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Interoception, health anxiety, and emotion regulation. psychometric properties of the original and reduced Italian versions of the multidimensional assessment of interoceptive awareness 2 (MAIA-2)

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Abstract

Objectives The Multidimensional Assessment of Interoceptive Awareness (MAIA-2) has been extensively used for evaluating self-reported interoception. This paper presents a validation of the original 37-item MAIA-2 in Italian samples. Moreover, we explored the possible development of a reduced version of the MAIA-2 questionnaire. Finally, we assessed the relationships between interoceptive awareness and both emotion dysregulation and health anxiety.

Methods In a first study we evaluated the psychometric properties (reliability, factorial structure, and validity dimensionality) of the MAIA-2 and devised a novel 19-item version, whose properties were also evaluated. Additionally, we examined the association between interoception and emotion dysregulation and health anxiety. In the second study, we ascertained the validity of the 19-item version of MAIA-2 and investigated the relationships between MAIA-2 and mindfulness in an independent sample of general population.

Results Study 1 showed not optimal psychometric indices for the integral Italian version of MAIA-2. An empirically derived 19-item, 5-factor (Not Distracting, Not Worrying, Attention Regulation, Emotional Awareness, and Trusting) version of MAIA-2 questionnaire showed instead good fit indices. Correlational analyses detected significant relationships between the dimensions of the interoception and both emotion dysregulation and health anxiety. Study 2 confirmed good psychometric properties of the 19-item MAIA-2 and demonstrated a weak-to-moderate relationship between interoception and the two dimensions of the mindfulness (Awareness and Acceptance), indicating that the measures share a modest amount of common variance.

Conclusions The present findings support the validity of MAIA-2 for assessing interoception and evaluating its possible involvement in emotional regulation and in the maintenance of anxiety disorder.

Keywords Interoception · Interoceptive awareness · Interoceptive sensibility · MAIA-2 · Health anxiety · Emotional Regulation

Introduction

Interoception is the process through which the individuals perceive, interpret, and integrate signals from within their own body, including signals from the heart and other organs. Craig (2003) defined interoception as a multifaceted construct by which the body communicates its internal physiological state to the brain, thereby modifying conscious and unconscious awareness of bodily sensations. This process allows for a comprehensive physiological representation of the body's state (Craig, 2003), which is relevant for cognition, emotion, and physiological regulation (Garfinkel et al., 2015).

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Garfinkel and Critchley (2013) distinguished three components of interoception reflecting different levels of awareness and processing of bodily signals: Interoceptive Accuracy (IAc), Interoceptive Sensibility (IS), and Interoceptive Awareness (IAw). IAc quantifies the ability to perceive internal body states. IAw is a metacognitive measure, expressing the subjective evaluation and confidence about own interoceptive accuracy (Garfinkel et al., 2015). IS represents an individual's tendency to focus on internal states. More recently, Nayok et al. (2023) suggested that interoception encompasses ten components partially overlapping those proposed by Garfinkel and Critchley (2013): attention, detection, magnitude, discrimination, accuracy, awareness, sensibility, appraisal, insight, and self-report.

Interoception plays a crucial role in controlling emotions and managing health concerns. Increased interoceptive awareness may support adaptive emotional regulation, and heightened interoceptive sensitivity can be linked to the emergence of health-related worries and anxiety symptoms. Indeed, interoception can play a potential role in several psychiatric disorders, including panic and anxiety disorders, depression, somatoform disorders, and eating disorders (Nayok et al., 2023). The thought "there's something wrong with my heart" can lead to fight-or-flight responses or avoidance behaviours. Indeed, atypically high interoception is a hallmark of panic attacks. Salkovskis and Clark (1993) suggested that patients with panic disorder have characteristic beliefs relating to the danger of bodily sensations. Consequently, they become hypervigilant, repeatedly scanning their body for potentially warning signs. This internal focus of attention lead patients to notice sensations that are usually ignored, which they then interpret as a sign of a serious physical or mental disorder.

Excessive worry about bodily sensations and about developing a serious medical condition, even in the absence of symptoms, are characteristics of health anxiety. Individuals with high levels of health anxiety are highly aware of their own bodily sensations, such as heart palpitations or stomach upset, which amplify anxiety and reinforce health-related concerns (Domschke et al., 2010). Krautwurst et al. (2014) reported that people who monitor their body functions more closely and more carefully were more prone to overestimating the frequency of physiological arousal. These individuals are, therefore, more prone to misinterpreting normal bodily sensations as due to a dysfunction or disease.

Ehlers (1993) suggested that hypersensitivity to bodily sensations is a result of increased awareness of bodily signals, while other authors (Paulus & Stein, 2006) suggested that such symptoms (e.g. hypersensitivity to bodily sensations, misinterpretation of normal sensations as signs of illness, increased anxiety due to these misinterpretations, behavioural symptoms such as avoidance, and cognitive symptoms related to health anxiety) are caused by a mismatch between the person's actual and expected physiological state, or by a prediction error. In general, it is possible to state that this hypersensitivity, together with the tendency to interpret body signals negatively, can contribute to the development of behavioural and cognitive symptoms related to health anxiety (Ehlers, 1993; Paulus & Stein, 2006).

Interoceptive awareness is also tightly related to emotional processing. Higher interoceptive sensitivity in healthy people is associated with improved emotional awareness and emotion management skills. The ability to identify and comprehend the physical correlate of emotions enables individuals to respond to emotional cues adaptively (Dunn et al., 2010). Moreover, emotional experiences are partly regulated by interoceptive awareness (Füstös et al., 2013). Indeed, people can successfully monitor and modify their affective states by identifying physiological markers associated with emotion. For example, individuals with high interoceptive awareness may use their body's feelings as insightful feedback to adjust their responses to emotional stressors (Garfinkel et al., 2015). On the other hand, individuals with low interoceptive awareness may find it more challenging to recognize and control their emotions due to their inability to detect and interpret body signals correctly (Dunn et al., 2010). Therefore, people with impaired interoceptive functioning may be prone to experience elevated anxiety and mood disorders.

Currently, the most used self-report questionnaires for interoceptive bodily awareness are the Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2012) and its second version (MAIA-2; Mehling et al., 2018). As Mehling et al. (2012) stated, the term "interoceptive awareness" in MAIA's development and validation is similar to the concept of "interoceptive sensibility" according to Garfinkel and Critchley's classification. Thus, it would be more appropriate to define the MAIA as a measure of the interoceptive sensibility rather than of interoceptive awareness. However, Mehling et al. (2018) considered MAIA as a measure of the conscious level of interoception with its multiple dimensions. This means that rather than only evaluating individuals' capacity to focus or appropriately perceive their own physical experiences, the questionnaire evaluates subjective beliefs, attitudes, and feelings regarding those sensations. This consideration is in line with the construct of interoceptive self-report (Nayok et al., 2023), referring to the ability to think about, to judge and to refer to personal interoceptive experiences. However, as the theoretical framework reminded above underlines that interoception is a multi-faceted construct and that its dimensions relate to several psychological variables, previous validation studies of MAIA and MAIA-2 have indicated suboptimal results. This has led other researchers to propose

models with a different number of factors for MAIA (Da Costa Silva et al., 2022; Rogowska et al., 2023; Teng et al., 2022), or even brief versions of MAIA-2 (Mensinger et al., 2025; Rogowska et al., 2023).

This study sought to contribute to the field of interoception research by presenting the Italian translation and validation of the MAIA, Version 2 (Mehling et al., 2018). In a previous Italian study, Calì et al. (2015) tested the psychometric properties of the Italian translation of the first version of the MAIA and explored the interplay between interoception and emotional susceptibility. No subsequent study has validated the updated MAIA-2 in an Italian-speaking population.

On the bases of the previous contrasting data on the psychometric properties of MAIA and MAIA-2, the present study was structured to pursue the following aims: i) to run a rigorous validation process to evaluate reliability and validity in the Italian context of the full 37-item MAIA-2 scale in a large sample of general population; ii) to provide a novel reduced scale to obtain better psychometric indices for MAIA-2 scale; iii) to confirm the structure and psychometric properties of the reduced scale in an independent sample; iv) to investigate the relationships between interoception (as assessed by the reduced version of MAIA-2), emotion regulation, and health anxiety; v) to explore the relationships of interoception with mindfulness, so to assess concurrent validity of the reduced version of MAIA-2.

