The Temporal Aspect of Bodily Experiences of Emotions: Where do You Feel The First Sensation?

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Abstract

Recently, body maps have increasingly been used to identify patterns in respect of the location of the physical sensations elicited by emotions. However, in addition to understanding how emotions are topographically manifest in the body, it is important to add a temporal aspect to deepen the interoceptive study of emotions. Therefore, the present study sought to explore the first perceived sensation. The study sample comprised a group of mindfulness practitioners (n=34) and a group of non-practitioners (n=64) to analyze if there was any difference in their perceptions of emotion. Participants were instructed to evoke five basic emotions (fear, disgust, anger, sadness, joy), and as soon as they became aware of where they felt the emotions start to emerge, were instructed to interrupt the observation and to indicate the region in a diagram of a human figure. Overall, the groups did not differ in the body regions identified for each emotion. Cochran's Q-test showed that the main regions mentioned were the head and the chest. In the case of disgust, the neck, rather than the chest, along with the lower part of the head were the most cited. The most cited regions corresponded to those identified in other studies of body topography as perceived with the greatest increase in activity in response to emotional stimuli. Regarding interoceptive awareness, the independent t-test verified that the mindfulness group scored significantly higher in all subscales of the Brazilian Portuguese version of the 37-item Multidimensional Assessment of Interoceptive Awareness questionnaire compared to the non-mindfulness group.

Keywords: emotions, feelings, bodily maps of emotions, mindfulness, interoception.

Introduction

Although there is still no consensus about the definition of emotion, in general terms, there is agreement among researchers that it is a process that involves cognitive, physiological, neural, expressive, and behavioral components (Paul et al., 2020). There are a number of different theories in respect of how each component is understood, how they are articulated and on which more emphasis should be given. These theories propose ways in which emotions should be classified and define how they are different from other bodily and mental processes. Different theoretical approaches propose different strategies to deal with them, as well as the types of procedures to use in scientific research, and even how their results should be interpreted.

Some authors have observed specific patterns in some of these components that could distinguish one emotion from others. For instance, facial expressions in Ekman (2004) and neural circuits and behaviors in Panksepp & Watt (2011). Others point out that some of these components, on the contrary, are undifferentiated among emotions [e.g., the activation of the autonomic nervous system (ANS) for Cannon (1929)]. There are also those, such as Barrett (2017), who think that there are a variety of possibilities by which emotions can change each of the components in different individuals or in the same individual in different contexts. Therefore, there would not be specific patterns that characterize an emotion as a natural kind. (Barrett, 2006). In other words, For Ekman (2004) and Panksepp & Watt (2011), the distinction among emotions would be due to the specific patterns of activation and manifestation of discrete emotions, while for Cannon (1929) and Barrett (2017), the differentiation would occur according to other components, such as context, culture and language.

An important approach in respect of emotions dates back to the work of William James (1884) and his peripheral feedback theories that point to the fundamental role of the body in emotional experience. According to these theories, it is impossible to disassociate an emotion from its bodily reactions, as, from this perspective, body reactions serve as the basis for emotional feelings (Damasio, 1994; Craig, 2002). That is to say feelings are

necessarily constituted, or at least undergo some modulation (their intensity is increased) by sensations that emerge as a consequence of changes in body states associated with the cardiovascular, respiratory, musculoskeletal, endocrine, exocrine, and gastrointestinal systems (Damasio & Carvalho, 2013; Kreibig, 2010; Levenson, 2003). These bodily changes are elicited by emotionally competent stimuli (Damasio, 1994), which are thus generally automatically appraised. There is also a notion that these changes can only be simulated in the brain, not actually physically expressed; even so, the body is seen as the main theater of emotions (Damasio, 1994).

According to these theories, from an evolutionary and functional point of view, changes that occur in the body related to emotions mainly fulfill the function of preparing the organism to deal with the challenges of the environment (Damasio & Carvalho, 2013; Levenson, 2003) by redirecting the physiological resources that underlie the behaviors that confer survival advantages (Levenson, 2003). According to the somatic marker hypothesis, the interoceptive information obtained by feedback from somatic responses that translate into feelings is, in turn, used to guide decision making (Damasio & Carvalho, 2013; Bechara et al., 2005; Damasio, 1996).

Some scholars claim that for the human body to respond satisfactorily to these challenges and for specific feelings to be elicited, each emotion must have a unique pattern of physiological activation (Ekman, 2004; Levenson, 2003). There are still those who claim that there is a small group of basic emotions that are innate and universal and are also present in species other than humans (Ekman, 2004; Izard, 1992). Thus, a lot of research in the field of emotions has aimed to find these patterns that characterize specific emotions and differentiate one from the others, both in regard of physiological responses and other components, such as expressive and behavioral factors.

