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ORIGINAL ARTICLE

The effect of a single yoga class on interoceptive accuracy in patients affected by anorexia nervosa and in healthy controls: a pilot study

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Abstract

Purpose To evaluate interoceptive accuracy (Iac) before and after a single yoga class in a population of patients with anorexia nervosa (AN) and in a population of healthy controls (HC).

Methods Fifteen patients with AN and twenty HC were included in the study. All individuals participated in a single yoga class. Before (T0) and after (T1) the yoga class, they underwent the heartbeat detection task for the evaluation of Iac. At T0, all participants also underwent a psychological assessment, including evaluation of depression, anxiety, body awareness, alexithymia, self-objectification and eating disorders psychopathology.

Results Patients with AN had lower Iac than HC at T0. A significant improvement of Iac at T1 was found in the HC group but not in the group of patients with AN.

Conclusion We infer that our findings might be linked to the fact that patients with AN, differently from HC, did not properly attend to their bodies, despite the yoga class. This hypothesis is consistent with previous studies showing that patients with AN have decreased Iac during self-focused behavior because of body-related avoidance. Moreover, we surmise that HC might be keener to improve their perception of internal body signals even after a single yoga class because their emotional awareness system is not impaired. Patients with AN, on the contrary, may have an intrinsic impairment of their emotional awareness, making it harder for them to modulate their Iac.

Level of evidence Level III, evidence obtained from well-designed cohort or case–control analytical studies.

Keywords Anorexia nervosa · Yoga · Interoception · Interoceptive accuracy

Introduction

Altered interoception, defined as the perception of sensations relating to the physiological conditions of the body, including the working of internal organs, such as heartbeat, or respiration [1], has been identified as a key feature of eating disorders and most notably of anorexia nervosa (AN) [2]. Due to the complexity of interoceptive processes, Garfinkel and Critchley suggested distinguishing between different facets of interoception: (1) interoceptive accuracy (performance on objective behavioral testing), (2) interoceptive sensibility (self-assessment of subjective interoception, measured through self-report questionnaires), and (3) metacognition (metacognitive awareness of interoceptive accuracy, and confidence-accuracy correspondence) [3]. In the last years, few studies assessed the different facets of interoception in individuals diagnosed with AN. Pollatos et al. found that patients with anorexia nervosa had

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lower interoceptive accuracy (Iac) than healthy controls [2], whereas the review by Badoud et al. showed that lower Iac and lower interoceptive sensibility were associated with higher body-image concerns in non-clinical and in clinical samples [4]. In addition, Fisher and colleagues showed that lower Iac and interoceptive sensibility persisted in patients with AN even after treatment (cognitive-behavioural programme) and recovery [5]. Conversely, in a study by Di Lernia et al. patients with AN presented severe deficits in accuracy and sensibility, along with a pathologically enhanced metacognitive confidence in their wrong perceptions, in the acute phase of the disease. Even though the study is limited by the fact that it is a case report, the authors found that the entire interoceptive pattern was restored after recovery [6]. Pollatos et al. also showed that using self-focused attention (looking at one's face) reduced Iac in AN patients, while the opposite pattern was observed in healthy controls, suggesting that confronting AN patients with their body might increase body-related avoidance, subsequently decreasing Iac [7]. Lucci et al. further speculated that self-focus might act on Iac, this time both in patients with AN and in healthy controls, but that there might be a difference in how self-focus is achieved: looking at their own face in healthy controls and looking at another woman's face in AN [8]. These studies introduced new perspectives on the role of interoceptive accuracy, raising new questions regarding specific treatments targeting interoception in AN.

Yoga, a traditional Indian discipline, has been described to increase awareness of internal states and to improve the body's sense of embodiment and interoception in healthy subjects [9]. A growing body of evidence in the last years suggests that a variety of contemplative practices, including yoga, can improve interoception in healthy controls. Recently, there is also preliminary evidence that yoga may modulate the insula (an area of the brain known to be involved in the processing of bodily sensations) and enhance interoception by simply attending to the body (e.g., modulating breath or attending to the nociceptive cues in a "mindful" or non-reactive way) [10, 11]. More specifically, the philosophical system of *ashtanga* (eight limbs of yoga) proposes a framework of practices including (1) specific postures named *asanas*, which are carried out through concentration and breathing techniques called *pranayama*, (2) introspection, concentration and meditation practices called *pratyahara, dharana* and *dhyana*, respectively. All are directed at focussing the subject's attention inwards and transcending the mind and body dualism [12].