For these purposes, we conducted two studies. In the Study 1, we administered the Italian adaptation of the 37-item version of MAIA-2 to a large sample of the Italian general population, together with two validated questionnaires designed to assess emotion regulation, and health anxiety to assess their relationships with interoception. Based on previous evidence from validation studies of MAIA-2 in other languages MAIA (Da Costa Silva et al., 2022; Rogowska et al., 2023; Teng et al., 2022), we could expect to observe suboptimal psychometric indices and explored the possibility of devising an empirically-derived shorter version of the MAIA-2. In the Study 2, we administered the empirically-derived shorter version of the MAIA-2 to a new independent sample of general population, together with a validated questionnaire designed to assess mindfulness and obtain data about concurrent validity of the reduced version of MAIA-2.

Study 1

Materials and methods

Participants

A participant-to-item ratio of 7:1 was targeted, which is within the commonly recommended range of 5 to 10 participants per item (Anthoine et al., 2014), to provide sufficient power for factor analysis.

Enrolment began by advertising an invitation to complete an online questionnaire to undergraduate students from different courses at our university, and by sharing the questionnaire link on social networks to ensure a sufficiently heterogeneous sample.

Before being involved in the study, all participants provided their informed consent, which was approved by the ethical committee of the Department of Psychology, University of Campania "Luigi Vanvitelli" (protocol number: 6/2021) and conducted according to the guidelines of the Declaration of Helsinki. This study's design and its analysis were not preregistered.

Multidimensional assessment of interoceptive awareness version 2 (MAIA-2)

The English version of MAIA-2 (Mehling et al., 2018) includes 5 additional items with respect to the original MAIA questionnaire (Mehling et al., 2012) for a total of 37 items. The participants are required to rate "*how often each statement applies to you generally in daily life*" on a Likert scale from 0 ("*never*") to 5 ("*always*"). MAIA-2 has eight scales: i) Noticing, the awareness of one's body sensations (4 items); ii) Not-distracting, the tendency not to ignore or distract oneself from sensations of pain or discomfort (6 items); iii) Not-worrying, the tendency not to experience emotional distress or worry with sensations of pain or discomfort (5 items); iv) Attention regulation, the ability to sustain and direct attention to body sensation (7 items); v) Emotional awareness, the awareness of how bodily sensations relate to emotional states (5 items); vi) Self-regulation, the ability to direct attention to bodily sensations in order to regulate psychological distress (4 items); vii) Body listening, the ability to listen to the body for information (3 items); and viii) Trusting, the subjective experience of perceiving one's own body as a secure and reliable entity (3 items). The score for each scale is calculated by averaging the scores of its individual items and thus ranges 0–5. High scores may indicate heightened awareness and atonement to internal bodily sensations.

Translation Procedure of MAIA-2 After obtaining permission from the original author (Professor Mehling), a translation of the 5 additional items of English MAIA-2 into Italian was conducted whereas the other 32 items were borrowed from the Italian version of the first release of MAIA (Calì et al., 2015). The five new items of MAIA-2 (items 8, 9, 10, 14, 15) were independently translated by two Italian-speaker psychologists (YC and LS) and one neurologist (LT), familiar with the IA construct. As in Machorrinho et

al. (2019), the translators had high theoretical and practical knowledge in mind–body concepts.

Then, the three resulting Italian versions were compared, item by item, by the three authors (YC, LS and LT) and one additional psychologist (FDO). The authors also revised the 32 items already present in the Italian version of the first release of MAIA (Calì et al., 2015) and provided a novel translation for 5 items not deemed entirely adequate for Italian culture/idioms. After reaching a consensus as above on these items too, a provisional Italian version was drafted (see supplementary material 1). This version was then back translated by an English bilingual psychologist, not familiar with the IAw construct. Finally, in a final harmonisation meeting the back-translation and the Italian version of the questionnaire were compared to come to satisfactory formulations. MAIA-2 together with the scoring procedure details were reported in the supplementary materials 2.

Difficulties in emotion regulation scale

To assess emotion regulation difficulties, the Italian version (Sighinolfi et al., 2010) of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) was used. It includes 36 items divided in 6 subscales: i) Non-Acceptance, a person's tendency to avoid, suppress, or deny negative emotions (6 items); ii) Goals, inability to engage in goal-oriented behaviours when experiencing negative emotions (5 items); iii) Impulses, difficulties in controlling impulsive behaviours when experiencing negative emotions (6 items); iv) Strategies, restricted access to emotion regulation strategies perceived as effective (6 items); v) Awareness, lack of emotional awareness (8 items); vi) Clarity, lack of emotional clarity (5 items). Each item is rated on a Likert scale, ranging from 1 (almost never) to 5 (almost always). The total score on the DERS ranges 36–180, with higher scores indicating greater difficulties in emotion regulation. Higher scores on each of the subscales indicate greater perceived difficulties in the corresponding aspects of emotion regulation.

In our study, the internal consistency of the DERS was very good: the *omega* was .95 for the total scale and ranged from .79 to .91 for the five subscales (Non-Acceptance = .91; Goals = .88; Impulse = .89; Awareness = .79; Strategies = .91; Clarity = .85).

Health anxiety inventory

To assess health anxiety, the Italian short version (SHAI; Leveni et al., 2011) of the Health Anxiety Inventory (HAI; Salkovskis et al., 2002) was used. It is a self-rated scale including 37 items divided into 4 factors: i) Main, for the individual's health-related fears, concerns, and preoccupations (14 items); ii) Negative Consequences, that assesses the negative impact of health anxiety on the individual's life (4 items); iii) Avoidance, which evaluates a tendency to avoid every kind of situation that might aggravate or cause their health worry (10 items); and iv) Reassurance, for the evaluation of how much the individual seeks reassurance in others (9 items). A multiple-choice 4-sentence response format is used for Main and Negative Consequences scales whereas a Likert scale (0–8) is used for Avoidance and Reassurance scales. Higher scores in each section reflect a greater degree of worry about illness, fear of negative consequences, avoidance behaviour and a need for reassurance.

The internal consistency of the SHAI was good: the *omega* was .89 for the total scale and ranged from .72 to .84 for the subscales (Main = .90; Negative-Consequences = .72; Avoidance = .84; Reassurance = .81).

Procedure

The scales were uploaded to Psytoolkit (https://www.psytoolkit.org/), a web-based tool to allow easy distribution, access, and response submission for all respondents with the option to remain anonymous (Stoet, 2017). Before answering the questionnaires, participants read the information about the study and all instructions that were included in the platform as well as the consent form. After providing demographic information (e.g., age, sex, occupational status), all the participants were asked to complete the three scales: MAIA, DERS, and SHAI in the same order for all the participants.

Participants were required to respond truthfully to all items specifying that that there were no right or wrong answers. All items of each scale were designated as mandatory, yet participants were free to cease completion of the questionnaire at any time. Response times (RTs) were recorded and examined after data collection, to identify possible anomalies suggestive of random compilation or a possible lack of attention.

Participants who expressed their availability were contacted at least one month after the initial administration for a further completion of the MAIA-2 questionnaire.

Data collection lasted six months.

Statistical analysis

Before performing statistical analyses, a quality check of the responses was performed. Specific exclusion criteria were: completion of the questionnaire in unrealistically short times; RTs outside 2 SD the mean RTs; presence of repetitive responses (e.g., responding with the same option);

production of serial responses (e.g., following a predictable and recurring pattern).

To assess the factor structure of the original 37-item scale, we conducted an exploratory factor analysis (*EFA*) and an analysis of covariances within the framework of confirmatory factor analysis. To evaluate the adequacy of the original model proposed by Mehling et al. (2018), a confirmatory factor analysis (*CFA*) was conducted. To conduct *EFA* and *CFA*, the final sample was divided into two subsamples, by splitting participants into even and odd numbers. Following the *EFA* and *CFA*, the internal consistency of the questionnaires was evaluated. Test–retest reliability was assessed to determine whether the results were consistent over time. Finally, correlations between the constructs measured by the various questionnaires were conducted.

