tactile) come from the same event (Eshkevari et al. 2012). However, in the asynchronous condition, tactile stimulation does not coincide in time and space with visual information. Studies comparing the two conditions show that people in the synchronous condition experience a greater illusion than those in the asynchronous condition (e.g., Dummer et al. 2009). Nevertheless, some populations that experience the RHI in the asynchronous condition, such as individuals with eating disorders, are hypothesized to have a dominance of visual information over proprioceptive information (Eshkevari et al. 2012). By contrast, as mentioned above, the practice of mindfulness has been associated with an increase in the sensitivity to perceiving bodily sensations (Mirams et al. 2013). Therefore, it would be interesting to analyze possible differences between meditators and non-meditators in the asynchronous condition to determine whether there is a dominance of proprioceptive information over visual information, with meditators experiencing significantly less RHI than non-meditators in the asynchronous condition.

Other relevant limitations are related to the absence of physiological measurements (e.g., skin temperature), which have been shown to be related to the experience of the illusion (Moseley et al. 2008). Furthermore, as regards the sample size, the large variance in the values for proprioceptive drift and embodiment indicates the need for a large sample size in order to show differences in these measures between groups. Moreover, in order to provide more robust evidence about the relationship between embodiment, body awareness, and mindfulness, it would be interesting to analyze whether a mindfulness-based intervention in a clinical sample with low body awareness (e.g., people with eating disorders) would reduce the vulnerability to experience the RHI and maintain the embodiment processes unaltered.

In conclusion, this is the first study to examine the embodiment processes, body awareness, and mindfulness in long-term meditators through the RHI experimental paradigm. The hypotheses of this study are partially supported, as meditators reported a lower sense of agency in the rubber hand than non-meditators, and this lower sense of agency was related to higher scores on body awareness and dispositional mindfulness. These results highlight the role of body awareness and mindfulness in the cognitive processes of embodiment, that is, the cognitive processes that make us feel that we own a physical body and have control over it.

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Compliance with Ethical Standards All procedures performed in the current study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare that they have no conflict of interest.

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