Interoception

Interoception, a term coined over 100 years ago, is defined as the perception of the physiological conditions of the body, that is, the ability to perceive the internal sensations

that arise from the functioning of the internal organs (Craig, 2002). The importance of interoception for the individual is that, by providing information of internal signals, it helps to maintain homeostasis, and motivates behaviors that aim to preserve survival (Craig, 2002).

There is currently a growing interest in research on interoception, mainly due to its relationship with emotions and emotion regulation (Chen et al. 2021; Lischke et al., 2020). Studies have shown that individuals with greater interoceptive accuracy (ability to detect their internal signals more accurately) experience emotions more intensely and are able to regulate them more efficiently (Kever et al., 2015; Weiss et al., 2014; Füstös et al., 2013; Critchley et al., 2004; Craig, 2003). In addition, they can provide more accurate accounts of the body topography of their emotional states (Jung et al., 2017).

Bodily Maps of Emotions

In order to verify whether there really were patterns of discernible bodily sensations for each of the basic emotions and for some complex ones, Nummenmaa et al. (2014), carried out some experiments in which emotions were elicited in participants through emotional words, stories, pictures of facial expressions, or videos. The subjects were instructed to notice the sensations in their own bodies and then color in silhouettes of human figures to identify the regions of the body where they felt an increase in activity and those where they felt a decrease in activity. The results obtained by this study showed that it is possible to distinguish topographic patterns of the body for each of the emotions tested cross-culturally, regardless of the type of stimulus presented.

Subsequent studies have used the same method as Nummenmaa et al. (2014) (emBODY), to observe, for example, how emotions were perceived throughout childhood in different age groups (Hietanen et al., 2016); and in patients with schizophrenia (Torregrossa et al., 2019). Volynets et al. (2019) confirmed the findings of Nummenmaa et al. (2014), observing the universality of the emotional experience felt in the body regardless of differences between genders and cultures, with a weakening of this perception with aging. Nummenmaa et al. (2018) replicated their results in a study that covered sensations other

than emotions, namely cognitive processes, somatic states, and disease and homeostatic states. Novembre et al. (2019) used the same method to create body maps showing emotions experienced during social interactions. Jung et al. (2017) used a similar technique and covariates body maps with interoceptive accuracy. In other words, they evaluate whether interoceptive accuracy was associated with changes in topographical body maps following emotion-induced bodily sensations. The authors of these studies argue that these subjective maps of emotional feelings may correspond to the specific related physiological changes.

All these studies that used body maps of emotions were interested in locating the body regions perceived by individuals as being associated with different emotions in order to observe the topography of each one of them. In these studies, there were no limitations in respect of time restrictions, thus, the participants were able to explore their bodily sensations more closely, noting where they felt an increase or decrease activity. In the present study, the goal is to further explore bodily sensations related to emotions, adding a temporal aspect to the bodily experience of emotion, focusing on the first sensation perceived at the moment the emotion emerges as soon as it is evoked. The objective is to understand how emotions unfold temporally, in this case, their beginning, that is, what is first perceived in the transition from one state to another, in order to distinguish what is an initial and more internal experience of emotion, before it takes over the body through expressive manifestations and even automatic attempts at self-regulation. The importance of this investigation is that by better understanding how emotions start, it is possible to think of new strategies for emotional regulation. This is an important skill for psychological health for managing the experience and expression of emotion (Gross, 2002) in respect of starting an emotional episode, avoiding its appearance, inhibiting its manifestation, maintaining its experience or even modulating its duration and intensity (attenuating or accentuating) (Eisenberg & Spinrad, 2004). However, the difficulty is that emotions emerge quickly, in a cascade of reactions that unfold in a few seconds and have a short duration, which can make the task more difficult.

Mindfulness

In order to understand this interoceptive aspect and capture this first moment, mindfulness practitioners were recruited for this research in order to evaluate whether they would provide a different perspective than that given by non-practitioners, as they are trained in the ability to be deliberately aware of their experiences in an open and non-judgmental way in respect of sensations, thoughts and emotions, moment by moment, as they unfold (Kabat-Zinn, 2011). Previous studies show that this ability seems to promote greater interoceptive development and awareness of previously ignored aspects of experience (Farb et al., 2014). Precisely because of these acquired skills, there has been a great interest in using the mindfulness technique in research involving interoception (Fischer, Messner & Pollatos, 2017). For example, some studies have observed that brain areas linked to interoception undergo changes resulting from the practice of mindfulness, promoting an increase in awareness of the body's internal states (Farb Segal & Anderson, 2013; Ives-Deliperi, Solms & Meintjes, 2011). There are also studies that have observed improved interoceptive abilities and recognition of emotions in practitioners of meditation such as mindfulness, particularly in techniques such as Body Scan (Fischer et al., 2017; Dreeben, Marnberg & Salmon, 2013; Fox et al., 2012; Dunn et al., 2010, Wiens, Mezzacappa & Katkin, 2010; Ditto Eclache & Goldman, 2006), thus suggesting that they could provide more accurate interoceptive reporting.