EFA and *CFA* were conducted using RStudio (version 2022.02.0+443) (2025), while other analyses were conducted using IBM SPSS Statistics (version 25).

Exploratory Factor Analysis *The Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity were computed to assess the factorability of the data. The KMO should be>.80 and Bartlett's test of sphericity should be significant. Furthermore, before conducting the exploratory factor analysis, the Horn's parallel analysis (HPA) and the Velicer's minimum average partial (MAP) test (Velicer et al., 2000) were used to define the optimal number of factors to extract. EFA was conducted performing the principal axis factoring (PAF) in combination with the 'oblimin' rotation. This method aims to extract factors that maximise the explained variance of the original variables. PAF is commonly employed when there are no missing values in the dataset, as it is a factor extraction method based on the correlation among observable variables (Costello & Osborne, 2005). Since the questionnaire responses were mandatory and no missing values were present, PAF was the optimal choice for our analyses. In line with the recommendations set forth by Costello and Osborne (2005), three criteria were used to select the most interpretable factor structure: item loadings above .40; minimal or no cross-loadings (no secondary loading above .30); no factors with fewer than three items.*

Confirmatory Factor Analysis *To test the factor structure obtained with the EFA, a CFA was conducted. Since the MAIA-2 data are ordinal data, the diagonally weighted least square (DWLS) estimation method was used as it is less biased and more accurate compared to alternative methods, such as maximum likelihood, in estimating the factor loadings with ordinal data (Li, 2016). As model fit indices, the chi-square goodness of fit supplemented by the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root-mean-square error of approximation (RMSEA) and the standardised root-mean-square residual (SRMR) were used. For CFI, values of .95 or higher are considered adequate for an excellent model (Bentler, 1990). For TLI, values of .95 or higher are considered adequate for an excellent model (Hu & Bentler, 1999). The RMSEA with values lower than .08 reflect an acceptable error of approximation (Browne & Cudeck, 1992). For SRMR, Hu and Bentler (1998) suggested a cut-off criterion of .08, with lower values indicating a good fit.*

Furthermore, modifications of the model were carried out according to the highest modification indices and the results from likelihood ratio tests, to improve model fit.

Internal Consistency To assess the reliability of the scale, McDonald's *omega coefficient (ω)* was computed for the total sample for each scale. McDonald's omega coefficients with value > .7 are generally considered acceptable (Dunn et al., 2014). The decision to use the omega coefficient together with *Cronbach alpha (α)* is since the latter assumes an essential tau-equivalence model, which was considered unsuitable for the MAIA-2 instrument. Consequently, relying on Cronbach alpha may yield unreliable estimations of reliability (Flora, 2020) whereas the omega coefficient can offer a more dependable assessment of internal consistency specifically for the MAIA-2 instrument (Dunn et al., 2014). Internal Consistency for DERS and SHAI were also assessed with McDonald's omega coefficient.

Test–Retest reliability Test–retest reliability analyses were conducted to ensure that the results in measurement observed in our sample are consistent over time. The intraclass correlation coefficient (*ICC*) was computed as a measure of test–retest reliability, as it assesses the extent to which within-individual measurements are statistically similar, allowing for discrimination between individuals (Aldridge et al., 2017). A two-way mixed effects model was used for absolute agreement (Koo & Li, 2016). *ICC* values below .5 are indicative of poor reliability, between .50 and .75 are moderate, between .75 and .90 are good and greater than .90 are excellent reliability (Koo & Li, 2016).

Correlations To evaluate the relationship between interoception and both health anxiety and emotional regulation, Pearson correlations were calculated between MAIA-2 and both DERS and SHAI scores. A correlation coefficient that falls beneath .40 is deemed to be weak; between .40 and .69, it is regarded as moderate; between .70 and .90, it is

considered strong, and if it exceeds .90, then it is classified as very strong (Schober & Schwarte, 2018).

Results

Descriptive data

The initial sample consisted in 588 individuals. Considering the mean *RTs* (M=17.71 min, SD=15.12 min), 42 participants were excluded from the analysis because they filled out the questionnaires in unrealistically short times (e.g., 2 min), or long times (>2 *SD* above the mean). Moreover, 16 participants were excluded as they provided repetitive responses, whereas 7 were excluded as they gave serial responses.

The final sample consisted in 523 participants, aged between 18 and 68 years: 420 female (M=24.50 years, SD=8.23 years), 103 male (M=28.29 years, SD=8.71 years); and 2 preferring not to declare their sex (M=20.50 years, SD=2.12 years). Among participants, 356 (68.1% of the entire sample) were students.

Even-numbered participants were used for the *EFA*, which included 261 individuals (210 females and 1 participant who did not declare their sex; M=25.18 years, SD=8.24 years). Odd-numbered participants were used for the *CFA*, which included 262 individuals (212 females and 1 participant who did not declare their sex; M=25.26 years, SD=8.66 years).

Of the original sample, 295 participants (246 female and 2 not declaring their sex; M=22.77; SD=6.26) indicated their willingness to be contacted for the second administration, but only 229 of them completed the MAIA-2 questionnaire twice to assess test–retest reliability. Due to the quality control of the answers, 52 participants were excluded: 39 for the response times, 11 for repetitive responses; and 2 for recurring pattern of responses. Therefore, the final sample for the second administration consisted of 177 participants (145 female and 2 not declaring their sex; M=23.53 years; SD=6.70 years). Also in this case, participants were predominantly students (N=134, 72.8% of the sample). The time-interval between the first and second administration was 43.47±19.32 days. The total sample and the retest subsample did not show significant differences between groups for gender ($t(698)$=-.89, p= .37) and education ($t(698)$=1.58, p= .11). Age differed significantly between the two groups ($t(698)$=2.46, p= .02), as the total sample (M=25.22 years; SD=8.44 years) had a higher mean age than retest sample (M=23.50 years; SD=6.70). The observed age difference between the original and the retest groups could be partly explained by the higher representation of students in the retest subsample, although proportion of students in the two groups did not differ significantly ($\chi^2(1)$=3.67, p> .05).

Original 37-item Scale

Exploratory Factor Analysis *EFA is appropriate for analysing the data as Bartlett's test of sphericity and the Kaiser–Meyer–Olkin measure of sampling adequacy were significant ($\chi^2(666)$ = 4557, p< .001; KMO = .82). Parallel analysis, the original (Velicer, 1976) and the revised (Velicer et al., 2000) MAP test consistently indicated that 7 factors were the optimal number of factors to extract. Only 5 of the 7 factors respected Costello and Osborne (2005) criteria, whereas 2 included less than three items each. The original model with 8 factors explained 52.06% of the common variance. These results suggested that the original 37-item scale may not have a clear and well-defined factor structure in our sample.*

Confirmatory Factor Analysis *Despite the limitations of the EFA results for the original scale, we proceeded with CFA to test the theoretically proposed factor structure of the 37-item scale as outlined in the original MAIA-2 (Mehling et al., 2018). The KMO measure of sampling adequacy was .82, while Bartlett's test of sphericity yielded $\chi^2(666)$ = 4557, p< .001, indicating that the data were suitable for factor analysis. The CFA was performed using the diagonally weighted least squares (DWLS) estimation method on the full 37-item MAIA-2, following the original multidimensional model proposed by Mehling et al. (2018). The model demonstrated good fit indices (CFI = .966, TLI = .962, SRMR = .084), except for RMSEA = .088 (% Confidence Interval = .083—.092). All the items loaded onto the factors with standardised factor loading ranging from .214 to .940 (see Fig. 1).*

Inter-factor correlations for the original model with eight factors are reported in supplementary materials 3. All correlations were statistically significant (p< .001), except for the correlation between Not Distracting and Trusting factors.

Internal Consistency and Test–Retest The internal consistency of the 37-item MAIA-2 calculated on the total sample was good: the omega coefficient (ω) ranged from .63 to .860 for the eight scales. At time 2, the internal consistency was also good: the omega ranged from .76 to .89 for the five scales (Table 1).

The test–retest reliability analysis showed a good reliability of the test over time for the MAIA-2 scales, with *ICCs* ranging from .51 to .87 (Table 1).

