Multistudy Report

Are You Engaged With Bodily Signals?

Validation of the German Version of the Interoceptive Sensitivity and Attention Questionnaire (ISAQ) in Convenience Samples and Pathological Illness Anxiety

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Abstract: The conscious engagement with neutral and symptom-related bodily signals (i.e., interoceptive sensibility) is an important transdiagnostic factor whose assessment remains challenging. In two studies, we examined the psychometric properties and the validity of the German Interoceptive Sensitivity and Attention Questionnaire (ISAQ) assessing two convenience samples (N = 365 and N = 254), adults at risk for rosacea (N = 376) and 44 outpatients with pathological illness anxiety compared to 40 controls. Confirmatory factor analyses indicated the structure of the German ISAQ is best represented by the 3-factor model of the original version (F1: sensitivity to neutral bodily sensations, F2: attention to unpleasant bodily sensations, and F3: difficulty disengaging from unpleasant bodily sensations) with an acceptable model fit after consideration of modification indices. Reliability was acceptable for F1 and F2, but poor for F3. Higher correlations of F1 with measures of functional and of F2/F3 with measures of dysfunctional body focus indicated validity. Measurement invariance to the Dutch original was partially met. Persons with illness anxiety scored significantly higher in all ISAQ subscales. Comparable to the original, the German ISAQ is a valid instrument to assess neutral and negative body perception. The third subscale should be interpreted cautiously.

Keywords: interoception, interoceptive sensibility, illness anxiety, health anxiety, symptom perception

The processing of internal bodily signals (i.e., interoception) is involved in many important functions such as allostasis, emotional experience, and decision-making, including the judgment of whether one is healthy or sick (for example, Khalsa et al., 2018; Kleckner et al., 2017). Interoception contains several (un)conscious processing levels and the division in subfacets is discussed by different frameworks (for the most cited variant see Garfinkel et al., 2015; for recent approaches see Desmedt et al., 2023; Suksasilp & Garfinkel, 2022). One important sub-facet in all frameworks contains the subjective beliefs concerning bodily signals. This facet was termed interoceptive sensibility (Garfinkel et al., 2015), self-report and interoceptive beliefs (Suksasilp & Garfinkel, 2022), or interoceptive interpretation (Desmedt et al., 2023). Initially, individual assumptions concerning one's interoceptive ability, as well as how someone feels engaged by and responds to interoceptive signals were included (Garfinkel et al., 2015). Various self-reports have been developed to assess aspects of interoceptive sensibility. For example, self-reports of confidence in interoceptive accuracy (Brand et al., 2023; Murphy et al., 2020), sensing bodily sensations or symptoms (Gabriele et al., 2022), or interpreting and handling interoceptive signals were summarized under this term (Garfinkel et al., 2015). Independent factors of interoceptive sensibility were found in a recent study analyzing the most frequently used

instruments (Desmedt et al., 2023). This is in line with the assumption of interoceptive sensibility itself being an umbrella term for various aspects concerning the interpretation of bodily signals.

The heterogeneity of interoceptive sensibility operationalizations can be explained by the fact that questionnaires come from different research traditions. First, in accordance with Barsky's concept of somatosensory amplification (Barsky et al., 1988), sensibility for *bodily symptoms* is estimated by some instruments. For example, sensibility for jitteriness, swallowing, and constipation is assessed by the awareness subscale of the Body Perception Questionnaire (BPQ, Cabrera et al., 2018). In high somatic symptom perceivers, sensibility for bodily symptoms often goes along with negative affect (Bogaerts et al., 2022) and negative interpretations like catastrophic outcome beliefs (Barsky, 1992). High sensibility for bodily symptoms was positively related to illness anxiety and alexithymia, the inability to recognize and describe one's emotions (Ernst et al., 2014; Longarzo et al., 2015).

Second, some scales (e.g., Body Awareness Questionnaire [BAQ], Shields et al., 1989; Three-domain Interoceptive Sensations Questionnaire [THISQ], Vlemincx et al., 2023) are measures of sensibility for *neutral bodily sensations* (e.g., energy level) and perception of bodily responses or changes. In line with the assumption of higher precision and flexibility of sensible persons (Ainley et al., 2016), negative relations were found between sensibility for neutral bodily sensations and alexithymia (note that effect sizes were rather small; Zamariola et al., 2018) and a positive relation with emotional clarity (Tsur et al., 2016). Going a step further, Mehling and colleagues developed the Multidimensional Assessment of Interoceptive Awareness (MAIA) to assess non-judgmental acceptance, curiosity, and open sensibility for body sensations in the tradition of mind-body therapies (Mehling et al., 2011). Furthermore, the MAIA was designed to gauge the ability to regulate attention to the body, integrate mind and body, and assess the degree of trust in the body (Mehling et al., 2012). It thereby captures body sensation handling after initial perception.