Francisco Varela (1996), in his article 'Neurophenomenology: a methodological remedy for the hard problem', recognized the mindfulness technique as a phenomenological research tool par excellence, in the sense that it produces what the philosopher and mathematician Edmund Husserl (1859-1838) intended to achieve with his concept of phenomenological reduction, in which the phenomenon (what appears, what is shown to consciousness) could be apprehended in itself, when the individual suspends (puts in parentheses) their beliefs, judgments and assumptions about it. Thus, Varela (1996) proposed an investigation method inspired by phenomenology and Eastern contemplative traditions, which he called neurophenomenology. The proposal was to build a bridge

between subjective experience (*qualia*) and objective data (physiological and behavioral measures), that is to say, between first-person reports and third-person data.

Mindfulness practice training usually takes place with the practitioner seated and physically static, which helps to reduce body and expressive movements, and facilitates the redirection of attention to the body. In the current study, the participants were asked to remain immobile when evoking the emotion so that the temporal aspect of the emotion could be observed without its expression being influenced by any physical movement.

Materials and Methods

This study is a cross-sectional observational study carried out entirely online. It was approved by the Research Ethics Committee of the Universidade Federal de Sao Paulo - project grant (no. 0211/2021).

Participants

The sample consisted of a total of 103 individuals (84 women), with a mean age of 41.92 years ($SD = 11.19$) (minimum age was 19 years and maximum 67 years) who were allocated into two groups: a group of mindfulness practitioners with 39 participants and a group of non-practitioners with 64 participants. Volunteers were initially recruited online through social networks (WhatsApp, Facebook and Twitter) and by e-mail and were asked to share the invitation to the survey and the link to the form with their groups, friends and family.

Group of Mindfulness Practitioners

Mindfulness practitioners were defined as individuals who reported practicing mindfulness regularly and had taken an 8-week mindfulness training program. Also included in this group were those who maintained a practice routine based on meditation techniques such as Focused Attention (on breathing or other bodily sensations), Open Monitoring (as defined by Lutz et al., 2008), and Body Scan, even if they had not completed the mindfulness course. Those who reported having taken the 8-Week Mindfulness Program but

did not practice any of these techniques were excluded (1 excluded for this reason). Those who said they practiced mindfulness but did not take the 8-week training program or practice any of these techniques were also excluded (4 excluded for this reason).

The total sample consisted of 98 participants (80 women) with a mean age of 41.62 years ($SD = 11.19$), and comprised the mindfulness practitioners group ($N=34$) - 30 women, mean age 45.35 years ($SD = 9.33$); and the non-practitioners group ($N=64$) - 50 women; mean age 39.64 years old ($SD = 11.50$).

Sociodemographic Questionnaire

A sociodemographic questionnaire containing 12 questions was designed to obtain data on age, gender, education, etc.

Multidimensional Assessment of Interoceptive Awareness (MAIA) - 37 items

To assess interoceptive awareness, the open-access Multidimensional Assessment of Interoceptive Awareness (MAIA) questionnaire (Mehling et al., 2012) was used, which is organized in eight subscales (facets): 1) Noticing; 2) Not-Distracting; 3) Not-Worrying; 4) Attention Regulation; 5) Emotional Awareness; 6) Self-Regulation; 7) Body Listening and; 8) Trusting. To use it in this study, the 37-item MAIA Questionnaire was translated into Brazilian Portuguese. The MAIA questionnaire is available on its official website (www.osher.ucsf.edu/maia/). On the website, there is a Brazilian version of the questionnaire based on a systematic forward-backward translation to Brazilian Portuguese. However, in a pilot study with 8 volunteers ambiguities were found in some of the 32 questions. Therefore, using this translation, the original (English) version, and a validated translation into Portuguese from Portugal as a base, a third translation version was created. This translation was sent to five evaluators who judged it based on two criteria: 1) whether it included the original meaning and; 2) whether the questions were formulated in a clear, understandable way. The evaluators could give translation suggestions if they felt that any of these criteria was not being met. After these evaluations, a reformulated Brazilian Portuguese version of the MAIA was produced and used in this study.