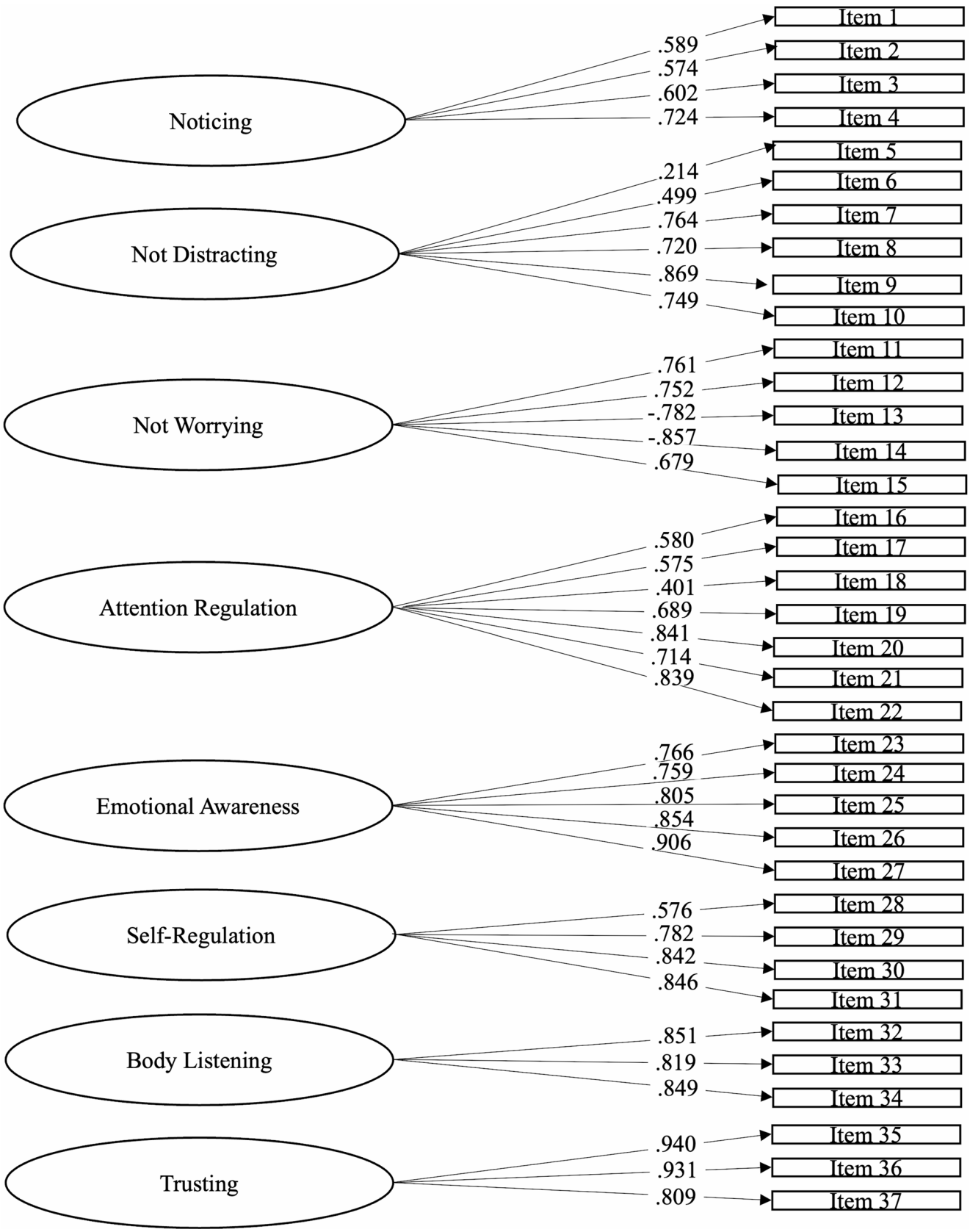

Fig. 1 *Standardized factor loadings from the CFA of the 8-factor, 37-item Italian MAIA-2 model. All loadings are statistically significant (p < .001)*

Reduced Version of MAIA-2

As the results on the Italian version of the original MAIA-2 demonstrated limited psychometric robustness, we performed further analyses, including detailed *EFA* and *CFA*, on a reduced version of the questionnaire to optimize its psychometric characteristics.

As reported above, of the 8 original factors, parallel analysis and MAP test indicated that 7 factors were the optimal number of factors to extract. However, only 5 of the 7 factors respected Costello and Osborne (2005) criteria, as 2 of them had less than three items each and were excluded on this basis. In detail, the items that loaded into these two factors (Items 30, 31; Items 1, 24), the items that did not show loadings above.40 (Items 3, 4, 5, 6, 18, 23, 28, 29, 33, 34) and the items with cross-loadings into two or more factors (2; 32) were discarded from further analyses.

Exploratory Factor Analysis *A new EFA conducted on the retained 21 items provided a 5-factor model: Not-Distracting (7, 8, 9, 10), Not-Worrying (11, 12, 13, 14, 15), Attention Regulation (16, 17, 19, 20, 21, 22), Emotional Awareness (25, 26, 27) and Trusting (35, 36, 37), according to the original structure. This model explained 56.4% of the common variance.*

Confirmatory Factor Analysis *The CFA conducted on the factors resulting from the EFA didn't show adequate indices (RMSEA = .084; CFI = .881; TLI = .860; SRMR = .083; $\chi^2(179) = 508.21$, $p < .001$). For this reason, modification indices were consulted to improve model fit. Excluding the items for which the modification indices showed standardised loadings on a non-target factor (items 14 and 20), a new 5-factor model with 19 items was obtained. This model had good fit model indices: RMSEA = .077 (% Confidence Interval = .067-.086); CFI = .986; TLI = .983; SRMR = .074; $\chi^2(142) = 358.27$, $p < .001$. All the items loaded onto the factors with significant standardised factor loading ranging from .613 to .957 (see Fig. 2).*

Detailed item-level factor loadings for the 19-item version of the MAIA-2 are reported in Table 2.

Internal Consistency and Test–Retest The internal consistency of the 19-item structure calculated on the total sample was good: the omega coefficient (ω) ranged from .79 to .88 for the five scales (Table 3). At time 2, the internal consistency was also good: the omega ranged from .82 to .89 for the five scales.

The test–retest reliability analysis showed a good reliability of the test over time for the 19-Item MAIA-2 scales, with *ICCs* ranging from .69 to .88 (Table 3).

Comparison between original and reduced versions We compared the psychometric properties of the original 37-item and the reduced 19-item versions of the Italian MAIA-2, in terms of explained variance and model fit indices (Table 1S in supplementary materials 5), and internal consistency and test–retest reliability coefficients (Table 2S in supplementary materials 5). The reduced version demonstrated improved model fit and explained variance, with comparable or higher reliability across the retained subscales.

Correlations

To further examine the construct validity of the Italian MAIA-2, the associations between interoceptive awareness and both emotion regulation (DERS) and health anxiety (SHAI) were investigated. As shown in Table 4, several significant correlations emerged: the MAIA-2 Emotional Awareness scale demonstrated positive correlation with the DERS Non-Acceptance and Goals subscales and negative correlation with DERS Awareness subscale. Notably, the MAIA-2 Not-Worrying scale exhibited negative correlations with all the DERS subscales except for Awareness. Moreover, both the MAIA-2 Attention Regulation and Trusting scales showed negative correlations with all the DERS subscales.

