

# Multidimensional Assessment of Interoceptive Awareness: Psychometric Properties of the Portuguese Version

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## Abstract

Interoceptive awareness involves several mind–body dimensions and can be evaluated by self-report with the Multidimensional Assessment of Interoceptive Awareness (MAIA), which has been translated and validated in several countries and is being used in research and clinical contexts. This study systematically translated the MAIA with six additional items using a focus group and evaluated its psychometric properties in a respondent sample of 204 Portuguese university students (52% females;  $M = 21.3$ ,  $SD = 3.9$  years). Based on exploratory factor analysis, we refined the tool into a 33-item version and tested it in a separate sample ( $n = 286$ ; 63% females;  $M = 21.3$ ,  $SD = 4.7$  years). We then conducted confirmatory factor analysis and examined test–retest reliability and convergent and discriminant validity. We confirmed an acceptable model fit for this Portuguese version (MAIA-P) with 33 items and seven scales; it showed good construct validity and acceptable temporal

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reliability, The MAIA-P appears to be valuable for assessing self-reported interoceptive awareness in Portuguese healthy adults.

### **Keywords**

interoception, MAIA, psychometrics, translating, validation

## **Introduction**

Interoception refers to the conscious and unconscious perception of our internal bodily states (Craig, 2008). Interoceptive ascending neural circuits allow visceral sensations, such as heartbeat, thirst, pain, and gastrointestinal discomfort, to provide the basis for subjective feelings and emotions and can become conscious (Calí, Ambrosini, Piccon, Mehling, & Committeri, 2015; Craig, 2008). Over the past decade, the processing of interoceptive sensations has been shown to play a key role in human affect and cognition and to be of major relevance in the study of mind–body approaches and human health (Ceunen, Vlaeyen, & van Diest, 2016; Farb et al., 2015; Khalsa et al., 2018). Considering the importance of interoception for biological homeostasis, emotional and attentional regulation (Craig, 2008), and the integrity of an embodied self (Tsakiris, 2010, 2017), clinical research and therapeutic interventions require a valid measure of interoception and its multiple dimensions (Duquette, 2017). Several authors (Calí et al., 2015; Garfinkel & Critchley, 2013; Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015; Khalsa et al., 2018; Mehling, 2016) have made important efforts to distinguish various dimensions of interoception and to agree on a common taxonomy: objective interoceptive sensitivity (accuracy), self-reported interoceptive sensibility, and interoceptive insight (confidence; formerly *awareness*), operationalized as metacognitive awareness of interoceptive accuracy.

Mehling et al. (2009) examined the psychometric quality of selected self-report measures related to interoception awareness. These authors reported that the majority of earlier self-report questionnaires assessing interoceptive bodily awareness lacked known systematic development (e.g., Body Perception Questionnaire; Porges, 1993), were insensitive to intervention effects (e.g., Body Responsiveness Questionnaire; Daubenmier, 2005), and did not take into account the important role of attention styles and regulatory aspects of interoception (e.g., Body Awareness Questionnaire; Shields, Mallory, & Simon, 1989). Considering these limitations, Mehling et al. (2012) developed the Multidimensional Assessment of Interoceptive Awareness (MAIA). The MAIA is a questionnaire able to distinguish between different interoceptive attentional styles that can be adaptive (referred to as a receptive, mindful awareness attitude according to Kabat-Zinn, 2008) or maladaptive (e.g., anxiety-driven) in processing interoceptive sensations to regulate emotions and behavior. Thus, through a complex systematic process that involved expert focus groups (with investigators, body awareness therapy instructors, and patients);

individual interviews; evaluation of prior instruments; and a refined conceptual framework, Mehling et al. (2012) developed the MAIA questionnaire and field-tested it with instructors and students of mind–body therapies, using multiple validation methods. The original MAIA comprises 32 items on eight scales, conceptually organized in five dimensions: (a) Awareness of body sensations (Noticing scale), (b) emotional reaction and attentional response to sensations (Not-Distracting and Not-Worrying scales), (c) capacity to regulate attention (Attention Regulation scale), (d) awareness of mind–body integration (Emotional Awareness, Self-Regulation, and Body Listening scales), and (e) trusting body sensations (Trusting scale). Interoceptive awareness as conceptualized within the MAIA is comparable with the construct of self-reported interoceptive sensibility as proposed by Garfinkel et al. (2015). It is important to note that the MAIA has recently been used for research in clinical samples of persons with eating disorders (Brown et al., 2017), posttraumatic stress (Mehling et al., 2017), chronic pain (de Jong et al., 2016), depression (Fissler et al., 2016), alexithymia (Muir, Madill, & Brown, 2017; Zamariola, Vlemincx, Luminet, & Corneille, 2018), and autism spectrum disorders (Mul, Stagg, Herbelin, & Aspell, 2018).