In the last decade, there has been a growing interest in the potential use of yoga as a complementary therapy for several medical conditions, including psychiatric disorders such as depression or anxiety [13]. Preliminary results, also among patients affected by eating disorders, suggest that yoga holds promise of becoming a complementary therapy to standard care [14, 15]. In particular, studies exploring yoga in the population with eating disorders (both on adults and adolescents) have found improvements in depression, anxiety, quality of life and shape concerns [16, 17]. For this reason, its use in treatment centers for eating disorders has significantly grown over the last few years. However, it is still unclear what is the physiopathological mechanism underlying the efficacy of yoga, both in non-clinical and in clinical samples: Hopkins and colleagues hypothesized that yoga efficacy might be mediated by modulation of cortisol reactivity [18], but no studies to date have explored the possible role of interoceptive accuracy.

The aim of our study was to evaluate Iac before (T0) and after (T1) a single yoga class in a sample of patients with AN and in a sample of healthy controls. We decided to specifically assess Iac, rather than sensitivity or metacognition, to prioritize to an objective measure of interoception. Moreover, we also aimed to assess possible correlations between levels of Iac at T0 and at T1 and psychological variables that have been shown by previous studies to be impacted by yoga [19–22]: levels of depression, anxiety, body awareness, alexithymia, self-objectification, eating disorder' psychopathology. Our hypothesis is that patients with AN have lower Iac than healthy controls and that Iac will improve in both populations after a yoga class.

Materials and methods

Participants

Fifteen patients affected by AN and twenty healthy controls (HC) were included in this pre–post-test design study involving observation of differences between two groups. Patients affected by AN were recruited at the Eating Disorders outpatient clinic of San Paolo Hospital in Milano. The diagnosis of AN was made according to the Diagnostic and Statistical Manual of Mental Disorders—fifth edition (DSM-5) [23] diagnostic criteria through the Structured Clinical Interview for DSM-5 (SCID-5) [24] administered by a trained psychiatrist. We excluded subjects with other psychiatric, neurological or medical disorders as identified from a complete anamnestic questionnaire and a clinical interview (SCID-5 [24]), administered by a trained psychiatrist. Exclusion criteria were (1) age lower than 18 years; (2) inability to communicate with the researcher or to complete the questionnaires because of language difficulties, the presence of learning disabilities or dementia; (3) previous diagnosis of bulimia nervosa (which might represent a confounding factor). Healthy controls were visitors to the hospital and hospital staff; however, they were not related to patients. Their "healthy state" was determined through a specifically designed anamnestic interview, including a questionnaire

designed to exclude medical and neurological disorders and the SCID-5 to exclude psychiatric disorders, both administered by a trained psychiatrist. All the participants were naïve to yoga.

All patients and healthy controls gave their written informed consent for the study. The Ethics Committee of Sigmund Freud University reviewed and approved the study protocol.