Table 1 *Mean, standard deviation (SD), Cronbach Alpha from the original validation study (α;* Mehling et al., 2018*), Omega coefficient (ω1) at first administration, the Omega coefficient at retest (ω2) and Intraclass Correlation Coefficient (ICC) with Interval of Confidence (IC) for the MAIA-2 scales*

MAIA-2	*M*	*SD*	*α*	ω_1	ω_2	*ICC*	*95% IC*
Noticing	3.22	.95	.64	.64	.78	.77	.53-.71
Not-Distracting	2.74	.90	.74	.78	.82	.68	.57-.76
Not-Worrying	2.78	1.10	.67	.79	.86	.87	.82-.91
Attention-Regulation	2.61	.90	.83	.82	.85	.66	.52-.76
Emotional-Awareness	3.42	1.06	.79	.86	.87	.56	.38-.69
Self-Regulation	2.37	1.07	.79	.80	.85	.51	.08-.71
Body Listening	2.64	1.14	.80	.82	.83	.61	.48-.72
Trusting	2.87	1.24	.83	.88	.89	.53	.37-.65

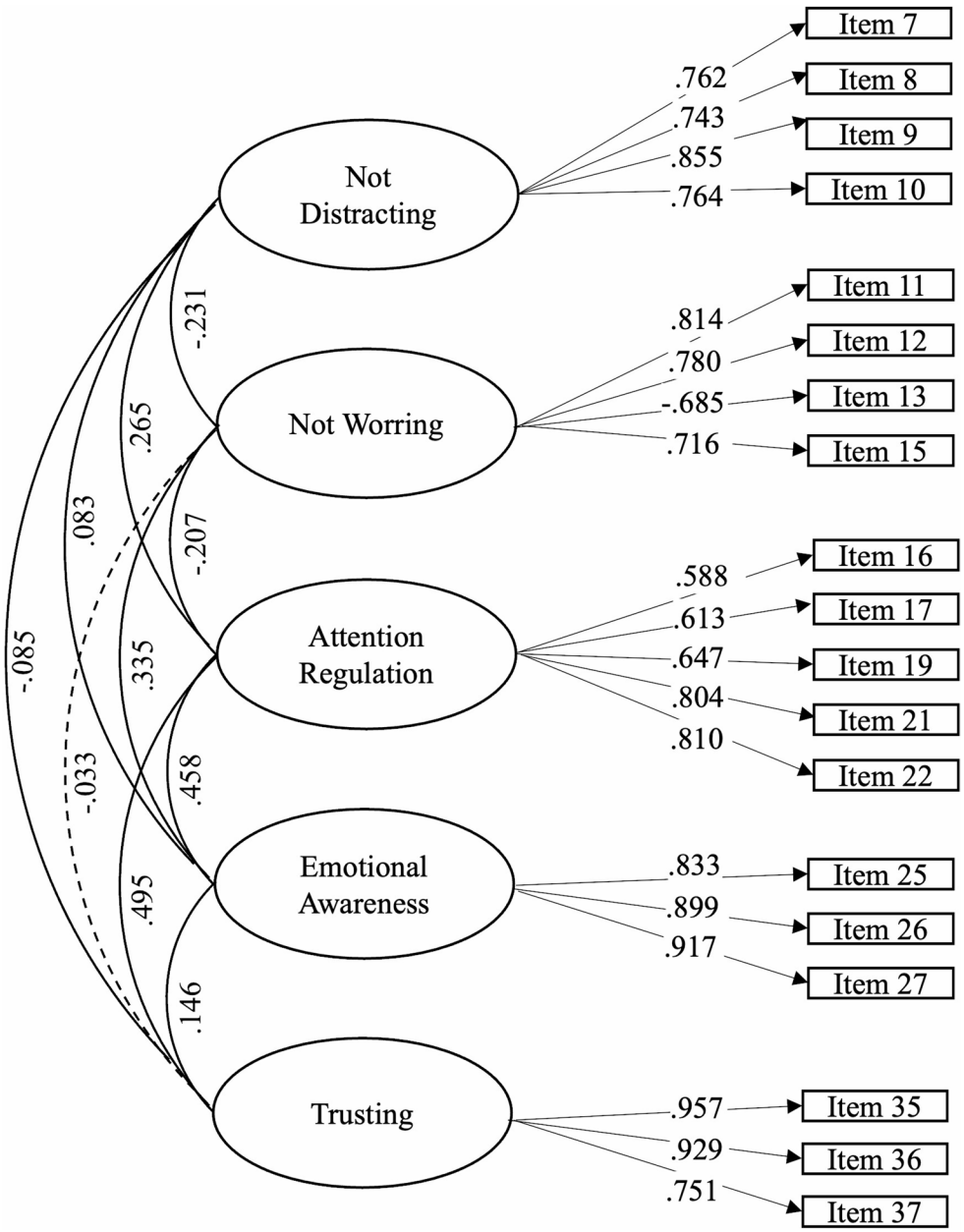

Fig. 2 Factor loadings of 19 items included in the final model: continuous lines represent significant correlations; dot lines represent non-significant correlation

About interoceptive awareness and health anxiety (Table 4), negative correlations were revealed between all MAIA-2 scales, except for Not-Distracting, and the SHAI total score and Main and Negative Consequences subscales and SHAI Avoidance and Reassurance subscales. Positive correlations were identified between the MAIA-2 Not Distracting scale and the SHAI total score and the Main and Negative Consequences subscales.

Comments

While the original 37-item scale demonstrated good fit indices in the CFA, the initial EFA suggested a more complex underlying structure in line with validation studies on the original English version (Mehling et al., 2018) and on versions in other languages (Da Costa Silva et al., 2022; Rogowska et al., 2023; Teng et al., 2022). Therefore, we derived a reduced 19-item scale showing a clearer factor structure in the *EFA* and demonstrating good fit indices in the *CFA*. We will deal with the implications of these findings in the discussion section.

The version of MAIA-2 with 19 items includes the following factors, according to the original structure: Not-Distracting (Items 7, 8, 9, 10), Not-Worrying (Items 11, 12, 13, 15), Attention Regulation (Items 16, 17, 19, 21, 22), Emotional Awareness (Items 25, 26, 27), and Trusting (Items 35,

Table 2 Item-level factor loadings for the 19-item version of the MAIA-2

Item	Not-Distracting	Not-Worrying	Attention Regulation	Emotional Awareness	Trusting
7	.076				
8	.743				
9	.855				
10	.764				
11		.814			
12		.780			
13		-.686			
15		.716			
16			.588		
17			.613		
19			.647		
21			.804		
22			.810		
25				.833	
26				.899	
27				.917	
35					.957
36					.929
37					.571

Table 4 Correlation results (r value) between MAIA-2 scales, DERS and SHAI subscales

	MAIA-2				
	ND	NW	AR	EA	T
DERS					
N-A	-.10*	-.29**	-.15**	.13**	-.30**
GOA	.11*	-.41**	-.21**	.15**	-.19**
IMP	.11*	-.36**	-.23**	.11*	-.27**
AWA	.02	-.07	-.37**	.34**	-.46**
STR	.06	-.39**	-.22**	.05	-.35**
CLA	-.08	-.23**	-.28**	-.04	-.45**
Total	.02	-.37**	-.30**	.05	-.43**
SHAI					
MAIN	.16**	-.61**	-.12**	.08	-.17**
N–C	.12**	-.28**	-.16**	-.04	-.22**
AVO	.04	-.30**	-.10*	.04	-.05
REAS	.04	-.30**	-.11*	.06	-.01
Total	.17**	-.60**	-.15**	.06	-.21**

*.01; **.05

AR: Attention-Regulation; AVO: Avoidance; AWA: Awareness; CLA: Clarity; EA: Emotional-Awareness; GOA: Goals; IMP: Impulses; N-A: Non-Acceptance; N–C: Negative-Consequences; ND: Not-Distracting; NW: Not-Worrying; REAS: Reassurance; STR: Strategies; T: Trust.

36, 37). The scales Noticing, Self-Regulation and Body Listening are not included in the model. Therefore, the 5-factor version of MAIA-2 has been further tested in Study 2.

Finally, the reduced version also showed meaningful associations with emotion regulation and health anxiety, further supporting its construct validity. However, before discussing this issue in depth, it was necessary to confirm the validity of the 19-item version of MAIA-2 by a further study.

Study 2

In Study 2, the psychometric properties of the 19-item version of MAIA-2 were further investigated on a new sample. Furthermore, participants were also asked to complete the Philadelphia Mindfulness Scale (PHLMS; Cardaciotto et al., 2008), an instrument for assessing mindfulness. Mindfulness refers to a state of awareness and attention in the present moment, observing thoughts, emotions and body feelings or sensations without any judgement (Bishop et al., 2004). Thus, the concept of awareness, particularly interoceptive awareness, is included and crucial to its definition. A specific aspect of interoceptive body awareness, the process of shifting from contemplating physical stimuli to a state of perceptual presence in the body, is often conceptualised as mindfulness. Therefore, consistent with several MAIA validation studies (Mehling et al., 2012; Teng et al., 2022), Pearson correlations were computed between the scales of the 19-item version of MAIA-2 and the two dimensions of the PHLMS (Awareness and Acceptance) to assess concurrent validity.

