Monitoring Embodied Mentalization with Ecological Momentary Assessment (EMA): a pilot study

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Abstract

This pilot study is an extension of body awareness research and embodied mentalization to improve the assessment of people suffering from somatic symptoms. Self-report questionnaires were completed by 64 young (18-30 years) male (34%) and female (66%) participants to establish two groups of somatic symptom severity (PHQ-15). Then, the IAQ-19 examined the adaptive and maladaptive body awareness of 58 participants. Finally, 48 participants were asked about their mental and physical states through Ecological Momentary Assessment (EMA) at five times each day for 14 days. The daily measurements were processed using multilevel analyses with the most parsimonious models comparing log likelihoods. The simple regressions between adaptive and maladaptive body awareness and somatic symptom severity were non-significant. However, daily repeated measures of affective states and self-reports of physical states were significantly associated. For participants with severe somatic symptoms, high irritation was correlated with relatively slow breathing and, low irritation with relatively fast breathing. All other interactions were non-significant. Conclusively, the findings confirm a link between bodily signals and mental states like stress, sadness, irritation and happiness. Additionally, these associations tentatively support the idea that through manipulation of our bodily state we may be able to change our mental states. This pilot study is a very first step in the understanding of the role of body awareness, affects and physical sensations in relation to somatic symptoms although improvements of the procedure and more sophisticated analyses are necessary before EMA could have practical implications for diagnosing and treatment planning in therapy.

Keywords: adaptive body awareness, maladaptive body awareness, embodied mentalization, somatic symptoms, Ecological Momentary Assessment

Preface

This thesis is part of the Master of Clinical Psychology of Utrecht University. The cooperation with Altrecht Psychosomatic Medicine in Zeist has made it possible to research a topic which may further impact the clinical setting. I would like to thank Dr. Jan Houtveen for his support regarding the methods and statistics. His passion and expertise were contagious. Also, I am particularly grateful for close supervision by Prof. Dr. Rinie Geenen. His engagement and enthusiasm for research is outstanding. Despite his busy schedule he always stayed in contact and encouraged me throughout the process. Thanks to his critical feedback I have learned a lot along the process. From one of our feedback sessions I will keep this quote by Albert Einstein in mind: “If you can't explain it to a six-year old, you don't understand it yourself.” It represents his value to give access to research to anyone and stay closely connected to patients.

Malin Böhne, March 2020

Introduction

According to the DSM-5 around 5 – 7% in the general adult population suffer from somatoform disorder, the precursor diagnostic category closest to somatic symptom and related disorders. Patients with somatic symptom disorder experience distressing somatic symptoms along with excessive thoughts, feelings and behaviours in response to these symptoms (American Psychiatric Association, 2013). Kalisvaart et al. (2012) and Luyten et al. (2012) raise the assumption that people who are chronically suffering from somatic symptoms may have a disturbed relationship to their bodies. The body communicates its needs to ensure successful functioning, regulation and survival (Khalsa et al., 2018). Besides misconception or overreaction of bodily signals, it can especially be a struggle for patients to understand their body signals (Kalisvaart et al., 2012). Moreover, patients may not be able to perceive a link between their physical sensations and mental states (Luyten et al., 2012). The capacity to reflect on that link (between bodily experiences and mental states) in the self and others is called embodied mentalization. A quote by the French phenomenologist Merleau-Ponty emphasizes the importance of the connection between the body and the mind: "Embodiment is the human experience of simultaneously having and being a body; the term conceptualizes the body as a dynamic, organic site of meaningful experience rather than as a physical object distinct from the self or mind" (Merleau-Ponty, 1945). Luyten et al. (2012) and Spaans, Koelen, & Bühring (2010) have argued that patients with somatic symptom disorder have difficulties with embodiment, connecting themselves to their body.

This study examines the relationship between body awareness, embodied mentalization, and somatic symptoms using trait (surveys) and state measurements (smartphone diary). An innovative novel method is used as a first attempt to measure body-oriented mentalization which could be a potential tool in treatment for somatic symptom disorder (Spaans et al., 2010).

Body awareness is defined as the capability to recognize and sense internal experiences of the body (like a tight muscle or breathing frequency) and the more general state of the body (feeling at ease or tense) (Price & Thompson, 2007). The nervous system constantly provides information in the form of bodily signals. This is a demand to take care about yourself and to regulate your body to become closer to a balanced state (Khalsa et al., 2018). Previous research associated heightened body awareness with worsening of somatic symptoms (Cioffi, 1991). Traditionally, awareness has been described as an attitude that exaggerates the "focus on physical symptoms, rumination, and beliefs of catastrophic

outcomes" (Mehling et al., 2009, p.1). The severity of perceived distressing body signals was used as a criterion for illness anxiety (hypochondriasis), anxiety and somatization and is associated with a development of a downward trajectory of acute pain to chronic pain (Pincus et al., 2002). However, Cioffi (1991) started questioning that bodily signals would be merely distressing. Nowadays, Cioffi's criticism and idea to differentiate between adaptive and maladaptive ways of attending to body signals is also considered by other researchers (Ginzburg et al., 2014; Mehling et al., 2011). In the maladaptive approach, which is more conform with the traditional view, people focus more on unpleasant physical sensations (Mehling et al., 2009). Constant body symptom scanning can lead to somatosensory amplification (Eccleston et al., 1997). A more recent study by Köteles & Doering (2016) has confirmed the maladaptive view by establishing that body awareness was one of the most important predictors for a heightened perception of somatic symptoms. Patients in psychiatric rehabilitation suffering from chronic pain seem to have lost their confidence in trusting their body signals and rather react with anxiety and distress to bodily signals (Gyllensten et al., 2010; Valenzuela-Moguillansky et al., 2017). An unhealthy body awareness might also play a role in anxiety and depression (Courtois et al., 2015). Patients who are overly concerned about their pain tend to perceive more somatic symptoms (Mehling et al., 2012).