Different aspects of interoceptive sensibility will probably relate differentially to the (pathological) experience of emotions and bodily symptoms. Therefore, it is interesting to map sensibility to neutral as well as symptom-related bodily signals in one inventory. Recently, the Interoceptive Sensitivity and Attention Questionnaire (ISAQ) was developed with the goal of separating self-reports of the perception of *neutral bodily sensations* versus unpleasant *bodily symptoms* and including a broad range of sensations from several bodily domains (Bogaerts et al., 2022). Initially, the inventory was designed to assess two factors. However, for the Dutch version of the ISAQ, Bogaerts and colleagues (2022) found a 3-factor solution including "sensitivity to neutral bodily sensations" (F1), "attention to unpleasant sensations" (F2), and "difficulty disengaging from unpleasant bodily sensations" (F3). Furthermore, dependent on diagnoses, different profiles with regard to the three subscales were found (seven different conditions were examined, for example, patients with medically unexplained syndromes, fibromyalgia/chronic fatigue, panic disorder, and controls). Patients with medically unexplained symptoms and patients with fibromyalgia/chronic fatigue scored higher on F1 compared to patients with panic disorders and controls. Patients with panic disorder scored highest on F2, followed by patients with medically unexplained symptoms and fibromyalgia/chronic fatigue, who scored higher compared to controls. Only patients with panic disorders had higher F3 scores than controls.

Aims of the Present Studies

We presented participants from four studies with the German translation of the ISAQ. The factor structure, reliability as well as convergent and discriminant validity, were evaluated in two convenience samples and adults at risk for rosacea. Based on findings with the Dutch ISAQ we assumed that a 3-factor solution would fit the German ISAQ translation (Bogaerts et al., 2022). Regarding convergent and discriminant validity, we assumed stronger associations of F1 with other instruments capturing the perception and attention to neutral body sensations and stronger associations of F2 and F3 with instruments on dysfunctional body focus, as well as anxiety. We further explored the relationship between emotion awareness and mindfulness. Psychopathological differences in the ISAQ were assessed in patients with illness anxiety and a control group. Based on previous findings by Bogaerts et al. (2022), we expected increased ISAQ scores for patients with illness anxiety, particularly on F2. Based on the results of the initial ISAQ validation, we also supposed increased scores of patients with illness anxiety on F1.

Methods

Design and Analysis Transparency

We report how we determined our sample size, all data exclusions, all data inclusion/exclusion criteria, whether inclusion/exclusion criteria were established prior to data analysis, all measures in the study, and all analyses including all tested models. If we use inferential tests, we report exact p values, effect sizes, and 95% confidence or credible intervals.

Participants and Procedure

The English version of the ISAQ including 19 items (provided alongside the Dutch version by Bogaerts et al., 2022) was forward- and backward-translated from English into German following recommendations by Brislin (1970). The backward translated version matched the original questionnaire well, we only had to use two German words ("Hals/Rachen") for translating "throat" to capture the targeted body area. Following the item reduction process of the original 19-item version, two items (noticing physical responses to changes in weather, and difficulty turning attention from exhaustion) were excluded from further analyses to form the 17-item ISAQ.

We collected data from two adult convenience samples that participated in an online survey for the validation of the ISAQ (sample 1) or filled out the ISAQ as part of a laboratory study (sample 2). We also included data from adults at risk for rosacea, a chronic skin condition that primarily affects the face, causing redness, flushing, visible blood vessels, and sometimes small, red, pus-filled bumps (sample 3), and in patients with pathological illness anxiety versus matched controls (sample 4). All data were collected via computer cross-sectionally between 2018 and 2022, either through online surveys (samples 1 and 3) or as part of a laboratory assessment (samples 2 and 4). Participants were recruited via social media, newsletters, flyers at local institutions (e.g., universities, clinics), or newspaper reports. Ethical approval was granted by the University of Cologne (reference number: AGHF000), the University of Mainz (reference number: 2021-JGU-psychEK-020), and the German Psychological Society DGPs (reference number: AS 092017). The main inclusion criterion was age (18 years and older). Individuals at high risk of rosacea were identified by a positive rosacea screening using the Rosascreen self-report questionnaire (Tan et al., 2016; the German version with cut-off calculation information was provided by Nabil Kerrouche after personal correspondence). In sample 4, patient inclusion criteria were (a) diagnosis of somatic symptom disorder (SSD) or illness anxiety disorder according to DSM-5, and (in case of SSD disorder)/or Fink criteria for hypochondriasis (Fink et al., 2004), and a Whiteley-Index (Pilowsky, 1967) score > 7. Only complete datasets were included (listwise deletion). The detailed inclusion and exclusion criteria, loss of data, and all established prior data analysis can be found in Supplement A. All participants gave informed consent for participation. In samples 1 to 3, participants were reimbursed (voucher raffle, 30€ for full participation, 8.50€ per hour, respectively).

A total of 1079 individuals, were analyzed. Across studies, the mean age was 36.72 (*SD* 14.78), ranging from 18 to 78 years. Around four in five participants identified as women (n = 837, 77.6%), and 76.5% (n = 825) had a high level of education (A-level and above). In the convenience samples (samples 1 and 2), 364 out of 619 participants (58.8%) were university students. Table 1 contains detailed participant characteristics.