Experimental protocol

The entire session took place at a local yoga studio. At T0 all participants underwent psychological assessments. The first is the Hamilton Rating Scale for Depression (HAM-D) [25], which is used to assess depressive symptoms. This is the most widely used clinician-administered depression assessment scale. The original 1960 version contains 17 items, but four other questions are not added to the total score, but used instead to provide additional clinical information. Each item on the questionnaire is scored on a three- or five-point scale, depending on the item, and the total score is compared to the corresponding descriptor. This assessment has been shown to yield reliable and internally consistent scores and to verify criterion-related validity. Secondly, we applied the Hamilton Anxiety Rating Scale (HAM-A) [26] to assess anxiety symptoms. This is the first rating scale developed to measure the severity of anxiety symptoms, and it is still widely used in both clinical and research settings. The scale consists of 14 items, each defined by a series of symptoms, and measures both psychic anxiety (mental agitation and psychological distress) and somatic anxiety (physical complaints related to anxiety). Several studies have also shown that this scale is reliable, internally consistent and valid. The Body-Awareness Questionnaire (BAQ) [27] was the third psychological assessment. This is an 18-item scale, which assesses the self-reported attentiveness to normal, non-emotive bodily processes (such as sensitivity to bodily cycles and rhythms, ability to anticipate body reactions); scoring ranges from 1 (not at all true) to 7 (very true to me). The reliability and validity of this scale have been confirmed. In fourth place, we used the Toronto Alexithymia Scale (TAS-20) [28, 29] to assess alexithymic features. The TAS-20 is the most commonly used self-report measurement of alexithymia, with demonstrated good reliability and factorial validity. It consists of 20 items rated on a 5-point scale, ranging from '1 = strongly disagree' to '5 = strongly agree', with a total score varying between 20 and 100. Three sub-scores can also be calculated but these were not used in the current study because of the relatively small sample sizes and related power issues. Higher scores indicate greater alexithymia. A total score of 61 is considered the cut off for alexithymia, based on studies on the general population. Fifth, the Self-Objectification Questionnaire (SOQ) [30] was used to assess self-objectification. The SOQ allows classifying the degree to which participants experience their body on the basis of observable, appearance-based (objectified) aspects versus non-observable, competence-based aspects. Participants are required to rank 10 body attributes according to the importance each has to their own physical self-concept, with the scale ranging from 0 (least impact) to 9 (greatest impact). Five of the attributes refer to appearance-based attributes (e.g., physical attractiveness) and five to competence-based attributes (e.g., energy level). Scores can vary from − 25 to + 25 with higher scores indicating a greater tendency to view the body in terms of appearance-related attributes. This measure has been shown to have sufficient convergent validity and high test–retest reliability. In sixth place, we asked participants to answer the Eating Disorder Inventory (version 2, EDI-2) [31] to assess the severity of eating disorder' psychopathology. It is composed by the following subscales: (a) Drive for Thinness;(b) Bulimia; (c) Body Dissatisfaction; (d) Interoceptive Awareness; (e) Ineffectiveness; (f) Interpersonal Distrust; (g) Maturity Fears; (h) Asceticism; (i) Impulse regulation; (j) Social Insecurity; (k) Perfectionism. Higher scores represent higher levels of eating disorder pathology. The subscales have good convergent and discriminant validity. Test–retest reliability in women with eating disorders is also high.

At T0 and at T1 all participants underwent the heartbeat detection task to evaluate Iac [32, 33] according to the protocol developed by Schandry [32]. To begin with, participants were seated, with their wrists gently resting on the band of a heart rate monitor, which was located on a table in front of them. The heart rate was recorded with a Polar wrist monitor (model RS 800 CX). Participants were first asked to sit quietly and relax for 30 s, after which we recorded baseline heart rate (HR) for 3 min before we started the task to evaluate differences in heart rates. Participants were asked to concentrate on their heartbeats and to count them silently. They were not permitted to take their pulse or to attempt any other physical manipulations, which could facilitate detection. There were three counting phases lasting for 25, 35, and 45 s and separated by 30 s resting periods. We randomized the order of the phases between the participants of each group. An acoustic signal provided the 'start' and 'stop' indications for each counting phase. After each stop signal, we asked the participants to report the number of counted heartbeats. Participants were not aware of the length of the counting phases nor of their performance.