Also in this case, data collection was based on an online procedure.

Materials and methods

Participants

The sample consisted of Italian participants not involved in Study 1, mainly recruited at the University of Campania "Luigi Vanvitelli" by advertising the online study in different courses. Participation in the study was voluntary, and

Table 3 Mean, standard deviation (SD) and Omega coefficient (ω1) at first administration, the Omega coefficient at retest (ω2) and Intraclass Correlation Coefficient (ICC) with Interval of Confidence (IC) for the 19-item MAIA-2 scale

MAIA-2	*M*	*SD*	ω_1	ω_2	*ICC*	*95% IC*
Not-Distracting	1.98	1.08	.83	.85	.70	.60-.78
Not-Worrying	2.34	1.14	.80	.84	.88	.84-.91
Attention-Regulation	2.63	.95	.79	.82	.69	.59-.73
Emotional-Awareness	3.52	1.17	.88	.89	.76	.67-.82
Trusting	2.87	1.24	.88	.89	.84	.79-.88

participants could withdraw at any time. Informed consent was obtained from the participants prior to their inclusion in the study.

Multidimensional assessment of interoceptive awareness version 2 (MAIA-2)

The reduced version of MAIA-2 consisted of 19 items divided into 5 scales: i) Not-distracting, the tendency not to ignore or distract oneself from sensations of pain or discomfort (4 items); ii) Not-worrying, the tendency not to experience emotional distress or worry with sensations of pain or discomfort (4 items); iii) Attention regulation, the ability to sustain and direct attention to body sensation (5 items); iv) Emotional awareness, the awareness of how bodily sensations relate to emotional states (3 items); and v) Trusting, the subjective experience of perceiving one's own body as a secure and reliable entity (3 items). This 19-item version of MAIA-2 together with the scoring procedure details were reported in the supplementary materials 4.

Philadelphia mindfulness scale (PHLMS)

The PHLMS (Italian validation provided by Simione et al., 2022) is a 20 items self-report questionnaire consisting of two scales: Awareness (10 items), used to evaluate the individual's ability to be aware of and focused on own thoughts, emotions, physical sensations, and surroundings in the present moment, without distraction; Acceptance (10 items), that concerns the importance of not judging or rejecting internal experiences, even when they are unpleasant. Each item is rated on a 5-point Likert scale, ranging from 1 (never) to 5 (very often). The score for each scale is given by the sum of the 10 items, with higher scores indicating greater mindfulness capacity.

Procedure

Participants were asked to complete the 19 items of MAIA2 and the PHLMS uploaded to the Psytoolkit website. Before compiling the questionnaire, all the information and instructions were provided. After reading and accepting the informed consent, participants filled out the questionnaire. The strategies used to maximize the quality of the responses were analogous to Study 1.

Data collection lasted about two months.

Statistical analysis

Quality check of the responses was performed as in Study 1. To investigate properties of the 19-item version of MAIA-2, an analysis of covariances within the framework of *CFA* were conducted as described in Study 1. Measurement invariance (configural, metric and scalar) between the *CFA* models of Study 1 and Study 2 was tested to evaluate the overall similarity in goodness of fit across samples: configural invariance was used to test whether the factorial structure was the same across groups; metric invariance tested by constraining factor loadings to ensure that the item contributes to the latent construct to a similar degree across groups; scalar invariance further tested by constraining the item intercepts to be equivalent to assess whether groups have comparable latent means (Putnick & Bornstein, 2016). McDonald's omega coefficient (ω) was computed to assess the reliability of both MAIA-2 and PHLMS scales. Finally, Pearson correlation was computed to assess the relationships between the two questionnaires.

Data analyses were performed using R (version 4.1.2).

Results

Descriptive data

The sample consisted of the 319 participants. Following exclusion criteria, 15 participants were excluded from the analysis because of their response times, and 3 as they provided repetitive responses. The final sample consisted of 301 participants (255 females, 46 males; age range: 18–44 years; $M = 20.39$, $SD = 2.70$).

Confirmatory factor Analysis (CFA)

The CFA was conducted on the structure resulting from Study 1. This model confirmed the 5-factor structure with 19 items, with good to very good fit indices: *RMSEA* = .068 (% *Confidence Interval* = .058-.077); *SRMR* = .070; *CFI* = .992; *TLI* = .991; $\chi^2(142) = 337.1$, $p < .001$.

The fit indices for Study 2 showed an improvement over those from Study 1: the *RMSEA* decreased from .077 to .068, indicating a better fit in the *CFA* model. Similarly, the *SRMR* decreased from .074 to .070. The *CFI* and *TLI* also showed improvements, with the *CFI* increasing from .986 to .992 and the *TLI* from .983 to .991. All the items loaded onto the factors with significant standardised factor loading ranging from .601 to .983.

Measurement invariance

Measurement invariance between Study 1 and Study 2 was assessed using a stepwise approach, following standard recommendations (Chen, 2007). Configural invariance was tested first, showing an acceptable model fit (*CFI* = .978; *TLI* = .974; *RMSEA* = .037; *% Confidence Interval* = .027–.045; *SRMR* = .062; $\chi^2(284) = 520.64$, $p < .001$), thus indicating that the factor structure was similar across the two samples. Then,

metric invariance demonstrated that the model fit remained adequate (*CFI* = .978; *TLI* = .975; *RMSEA* = .036 (% *Confidence Interval* = .027–.045); *SRMR* = .063; $\chi 2(298) = 523.43$, $p < .001$), suggesting that the relationships between observed items and their underlying factors were equivalent across samples. Finally, scalar invariance demonstrated that the model continued to show good fit, with minimal changes in fit indices (*CFI* = .977; *TLI* = .974; *RMSEA* = .036; % *Confidence Interval* = .027–.045; *SRMR* = .063; $\chi^2(312) = 528.59$, $p < .001$). The change in CFI was below the recommended threshold of .01 (Chen, 2007) and the chi-square difference tests were non-significant, confirming that the intercepts did not significantly differ between the two samples. These findings support the full measurement invariance of the MAIA-2, indicating that the factor structure, factor loadings, and item intercepts are equivalent across groups.

Internal consistency

The internal consistency calculated on the new sample was good: the omega coefficient (ω) ranged from .75 to .87 for the MAIA-2 five scales. The ω for the PHLMS scales were .75 and .88 for Awareness and Acceptance, respectively.

Correlation

Analyses showed significant correlations of several scores of MAIA-2 with PHLMS scales. In detail, the PHLMS scale Awareness positively correlated with the MAIA-2 scales Attention Regulation ($r = .50$), Emotional Awareness ($r = .35$) and Trusting ($r = .40$). The PHLMS scale Acceptance revealed significant positive correlation with all the MAIA-2 scales (ND: $r = .35$; NW: $r = .29$; AR: $r = .21$; T: $r = .32$), except for Emotional Awareness ($r = .03$). All correlational data for the MAIA-2 scores and PHLMS were reported in Table 3S (supplementary materials 5).

Comments

The Study 2 confirmed the good psychometric indices and the 5-factor model of the 19-item version identified in Study 1. Therefore, this version could be considered a valid reduced version of the MAIA-2. Significant correlations between the PHLMS and the MAIA-2 scales suggested that both measures assess convergent aspects of interoceptive awareness.

Discussion

The primary objective of the present study was to develop the Italian version of MAIA-2 and to evaluate its psychometric properties in a substantial adult sample. Furthermore, a new, shorter version of the MAIA-2 was developed, which showed satisfying psychometric indices in a validation study on an independent sample of Italian population. This offers a reliable and efficient tool for both research and clinical practice. The present study also investigated the relationships of interoception evaluated by Italian versions of MAIA-2, with other psychological constructs, namely emotional regulation and health anxiety, and assessed the concurrent validity of MAIA-2 with mindfulness.

Psychometric property of Italian MAIA-2

The original 37-item English version of the MAIA-2 aims to capture a broad range of interoceptive experiences. However, analysis revealed that not all items contributed equally to the underlying factor structure within the Italian sample. The item-level CFA results demonstrated a broad spectrum of factor loadings (.21-.94), indicating substantial heterogeneity in the way the individual items correspond to the latent factors. Consequently, while a subset of items demonstrated excellent measurement properties, the overall factor structure was undermined by inclusion of several weak items.