In contrast, a non-judgmental perception of physical cues can foster an adaptive body awareness and strengthen a positive attitude towards the body and self (Gard, 2005; Gyllensten, Skär, Miller, & Gard, 2010). According to Mehling et al. (2009), a mindful, adaptive body awareness entails non-reactivity and neutral observation of bodily sensations before acting in a habitual automatic manner (Mehling et al., 2009). When engaging in an adaptive body awareness, people seem less likely to get stuck in rumination about their somatic symptoms. Instead of trying to distract themselves from their bodily cues they react with a different attentional focus (Mehling et al., 2012). Within the last decade, research has suggested that an altered attentional style can change pain perception. Hence, the intensity of chronic pain can be affected by the focus of attention in the body (Mehling et al., 2013).

Additional to the theory of Mehling, it seems to be crucial to examine the emotional state of somatic symptom disorder patients related to their body. Salient bodily signals can provide information about the mental state. Mehling et al. (2009) integrated the recognition of internal experiences like emotions into their definition of a mindful and adaptive body awareness. This is in line with the concept of embodied mentalization defined as experiencing a link between emotional and bodily experiences. It has been suggested that patients with chronic somatic symptoms such as pain and fatigue do neither have the ability to observe and

be open to bodily experiences in the self and others, nor to connect these to mental states (De Gucht & Heiser, 2003; Luyten et al., 2012; Waller & Scheidt, 2006). The ability known as body-oriented or embodied mentalization is "the capacity to see the body as the seat of emotions, wishes and feelings and the capacity to reflect on one's own bodily experiences and sensations and their relationships to intentional mental states in the self and others" (Luyten et al., 2012, p. 125). Spaans et al. (2010) assume that patients with somatic symptoms tend to miss the importance of their mental state and exclude certain bodily signals from their experience.

Given difficulties assessing the overarching concept of mentalization, similar problems are assumed to be present with embodied mentalization in trait-like measurements. Fonagy & Luyten (2009), doubt that individual differences in mentalizing can be reflected in trait-like measurements and express the importance of taking the fluctuations of mentalization over time and across contexts into account when investigating mentalization. People with low body awareness and poor ability to connect their bodily sensations to their mental states, may have difficulties answering trait-like questions in retrospection. Using state measurements could be an attempt to assess (embodied) mentalization more reliably than using trait measurements. Until now, no empirical method has been established. Findings about embodied mentalization are rather based on clinical observations and interviews with patients (Spaans et al., 2010). So, there is an urgent need for research to develop an assessment method of (embodied) mentalization that also considers its state aspects (Fonagy & Luyten, 2009; Spaans et al., 2009).

Ecological Momentary Assessment (EMA) refers to the repeated measurement of affect, behavior and cognitions close in time to experiences in daily life using a smartphone (Shiffman et al., 2008). This method offers the possibility to examine fluctuations in mental states as well as the dynamic (time-lagged) covariances between state variables like affect and self-perceived body posture, muscle tension and breathing. It is core to the definition of body-oriented mentalization that mental states are congruent with bodily states. In terms of the congruency, an affective state like sadness would, for example, be noticed through a more slumped body position.

Incongruent mental and bodily states (self-reported affect is not associated with self-reported bodily experiences) could be related to somatic symptoms. In patients with chronic somatic symptoms physical experiences do not seem to be integrated well with their mental states. In clinical settings, patients are observed to have a conflict between their inner self and their physical expression and seemed less receptive to their own and other people's body

signals (Spaans et al., 2009). Less synergy between affective and bodily states might lead to less ability to understand current experiences. Patients perceive their body as dysfunctional due to this disconnection between their mental and bodily sensations (Kalisvaart et al., 2012; Mehling et al., 2011; Spaans, 2017). Conclusively, it seems that adaptive body awareness is a process of more distant and non-judgmental (mindful) perception of internal physical signals and is incorporated in the state of embodiment: the extent to which a person integrates both the mind and body, which could have salutary effects on somatic symptoms (Luyten et al., 2012; Mehling et al., 2009).

The aim of the present study is to first, test the theory of Mehling about how adaptive and maladaptive body awareness relate to somatic symptoms, and secondly, to examine the (dynamic) relationships between self-reported affects and body experiences (body posture, muscle tension and breathing). In the first part of the study body awareness as measured with questionnaires is related to somatic symptom severity. Firstly, it is hypothesized that maladaptive body awareness is positively correlated to somatic symptom severity. The second hypothesis is that adaptive body awareness is negatively correlated to the severity of somatic symptoms. If the hypotheses yield the expected outcomes, it would provide more foundation to the idea that body awareness includes the distinctive types (Mehling et al., 2011). In the second part of this study we examine whether there is a connection between affect and body experiences and explore whether this link is related to somatic symptoms by using state measurements. Considering theoreticians' assume (Luyten et al., 2012), and clinicians' observe (Spaans et al., 2009), that people with high somatic symptom severity have lower (embodied) mentalization, the following questions are raised: Firstly, can we measure the link between affective and physical experiences? Secondly, does the strength of the association between affect and body depend on the severity of somatic symptoms? Hence, a tentative hypothesis is formulated: In people with higher severity of somatic symptoms, the association between repeated measures of affective and bodily sensations will be lower.