Instruments

The ISAQ was administered in all samples. If not otherwise stated, the following instruments were assessed as part of sample 1, and reliabilities are reported for the current studies. Furthermore, demographic characteristics were assessed (see Table 1). For a full list of questionnaires included in the four samples, see Supplement A.

Interoceptive Sensitivity and Attention Questionnaire (ISAQ)

The sensitivity and attention to a broad range of either neutral or unpleasant bodily interoceptive stimuli (cardiovascular, respiratory, gastrointestinal, cerebral, energy level, posture and muscles, and thermoregulation) were measured using the initial 19-item version of the ISAQ (Bogaerts et al., 2022). Answers were rated on a 5-point scale (1 = *strongly disagree* to 5 = *strongly agree*). The German ISAQ can be found in Supplement B.

Attention to Neutral Body Sensations and Self-Reported Interoceptive Accuracy

The Body Awareness Questionnaire (BAQ; Shields et al., 1989) measures self-reported attentiveness to non-emotive bodily processes (e.g., "I know I'm running a fever without taking my temperature") in 18 statements with an answer scale from 1 (= *not at all true about me*) to 7 (= *very true about me*). Reliability was α = .83.

The Interoceptive Accuracy Scale (IAS) assesses how accurately individuals perceive internal bodily sensations (Murphy et al., 2020) in 21 items (e.g., Item 9: "I can always accurately perceive when I am going to sneeze") which are rated on a 5-point scale from 1 (= *strongly disagree*) to 5 (= *strongly agree*) that form a unidimensional factor (Brand et al., 2022). It was administered in sample 2, reliability was α = .87.

Dysfunctional Body Focus

The Somatosensory Amplification Scale (SSAS) measures the tendency to experience somatic sensations as intense, noxious, and disturbing (Barsky et al., 1990). Participants respond to 10 items on a 5-point scale ranging from 0 (= *very inapplicable*) to 4 (= *very applicable*). Reliability was α = .73.

The Pain Catastrophizing Scale, PCS (Sullivan et al., 1995) evaluates cognitions about potentially harmful noxious stimuli on three subscales (rumination, magnification,

Table 1. Participant characteristics

	Sample 1 (online-survey convenience sample)	Sample 2 (laboratory experiment convenience sample)	Sample 3 (Rosacea screening)	Sample 4 (pathological illness anxiety and controls)	
	N = 365	*N* = 254	*N* = 376	Controls (*n* = 40)	Patients (*n* = 44)
Age (*M*, *SD*, range)	32.38 (13.48), 18–78	28.51 (10.74), 19–66	45.88 (13.38), 18–78	37.33 (14.01), 18–65	41.27 (14.27), 18–65
Gender: identified as women (*n*, %)	271 (74.2)[1]	174 (68.5)[2]	344 (91.5)	24 (60)	24 (54.5)
Education (*n*, %)[3]				*n* = 39	
Low	10 (2.8)	8 (3.1)	7 (1.9)	–	–
Medium	44 (12.1)	9 (3.5)	157 (42.4)	5 (12.8)	7 (15.9)
High	311 (85.2)	237 (93.3)	206 (55.7)	34 (87.2)	37 (84.1)

Note. [1]*n* = 91 (24.9%) identified as men and *n* = 3 (0.8%) as diverse. [2]*n* = 78 (30.7%) identified as men and *n* = 2 (0.8%) as diverse. Note that identification with diverse gender was not examined in samples 3 and 4. [3]Complete data, excluding unspecified answers. Education: High = A level and above (tertiary entrance requirements); Medium = secondary school certificate/completed vocational training; Low = less than secondary school certificate/no graduation.

and hopelessness). Thirteen statements about those cognitions are rated on a 5-point scale ranging from 0 (= *not at all*) to 4 (= *always*). Reliability was α = .90.

Somatic symptom distress was evaluated by the Patient Health Questionnaire, somatic symptom scale, PHQ-15 (Kroenke et al., 2002) in samples 1 and 2, which covers the most typical somatic complaints in primary care. They are rated regarding their burdensomeness in the past 4 weeks (0 = *not bothered at all* to 2 = *bothered a lot*). The total score ranges between 0 and 30 points. Reliabilities were α = .68 (sample 1) and α = .78 (sample 2).

In sample 2, the German version of the 12-item Somatic Symptom Disorder B-Criterion Scale (SSD-12) (Toussaint et al., 2016) was administered for psychobehavioral symptoms of the somatic symptom disorder, including affective (e.g., distressing illness worries), cognitive (e.g., catastrophic interpretation of bodily sensations), and behavioral (e.g., interference with daily life) reactions to persistent somatic symptoms. The response scale ranges from 0 (= *never*) to 4 (= *very often*), and reliability in the current study was α = .92.

Illness anxiety was measured with the 14-item modified Short Health Anxiety Inventory (mSHAI) (Bailer & Witthöft, 2006) using a 5-point answer scale (0 = *strongly disagree* to 4 = *strongly agree*). Reliability was α = .90.

Anxiety

The Generalized Anxiety Disorder Questionnaire, GAD-7 (Spitzer et al., 2006) includes seven symptoms of general anxiety that are rated for the last 2 weeks on a 4-point scale ranging from 0 (= *not at all*) to 3 (= *nearly every day*). Reliability was α = .86.