Routine Mindfulness Practice Questionnaire

An 11-item questionnaire was designed for mindfulness practitioners to report their practice routine. Questions referred to participation in a program of 8 Weeks or more; to the length of time they had been practicing (how many years, how many times a week, how many times a day, how many minutes per session); whether, in addition to formal practice sessions, they also undertook any informal practice (i.e., take a moment to stop and use mindfulness at other times of the day or bring the mindset of attention cultivated in practice to daily tasks); the type of practice, such as (i) Focused attention on breathing, some bodily sensation, or some external object (e.g., visual or auditory), (ii) Open Monitoring (remain open to any perception, sensation, feeling or thought that arises), (iii) Body Scan (scan the body's current state), (iv) Compassion Meditation, or (v) other); the quality of practice (on the ability to sustain attention and return to the focal object); and finally, whether the participant had been practicing regularly (at least, on average, 3 times a week) in the last month.

Humanoid Figure

A diagram of a humanoid figure divided into 12 numbered body regions (Figure 1) was shown to the participants so that, after evoking and identifying their first body sensations arising from each emotion, they could indicate the corresponding region on the figure. The regions were divided based on the maps generated in the study of Nummenmaa et al. (2014) and subsequent studies (Torregrossa et al., 2019; Volynets et al., 2019; Hietanen et al., 2016). Thus, the trapeziuses, arms, forearms, hands, and legs on each side had the same number, as these studies showed a symmetry of sensations. The head and abdomen were divided into two parts each (upper and lower). The chest and pelvis were not divided into sub-regions, as each was considered a single region. The regions were numbered as follows: 1- Head (upper), 2- Head (lower), 3- Neck, 4- Chest, 5- Abdomen (upper), 6- Abdomen (lower), 7- Pelvis, 8- Trapezius, 9- Arms, 10- Forearms, 11-Hands, 12- Legs (Figure 1).

Figure 1

In Google Forms the options to be checked were presented below the image. *None

The survey was carried out completely online through a form created using the Google Forms tool. This form was available for 40 days (from May 31, 2021 to July 9, 2021). In the first section, the volunteer was presented with the Informed Consent Form (ICF) and was asked to agree to participate in the study. Upon confirming their agreement, in the next section, the participant first typed in their e-mail address so that they could be sent a copy of the ICF and their responses to the form (as requested by the Ethics Committee) and in the same section they completed the demographic questionnaire (gender, age, education, etc.).

In section 3, they completed the MAIA, and in section 4 provided details about their mindfulness practice routine (in both the consent form and in the description of the questionnaire it was clearly stated that this section should be completed only by mindfulness practitioners, and that if they were not a practitioner, to skip it, going directly to the task section).

Task

The task was presented in the following section; First, the participants were asked to read the guidelines for carrying it out. Below are the guidelines and the five steps that were presented to the participants (translated from Portuguese):

“Carefully read the directions to the end before starting the task. Below the guidelines, you will see a human figure, and the name of one of the following five emotions will appear: fear, disgust, anger, sadness, and joy.

Guidelines for performing the task:

1) Sit comfortably on a chair with your spine erect. Read the name of the emotion that appears; Then, with your eyes open or closed, rest them comfortably on some spot in front of you where there are not too many stimuli (preferably a neutral wall), and remain still; 2) Then take a moment to notice the current state of your body; 3) Try to evoke the requested emotion (suggestion: think of some situation or someone you know that provokes the emotion in you); 4) Be aware of the location of the 'first bodily sensation' you experience when you feel the emotion arising; 5) immediately after feeling the 'first bodily sensation', look at the human figure and indicate the area corresponding to the region of the body where you felt the sensation).

Attention: Indicate only the region corresponding to the 'first bodily sensation' perceived. If you experience sensations in more than one region – exactly at the same time - checking the options that contain the numbers corresponding to those regions. If no sensations is noticed, check the option 'None'."

Statistical Analysis

An independent t-test was used to compare the groups for MAIA scores. Effect size was verified using Cohen's d for homogeneous subscales and Glass's delta for non-homogeneous ones. To compare the groups regarding the most mentioned areas in each emotion, the chi-square with Yates correction was used. To compare the proportions of regions within each emotion, Cochran's Q test was used for pairwise comparisons. For each emotion the chance corrected effect size for Cochran's Q test was analyzed.