Methods

Participants

Participants were between 18 and 30 years old and spoke English or Dutch. They were not allowed to participate if they had inflammatory (rheumatoid arthritis), infectious (Epstein-Barr) or other malignant diseases (cancer or multiple sclerosis) with pathological substrates causing somatic symptoms. Participants were recruited in three ways: through the university

intern recruitment procedure (SONA), via sampling technique, in which the personal network was activated by direct approach and/or social media and through snowball sampling in which participants were encouraged to ask other suitable candidates (Marshall, 1996). An a priori power calculation for repeated measures analysis of variance according to Pearson's Correlation, (r =.50 and significance =.05) resulted in a power of .82 when 30 subjects were included. In total, 64 participants provided valid data in the first questionnaire that was used to select participants in a prescreening procedure. Considering a rather high dropout rate throughout the more demanding part of the study by using the application five times daily for 14 days, we aimed to start off with more participants. Individuals were excluded if they did not give consent, did not fill out the general questionnaires or did not complete at least ten of the daily questionnaires (Table 1).

Procedure

Prescreening included an information letter, informed consent, demographics (gender, age, nationality) and a first questionnaire about somatic symptoms. After checking the number of participants in each group based on somatic symptom severity (cut-off score of 6), participants filled out a questionnaire concerning their body awareness, the second part of the study. As both groups were almost equal in subject number, no participant was excluded. In the third part, the EMA study, participants used the application 'Ethica' to examine state levels of affective and bodily experiences i.e. embodied mentalization using visual analogue scales (VAS) from 0 to 100 mm (Ethica, 2017). They received notifications on the phone to complete the same questionnaire for five times a day at random times for the consecutive 14 days (see Appendix for more detail). After the 14 days participants were contacted to repeat the body awareness questionnaire and to provide feedback for the pilot study. All parts of the study were made available in two languages (English and Dutch). Ethical approval was granted by the Ethical Committee of the Faculty of Social and Behavioral Sciences of Utrecht University (FETC15-085). In the current study, the repeated measure of the awareness questionnaire after 14 days was only used to assess its test-retest reliability.

Instruments

Somatic Symptoms. The 15-item Patient Health Questionnaire-15 (PHQ-15) was used to measure severity of somatic symptoms (Kroenke et al., 2002). Participants rated the severity of symptom in the last four weeks, as 'Not bothered at all' (0), 'Bothered a little' (1), or 'Bothered a lot' (2). The reliability of the PHQ items in this study are moderate shown by Cronbach's α of .65 for female and .74 for male participants.

Body Awareness. The Interoceptive Awareness Questionnaire (IAQ-19) was used to measure adaptive and maladaptive body awareness (Van den Bergh et al., 2015). A 5-point Likert scale ranging from 'Strongly agree' (1) to 'Strongly disagree (5) assessed the two subscales. For the subscale indicating adaptive body awareness (Awareness of bodily sensations) Cronbach's α was calculated with an average of .54 across the 10 items. Although the reliability value is not satisfactory, no item was deleted as it would not have increased the reliability coefficient. The second subscale, indicating maladaptive body awareness, called Attention to unpleasant bodily sensations with the remaining 9 items has a Cronbach's α of .71, which is considered acceptable. The IAQ-19 is not yet evaluated for its test-retest reliability which is why it was administered twice (Van den Bergh et al., 2015). At the second administration reliability values increased to .63 for the Awareness to bodily sensations subscale and .81 for the Attention to unpleasant bodily sensations subscale. Pearson's *r* of .66 for the Awareness of bodily sensations and .86 for the Attention to unpleasant bodily sensations subscale show high test retest reliability. Cautious interpretation of the test-retest reliability is necessary as subjects were stimulated to attend to their body between the two measurements.

Mind-body experience association. In the second part of the study four affective states were included, namely sadness, irritation, stress and increased happiness. The bodily experiences that were measured are muscle tension (relaxed/tense), breathing (slow/fast) and body posture (slumped/upright). All items were assessed using VAS scales from 0 to 100mm to indicate the intensity of the experience. If the intensity of an affective state was higher or equal to 20, the participants were additionally asked how they experienced the match between the mental state and the physical state that they indicated before, namely if they have embodied mentalization (see Appendix for more detail). The data about the match between their body awareness and embodied mentalization i.e. mental and physical state were not analyzed in the current study.

Statistical analysis

For processing and all statistical analyses, the Statistical Package for Social Science (SPSS version 24.0) was used. Significance levels were set at $p < 0.05$ (two-tailed). To analyze the relationship between somatic symptom severity and maladaptive body awareness, a linear regression analysis was performed with the subscale mean of Attention to unpleasant bodily sensations of the IAQ as the independent variables and the sum of the PHQ-15 as the dependent variable. Similarly, the relationship of somatic symptom severity and adaptive body awareness was tested with another linear regression using the subscale mean of

Awareness to bodily sensations of the IAQ as the independent variables, and the sum of the PHQ-15 as the dependent variable. For both linear regressions the assumptions of normality were violated which is why for both hypotheses simple regression analysis was repeated with bootstrapping. Age and gender were tested for covariance which did not apply in this case.

The data of the ecological momentary assessments were programmed at two levels: Level 1, the within-subjects (state) level entailed four variables, namely one affective state as the dependent variable and three physical states as fixed covariates; Level 2, the between-subjects (trait) level consisted of somatic symptom severity as the predictor. Here, the hierarchical two-level design is structured to hold 5 daily time points in 14 days at level 1 nested within persons at level 2 for every participant. For hypothesis testing multilevel modelling analysis was used (Hayes, 2006). A multilevel analysis compares different models with restricted maximum likelihood ratio (REML). The number of the parameters added to the model (degrees of freedom) are getting compared and a chi square test ($\chi 2$) is applied to check for a significant difference in the likelihood values of each model (see Tables to 7 in the Appendix) (Field, 2009). The described method results in a two-level model with (maximum) 70 measurement points (14 days, 5 measurements each day) at the within-person level for 48 participants at the between-person level.