Social anxiety was assessed in sample 3 via the Social Phobia Scale (SPS) which consists of 20 items measured on a 5-point Likert-type scale (1 = *not at all* to 5 = e*xtremely*). This scale is typically divided into three factors: Fear of Negative Evaluation, Social Interaction Anxiety, and Fear of Public Speaking. Reliability for the total scale was α = .94.

Emotion Awareness and Reactivity

Alexithymia (i.e., the inability to perceive and express emotional needs) was measured in sample 2 by the German version of the Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994), with a 5-point scale from 1 (= *strongly disagree*) to 5 (= *strongly agree*) that form a three factorial structure: Difficulties Describing Feelings [DDF], Difficulties Identifying Feelings [DIF], and External Oriented Thinking [EOT] (Parker et al., 2003). Reliabilities were α = .77 (DDF), α = .80 (DIF), and α = .52 (EOT).

The Perth Emotional Reactivity Scale (PERS; Becerra et al., 2019) was used to capture the three dimensions of activation, intensity, and duration of emotional reactivity for emotions with positive and negative valence. Participants respond to 30 items on a 5-point scale ranging from 1 (= *very unlike me*) to 5 (= *very like me*). For all scales, higher scores reflect stronger emotional reactivity, that is emotions are activated more quickly/easily, are more intense, or longer-lasting. The subscales of the same valence can be combined into the superordinate scales General negative reactivity and General positive reactivity. Reliabilities were α = .92 (negative reactivity) and α = .88 (positive reactivity).

Mindfulness

The Mindfulness Attention and Awareness Scale (MAAS; Michalak et al., 2011) captures directing attention to the present moment and includes 15 items that form a unidimensional scale. Answers are rated on a 6-point scale ranging from 1 (= *almost always*) to 6 (= *almost never*). Item scores were inverted to indicate higher mindfulness. Reliability was α = .86.

Data Analysis

Supplement A contains the number of participants that were excluded. Item descriptives, including distribution characteristics and item-total scale correlations, were calculated based on raw data. We used confirmatory factor analysis (CFA) to confirm the 3-factor structure of the ISAQ:

sensitivity to neutral bodily sensations (F1), attention to unpleasant bodily sensations (F2), and difficulty disengaging from unpleasant bodily sensations (F3) (Bogaerts et al., 2022). In Study 1, analyses were carried out separately in samples 1, 2, and 3 and then repeated in a collapsed sample from both convenience samples (1 and 2) to detect potential differences due to lower statistical power. Since Likert-type scales can be considered to produce categorical data (Flora & Curran, 2004), weighted least-squares with mean and variance adjustment (WLSMV) was chosen as a robust and distribution-free estimation method, which fits a polychoric correlation matrix estimated directly from observed data (Li, 2016). To avoid estimation problems, infrequent response categories were collapsed with neighbor categories to reach cell frequencies $\geq$ 5% (DiStefano et al., 2020). Supplement C lists the collapsed items. The model fit was determined using the Root Mean Square Error Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Standard Root Mean Square Residual (SRMR). At least two indices were required to fulfill the following cut-off criteria for good model fit: RMSEA smaller than .06, CFI/TLI $\geq$ 0.90, and SRMR $\leq$ .08 (Browne & Cudeck, 1992; Hu & Bentler, 1998). Standardized factor loadings and factor correlations are reported. In a second step, modification indices were inspected to examine whether there are systematic (i.e., occurring across studies), meaningful (i.e., in accordance with the theoretical framework and item formulation), and significant (i.e., expected χ^2 change, improvement in model fit) co-variations that should be considered. Analyses were then rerun with these modifications and improvement in model fit was inspected, including χ^2 difference tests. Internal consistency of the subscales was assessed by Cronbach's alpha (α). The convergent and divergent validity of the subscales were investigated based on the correlations with conceptually relevant constructs assessed across samples 1–3: perception and attention to neutral bodily sensations (BAQ, IAS), dysfunctional bodily focus (SSAS, PCS, mSHAI, PHQ-15, SSD-12), as well as anxiety (GAD-7, SPS), emotion awareness (PERS, TAS-20), and mindfulness (MAAS). Effects are interpreted according to Cohen (1988). To examine the measurement invariance of the best-fitting model in the collapsed samples 1 and 2 compared to the data from the original ISAQ version (Bogaerts et al., 2022), multi-group CFA procedures as outlined by Brown et al. (2015) were employed. Sequentially, we tested for configural invariance (i.e., model fit indices on the full sample achieve the aforementioned benchmarks for good model fit), metric invariance, and scalar invariance (both assessed using the difference in CFI between metric and configural invariance model, ΔCFI < 0.01).

In Study 2 (sample 4), patients were compared to healthy controls using independent *t*-tests and χ^2-tests. Analyses were performed using SPSS v.23, Mplus v.7.3 (Muthén & Muthén, 1998–2012) and JASP v.0.17.3.0 (JASP Team, 2023).