Consequently, to enhance the model fit and the reliability of the resulting subscales, we removed several items from analyses. This resulted in a reduced version including 21 items, which EFA classified into 5 scales. The CFA confirmed this factor structure but led to exclusion of 2 additional items. Thus, the 19-item reduced version of Italian MAIA-2 emerging from Study 1 includes the following factors (and items), according to the original structure: Not-Distracting (Items 7, 8, 9, 10), Not-Worrying (Items 11, 12, 13, 15), Attention Regulation (Items 16, 17, 19, 21, 22), Emotional Awareness (Items 25, 26, 27), and Trusting (Items 35, 36, 37). The other factors (Noticing, Self-regulation, Body listening) were thus not included in the reduced version.

A second study was conducted on a different sample to further assess the psychometric properties of this 19-item structure. While the original version did not present optimal indices, the 19-item reduced model was supported by good internal consistency and good reliability over time. Excellent internal consistency of the entire model was supported by McDonald's omega, which was above 0.70 for the five scales (Dunn et al., 2014). Study 2 supported the good model fit indices. The robustness of the findings of both studies was underlined by the alignment of the identified factors with the original theoretical model. This suggests that, even after the exclusion of some items, the instrument effectively measures the intended psychological constructs.

It's noteworthy that cross-cultural studies validating the MAIA have largely supported its generalisability as a measure of interoception, despite mixed findings regarding the

reliability of its subscales and slight variations in its factor structure (Ma-Kellams et al., 2024). Indeed, except from the Arabic version of MAIA-2 (Fekih-Romdhane et al., 2023), previous validation studies for MAIA and MAIA-2 have not demonstrated a good reliability (for example, Özpınar et al., 2021a) or the same model and factor structure (Da Costa Silva et al., 2022; Rogowska et al., 2023; Teng et al., 2022) as the original versions by Mehling et al. (2018). Similarly, the very recent Czech validation (Klocek et al., 2025) supported the original eight-factor structure but highlighted poor internal consistency for the Not-Distracting and Not-Worrying scales. This finding suggests that these dimensions may not fully align with a unified construct of interoception in Czech individuals. Da Costa Silva et al. (2022) obtained analogous results for the French version, identifying the six-factor model as the optimal model fit. This model encompasses factors such as Noticing, Attention Regulation, Emotional Awareness, Self-Regulation, Body Listening, and Trusting. A six-factor model, including Emotional Awareness, Attention Regulation, Body Listening, Not-Distracting, Trusting and Not-Worrying, was also reported for the Turkish version (Özpınar et al., 2021a, 2021b). Teng et al. (2022) obtained an additional 7-factor model (with the exclusion of the Noticing scale) for the Chinese version.

The decision to develop a reduced version of the MAIA-2 was based on the sub-optimal psychometric performance of the full 37-item scale in these previous studies and in our initial analyses. The aim was to create a tool that was both psychometrically robust and clinically practical. Our approach to creating a short form differs from that of existing versions (e.g., Mensinger et al., 2025; Rogowska et al., 2023), which maintained the original structure by excluding some items with poor factor loading. Here, instead, the reduced version of the MAIA-2 was derived entirely from psychometric indices obtained in the first study and then verified in an independent Italian sample to ensure that the shortened 19-item version accurately reflects the factorial structure and properties within this specific cultural context.

The validation of the MAIA in Italy, like in other cultural contexts, is likely to be influenced by specific cultural factors. Indeed, certain subscales may not perform consistently across different cultures. As suggested by Ma-Kellams et al. (2024) despite the corroboration of the MAIA's robust psychometric properties by global validation studies, enduring cultural variations still pose challenges for the consistency of specific subscales. We can therefore hypothesise that Italian validation may have been influenced by the specificity of Italian culture that may shape how individuals perceive and experience their bodies, such as body image, body-related emotional experience, language, and norms about self-regulation (Chirico et al., 2021; Giorgetta et al., 2023; Ruggiero et al., 2000). In the Italian cultural context, where external expression and social emotion might take precedence, reporting on detached, internal awareness could be subject to differential interpretation compared to highly introspective cultures. This observation is consistent with the findings from other international validations (e.g., Chinese and French), demonstrating that factor structures frequently differ and that certain items are not adequately retained. This finding also implies that the experience and language used to describe interoception are not universal. These cross-cultural variations underscore that the way we think about the internal signals and body is, to some degree, culturally mediated. Our derived factor structure, therefore, not only offers a psychometrically sound short form but also reflects the most salient and reliable dimensions of interoception within the Italian-speaking population.

It should be remarked that in the second version of the MAIA by Mehling et al. (2018), the aim was to enhance its psychometric properties through the inclusion of 5 new items into the Not-Worrying and Not-Distracting scales. Despite our model has a reduced structure, yet it includes all the added items of MAIA-2, but one (item 14), and the internal consistency of the two scales is very good, contrary to the claims of Da Costa Silva et al. (2022), who suggested that these two scales might not be related to the common factor of interoceptive body awareness.

The Italian version of the MAIA-2 demonstrates good stability over time, with participants consistently providing similar responses on the questionnaire across the two measurement points. These findings also prove that the Italian version of the MAIA-2 is an instrument that can be confidently used for longitudinal research or clinical evaluations.

Summarizing, even though the original version presented suboptimal indices, it could be employed when a more complete evaluation of interoception is desired, whereas the reduced 19-item version appears to be suitable for assessing specific dimensions by means of a more concise instrument.

Relationship with difficulties in emotion regulation and health anxiety

Several scales of MAIA-2 correlated with both emotion regulation difficulties and with anxiety thus corroborating the idea that being aware of one's own internal state helps to maintain low anxiety levels and to regulate emotion. Indeed, weak and moderate negative correlations were found between 19-item MAIA-2 and the overall and the subscale scores of DERS. In detail, 19-item MAIA-2 Not-Worrying, Attention-Regulation and Trusting scales negatively correlated with the DERS subscales. This pattern of results supports a strong relationship between interoception and difficulties in emotional regulation such that a better perception of one's own bodily signals is associated

with better adaptive emotion regulation strategies (Füstös et al., 2013; Kever et al., 2015). Specifically, our finding suggested that the ability to control attention allocation to bodily signals, and at the same time ignoring and suppressing some signals, could be key factors modulating emotional arousal. Indeed, Paulus and Stein (2010) suggested that being aware of bodily signals is an important component for the preservation of homeostasis via adaptive attention allocation, contextual evaluation, and action planning. In line with this suggestion, Füstös et al. (2013) demonstrated that the awareness of bodily signals can advance consolidation of the somatic markers required for guiding individual behaviour and facilitate downregulation of affect. The ability of not worrying or catastrophizing, and of trusting or viewing bodily sensations as helpful, could determine a better emotional management and acceptance. These findings are in line with those of Kever et al. (2015) who reported a positive correlation between interoceptive sensitivity and expressive suppression and cognitive reappraisal demonstrating that a better processing of bodily signals facilitates the selection and implementation of antecedent-focused as well as response-focused emotion regulation strategies.

Notably, MAIA-2 scales Emotional Awareness demonstrated weak positive correlation with the DERS subscales Non-Acceptance and Goals and Awareness. This finding was not entirely consistent with previous evidence and our hypothesis. Nevertheless, it could be read in the light of the construct of "fear of emotion" (Farnsworth & Sewell, 2011). Indeed, some people may experience fear of strong emotions because they worry about losing control over their emotions or their behavioural responses to emotions, even strong positive emotions. Previous studies have shown that fear of emotion may be associated with increases in emotional distress and physiological arousal (Salters-Pedneault et al., 2007) and could mediate the expression of post-traumatic symptoms (Farnsworth & Sewell, 2011). In this perspective, the findings of the present study seem to fit the construct of fear of emotion and suggest that being aware that certain physical sensations are the sensory face of emotions could increase the tendency to avoid, suppress, or deny negative emotions and reduce emotional awareness and goal-oriented behaviours when experiencing negative emotions. However, to further assess this interpretation, future studies should also use a measure of fear of loss of control while experiencing strong emotion, anxiety, depressed mood, and anger.