The yoga class was the first of a broader intervention consisting of 10 full yoga-inspired accessible hatha classes. All participants attended the yoga class at the same time. The practices were led by a registered yoga teacher trained at the Foundation 20-h TCTSY (Trauma Center Trauma Sensitive Yoga) and Accessible Yoga, and a licensed psychotherapist. The yoga class lasted for 75 min, adapted to

the participants' needs according to the Accessible Yoga methodology, and included trauma-informed specifications concerning choices, invitational language, and limited physical assistance. The class incorporated the traditional main yoga tools—45′ warm-up activity and physical postures, 15′ deep relaxation, 15′ breathing techniques and meditative concentration. The session began with a mental centering practice focused on body and breathing awareness. This was followed by a warm-up routine aimed at preparing the body for the principal work, consisting of light joint warm-ups for releasing tension, and a dynamic muscle warm-up practice for raising energy levels. The sequence of postures followed a precise organization, from backward bends to forward bends, adapted inversions, and twists. This was designed to move the body in all directions and increase self-awareness. All postures were practiced with the attention focused on breath and sensations. The breathing part, known as *pranayama* (=expansion of the vital force), incorporated two techniques: *deerga swasam*—a three-part breathing routine where all alveoli are employed in respiration with a higher amount of oxygen intake compared to regular breathing, and *nadi suddhi*, an alternate nostril breathing aimed at balancing all systems and developing a clear mental vision. As a closing practice, we proposed a few minutes of guided meditation, asking participants to focus their minds on a concentration point, thus training empowerment, strength and possibly to self-awareness.

Statistical analysis

Before performing the statistical analysis, we scrutinized the files exported from Polar watch to check whether there were individuals with large changes in heart rate between trials and also to exclude participants whose data appeared to be corrupted. This operation did not lead to the exclusion of any participant.

The statistical data were analyzed using SPSS version 25 (Statistical Package for Social Science).

We computed the accuracy of heartbeat perception as the mean score of three heartbeat perception intervals according to the following transformation [32]:

$1/3\sum[(1 - (|\text{recorded heartbeats} - \text{counted heartbeats}|/\text{recorded heartbeats})]$.

We tested the variables first for normality using the Shapiro–Wilks test. The variables that were not normally distributed ($p < 0.05$) were log10-transformed.

We compared sociodemographic variables by group using Fisher's exact test or *t* test for independent variables, depending on whether the variable was qualitative or quantitative ($p < 0.05$). We ran a univariate independent-measures ANOVA with factor "group" (between factors, levels "patients" and "HC") to assess differences in Iac and in psychological tests between patients and HC. To check for consistency between the three measures of Iac from the three heartbeat counting trials (25, 45, 65 s), we performed a one-way ANOVA. To assess the differences in Iac and in HR between patients with AN and HC in the two observation periods, we performed a two-way repeated measures ANOVA with one between-subjects factor (group) and one within-subjects factor (time). We also checked for correlations using Pearson or Spearman's coefficients as appropriate.

Results

Sociodemographic variables, psychological and clinical evaluation

We did not find significant differences between patients and HC for sex, age, marital status, educational level and 3-min baseline heart rate (Table 1). Body mass index (BMI) was significantly lower in the group of patients ($t = -5.009$, $p < 0.001$). Whereas the control group had normal rating scores for psychopathology, patients had abnormal scales, in terms of depression (HAM-D), anxiety (HAM-A), alexithymia (TAS-20) and eating disorders psychopathology (EDI-2) (Table 1). No significant differences were found between the three measures of Iac taken on each of the three heartbeat counting trials [$F(1, 33) = 4.212$, $p = 0.451$]. In addition, at T0 Iac in patients with AN was significantly lower than Iac in HC ($t = -6.233$, $p = 0.017$). We did not find a significant change in measured heart rates between the two time measurements of Iac [$F(1, 33) = 2.433$, $p = 0.548$]. However, a repeated measures ANOVA determined that mean Iac differed significantly between the two time points [$F(1, 33) = 6.233$, $p = 0.018$], in terms of significant improvement. There was also a significant interaction effect between time and group [$F(1, 33) = 7.612$, $p = 0.009$]. The Effect Size (Cohen's d) was medium (0.58). This indicates that patients with AN and HC behaved differently with respect to Iac over the two time points; while HC significantly improved their Iac between T0 and T1, patients with ANAN did not (Fig. 1). The Iac at T0 was correlated with (1) TAS-20 score ($r = -0.334$, $p = 0.025$) and (2) EDI-2 interoceptive awareness subscale ($r = 0.355$, $p = 0.015$). A negative correlation was also found between TAS-20 score and EDI-2 interoceptive awareness subscale ($r = -0.543$, $p = 0.015$). All the other correlations between Iac and psychometric scales were not significant.