Results

Factorial Structure

The fit of the 3-factor model was examined in Study 1 using CFA (Table 2). The 3-factor model showed a near-acceptable model fit (Browne & Cudeck, 1992) and fit indices were largely comparable across studies (see Table 2). The CFA for collapsed data of convenience samples 1 and 2 (N = 619, $\chi^2(116)$ = 399.38, RMSEA = .063 [.056, .070], CFI = .890, TLI = .871, SRMR = .063) produced results similar to the single samples.

In sample 1, factor loadings for the original 3-factor model ranged from 0.210 (Item 12, "I suppress headaches when they occur") to 0.801 (all *p*s < .001). In sample 2, factor loadings ranged from 0.284 (Item 11, "I quickly notice changes in my blood pressure without having to measure this explicitly") to 0.810 (all *p*s < .001), and in sample 3 from 0.312 (item 7, "When my stomach feels bloated, I usually don't focus on this") to 0.816 (all *p*s < .001), see Supplement D for details.

The inspection of modification indices in samples 2 and 3 suggested improved model fit by allowing correlated error terms for two items of F1, item 9 ("As soon as I wake up in the morning, I know how much energy I am going to have during the day") and 13 ("When there is a considerable increase or decrease in my physical activity, I can predict exactly how this change will affect my energy levels"). This seemed plausible given their relationship with sensing energy levels. We reran the modified two-factor model across all studies. The modified model (B) fitted the data significantly better than the original three-factor model (A), yet some indices did not yet indicate good model fit (see Table 2). Accordingly, we made another specification search. Modification indices in sample 3 indicated improved model fit by allowing for a double loading of item 7 ("When my stomach feels bloated, I usually don't focus on this") on F3 (inhibition) and F2 (attention). This seemed plausible since this item uses the term "focus" which is a semantic characteristic for all other items related to F2. Combining this double loading with correlated-error terms (C) led to a significant, albeit small improvement in χ^2 values and model fit indices over model (B) for samples 1 and 3 but not for sample 2. In this modified three-factor model (C), model fit was acceptable for samples 2 and 3 (at least two fit indices met the requested criterion), while it remained near acceptable for sample 1. Further item statistics (means, *SD*s, corrected item-total correlations) can be found in Supplement D.

Table 2. Fit statistics for the confirmatory factor analysis (CFA) of the original and modified 3 factor models of the German ISAQ

Factor model	Sample	$\chi^2(df)$, p	RMSEA [95% CI]	CFI	TLI	SRMR	$\Delta\chi^2(df)$, p
(A) Three-factor model	1	278.36 (116)***	.062 [.053, .071]	.896	.878	.068	–
	2	228.79 (116)***	.062 [.050, .074]	.884	.864	.076	–
	3	321.90 (116)***	.069 [.060, .078]	.881	.861	.069	–
(B) Modified three-factor model with two correlated δs[a]	1	270.56 (115)***	.061 [.052, .070]	.901	.883	.067	8.75 (1)**
	2	213.90 (115)***	.058 [.046, .070]	.898	.879	.074	22.57 (1)***
	3	290.77 (115)***	.064 [.055, .073]	.899	.880	.067	34.12 (1)***
(C) Modified three-factor model with two correlated δs and double loading of item 7[b] on F2 and F3	1	266.01 (114)***	.060 [.051, .070]	.903	.884	.066	4.77 (1)*
	2	215.05 (114)***	.059 [.047, .071]	.896	.876	.073	0.97 (1), p = .324
	3	244.94 (114)***	.055 [.046, .065]	.924	.910	.059	19.48 (1)***

Note. $\Delta\chi^2$ = Chi-square difference testing (model A vs. B. and B vs. C). [a]Items 9 (knowing energy during the day) and 13 (predict change in energy levels). [b]Item 7 (no focus bloated stomach). ***p < .001; **p < .01; *p < .05.

In Study 1, factor correlations for F1 and F2 were moderate to largely positive across samples (original three-factor model A). Correlations between F1 and F3 as well as F2 and F3 were more heterogeneous across samples and partly did not reach significance, see Supplement E.

Measurement Invariance

The fit indices of the measurement invariance tests of the original three-factor model can be found in Supplement D. Configural invariance was indicated by good model fit in the full sample (N = 1,413), suggesting that the factor structure was the same across the subsamples of Dutch and German versions. The metric invariance model also fits the data well, as indicated by a CFI difference < 0.01. However, scalar invariance across the Dutch and German versions was not met, with poorer model fit (RMSEA = 0.068, TLI = 0.742, CFI = 0.751) and CFI difference above the threshold (ΔCFI = 0.143).

Reliability

Table 3 contains the reliabilities across studies for the three subscales of the ISAQ as proposed by Bogaerts et al. (2022). The reliability of two of the scales F1 and F2 were acceptable (α = .69 to .81), while the reliability of F3 was consistently poor (α = .41 to .62).