In the test of the hypothesis, the median of 6 of somatic symptoms severity was taken as the cut-off value to make two subgroups, one with low and one with medium to high somatic symptoms. To take account of individual differences in affective state levels, a random intercept, fixed slope model was calculated for each affective state (stress, sadness, irritation and increased happiness) separately as the dependent variables. Somatic symptom severity was defined as the predictor variable at the between-subjects level 2 whereas the physical states, namely muscle tension, breathing and body posture, were defined as fixed covariates in the model at the within-subjects level 1 (Field, 2009). Upon the calculation of the null model, intraclass correlations (ICC) were calculated to check how much variance in the dependent variable was attributable to differences between people. Additionally, the ICC informs about the power of the analysis together with the sample size. With smaller group samples it is recommended by Heck, Thomas, & Tabata (2014) to use REML to be more conservative.

Results

Sixty-four participants gave consent and finished the prescreening. If a subset of a questionnaire was not completed, that part of the survey was excluded from the analysis (pairwise deletion). The sample size finalizing the somatic symptom questionnaire was *n*=64, for body awareness *n*=58, and *n*= 48 for the affective and physical states. Most participants were female, with an average age of 23 years (range=18-30), with mostly German or Dutch nationality (Table 1 and Table 2).

Table 1. Representation of demographic variables.

Demographic variables	
Age, *M* (*SD*)	23.22 (3.052)
Gender, *n* (%)	
Male	22 (34.4%)
Female	42 (65.6%)
Nationality, *n* (%)	
German	26 (40.6%)
Dutch	25 (39.1%)
English	3 (4.7%)
Italian	2 (3.1 %)
Spanish	2 (3.1 %)
French	1 (1.6%)
Greek	1 (1.6%)
Turkish	1 (1.6%)
United States of America	1 (1.6%)
Venezuelan	1 (1.6%)
Peruvian	1 (1.6%)

Note. *M* = mean; *SD* = standard deviation.

Neither the association between maladaptive body awareness (Attention to unpleasant bodily sensations) and somatic symptom severity (PHQ-15) in linear regression analysis with bootstrapping was significant ($F(1, 56) = 3.043$, $p = .068$), with an R^2 of .052, nor the association between adaptive body awareness (Awareness of bodily sensations) and somatic symptom severity (PHQ-15) in linear regression analysis with bootstrapping revealed statistical significance ($F(1, 56) = .042$, $p = .842$), with an R^2 of .001.

Testing the ICCs of the four separate multilevel analyses justified the reasoning that daily observations were substantially clustered within people, as 14% (stress), 25% (sadness), 21% (irritation), 15% (increased happiness), of the variation in the affective states are attributable to differences between people (see Appendix Table 4, to Table 7). Table 2 shows fixed and random predictors of affective states: stress, sadness, irritation and increased happiness. The significant intercept estimates reflect that the baseline levels of the variables, sadness, irritation and increased happiness deviate from zero. The intercepts being higher than zero, represent relatively high baseline levels in the beginning as compared to later measurements. Somatic symptom severity was not a significant predictor of any of the four affective states. Higher muscle tension shows to have a significant association with all four affective states. In high levels of stress, sadness and irritation participants show to have more tensed muscles in comparison to increased happiness in which they reported more relaxed muscles. Fast breathing was significantly correlated with high stress levels and increased happiness but did not predict sadness or irritation. Moreover, a slumped body posture is related to higher levels of sadness whereas in increased happiness participants indicated to be more upright.

Looking at the interaction of somatic symptom severity and irritation with breathing frequency, which is part of the less parsimonious model, it shows to be significant (see Appendix, Table 6). Hence, for participants with higher somatic symptom severity, high irritation is associated with relatively slow breathing and low irritation with relatively fast breathing. This reveals low perception of coupling of irritation and breathing in people who are suffering from severe symptoms and is in favour of the third hypothesis. The other eleven tests of stress, sadness, irritation and increased happiness interactions with physical experiences were not significant. All between- and within-subject variabilities were significant, shown by the variation in prediction errors at level 1 and the variation in intercepts that can be explained across subjects, at level 2.

Post hoc analyses

Auxiliary analyses in this pilot study were done to examine interaction severity of somatic symptoms and physical experiences using three multilevel analyses for each physical state separately instead of including the three physical state-reports in one regression analysis. The results indicated similar results: all interactions were not significant with exception of the interaction of somatic symptom severity and irritation that showed to be significant for all physical states (muscle tension, breathing, body posture).

Table 2. Fixed and random predictors of affective states: stress, sadness, irritation and increased happiness.

	Estimates + (SE)			
Fixed Effects	**Stress**	**Sadness**	**Irritation**	**Increased Happiness**
Intercept	-2.823 (2.817)	17.346*** (2.390)	7.122 (2.109)**	9.541** (3.084)
SS	-2.136 (2.697)	-3.421 (2.487)	-2.751 (2.137)	3.658 (2.917)
Muscle Tension	.351*** (.037)	.096** (.028)	.196 (.026)***	-.181*** (.041)
Breathing	.143** (.045)	.020 (.034)	.017 (.031)	.131** (.049)
Body Posture	.041 (.035)	-0.135*** (.026)	-.036 (.024)	.332*** (.038)
Random Effects (Variance)				
Residual	345.682 (11.790)***	201.467 (6.877)***	167.592 (5.715)***	420.492 (14.335)***
Intercept	72.010 (18.896)***	64.925 (16.555)***	47.035 (12.035)***	84.628 (21.720)***

Note. Random intercept fixed slope models for each affective state separately (Stress, Sadness, Irritation, Increased Happiness). *n*=48. SE = standard error; SS = Somatic Symptoms: Somatic Symptoms is a between-subjects variable as a dichotomous measure of PHQ-15 with $0 \leq 6$ and $1 > 6$. The physical states reflect within-subjects variance. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed). The most parsimonious Model 1 is reported in this table for all affective states. See interactions in Table 4, Table 5, Table 6, Table 7.