The MAIA has been translated into 20 languages, and it has been validated for eight of these translations (Chinese, German, Italian, Korean, Lithuanian, Persian, Polish, and Spanish), showing good overall psychometric properties (Root Mean Square Error of Approximation [RMSEA]=0.023–0.072; Standardized Root Mean-Square Residual [SRMR]=0.056–0.072; Comparative Fit Index [CFI]=0.850–0.974). Three validation studies found different structured models (Baranauskas, Grabauskaitė & Griskova-Bulanova, 2016; Brytek-Matera & Koziel, 2015; Gim, Sim, & Cho, 2016), and most studies have found low internal consistency in both Not-Distracting and Not-Worrying scales. The Not-Distracting scale relates to the emotional reaction and the attentional response to sensations and assesses the tendency to ignore negative body sensations such as pain or discomfort; the Not-Worrying scale assesses the tendency not to experience emotional distress with such negative body sensations (Mehling et al., 2012). In addition, these are the only MAIA scales with reversed items. To address this internal consistency limitation, Mehling and collaborators provided six additional items, which were included in this study. As there was no interoceptive awareness assessment tool adapted for use in Portugal, this study translated the original 32 items of the MAIA and the six additional items and assessed its psychometric properties in a Portuguese population.

## Method

### *Participants and Procedures*

This study was approved by the Ethics Committee of the University of Évora, Portugal and was carried out in accordance with the standards set by the

Helsinki Declaration (General Assembly of the World Medical Association, 2014). The validation procedure of this Portuguese version of the MAIA included three key steps: (a) a systematic translation with a focus group, (b) an exploratory factor analysis (EFA) of the MAIA-P, and (c) a confirmatory factor analysis (CFA) of the modified MAIA-P. A total of 497 students from the University of Évora (Portugal) participated. In the focus-group phase, participants were seven university students with similar sociodemographic characteristics to the ones of separate participant subgroup Samples A and B ( $M$  age = 23.3 years; 86% females) from different curriculum areas (e.g., psychology, sports sciences, psychomotor therapy, arts). Sample A was composed of 204 participants (51.9% female;  $M$  age = 21.3,  $SD$  = 3.9 years; age range = 18–43 years) who completed the first version of the translated Portuguese MAIA (MAIA-Pa), including the six additional items for the two scales with low consistency reliability in prior research. Based on findings from this EFA, we created a second, revised Portuguese version of the MAIA (MAIA-Pb), which was completed by Sample B consisting of a separate comparable group of 286 participants (62.9% female;  $M$  age = 21.3,  $SD$  = 4.7 years; age range = 18–45 years).

Sample characteristics are shown in Table 1. Participants of Sample A did not differ statistically from those in Sample B in terms of age or experience in mind–body practices, but Sample B had more female students. Both MAIA-P versions required approximately 10 minutes to complete. Fifteen days after Sample B was assessed, 20 participants from this sample were retested for test–retest reliability. Similar to the procedures in the original validation (Mehling et al., 2012), 40 students additionally completed Portuguese versions of the State and Trait Anxiety Inventory (STAI; Silva, 2003) and the Five Facets of Mindfulness Questionnaire (FFMQ; Gregório & Gouveia, 2011) to probe convergent and discriminatory construct validity. Participants in the retest and construct validity groups did not differ statistically from those in Sample B in terms of age and sex. Participants also completed a questionnaire about socio-demographics and provided information about past and current experience in mind–body practices (e.g., yoga, meditation, martial arts, etc.; see Table 1).