Discussion

We studied the effect of a single yoga class on Iac in a sample of patients with AN and in a sample of HC. In our results, patients with AN had lower Iac than HC at T0. In

Table 1 Demographic variables and psychometric assessment

	Patients with AN ($n=15$)	HC ($n=20$)		Significance
Sex, female *n* (%)	15 (100)	20 (100)		
Age, years (SD)	28.00 (11.22)	28.59 (9.85)		$t=-0.172$, $p=0.430$
Educational level, years (SD)	14.88 (3.09)	15.95 (2.95)		$t=-1.091$, $p=0.755$
Marital status, *n* (%)				
Single	13 (86.66)	18 (90)		$p=0.267$
Married	1 (6.66)	2 (2)		
Divorced	1 (6.66)	0		
Widowed	0	0		
BMI (SD)	16.11 (4.33)	21.23 (3.12)		$t=-5.009$, $p<0.001$*
TAS-20 mean score (SD)	57.19 (16.84)	39 (6.45)		$t=4.637$, $p<0.001$*
HAM-D mean score (SD)	5.81 (4.37)	2.05 (2.75)		$t=3.260$, $p=0.009$*
HAM-D log10 mean score (SD)	0.71 (0.38)	0.44 (0.28)		
HAM-A mean score (SD)	6.63 (5.40)	2.73 (3.42)		$t=2.721$, $p=0.024$*
HAM-A log10 mean score (SD)	0.70 (0.43)	0.46 (0.36)		
SOQ mean score (SD)	− 1.94 (9.94)	− 7.27. (10.29)		$t=1.600$, $p=0.794$
BAQ mean score (SD)	69.13 (17.23)	79.59 (16.71)		$t=-1.881$, $p=0.957$
EDI-2 mean score (SD)	79.81 (53.04)		30.10 (24.55)	$t=3.801$, $p=0.003$*
EDI-2 log10 mean score (SD)	1.80 (0.30)		1.37 (0.30)	
EDI-2 interoceptive awareness subscale mean (SD)	7.45 (5.65)	2.22 (2.87)		$t=2.433$, $p<0.001$*
Mean 3-min baseline heart rate (SD)	226.6 (47.3)	238.5 (61.3)		$t=3.643$, $p=0.432$
Mean interoceptive accuracy T0 (SD)	0.37 (0.12)	0.55 (0.26)		$t=-6.233$, $p=0.017$*
Mean Interoceptive accuracy T1 (SD)	0.40 (0.16)	0.74 (0.22)		$t=25.517$, $p<0.001$*
Disease duration, years (SD)	3.5 (1.3)			

*$p<0.05$. *AN* anorexia nervosa, *HC* healthy controls, *SD* standard deviation, *BMI* body mass index, *TAS-20* 20-item Toronto Alexithymia Scale, *HAM-D* Hamilton Rating Scale for Depression, *HAM-D* Hamilton Rating Scale for Anxiety, *SOQ* Self-objectification Questionnaire, *BAQ* Body Awareness Scale, *EDI-2* Eating Disorder Inventory 2