Validity

Convergent validity of the scale sensitivity to neutral bodily sensations (F1) was supported by the strongest correlation with the perception of neutral bodily sensations, as assessed by the BAQ, as well as a moderate correlation with self-reported interoceptive accuracy (IAS). We found a positive F1 correlation to emotional reactivity (both valences). Divergent validity for this factor was established by smaller correlations with measures of dysfunctional body focus (PCS, PHQ-15, SSD-12, mSHAI, anxiety (GAD-7, SPS), or alexithymia (TAS-20), all rs $\leq$ .23, however, SSAS was related moderately with F1 (r = .44) and F2 (r = .42). The attention to unpleasant bodily sensations scale (F2) showed small to moderate correlations with measures of dysfunctional bodily focus (highest correlation with SSAS). However, the relation with the SSAS was comparable to the F1 relation with this scale. As for the divergent validity, correlations were weaker with the perception of neutral bodily sensations and self-reported interoceptive accuracy (BAQ, IAS). There was a small relation of F2 with emotional reactivity concerning negative emotions, but no significant relation with alexithymia. The difficulty disengaging from unpleasant bodily sensations scale (F3) correlated the highest with somatosensory amplification (SSAS), pain catastrophizing (PCS), and illness anxiety (mSHAI) as indicators of dysfunctional bodily focus. In contrast to these associations, correlations of F2 were descriptively lower with measures of anxiety as well as neutral bodily perception and interoceptive accuracy (BAQ, IAS). All correlations are presented in Table 4.

Results from Study 2 showed significantly higher ISAQ scale scores in the patient group than in controls on all ISAQ scales, with the largest difference on F2 (negative sensations), d = 1.89 (see Supplement F).

Table 3. Reliability (Cronbach's α) for the originally proposed subscales of the ISAQ

	F1	F2	F3
Sample	Sensitivity to neutral bodily sensations	Attention to unpleasant bodily sensations	Difficulty disengaging from unpleasant bodily sensations
1	.71	.74	.51
2	.71	.69	.54
3	.72	.70	.55
4	.72/76	.81/.71	.62/.41

Note. Sample 1 = online-survey convenience sample (N = 365); Sample 2 = laboratory experiment convenience sample (N = 254); Sample 3 = Rosacea screening sample (N = 376); Sample 4 = patients with pathological illness anxiety (n = 40) and controls (n = 44), values displayed separately. Coefficients based on non-collapsed items.

Table 4. Correlations between ISAQ subscales and other questionnaires

		F1 (Sensitivity neutral sensations)	F2 (Attention unpleasant sensations)	F3 (Difficulty disengaging)
Attention to neutral body sensations	BAQ[1]	.619***	.229***	.203***
Interoceptive accuracy	IAS[2]	.476**	.184**	.181**
Dysfunctional body focus	SSAS[1]	.443***	.424***	.288***
	PCS[1]	.088 (n.s.)	.262***	.208***
	PHQ-15[1,2]	.128* /.071 (n.s.)	.128* /.004 (n.s.)	.087 (n.s.) / .146*
	SSD-12[2]	.028 (n.s.)	.123*	.133*
	mSHAI[1]	.246***	.355***	.207***
Anxiety	GAD-7[1]	.034 (n.s.)	.141**	.085 (n.s.)
	SPS[3]	.176**	.236**	.013 (n.s.)
Emotion Awareness	TAS-20[2]	−.035 (n.s.)	.018 (n.s.)	−.103 (n.s.)
	PERS POS[1]	.239***	.080 (n.s.)	.087 (n.s.)
	PERS NEG[1]	.117*	.227***	.179**
Mindfulness	MAAS[1]	−.045 (n.s.)	.108*	−.083 (n.s.)

Note. [1]sample 1 (online survey convenience sample), [2]sample 2 (laboratory experiment convenience sample), [3]sample 3 (Rosacea screening sample). ***$p < .001$, **$p < .01$, *$p < .05$, n.s. non-significant. F1 = sensitivity to neutral bodily sensations; F2 = attention to unpleasant bodily sensations; F3 = difficulty disengaging from unpleasant bodily sensations. BAQ = Body Awareness Questionnaire; IAS = Interoceptive Accuracy Scale; GAD-7 = Generalized Anxiety Disorder Scale; MAAS = Mindfulness Attention and Awareness Scale; mSHAI = modified Short Health Anxiety Inventory; PCS = Pain Catastrophizing Scale; PERS = Perth Emotional Reactivity Scale; PHQ-15 = Patient Health Questionnaire, somatic symptom scale; SSD-12 = Somatic Symptom Disorder B-Criteria Scale, SPS = Social Phobia Scale; TAS-20 = Toronto Alexithymia Scale. Correlations based on non-collapsed item data.

Discussion

Factorial Structure

In a set of cross-sectional survey studies, our research aimed to validate a German version of the ISAQ (Bogaerts et al., 2022) in several diverse samples. The three-factor structure of the ISAQ could be largely replicated with an acceptable to good model fit in two convenience samples and in participants of an online Rosacea screening sample. The model fit for the three-factor structure was largely consistent across our studies, but was initially lower than of the original scale version (Bogaerts et al., 2022) and also somewhat lower than other newly developed inventories for capturing attention toward bodily sensations and symptoms (Brand et al., 2023; Vlemincx et al., 2023). While the three factors were sufficiently distinct as indicated by their intercorrelations and different associations with further constructs, F3 featured heterogeneous correlations with the other factors, while F1 and F2 correlated consistently across the samples. Also, data from two samples showed some insufficient/small item loadings with one of the items (items 7, 11). This resembles the loadings of the original study (Bogaerts et al., 2022) though.