Results

Routine of Mindfulness Practice - A Descriptive Analysis

Of the 34 participants in the mindfulness group, six reported not having been through an 8-Week Training Program; nine had practiced for at least one year, four for two years, seven from three to four years, 11 from five to ten years, and three for more than ten years. The average number of days per week they practiced was 5.09 (SD=2.05). The average number of times they practice per day was 1.44 (SD = .82). In terms of the duration of one practice session, two participants practiced for five min; 12 practiced 10 to 15 min; 15 practiced 20 to 30 min; five practiced 40 to 50 min; none practiced one hour or more per session. Twenty-eight participants in this group practiced regularly in the previous month. Thirty-two reported that besides the formal practice (sitting to meditate) they also performed informal practice. In respect of the quality of the practice: two said they had difficulty sustaining and returning their attention to the object they chose as focus; fifteen said they had difficulty sustaining their attention on the object they chose as focus, but could return to it easily; and 17 said they could sustain their attention for a long time on the object they chose as focus. In respect of the types of practice (n): Focused on Breathing (32), Focused on Other Body Sensations (21), Focused on External Objects (19), Open Monitoring (19), Body Scan (21), Compassion (21), and other (12). Regarding the quantity of types of practice: two participants practiced only one type of practice, two practiced two types, 11 practiced three types, five practiced four, four practiced five, four practiced six and six practiced seven. But 12 practiced more types, as they also selected 'other'.

Multidimensional Assessment of Interoceptive Awareness (MAIA) 37-items

The independent t-test showed that mindfulness practitioners scored significantly higher compared to non-practicing participants in the total MAIA Questionnaire: ($t(96) = 7.552$; $p < .05$), with a very large Cohen's $d = 1.60$ and on all of its eight facets: 1) Noticing: ($t(96) = 3.657$; $p < .05$), with a mean Cohen's $d = .78$; 2) Not-Distracting: ($t(96) = 4.133$; $p < .05$), with a large Cohen's $d = .88$; 3) Not-Worrying: ($t(96) = 3.702$; $p < .05$), with a mean Cohen's $d = .79$; 4) Attention Regulation: ($t(94,700) = 7.869$; $p < .05$), with a very large Glass (1) $\delta = 1.27$ and a very large Glass (2) $\delta = -2.14$; 5) Emotional Awareness:

($t(94,871) = 3.698$; $p < .05$), with a medium Glass (1) delta = .59 and a large Glass (2) delta = -1.01; 6) Self-Regulation: ($t(96) = 5.893$; $p < .05$), with a very large Cohen's $d = 1.25$; 7) Body Listening: ($t(89,263) = 3.973$; $p < .05$), with a mean Glass (1) delta = .68 and a large Glass (2) delta = -.99 ; 8) Trusting: ($t(96,000) = 3.549$; $p < .05$), with a mean Glass (1) delta = .55 and a large Glass (2) delta = -1.04 (see Table1).

Tabela 1. MAIA - Multidimensional Assessment of Interoceptive Awareness (37 items)

Sub-scales	Groups	N	Average	Standard Deviation	Mean Standard Error	95% Confidence Interval
Noticing	Control	64	14.64	3.335	.417	13.81-15.47
	Mindfulness	34	17.03	2.516	.432	16.15-17.91
Not-Distracting	Control	64	11.88	6.341	.793	10.29-13.46
	Mindfulness	34	17.50	6.547	1.123	15.22-19.78
Not-Worrying	Control	64	11.03	4.684	.585	9.86-12.20
	Mindfulness	34	14.65	4.444	.762	13.10-16.20
Attention Regulation	Control	64	16.50	8.018	1.002	14.50-18.50
	Mindfulness	34	26.68	4.766	.817	25.01-28.34
Emotional Awareness	Control	64	18.89	4.834	.604	17.68-20.10
	Mindfulness	34	21.76	2.850	.489	20.77-22.76
Self-Regulation	Control	64	10.78	4.456	.557	9.67-11.89
	Mindfulness	34	15.91	3.325	.570	14.75-17.07
Body Listening	Control	64	8.61	4.135	.517	7.58-9.64
	Mindfulness	34	11.44	2.862	.491	10.44-12.44
Trusting	Control	64	10.67	3.712	.464	9.74-11.60
	Mindfulness	34	12.71	1.962	.337	12.02-13.39
Total	Control	64	103.00	23.367	2.921	97.16-108.84
	Mindfulness	34	137.68	17.875	3.065	131.44-143.91

Comparison between the groups regarding the regions cited by emotions

The Chi-square test with Yates' correction showed that there was no difference between the groups regarding the regions cited in respect of the first perceived sensation. Fear ($p = .5$); Disgust ($p = .5$); Anger ($p = .07$); Sadness ($p = .6$); Joy ($p = .5$).