Discussion

This pilot study investigated the link between physical symptoms and body awareness. The first part rejected the hypotheses that adaptive body awareness would be associated with less somatic symptoms and maladaptive body awareness with more severe somatic symptoms. This is not in favor of Mehling's argumentation of the existence of two subtypes of body awareness. The finding indicates that the body awareness as measured with the IAQ questionnaire may neither be maladaptive nor adaptive, or that adaptive body awareness helped to positively influence pain perception and develop a positive body relationship (Courtois et al., 2015; Sertel et al., 2017).

In the second part, momentary self-reports of stress were associated with more tensed muscles and faster breathing; as well as sadness with high muscle tension and a more slumped body posture; irritation with a higher muscle tonus; and increased happiness with relaxed muscles, an upright body position and faster breathing. These outcomes show how closely related the affective states are with the physical states and hence tentatively convey that affective states may alter muscle tension, breathing or body posture, or the other way round that a change of bodily states may change mental states. This indicates that mind-body therapies such as Yoga, Tai Chi or Feldenkrais may have potential salutary effects by moving the body with awareness to induce a state of embodiment (Mehling et al., 2013). However, it is important to realize that there are many more bodily sensations that influence how we understand our mental state, that there are many mental states that influence our physical experience, and that there are multiple factors that may influence our perception of both mental and physical states.

The tentative hypothesis that people with higher severity of somatic symptoms have a lower association between repeated measures of affective and bodily sensations, was confirmed for one of 12 tests for this sample. This single confirmation of the hypothesis is too low to accept it. The rejection could indicate that regardless of somatic symptom severity participants are able to perceive a connection between their affective state and bodily experiences. Furthermore, the outcome could yield that people with severe physical symptoms may experience their affective states in synergy with their bodily sensations. These interpretations need to be understood with the consideration that this study is not generalizable to the general public or patients with, for instance, somatic symptom disorder. The single significant interaction hints a possibility for different results when repeating the study in other populations. The outcome uncovers an incongruence in participants with higher

somatic symptom severity, as they experienced less synergy between irritation and pace of breathing than people low on somatic symptom severity.

The analysis in this pilot study might be a very first step into the direction towards an assessment of embodied mentalization. To answer the questions posed in the introduction if we can measure the link between affective and physical experiences - it is a 'yes'. This is a precursor for the assessment of embodied mentalization. Unclarity remains about how aware participants were about the mind-body connection i.e. embodied mentalization. The second question whether the strength of the association between affective and bodily depend on the severity of somatic symptoms is negated as 11 of 12 interaction were not promising for this sample but hinting towards a replication. More understanding of the concept of embodied mentalization and its subdomains is needed before a reliable assessment can be developed. To comprehend if body awareness (Kalisvaart et al., 2012) or emotional awareness (Waller & Scheidt, 2006) require more importance, more insight is needed in investigating their relationship with somatic symptom disorder and if and how embodied mentalization plays a role in somatic symptom disorder.

Limitations, Strengths and Future Research

Advantages of state measurements like EMA have led to its use in combination with mental and physical experience reporting. The fluctuations of the experiences can be measured over time which helps to deduce the typical states within subjects because the affective and physical states are highly influenced by different settings and time. Moreover, memories can be unreliable while reporting about past experience, especially with emotional and physical states that change momentarily (Bradburn et al., 1987). Thus, momentary assessments are helpful to minimize recall and retrospective bias (Bolger et al., 2003; Shiffman et al., 2008).

Several factors might have been responsible for the high dropout rate (*Table 3*). Most participants (73%) were not offered incentives, which may have caused more drop outs. In addition, certain challenges emerged using the app (EMA) such as not having received push notifications as a result of incorrect device' 'Notification' settings. Others received incorrect reminders to participate.

The findings of this study should be considered in light of their limitations. In a review of self-report measurements of body awareness, Mehling et al. (2009) criticized the lack of conceptual clarity of body awareness assessment. The wording of items barely distinguishes between different aspects of body awareness. This might have to do with the fact that until recently heightened body awareness was anticipated to lead to somatosensory amplification

(Mehling et al., 2009). Hence, many measures focused on symptoms which were rather evaluated as uncomfortable. To suit all perspectives of body awareness, the definition of the construct may have lost power and precision (Mehling et al., 2009).

Another factor that may have influenced the results is that dichotomous groups were created based on the median of the PHQ-15 questionnaire while the score distribution was normal. Using PHQ-15 as a continuous variable and probe it as suggested by Aiken et al., (1991) might have yielded a different outcome, because in our analysis the group with the most frequent scores in the middle was distributed across the two groups.

Moreover, the EMA questionnaire provided no option for participants to respond with 'I don't know how I feel' or 'I don't know how I perceive my body'. Some participants might have been unaware of their physical and/or mental state in some measurements. This response should be implemented in future questionnaires. The attempt to capture awareness of a mind-body connection could be additionally used as a covariate or variable in future analyses.