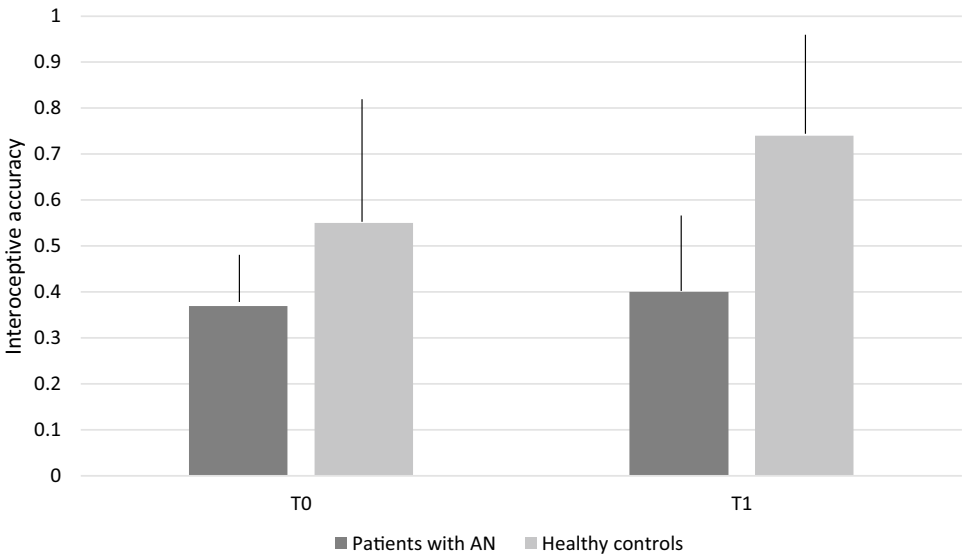

Fig. 1 Interoceptive accuracy in patients with anorexia nervosa and healthy controls, at T0 and T1. *AN* anorexia nervosa. The figure shows mean and capped standard error of mean

addition, contrary to our predictions, we found a significant improvement in Iac at T1 in the HC group, but not in the group of patients with AN.

A possible reason for the increase in Iac observed among healthy controls after the yoga class might be an increased attention to the body. This interpretation, although

speculative, is in line with previous studies showing that the heartbeat-evoked brain potential (HEP), an index of the cortical reflection of cardiac interoceptive signals, is higher in "attention to the heart" states than in resting states [34] and that the HEP is positively correlated with Iac [35]. Furthermore, we excluded that the increase in Iac observed among healthy controls after the yoga class might be linked to changes in participants' levels of arousal since we found no significant change in objectively measured heart rates across the two time measurements of Iac. However, it is important to acknowledge that the increase in Iac seen in healthy controls after the yoga class might also be due to a learning effect.

Our results for patients with AN are in keeping with previous studies according to which patients affected by AN exhibit a reduced capacity to accurately perceive signals from within the body, confirming the theoretical psychopathological frame of impaired interoception as a core feature of this condition. Moreover, our findings showed that patients with AN have reduced interoceptive awareness, as measured by the specific subscale of the EDI-2, which covers aspects related to the ability to discriminate between individual visceral sensations (such as hunger and satiety) and to accurately respond to emotional states [31]. However, curiously, we found no significant difference between patients with anorexia nervosa and healthy controls with respect to body awareness (BAQ score); this result is not consistent with previous studies assessing body awareness in patients with anorexia nervosa and might be related to the small sample size [36]. In our study, unlike Pollatos et al. [2], we found interoceptive awareness and interoceptive accuracy to correlate with each other, and both of them to correlate with alexithymia (TAS-20 score). Thus, we hypothesized that interoceptive awareness, Iac and alexithymia might be linked in a multi-dimensional construct that takes into account how people attend to, appraise and respond to sensations [37]. However, it is important to mention that the EDI-2 subscale of interoceptive awareness does not discriminate between emotional- and body-related sensibility and may, therefore, confuse interoceptive awareness and alexithymia [38, 39]. Indeed, individual sensitivity to bodily signals is an essential variable in many theories of emotions [37], according to which we feel emotions because we perceive our bodily signals [40].

In this study, we take a step further by showing that individuals diagnosed with anorexia nervosa, differently from HC, are not able to improve their ability to detect signals from within their bodies when exposed to a single yoga class. This finding might be due to patients with AN, differently from healthy controls, not properly attending to their bodies, despite the yoga class. This interpretation is consistent with previous studies finding that patients with AN showed a decreased Iac during self-focused behavior (looking at one's own face) because of body-related avoidance [7, 8]. Even though our finding prevents us from drawing firm conclusions since they might be influenced by outside factors (such as patients' malnutrition state, eating disorder severity, psychological factors or the need of more yoga sessions to elicit an improvement of Iac in patients with AN), we corroborated the hypothesis according to which reduced Iac in patients with AN might be a trait-dependent intrinsic feature of the disorder, and not a state-dependent condition. In this view, while HC are able to improve their ability to perceive internal body signals even after a single yoga class because their emotional awareness system is not impaired, patients with AN, having an intrinsic impairment of their system, have greater difficulty in modulating their Iac.