Negative correlations were found between all the 19-item MAIA-2 scales and the SHAI scales. Specifically, weak-moderate negative correlations were reported between the 19-item MAIA-2 scale Not Worrying and all subscales of the SHAI. This finding is consistent with the original MAIA study (Mehling et al., 2012) and also with the Chinese MAIA-2 version study (Teng et al., 2022), which demonstrated negative correlations between the MAIA scales and the trait anxiety scale. This finding, together with the weak positive correlations between Not-Distracting scale and the SHAI total score and Main and Negative consequences subscales seems to demonstrate that individuals less prone to express health-related fears, concerns, and preoccupations tend to focus on, or not distract themselves from, sensations of pain or discomfort probably to reduce the negative impact of health anxiety. This interpretation is in line with the weak negative correlation between 19-item MAIA-2 Attention Regulation scale and SHAI Avoidance and Reassurance subscales. These findings may indicate that the ability to adequately regulate attention to internal bodily signals, allowing to distinguish between normal bodily sensations and potential signs of illness, would reduce avoidance behaviours and search for excessive reassurance as a means of coping with health-related concerns. However, it should be noted that all observed correlations fall within the weak to moderate range, thus necessitating caution when drawing strong conclusions.

Paulus and Stein (2010) suggested that people prone to anxiety and depression have weaker filtering of internal body signals, making it difficult to distinguish important signals from the constant background noise, leading to possible misinterpretations. For example, a normal heartbeat might be perceived as a sign of danger, triggering thoughts like "There's something wrong with my heart". Nevertheless, previous studies evaluating interoceptive accuracy in patients with health anxiety have reached contradictory conclusions: Tyrer et al. (1980) reported that patients with "hypochondriac and anxious neurosis" showed a better perception of the heartbeat than controls, whereas Barsky and Borus (1995) found no difference between the two groups. It is possible to attribute such discrepancies to the use of only one experimental paradigm (heartbeat perception) for the evaluation of IAc, where a multimethod approach for the assessment of interoception would be more appropriate.

Relationship between interoception and mindfulness

The correlation between the 19-item MAIA-2 and the PHLMS confirmed the relationship between interoception and mindfulness. In terms of concurrent validity, however, the magnitude of the correlations is in the weak-to-moderate range. This indicates that, although the measures are related, they likely capture distinct facets of the ability to focus on, regulate, and accept bodily sensations. Significant weak and moderate positive correlations between the PHLMS

Awareness scale and the 19-item MAIA-2 Attention Regulation, Emotional Awareness and Trusting scales is consistent with the assumption that present-moment awareness, central to mindfulness, includes the ability to focus and regulate attention towards bodily sensations, to trust one's inner sensations and to be attuned to bodily emotions. In addition, positive significant weak correlation between the PHLMS Acceptance scale and the 19-item MAIA-2 Attention Regulation scale indicates that individuals who exhibit an attitude of acceptance towards their current experience may tend to regulate their internal bodily sensations in a more effective manner, without overreacting or worrying; significant positive correlation between Acceptance and Not Worrying or Not Distracting, suggests that 19-item MAIA-2 is able to discern these characteristics, which are indicative of a functional interoceptive awareness.

Clinical application of the MAIA-2

Interoception, as measured by the MAIA-2 and its reduced 19-item version, is not merely a general construct but a crucial tool for clinical case formulation and intervention tailoring. Dysfunctional interoception has been identified as a core feature of several psychopathologies. MAIA-2 profiles are of crucial importance in the understanding of several psychopathological disorders. Health anxiety and panic disorder are two such conditions characterised by hypervigilance and misinterpretation of body sensations (Domschke et al., 2010). Eating disorders are also associated with a distortion or suppression of hunger/satiety signals and higher score on body listening, noticing, and emotional awareness scales predicted the severity of the disorder (Mensinger et al., 2025). Post-traumatic stress disorder is linked to dissociation or blunting of body signals probably linked to poor interoception (Beydoun & Mehling, 2023). Depression is associated with alexithymia and emotional numbing, which can result from impaired interoception especially for noticing, self-regulation and trusting components (Zhou et al., 2024). In terms of treatment, high scores on the body listening or noticing scale of the MAIA-2 may signify a robust foundation for somatic therapies or mindfulness-based interventions. However, it is important to note that analogous interventions could be employed in cases where patients are unable to focus on their bodies or detect physical changes. Conversely, a profile featuring elevated levels of worry in combination with suboptimal attention regulation indicates the necessity for therapeutic interventions targeting catastrophic misinterpretation and attention control strategies. By evaluating changes in subscales such as trusting or self-regulation, clinicians can monitor treatment efficacy and patients' increasing sense of agency and safety within their body.

Limitations

This study has several limitations. Firstly, the sample was predominantly young and female, and mostly comprised university students, which may limit the generalisability of our findings to other populations. Secondly, the lack of specific clinical exclusion criteria is a key limitation, given the known relationship between interoception and various psychopathologies. Future research should include clinical screening to enable more accurate interpretation of findings within specific diagnostic contexts.

A further limitation is related to the 19-item version. Indeed, while some removed items and factors were conceptually relevant to the broader construct, their inclusion negatively impacted the overall psychometric properties of the Italian version. For instance, the decision to omit the Self-Regulation scale from the 19-item version, while statistically substantiated, requires further consideration. It can be argued that the exclusion of this scale may result in a limitation of the MAIA-2's comprehensiveness in capturing the full dimensions of interoception's regulatory aspects. Future research should explore the content domains represented by the excluded items, potentially through the development of revised or new items. This would allow for a more comprehensive assessment of interoception while maintaining the psychometric rigor. Moreover, this study did not examine the convergent and discriminant validity of MAIA-2 with other measures of interoception, including the original Italian MAIA. Future research should address this gap by directly comparing MAIA-2 with other interoception scales.

An aspect of the present studies that may limit the generalisability of our results is related to the online administration. Nevertheless, online administration also been used in previous validation studies of MAIA-2 questionnaires (Fekih-Romdhane et al., 2023; Rogowska et al., 2023), and allowed us to reach for sufficiently heterogeneous participants in terms of socio-demographic characteristics.

Conclusions

The studies reported in this paper provide several original contributions. First, they provide the first Italian adaptation of the 37-item MAIA-2, and, secondly, make available its novel 19-item short version, whose psychometric features have been demonstrated invariant across independent Italian samples. The empirical derivation and validation of a new, efficient 19-item short-form of the MAIA-2 specifically for the Italian context could be considered as a primary innovation in the field.

Although the original version did not demonstrate optimal fit indices, it may still be suitable for researchers seeking a more comprehensive assessment of interoception, whereas the reduced version offers a more parsimonious alternative for those interested in evaluating specific components with fewer items. Both versions of MAIA-2 have the potential to improve our knowledge of interoceptive processes and is a promising tool for practical applications in the Italian population. The reduced version, on the other hand, could be less burdensome for respondents, requiring less time and effort to complete. For this reason, the 19-item MAIA-2 may be used in clinical psychology to better investigate the relationship between interoceptive awareness and common mental health conditions in Italy, such as fatigue and anxiety. It could also support the development of tailored interventions. The 19-item MAIA-2 might be used to assess the impact of mindfulness and yoga, as well as other forms of intervention based on the body, on interoceptive awareness. Additionally, future studies could examine whether both versions of MAIA-2 predict changes in emotional regulation strategies, health anxiety levels, or responses to interventions designed to improve interoceptive awareness.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12144-025-08938-x.

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Author contributions **YC:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Writing – original draft, Writing – review and editing; **SC:** Data curation, Formal analysis, Supervision, Writing – review and editing; **LT:** Conceptualization, Methodology, Supervision, Writing – review and editing; **FDO:** Funding acquisition, Methodology, Supervision, Writing – review and editing; **MF:** Investigation, Methodology, Supervision, Writing – review and editing; **LS:** Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Resources, Supervision, Validation, Writing – original draft, Writing – review and editing.

Data availability Readers seeking access to the data should contact the corresponding authors.

Declarations

Informed consent This research involved human participants, so informed consent was obtained from all participants.

Ethical approval This investigation was approved by the authors' University Ethics Committee.

Consent to publish The participants agreed for their anonymized data to be publish.

Competing interest All authors declare no conflicts of interest.

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