### *MAIA Translation Into Portuguese*

As recommended by Epstein, Santo, and Guillemin (2015), we adapted the MAIA into Portuguese using a systematic translation with the aid of a focus group. Three native Portuguese speakers, fluent in English and familiar with the concepts of interoception and mindfulness, independently translated the 38 items of the English MAIA version into Portuguese. The three Portuguese versions were discussed by these experts to ensure the conceptual equivalence of the items. The consensus version was then cognitively tested in a 1-hour focus group of seven university students, led by two moderators who documented

**Table 1.** General Characteristics of the Participants.

	Sample A (N = 204)		Sample B (N = 286)		p*
	n	%	n	%	
Age (years)					.838
Mean ± SD	21.3 ± 3.9	–	21.3 ± 4.7	–	
Range	18–43	–	18–45	–	
Sex					.015
Female	106	51.9	180	62.9	
Mind–body practices					.606
Never tried	128	62.7	187	65.4	
Some experience	76	37.3	98	34.6	
Current practice					.785
Yes	15	7.4	19	6.7	
No	61	29.9	79	28.0	
Types of practice					.286
Yoga	27	13.2	33	11.7	
Meditation	3	1.5	12	4.3	
Martial arts	33	16.2	35	12.4	
Reiki	2	1.0	9	3.2	
Various	11	5.4	9	3.2	

\*p values obtained from independent samples t test for continuous variables and from chi-square test for nominal variables.

suggestions and comments and audio-recorded the meeting. Using the input from these focus-group participants and moderators (J. Mac and J. Mar), several items were revised for a consensual version of the questionnaire (MAIA-Pa).

**Instruments**

*The MAIA (Mehling et al., 2012).* As noted in the introduction to this article, the MAIA is a self-report questionnaire with 32 items within eight scales that measure interoceptive bodily awareness: (a) Noticing (awareness of uncomfortable, pleasant, and neutral body sensations), consisting of four items (e.g., “I notice when I am uncomfortable in my body.”), *r* = .69; (b) Not-Distracting (tendency to self-distract or not from body sensations of pain or discomfort), consisting of three items (e.g., “When I feel pain or discomfort, I try to power through it.”), *r* = .66; (c) Not-Worrying (ability to maintain emotional balance with sensations

of pain or discomfort), consisting of three items (e.g., “I can notice an unpleasant body sensation without worrying about it.”),  $r = .67$ ; (d) Attention Regulation (ability to control attention to body sensations), consisting of seven items (e.g., “I can maintain awareness of my inner bodily sensations even when there is a lot going on around me.”),  $r = .87$ ; (e) Emotional Awareness (awareness of the relation between body sensations and emotional states), consisting of five items (e.g., “I notice how my body changes when I am angry.”),  $r = .82$ ; (f) Self-Regulation (ability to regulate distress by pain attention to body sensations), consisting of four items (e.g., “When I feel overwhelmed I can find a calm place inside.”),  $r = .83$ ; (g) Body Listening (tendency to active listening body to insight), consisting of three items (e.g., “I listen to my body to inform me about what to do.”),  $r = .82$ ; and (h) Trusting (experience one’s body as safe), consisting of three items (e.g., “I am at home in my body.”),  $r = .79$ . Participants are asked to rate on a 6-point Likert scale (0: *never*; 5: *always*) how often each statement applies to them. Higher scores represent more positive interoceptive awareness (Mehling et al., 2012). Most of the scales from the original MAIA have shown good reliability. In the original MAIA version, both scales Not-Distracting and Not-Worrying showed lower internal consistency ( $\alpha = .66$ ,  $\alpha = .67$ , respectively), as confirmed in other cross-cultural adaptations (Abbasi, Ghorbani, Hatami, & Lavasani, 2015; Bornemann, Herbert, Mehling, & Singer, 2014; Brytek-Matera & Koziel, 2015; Calí et al., 2015; Lin, Hsu, Mehling, & Yeh, 2017; Valenzuela-Moguillansky & Reyes-Reyes, 2015). As these scales are the only three-item scales with reversed items, Mehling and collaborators developed three additional items for each scale, resulting in a preliminary 38-item questionnaire. Therefore, the current study tested the translated MAIA-P with the six additional preliminary items.