In addition, our results on HC are in line with recent studies showing that several contemplative practices such as yoga [10, 11], but also meditation [41, 42], mindfulness [43] and tai chi [44] improve Iac through a mechanism which involves neuroplasticity changes in the insula, which is known to be the primary neural hub for interoception. Moreover, the lack of improvement in Iac in patients with AN is consistent with the so-called "insula hypothesis" of anorexia nervosa, which proposes that anorexia nervosa is characterized by an impairment within a circuit involving cortical and sub-cortical structures because of a dysfunction of the insula, which has a central role in the communication between these structures, possibly as a result of early developmental damage [45]. In this model, insula dysfunction, verifiable through structural and functional neuroimaging techniques [46–49], might be responsible for the deficit of interoception seen in these patients. This innovative view in the pathophysiology of anorexia nervosa may also have some important clinical implications. In particular, the inefficacy or partial efficacy of many treatments (such as cognitive-behavioural therapy), traditionally used for treating these patients, could be due to the fact that they are dependent on insula integrity and do not address the primary insula dysfunction. Thus, our preliminary results on the efficacy of yoga as a promising adjunct treatment strategy in patients with anorexia nervosa could be explained by other non-specific factors such as the effect on depression or anxiety, but not by its effect on interoception.

We acknowledge the limitations of our study: first, the small sample size that might limit the external validity of the results and, second, the fact that we only tested female participants, that may create a further bias on the generality of our results. Third, the lack of an observer control condition (e.g., relaxation) prevents us from drawing firm conclusions from a causation viewpoint. Fourth, we assessed Iac after a single yoga class, whereas it would be of interest to evaluate the same parameter after the complete yoga course. Fifth, the use of the heartbeat detection task as a measure

of Iac has been recently criticized for being biased and of uncertain validity; in particular, it has been criticized the use of the belt on patients' wrists rather than around their chest. Nevertheless, in our study, we scrutinized Polar watch exported files to check whether there were individuals with large changes in heart rate between trials to exclude participants whose data appeared to be corrupted.[50, 51]. Sixth, the controls were recruited from a convenience sample that may not reflect the general population (as all controls were visitors to the hospital or hospital staff). Finally, we only assessed two facets of interoception, namely interoceptive accuracy and awareness, without considering sensitivity and confidence, which might give some additional information.

In conclusion, we found that patients with AN had lower Iac than HC before the yoga class. Moreover, we recorded a significant improvement in Iac after a single yoga class in the HC group, but not in the group of patients with AN. To confirm our hypothesis, future studies exploring whether Iac improvements are associated with changes in insula activity are needed.

What is already known on this subject?

Preliminary results on patients affected by eating disorders have suggested that yoga might be a promising adjunctive therapy to standard care. Moreover, previous studies on this topic have shown that deficits in interoception are present in patients with eating disorders, especially in anorexia nervosa. However, it is still unclear which is the physiopathological mechanism underlying the efficacy of yoga in eating disorders.

What this study adds?

Our findings suggested that individuals diagnosed with anorexia nervosa, differently from healthy controls, did not attend properly to their bodies, despite the yoga class. Moreover, we hypothesize that healthy controls might be keener to improve their ability to perceive internal body signals even after a single yoga class because their emotional awareness system is not impaired, while patients with anorexia nervosa might have an intrinsic impairment of the system, making it more difficult for them to modulate their interoceptive accuracy. This innovative view in the pathophysiology of anorexia nervosa could also have important therapeutic implications.

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Data availability Anonymized data will be shared by request from any qualified investigator.

Compliance with ethical standards

Conflict of interest Authors have no conflict of interest to declare.

Ethical approval with the full name of the committee The Ethics Committee of Sigmund Freud University reviewed and approved the study protocol.

Informed consent All patients and healthy controls gave their written informed consent for the study.

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