The most cited body regions for each emotion

Cochran's Q-test was performed to verify whether the frequencies of citations of body regions within each emotion differed statistically from each other, both in the groups

separately and in the total sample. Cochran's Q-test showed that for all analyses there was a statistical difference among the body regions regarding the frequency of citations in each emotion in the Mindfulness, Control, and Total Sample groups. Table 2 below shows the results of the test and the pairwise comparison (Table 2):

Table 2. Most Frequently Cited Regions for each Emotion

Emotions	Groups		
	Total Sample	Mindfulness	Control
Fear	$X^2(12) = 240.147; p < .001$	$X^2(12) = 93.290; p < .001$	$X^2(12) = 152.955; p < .001$
	Region 4 differed significantly from all other regions ($p < .001$). In addition to 4 , region 5 differed significantly only from regions 7 and 10 ($p < .05$). All other regions did not differ.	Region 4 differed significantly from all other regions ($p < .001$). All other regions did not differ.	Region 4 differed significantly from all other regions ($p < .001$). In addition to region 4, region 5 differed significantly only from region 10 ($p < .05$). All other regions did not differ.
Disgust	$X^2(12) = 297.067; p < .001$	$X^2(12) = 114.092; p < .001$	$X^2(12) = 188.633; p < .001$
	Regions 2 and 3 did not differ from each other. Both differed significantly from all other regions ($p < .001$). All other regions did not differ from each other.	Regions 2 and 3 did not differ from each other. Both differed significantly from all other regions ($p < .001$). All other regions did not differ from each other.	Regions 2 and 3 did not differ from each other. Both differed significantly from all other regions ($p < .001$). All other regions did not differ from each other.
Anger	$X^2(12) = 116.174; p < .001$	$X^2(12) = 67.317; p < .001$	$X^2(12) = 80.774; p < .001$
	Regions 1 , 2 , and 4 did not differ. Region 4 differed significantly from all others (3 ($p < .01$); 5 and 8 ($p < .05$) and the others ($p < .001$)). Region 1 also did not differ from regions 5 and 8; and differed significantly from all others (3 ($p < .05$); 6 and 11 ($p < .005$); ($p < .001$) for the others). All other regions did not differ.	Region 4 differed significantly from all other regions (1, 11, 8, 3 and 5 ($p < .005$) and from the others ($p < .001$)). All other regions did not differ.	Regions 1 , 2 , and 4 did not differ. Region 1 differed significantly from all Other regions (5 and 6 ($p < .05$); 3 and 8 ($p < .005$) and the others ($p < .001$)). Region 4 differed significantly from region 12 and 'None' ($p < .05$) and from 7 and 10 ($p < .005$) and did not differ from all others. All other regions did not differ.
Sadness	$X^2(12) = 248.530; p < .001$	$X^2(12) = 84.392; p < .001$	$X^2(12) = 178.616; p < .001$

	Regions 1 and 4 did not differ from each other, and differed significantly from all others ($p < .001$). Region 3 differed significantly, in addition to 1 and 4 ($p < .001$), from 11 and 10 ($p < .05$), and did not differ from the others. All other regions did not differ.	Region 4 did not differ from 1, and differed significantly from all other regions ($p < .001$). Region 1 differed significantly from 10, 11, and 'None' ($p < .05$), and did not differ from all other regions. All other regions did not differ.	Regions 1 and 4 did not differ from each other and differed significantly from all Other regions ($p < .001$). 4 (3 ($p < .005$)). Region 3 differed significantly from 10 and 11, and did not differ from all other regions. All other regions did not differ.
	$X^2(12) = 249.383; p < .001$	$X^2(12) = 99.120; p < .001$	$X^2(12) = 166.746; p < .001$
Joy	Regions 2 and 4 did not differ from each other. Region 4 differed significantly from all other regions (from region 1 ($p < .005$) and ($p < .001$) to all others). Region 2 also did not differ from 1 and differed significantly from all others ($p < .001$). Region 1 also did not differ from 5 and differed significantly from all others (3 and 4 ($p < .005$); 8 and 9 ($p < .01$) and the others ($p < .001$)). All other regions did not differ.	Region 4 did not differ from 2, and differed significantly from all others ($p < .001$). Region 2 differed from 10, 11 ($p < .05$) and 'None' ($p < .001$), and did not differ from all others. All other regions did not differ.	Regions 1, 2, and 4 did not differ from each other. Regions 2 and 4 differed significantly from all other regions ($p < .001$), 2 (5 $p < .005$). Region 1 also did not differ from 5, and differed significantly from all other regions (6 and 9 ($p < .05$), 12 ($p < .01$)). All other regions did not differ.
Cochran's Q score and pairwise comparisons. 1- Head (top), 2- Head (bottom), 3- Neck, 4- Chest, 5- Abdomen (top), 6- Abdomen (bottom), 7- Pelvis, 8- Trapezius, 9- Arms, 10- Forearms, 11-Hands, 12- Legs. The Effect Size for each emotion was obtained by Chance corrected effect size for Cochran's Q test. For the Total Sample: Fear ($R = .76$); Disgust ($R = .51$); Anger ($R = .66$); Sadness ($R = .65$); Joy ($R = .70$). For the Control Group: Fear ($R = .75$); Disgust ($R = .53$); Anger ($R = .64$); Sadness ($R = .64$); Joy ($R = .69$). For the Mindfulness Group: Fear ($R = .76$); Disgust ($R = .44$); Anger ($R = .71$); Sadness ($R = .70$); Joy ($R = .71$).			