Future studies could also examine proprioceptive body awareness to investigate if a disturbance in interoceptive or proprioceptive awareness are correlated with somatic symptom severity. Furthermore, an investigation of the trait aspects of emotional awareness, for example measured by the Levels of Emotional Awareness Scale (LEAS), could gain insight into a possible correlation between low emotional awareness and somatic symptom severity and to compare it to the state measures of emotional awareness (EMA). Similarly, the already existing data could be analyzed focusing on the comparison of trait measures of body awareness (IAQ) and state measures of body awareness (EMA) to check if they yield similar correlations with somatic symptoms within the same participants. Moreover, dynamic (time-lagged) covariances between state variables like affect and self-perceived body posture, muscle tension and breathing could be examined with the current data.

Having a trait questionnaire that includes all relevant subdomains of body awareness like interoceptive, proprioceptive and emotional awareness could have led to more insight into the relationship of aspects of awareness and somatic symptoms. In addition, all the trait measurements of awareness could have been compared with the state measurements (EMA) of embodied mentalization. As a suggestion for future research, the Multidimensional Assessment of Interoceptive Awareness (MAIA) could be used as it combines the proposed aspects (Mehling et al., 2012). These comparisons could help the development of improved assessment methods for patients suffering from severe somatic symptoms by understanding which type of awareness is most relevant to research and if trait or state measurements are more suitable.

Conclusion

Conclusively, the pilot study extends research on somatic symptom disorder in three ways. First, the hypothesized relationships between the types of adaptive and maladaptive body awareness, suggested by Mehling, and somatic symptoms severity were rejected. Further investigations in the patient population are advised. Secondly, the findings confirm a link between bodily signals and mental states like stress, sadness, irritation and happiness. Additionally, these associations tentatively support the idea that through manipulation of our bodily state we may be able to change our mental states. Third, the incongruence for people with higher symptom severity, between high irritation and slow breathing, opposite to the expected direction, could be an indicator for a disturbance in the awareness. Using Ecological Momentary Assessment as a first innovative attempt to measure embodied mentalization may be a way to assess the synergies between mental and physical somatic symptoms which could have practical implications for diagnosing and treatment planning in therapy. Further investigation of the EMA in the population with somatic symptom disorder is needed to have more generalizable outcomes. This pilot study is a very first step in the understanding of the role of body awareness, affects and physical sensations in relation to somatic symptoms although improvements of the procedure and more sophisticated analyses are necessary.

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Appendix

Table 3. Descriptive statistics of explanatory variables.

Measure	*M*	*SD*	Range	Frequency	%
Gender					
Female				22	34.4
Male				42	65.6
Age	23.22	3.052		64	100
Somatic Symptoms (PHQ-15)	6.902	3.708	1 - 30	64	100
Body Awareness (IAQ-19 - 1. measurement)					
Adaptive (Awareness to bodily sensations)	3.193	.445	1 - 5	58	90.63
Maladaptive (Attention to unpleasant bodily sensations)	3,191	.574	1 - 5	58	90.63
Body Awareness (IAQ-19 - 2. measurement)					
Adaptive (Awareness to bodily sensations)	3.184	.453	1 - 5	26	40.63
Maladaptive (Attention to unpleasant bodily sensations)	3.072	.668	1 - 5	26	40.63

Table 4. Multi-Level Models predicting Stress from Somatic Symptoms, Physical States and their Interactions.

	Null Model		Model 1		Model 2	
Parameter	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*
Fixed Effects						
Intercept	21.404***	1.288	-2.823	2.817	-4.185	3.311
SS			-2.136	2.697	1.035	4.940
MT			0.351***	0.037	0.347***	0.045
B			0.143**	0.045	0.185**	0.057
BP			0.041	0.035	0.032	0.045
SS x MT					0.021	0.080
SS x B					-0.108	0.093
SS x BP					0.020	0.071
Random Effects	Variance		Variance		Variance	
Residual	383.269***	13.048	345.361***	11.770	345.682***	11.790
Intercept	63.908***	17.072	72.158***	18.978	72.010***	18.896
-2*LL	15698.024		15528.254		15536.777	
Δ – 2*LL			169.77***		-8.523	

Note. Models are random intercept fixed slope models. *N*=48. Model 1 was compared to the Null Model; Model 2 was compared to Model 1 to estimate respective model fit increase.

Δ = difference; SE = standard error; LL = log likelihood. SS = Somatic Symptoms; MT = Muscle Tension; B = Breathing; BP = Body Posture.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

Table 5. Multi-Level Models predicting Sadness from Somatic Symptoms, Physical States and their interactions.

	Null Model		Model 1		Model 2	
Parameter	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*
Fixed Effects						
Intercept	14.855***	1.286	17.346***	2.390	18.342***	2.737
SS			-3.421	2.487	-5.795	4.029
MT			.096**	.028	.089*	.034
B			.020	.034	.031	.043
BP			-.135***	.026	-.161***	.034
SS x MT					.017	.061
SS x B					-.030	.071
SS x BP					.064	.054
Random Effects	Variance		Variance		Variance	
Residual	204.588***	6.971	201.324***	6.865	201.467***	6.877
Intercept	70.134***	17.505	64.671***	16.438	64.925***	16.555
-2*LL	14611.759		14588.829		14598.818	
Δ – 2*LL			22.93***		-9.989	

Note. Models are random intercept fixed slope models. *N*=48. Model 1 was compared to the Null Model; Model 2 was compared to Model 1 to estimate respective model fit increase.

Δ = difference; SE = standard error; LL = log likelihood. SS = Somatic Symptoms; MT = Muscle Tension; B = Breathing; BP = Body Posture.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

Table 6. Multi-Level Models predicting Irritation from Somatic Symptoms, Physical States and their interactions.