Informed by modification indices, allowing for one double loading (item 7) and covariance of error terms (items 9, 13), respectively lead to a good overall model fit in two of three samples and an acceptable model fit in one sample.

Though configural and metric invariance between the original and the German version was demonstrated, the non-scalar-invariance of the three-factor model across samples of the two language versions implies that observed differences in scores cannot be fully attributed to true differences in levels of latent constructs. However, scalar invariance can be regarded as a rather idealistic parameter that is seldomly reached and often requires selective parameter specifications that again hamper generalization (Marsh et al., 2018).

While the reliability of the first two scales was acceptable, the difficulty disengaging scale (F3) was poor, which, is yet comparable to Bogaerts et al. (2022). As suggested by the authors, possible causes could be the relatively low number of F3 items together with the items being the only negatively worded ones. Reversed items could be harder to understand, particularly polar opposites (Kam, 2023) such as items 2 and 12. Likewise, the comparable not-distracting subscale of the MAIA also showed a questionable internal consistency (Mehling et al., 2012). Here too, the scale consisted of only a few and also reversed coded items. Interestingly, an expansion of the scale items led to an improvement in internal consistency to an acceptable level, although only reverse-coded items were used here as well (Mehling et al., 2018). Nevertheless, we also acknowledge the challenge of formulating simple and comprehensible items that differentiate functional from dysfunctional attention allocation, since these are typically dynamic within persons or bodily signals.

Validity

In line with our hypotheses, the ISAQ neutral bodily focus scale (F1) showed greater associations with neutral body awareness and self-reported interoceptive accuracy than with most assessments of a dysfunctional bodily focus, as

well as anxiety (e.g., pain catastrophizing, somatic symptom distress, or health anxiety), and vice versa for the negative bodily attention scale (F2). Importantly, there was only a small relation between F2 with attentiveness toward neutral body sensations assessed with the BAQ, while there was a large relation between BAQ and F1. The F1-BAQ relation exceeded a previously reported relation of the BAQ and the self-reported awareness for neutral body sensations assessed with the THISQ (Vlemincx et al., 2023). This might be due to differing specificity of examined body sensations in the THISQ (high specificity, e.g., breathing faster/slower) compared to the BAQ and the ISAQ (lower specificity, e.g., energy level). Furthermore, the activation and deactivation of bodily reactions are more at the center of the THISQ, compared to the ISAQ and BAQ. In line with our F1 relation, somatic symptom burden, assessed with the PHQ-15, was only marginally associated with self-reported accuracy in detecting bodily signals in a previous study (Brand et al., 2023).

Interestingly, while only the self-reported awareness for neutral body sensations was related to the reactivity to positive emotions, F1 and F2 significantly correlated with the activation of negative emotions, whereby the relation of F1 was very small. No relation was found between subscales of ISAQ and difficulties in emotional awareness (i.e., alexithymia). This is in line with a previous study, in which there were no associations between self-reported perception of neutral bodily sensations (as assessed by THISQ) and alexithymia (Vlemincx et al., 2023). In contrast, (disturbed) emotional awareness was significantly related to self-reported interoceptive accuracy (Brand et al., 2023). Because the lack of correlation with the ISAQ subscales was independent of whether neutral or unpleasant bodily sensations were assessed (F1 vs. F2/F3), this may be due to a lower emphasis on perceptual *accuracy* in the ISAQ. People who report being able to perceive their emotions less accurately may also tend to rate their body awareness as poorer. This relation might disappear if accuracy is not asked as directly.

In contrast to our data on the ISAQ, the German version of the IAS was related to self-reported mindfulness (Brand et al., 2023). This discrepancy could also be due to the different emphasis on the accuracy aspect. However, this should be interpreted cautiously, because of the differing operationalization of mindfulness.

The difficulty disengaging from unpleasant bodily sensations (F3) needs to be interpreted with caution due to its low reliability and difficulties in differentiating, having a similar correlational pattern as F2.

Data from sample 4 showed higher values in dysfunctional bodily engagement (F2 (and F3)) in patients with pathological illness anxiety compared to controls. This is in line with various previous studies (Bogaerts et al., 2022). Comparable to patients with medically unexplained dyspnea, fibromyalgia, or chronic fatigue (Bogaerts et al., 2022), illness-anxious patients also reported significantly higher neutral bodily perception (F1). This could be due to the sample composition in Study 2. Approximately half of the patients with pathological illness anxiety fulfilled the criteria of somatic symptoms disorder according to DSM-5.