Regions by Emotions (as percentages)

Table 3. Regions by Emotions (as percentages) of Total Sample

Emotions	Body Regions % (N=98)												
	Head (upper)	Head (lower)	Neck	Chest	Abdomen (upper)	Abdomen (lower)	Pelvis	Trapeziuses	Arms	Forearms	Hands	Legs	None
Fear	17	5	9	57	18	12	2	12	3	2	4	5	4
Disgust	10	46	47	4	8	12	3	3	2	1	5	3	4
Anger	34	19	15	36	17	12	2	17	8	4	12	5	3
Sadness	44	15	18	51	16	16	5	11	4	1	1	4	3
Happiness	36	46	13	58	21	18	8	15	15	8	8	12	3

Table 4. Regions by Emotions (as percentages) of Mindfulness Practitioners Group

Emotions	Body Regions % (n=34)												
	Head (upper)	Head (lower)	Neck	Chest	Abdomen (upper)	Abdomen (lower)	Pelvis	Trapeziuses	Arms	Forearms	Hands	Legs	None
Fear	15	3	12	59	15	18	3	12	3	6	0	0	3
Disgust	6	44	50	6	6	9	0	0	3	0	0	3	9
Anger	18	12	15	50	15	0	0	18	6	6	18	3	0
Sadness	29	15	9	56	12	18	3	15	6	0	0	6	0
Happiness	29	41	24	71	24	21	12	26	15	9	9	15	0

Table 5. Regions by Emotions (as percentages) of Control Group (non-practitioners)

Emotions	Body Regions % (n=64)												
	Head (upper)	Head (lower)	Neck	Chest	Abdomen (upper)	Abdomen (lower)	Pelvis	Trapeziuses	Arms	Forearms	Hands	Legs	None
Fear	19	6	8	56	20	9	2	13	3	0	6	8	5
Disgust	13	47	45	3	9	14	5	5	2	2	8	3	2
Anger	42	23	16	28	19	19	3	17	9	3	9	6	5
Sadness	52	16	23	48	19	16	6	9	3	2	2	3	5
Happiness	39	48	8	52	20	17	6	9	16	8	8	11	5

Discussion

As in previous studies, in which mindfulness practitioners or individuals with a mindfulness disposition profile scored better in interoception questionnaires in most, or at least in some, subscales (Lefranc et al., 2020; Bornemann et al., 2015; Farb et al., 2015;

Daubenmier et al., 2013; Füstos, 2013), the mindfulness practitioners in the current study scored higher in all the MAIA questionnaire subscales than the control group. They reported been able to redirect their attention, to notice, to trust, and to use body sensations to guide them in their decision-making and showing that overall, the translation of the questionnaire was successful, although its application was mostly limited to individuals with higher education. This suggests that individuals who practice mindfulness have greater interoceptive abilities. Although mindfulness practice trains interoceptive ability, most studies have found no difference in interoceptive accuracy, showing that practitioners of these types of meditative practices did not differ from control groups (non-practitioners or novice practitioners) (Khalsa et al., 2020; Parkin et al, 2014; Daubenmier et al., 2013; Melloni et al., 2013; Nielsen & Kaszniak, 2006). In these studies, interoceptive accuracy was measured by the heartbeat count test or by the perception of respiratory changes. The study by Palascha et al. (2021), however, showed that a brief mindfulness intervention obtained a difference in the time it took individuals to perceive internal changes (they perceive hunger signals faster when compared to the control group, but no difference regarding the perception of satiety). Khalsa et al. (2020) observed that meditators perceived heartbeat sensations in more regions of the body than non-meditators, who identified then preferentially in the left chest region.

Regarding perceived body regions in the current study, overall, except for disgust, the chest region (4) consistently appeared in all evoked basic emotions as one of the areas where the first bodily sensation is perceived as soon as the emotion emerges. This may correspond to the perception of actual changes in heart rate and/or breathing. However, this may also be due to cultural aspects that associate the heart as being the "seat of emotions"; or even because these are the regions where the most intense sensations are noticed, as seen in previous studies, and for this reason, are the easiest to detect and do not really correspond to the first bodily changes. The head regions were also significantly more cited than most other body regions: The upper head region (1) was mainly cited in respect of anger and sadness and the lower head region (2) was preferentially cited in disgust and joy.