	Null Model		Model 1		Model 2	
Parameter	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*
Fixed Effects						
Intercept	14.117***	1.069	7.122**	2.109	2.722	2.444
SS			-2.751	2.137	7.691*	3.603
MT			.196***	.026	.223***	.031
B			.017	.031	.076	.039
BP			-.036	.024	-.028	.031
SS x MT					-.064	.055
SS x B					-.137*	.065
SS x BP					-.016	.049
Random Effects	Variance		Variance		Variance	
Residual	174.611***	5.952	167.592***	5.715	166.420***	5.680
Intercept	47.141***	12.129	47.035***	12.055	48.287***	12.309
-2*LL	14312.536		14250.446		14248.506	
Δ – 2*LL			62.09***		1.94	

Note. Models are random intercept fixed slope models. *N*=48. Model 1 was compared to the Null Model; Model 2 was compared to Model 1 to estimate respective model fit increase.

Δ = difference; SE = standard error; LL = log likelihood. SS = Somatic Symptoms; MT = Muscle Tension; B = Breathing; BP = Body Posture.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

Table 7. Multi-Level Models predicting Increased Happiness from Somatic Symptoms, Physical States and their interactions.

	Null Model		Model 1		Model 2	
Parameter	Estimate	*SE*	Estimate	*SE*	Estimate	*SE*
Fixed Effects						
Intercept	24.368***	1.440	9.541**	3.084	8.517*	3.646
SS			3.658	2.917	6.204	5.433
MT			-0.181***	0.041	-0.152**	0.050
B			0.131**	0.049	0.149*	0.063
BP			0.332***	0.038	0.307***	0.049
SS x MT					-0.085	0.088
SS x B					-0.031	0.103
SS x BP					0.066	0.079
Random Effects	Variance		Variance		Variance	
Residual	446.159***	15.178	420.292***	14.315	420.492***	14.335
Intercept	80.953***	20.554	83.855***	21.492	84.628***	21.720
-2*LL	15962.066		15865.499		15873.074	
Δ – 2*LL			96.567***		-7.575	

Note. Models are random intercept fixed slope models. *N*=48. Model 1 was compared to the Null Model; Model 2 was compared to Model 1 to estimate respective model fit increase.

Δ = difference; SE = standard error; LL = log likelihood. SS = Somatic Symptoms; MT = Muscle Tension; B = Breathing; BP = Body Posture.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

Ecological Momentary Assessment

English version:

Objective of EMA and body experience study:

The components of emotions are:

1. Expressions and behavior (e.g. body posture)
2. Fight-flight physiology (e.g. breathing and muscle tension)
3. Self-reported feelings

Our main objective is to question if patients of Eikenboom and Breburg have less ability to link their physical experiences to their affective states (stress, sadness, anxiety, anger a.s.o). First, participants are asked about mental and physical experiences. Subsequently participants are asked to which extent they perceive a link between the components of the mental and physical experiences.

Questions 5 times a day (random times):

- Physical sensations of emotions (body posture, muscle tensions, breathing)
- Mental states (stress, sadness, irritation, increased happiness)
- Perception of link/coupling → mentalization: identifying a meaningful link between mental states and physical sensations

Baseline questions:

1 What is your participant number?

2 Choose now in which language and the time interval during the day you would like to fill in the questionnaires (i.e., notifications are generated randomly during this time interval)? Choose wisely, you cannot change it during the study.

[single choice]:

English; 9:00 - 21:00 hrs → *option 1*

English; 10:00 - 22:00 hrs → *option 2*

English; 11:00 - 23:00 hrs → *option 3*

Dutch; 9:00 - 21:00 hrs → *option 4*

Dutch; 10:00 - 22:00 hrs → *option 5*

Dutch; 11:00 - 23:00 hrs → *option 6*

Ecological Momentary Assessment:

1 In the past 15 minutes my **muscle tension** was [in respect to my normal muscle tension]:

[0-100] A lot lower, Lower, Normal, Higher, A lot higher

2 In the past 15 minutes my **breathing** was [in respect to the normal speed of my breath]:

[0-100] A lot slower, Slower, Normal, Faster, A lot faster

3 In the past 15 minutes my **body posture** was [in respect to my normal body posture]:

[0-100] A lot more slumped , More slumped, Normal, More upright, A lot more upright

4 This is how **stressed** This is how

[0-100] Not at all, Slightly, Moderately, Very, Extremely

5 [4>= 20] In the past 15 minutes, my **muscle tension** matched this **stress** level:

[0-100] Not at all, Slightly, Moderately, Very, Extremely

6 [4>= 20] In the past 15 minutes, my **breathing** matched this **stress** level:

[0-100] Not at all, Slightly, Moderately, Very, Extremely

7 [4>= 20] In the past 15 minutes, my **body posture** matched this **stress** level:

[0-100] Not at all, Slightly, Moderately, Very, Extremely

8 This is how **sad** I was feeling in the last 15 minutes:

[0-100] Not at all, Slightly, Moderately, Very, Extremely

9 [8>= 20] In the past 15 minutes, my **muscle tension** matched this level of **sadness:**

[0-100] Not at all, Slightly, Moderately, Very, Extremely

10 [8>= 20] In the past 15 minutes, my **breathing** matched this level of **sadness:**

[0-100] Not at all, Slightly, Moderately, Very, Extremely

11 [8>= 20] In the past 15 minutes, my **body posture** matched this level of **sadness:**