Suggestions for Future Work on the Inventory

Although the model fit can be considered acceptable, our findings suggest interpreting factor three cautiously and stimulating further developments of the questionnaire. Practical solutions could be to re-inverse the items of F3 (e.g., Item 2 "I find it hard to ignore when my throat hurts."), or to increase the number of items to be comparable to the other factors. It might also be worth considering whether a reformulation of the items with the aim of loading them on one of the first two factors or the elimination of F3 items would make sense, as the third scale was not planned during the conceptual development of the original inventory. However, the difficulty of disengaging from unpleasant sensations through dysfunctional attention allocation, suppression, or avoidance is of high relevance for psychopathology in general and somatic symptom burden and illness anxiety in particular (Gámez et al., 2014; Shi et al., 2022). Admittedly, it seems to be a challenge to formulate items in such a way that people understand the difference between functional and dysfunctional attention allocation.

Integration of the ISAQ Into Existing Interoception Self-Reports and Application Areas

The blend of different aspects in the measurement of subjective body perception makes the valid research of interoceptive sensibility a major challenge. The categorization of the sub-facets is applied differently by different groups of authors. For example, while some authors emphasize the relevance of the distinction between accuracy and attention (Gabriele et al., 2022; Murphy et al., 2020), others consider the differentiation between the perception of neutral and negatively connoted bodily sensations to be important (Shields et al., 1989; Vlemincx et al., 2023).

As the present questionnaire is the only inventory to capture neutral *and* negatively connoted perceptions of bodily sensations in separate subscales, it is particularly suitable for use in studies investigating the psychopathological mechanisms of somatic symptom burden, illness anxiety,

and other forms of anxiety concerning bodily sensations. Here, it can be determined whether the perception of natural physical sensations is already altered, or only becomes apparent during the processing of somatic symptoms.

Despite various attempts to conceptualize interoception, a uniform solution has yet to be found (Desmedt et al., 2023; Garfinkel et al., 2015; Khalsa et al., 2018; Murphy et al., 2020; Suksasilp & Garfinkel, 2022). We could imagine that, in addition to the subdivision of neutral and negatively connoted body symptoms, it could also be useful to divide interoception into perception versus processing using different psychological description levels (Desmedt et al., 2023; Suksasilp & Garfinkel, 2022) and adding a distinction of functional and dysfunctional coping strategies, simultaneously.

Strengths and Limitations of the Studies

The present study contributes to the knowledge about the ISAQ's validity by being the first to examine the factorial structure across three independent samples. Heterogeneity in study contexts (e.g., online survey, lab experiment), population (e.g., clinical, non-clinical), or representativity (i.e., younger mean age, higher education) provides a higher degree of diversity, which is important when applying the ISAQ in different contexts. However, the temporal stability of the German version of the ISAQ remains unclear. Next to the work on the third factor, future studies should assess retest reliability. We examined differences concerning the German version of the ISAQ in a small clinical sample, only. Whether it can reliably screen out people with heightened attention to bodily sensations should be investigated in a large sample of persons with persistent physical symptoms.

Conclusion

We introduce the German version of the Interoceptive Sensitivity and Attention Questionnaire (ISAQ), which is suitable for examining the perception of neutral as well as negative connotated body sensations and symptoms. Across three studies the questionnaire showed an acceptable model fit and reliability in two of three factors. These two factors showed also good convergent and divergent reliability. After improving the questionnaire, it will be particularly suitable for studies that investigate somatic symptom burden and illness anxiety.

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History
Received March 13, 2024
Revision received October 25, 2024
Accepted October 30, 2024
Published online February 4, 2025
EJPA Section / Category Clinical Psychology

Acknowledgments

The authors would like to thank the students who helped to carry out the online survey of Study 1 (R. Büsching, J. Kirsch, M. Leitner, C. Ruth, A. Wanke, K. Zeidler, L. Zucchello) and people helping with the data acquisition for Study 2 (K. Lang, F. Jutzi, A. Müller, D. Schäfer), as well as Studies 3 (L. Leonhardt, H. Chen) and 4 (J. Ratayczak, A. Marcu, T. Slotta).

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

Publication Ethics
Informed consent was obtained from all participants included in this study.
All studies were performed in accordance with the ethical standards of the institution's Human Research Ethics Committees. Ethical approval was granted by the University of Cologne (reference number: AGHF000), the University of Mainz (protocol 2021-JGU-psychEK-020), and the German Psychological Society DGPs (reference number: AS 092017).

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Open Science
Open Data: We confirm that there is sufficient information for an independent researcher to reproduce all of the reported results, including codebook if relevant (data of samples 1, 3, 4: Pohl et al., 2024; data of sample 2: Petzke et al., 2023).
Open Materials: We confirm that there is sufficient information for an independent researcher to reproduce all of the reported methodology (Pohl et al., 2024)
Preregistration of Studies and Analysis Plans: This study was not preregistered. Links to the preregistration of projects from which samples were included are listed in Supplement A.
Open Analytic Code: We confirm that all the scripts, code, and outputs needed to reproduce the results are provided (Pohl et al., 2024).
The online supplementary materials are available at https://osf.io/4t7en/.

Funding
This research was partly supported by a grant from the German Research Foundation (Deutsche Forschungsgemeinschaft DFG, 403266317). Tara Petzke received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No 956673. This article reflects only the authors' view and the Agency is not responsible for any use that may be made of the information it contains. Open access publication enabled by University of Cologne, Germany.

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