In disgust, the other most frequently mentioned region was the neck (3). These two regions, in disgust, correspond to the upper part of the gastrointestinal tract that is linked to this emotion in order to avoid eating spoiled foods. In joy, the lower part of the head is probably related to the smile muscles, a characteristic expression of this emotion. In sadness, previous studies have shown that in the head, there is mainly a sensation of increased activity in the eye region. In anger, a sensation in the upper region of the head may also be related to the muscles of eye expression.

The study also revealed that the regions identified as having the highest frequency in respect of the perception of the first bodily sensation of the emotion, corresponded precisely with those identified in other studies as having a greater increase in activity in respect of all the basic emotions (Torregrossa et al., 2019; Volynets et al., 2019; Hietanen et al., 2016; Nummenmaa et al., 2014). In those previous studies the hands, as much as chest and head, were associated with increased perceived activity in respect to anger. However, in the current study the hands did not stand out as the most frequently cited regions. This could be explained by the fact that sensations in the hands may arise later, as a reaction to the first sensations perceived. In general, it seems that when the observation time is limited to the first immediate sensation, without giving the subject time to do a longer scan over their body or to move, the upper body (with the exception of the arms) is the area associated with the greatest increase in activity.

In the current study, both groups associated body regions with emotions in a very similar way, except in respect of the anger, with the mindfulness group significantly citing the chest region (4) more frequently compared to all other regions, while the top of the head (1) was the most prominent region within the control group.

Finally, it should be noted that while this manuscript was being finalized, an integrative review was published by Davey, Halberstadt & Bell (2021) that emphasizes the importance of observing the first sensation of the emotion in the body in relation to dealing with emotions, as discussed above. The authors also propose a methodology similar to ours. The present study focused on the first perceived sensation, restricting the observation time

of the participants who should interrupt it and immediately respond to the perception of this first sensation (the type of sensation they should notice was not specified, as perhaps the first sensation could be felt in regions where decreased activity occurred (e.g., feeling the arms or legs weaken). The MAIA questionnaire was also used, participants who train their interoceptive capacity through mindfulness techniques, as well as requests not to move their bodies (movement restrictions).

This study has a number of limitations which should be noted. First, the mindfulness group was almost half the size of the control group, so the comparison may have been distorted. Second, the average age of the participants was around 40 years old, and it has been reported that there is a decline in interoceptive ability in older individuals, with indications of this decline being already present in this age group (Khalsa Rudrauf & Tranel, 2009; Shiota & Levenson, 2009). Third, exclusion criteria related to factors such as BMI and mental health were not used, which can also interfere with the quality of interoceptive accuracy (Andrei et al., 2018; Aldao & Nolen-Hoeksema, 2010; Pollatos, Traut-Mattausch & Schandry, 2009). As for mental health, around 20% of the sample reported having a diagnosed psychological disorder (In the Control group, four reported having depression, six an anxiety disorder, one social anxiety, one a bipolar disorder, one a bipolar disorder and depression, and one depression and anxiety disorder; In the mindfulness group, two reported having depression and four have anxiety). Fourth, the way in which the figure of the human body was subdivided can influence the frequency that a region is mentioned (that is, larger regions, may have more points to be noticed); however, as the most mentioned regions were also the most relevant in topographic studies of emotions, this seems to have had no influence. Fifth, women accounted for 82% of the total sample. Finally, in respect of the application of the MAIA questionnaire the fact that the majority of the sample had completed higher education ($n = 90$) might have influenced the results.

Future Research

Other research focusing on the throat/neck region conducted has been conducted by our group but was halted due to Covid-19 pandemic. As the review by Davey et al. (2021) points out, this is one of the three regions (along with the head and chest) that appears to be consistently associated with increased perceived activity across all emotions. Although in the current study the head/face and the chest were the most mentioned, these areas have already been explored extensively. The focus of this interrupted study is the capture of electromyographic (EMG) signals from the throat/neck area (more precisely from the hyoid muscles) in response to an emotional stimulus, in this case, an acoustic startle stimulus. The idea behind this is that the muscles that connect to the hyoid bone - the only bone that does not articulate with any other, and is highly mobile, being able to move to all directions (Mao et al., 2019), may be significant in the early stages of an emotional reaction. This region participates in important functions such as chewing, swallowing, intraoral transport, and some functions directly related to emotions such as breathing, and phonation (German et al., 2011) and is a part of the stomatognathic system, which has been observed to influence body posture as a whole (Solovykh, 2013).

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