[0-100] Not at all, Slightly, Moderately, Very, Extremely

12 This is how **irritated** I was feeling in the last 15 minutes:

[0-100] Not at all, Slightly, Moderately, Very, Extremely

13 [12>= 20] In the past 15 minutes, my **muscle tension** matched this level of **irritation:**

[0-100] Not at all, Slightly, Moderately, Very, Extremely

14 [12>= 20] In the past 15 minutes, my **breathing** matched this level of **irritation:**

[0-100] Not at all, Slightly, Moderately, Very, Extremely

15 [12>= 20] In the past 15 minutes, my **body posture** matched this level of **irritation:**

[0-100] Not at all, Slightly, Moderately, Very, Extremely

16 This is the amount of **increased happiness** I was feeling in the last 15 minutes (as compared to normal):

[0-100] Not at all, Slightly, Moderately, Very, Extremely

17 [16>= 20] In the past 15 minutes, my **muscle tension** matched this level of **increased happiness:**

[0-100] Not at all, Slightly, Moderately, Very, Extremely

18 [16>= 20] In the past 15 minutes, my **breathing** matched this level of **increased happiness**:

[0-100] Not at all, Slightly, Moderately, Very, Extremely

19 [16>= 20] In the past 15 minutes, my **body posture** matched this level of **increased happiness**:

[0-100] Not at all, Slightly, Moderately, Very, Extremely

20 Thank you for completing the questionnaire. Feel free to add an event/keyword or anything that might be relevant here. Press '**Submit'** to send your responses.

[open textfield]

Dutch version:

Doelstelling EMA en lichaamsbeleving onderzoek:

De componenten van emotie zijn: 1) expressies en gedrag (o.a. lichaamshouding), 2) fight-flight fysiologie (ademhaling, spierspanning, etc.), 3) zelfgerapporteerde gevoelens. Patiënten

van de Eikenboom en Breburg hebben vaak geen idee van de koppeling tussen wat ze beleven in hun lichaam en wat ze mentaal voelen (stress, somberheid, angst, boosheid, etc.) en dat is eigenlijk de kern van wat we willen weten. We vragen eerst de componenten uit (wat voel je mentaal, wat merk je fysiek op), en daarna vragen we naar de mate waarin ze deze componenten van mentaal en fysiek voelen bij elkaar vinden passen (two sides of the same coin).

Uitvragen over:

- fysieke sensaties van emoties (lichaamshouding, spierspanning, snelheid ademhaling)

- mentale gevoelens (stress, somberheid, geïrriteerdheid, opgewektheid)

- een koppeling zien (onderkennen/herkennen/erkennen/bij elkaar vinden passen) tussen de fysieke sensaties van emoties en mentale gevoelens, en daaraan betekenis verlenen (mentaliseren)

Ecological Momentary Assesment:

1 Afgelopen 15 minuten was mijn **spierspanning**:

[0-100] Veel lager dan normaal Lager dan normaal Normaal Hoger dan normaal Veel hoger dan normaal

2 Afgelopen 15 minuten was mijn **snelheid van ademhalen**:

[0-100] Veel trager dan normaal Trager dan normaal Normaal Sneller dan normaal Veel sneller dan normaal

3 Afgelopen 15 minuten was mijn **lichaamshouding**:

[0-100] Veel meer ingezakt dan normaal Meer Ingezakt dan normaal Normaal Meer Rechtop dan normaal Veel meer rechtop dan normaal

4 Ik voelde mij afgelopen 15 minuten **gestrest**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

5 Afgelopen 15 minuten paste mijn normale, lagere of hogere **spierspanning** bij deze hoeveelheid **stress**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

6 Afgelopen 15 minuten paste mijn normale, tragere of snellere **ademhaling** bij deze hoeveelheid **stress**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

7 Afgelopen 15 minuten paste mijn normale, meer ingezakt of meer rechtop **lichaamshouding** bij deze hoeveelheid **stress**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

8 Ik voelde mij afgelopen 15 minuten **somber**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

9 Afgelopen 15 minuten paste mijn normale, lagere of hogere **spierspanning** bij deze hoeveelheid **somberheid**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

10 Afgelopen 15 minuten paste mijn normale, tragere of snellere **ademhaling** bij deze hoeveelheid **somberheid**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

11 Afgelopen 15 minuten paste mijn normale, meer ingezakt of meer rechtop **lichaamshouding** bij deze hoeveelheid **somberheid**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

12 Ik voelde mij afgelopen 15 minuten **geïrriteerd**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

13 Afgelopen 15 minuten paste mijn normale, lagere of hogere **spierspanning** bij deze hoeveelheid **irritatie**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

14 Afgelopen 15 minuten paste mijn normale, tragere of snellere **ademhaling** bij deze hoeveelheid **irritatie**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

15 Afgelopen 15 minuten paste mijn normale, meer ingezakte of meer rechtop **lichaamshouding** bij deze hoeveelheid **irritatie**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

16 Ik voelde mij afgelopen 15 minuten **opgewekt**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

17 Afgelopen 15 minuten paste mijn normale, lagere of hogere **spierspanning** bij deze hoeveelheid **opgewektheid**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

18 Afgelopen 15 minuten paste mijn normale, tragere of snellere **ademhaling** bij deze hoeveelheid **opgewektheid**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

19 Afgelopen 15 minuten paste mijn normale, meer ingezakt of meer rechtop **lichaamshouding** bij deze hoeveelheid **opgewektheid**:

[0-100] Helemaal niet Nauwelijks Een beetje Tamelijk Erg

20 Dank voor het invullen. Desgewenst kun je hier nog een relevante gebeurtenis invoeren waar sprake van was. Druk op **Verzend** om je antwoorden op te slaan.

[open textveld]