*FFMQ* (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). The FFMQ is a 39-item questionnaire assessing five mindfulness dimensions: (a) the ability to observe body sensations; (b) the ability to describe emotions; (c) the ability to act with awareness; (d) the ability of nonjudging; and (e) nonreactivity to inner experience. The FFMQ has shown good convergent validity with the MAIA (Bornemann et al., 2014; Mehling et al., 2012). Although the Portuguese version of the FFMQ (Gregório & Gouveia, 2011) has one item less than the original version, the five subscales have shown good reliabilities.

*The STAI* (Spielberger, 1983). The STAI is a self-report questionnaire comprised of two 20-item scales that measure state and trait anxiety. As in the validation of the original MAIA, the trait anxiety scale was used as a discriminatory validity measure. The Portuguese version that we used resulted from multiple complex adaptation studies, and it has been shown to have adequate psychometric properties (alpha for state-anxiety: .91 for men and .93 for women; alpha for trait-anxiety: .89) and relative independence between the scales (Lourenço & Parreira, 2012; Silva, 2003).

## Data Analysis

Descriptive data (means and standard deviations), and distribution skewness and kurtosis were obtained for all variables derived from Sample A (MAIA-Pa), and we assessed the internal consistency of the translated MAIA-Pa scales. Subsequently, to explore the underlying factor structure of the MAIA-Pa, we subjected the 38 test items to EFA, using principal components analysis as the extraction method, with both obliquus direct oblimin and orthogonal varimax rotation methods, allowing for the factors on our Portuguese version to be interrelated or not. Noticing that all the primary outcomes were similar when applying both methods, we accepted the results from varimax rotation, and these are presented in this article. We confirmed that our data were suitable for factor analysis by testing for skewness and kurtosis (distribution between  $-1.5$  and  $1.5$ ), Bartlett's Test of Sphericity, and Kaiser–Meyer–Olkin (KMO) measure for sample adequacy, judging them as adequate when the value was above  $.70$  ( $p < .001$ ; Leech, Barrett, & Morgan, 2005). The factor count was limited to the theoretically assumed eight factors.

After discussion of the EFA results, we made modifications to the questionnaire and repeated the statistical procedures described earlier on the revised version MAIA-Pb with a seven-factor structure. We confirmed the seven-factor structure of the MAIA-Pb through a CFA. The model fit was evaluated using CFI, RMSEA, SRMR, and the ratio  $\chi^2/df$ , following recommendation values of Kline (2005) and Brown (2015) for an adequate model fit (CFI  $> 0.9$ ; RMSEA  $< .08$  [ideal if  $< .06$ ]; SRMR  $< 0.1$  and  $\chi^2/df < 3$ ).

Finally, for testing convergent and discriminatory validity of the MAIA-Pb, we calculated correlations with both FFMQ and STAI. Test–retest reliability was assessed with intraclass correlation coefficient using a two-way mixed model with measures of consistency, considering reliability as low if  $< .5$ , as moderate when between  $.5$  and  $.75$ , as good between  $.75$  and  $.9$ , and as excellent if  $> .9$  (Koo & Li, 2016).

Few values ( $< 5\%$ ) were missing, and Little's MCAR test ( $p > .05$ ) indicated that these were missing at random. Therefore, all participants were included, and missing values were replaced by the mean value of the respective item scores. All statistical analyses were conducted using version 24.0 of SPSS for windows including AMOS (IBM Corp., 2017).

## Results

The results from Bartlett's test ( $\chi^2 = 3510.44$ ;  $p < .001$ ) and Kaiser-Meyer-Olkin (KMO =  $.786$ ), as well as skewness and kurtosis values showed that our data were suitable for factor analysis. Table 2 shows the results of the EFA with similarities between items' distribution of the MAIA-Pa and

the original MAIA, with all item loading  $>.49$  on their keyed factor (explaining 60% of the variance), except for Item 4 (Noticing) and Item 14 (Not Worrying). However, the eight-factor structure was not confirmed. The eighth factor included only loose items (4, 14, and 17) with no relation to any of the original MAIA scales. Items 29 to 35, originally regarded as two different scales (Self-Regulation and Body Listening), loaded on one single factor. Items 4 and 14 showed low and crossed factor loadings and, therefore, were excluded from the MAIA-Pa. Regarding the Not-Distracting and Not-Worrying scales, we excluded Items 5, 6 (Not-Distracting), and 11 (Not-Worrying) due to low factor loadings and low item-scale correlations ( $<.48$ ), which resulted in an increase of both scales' consistency reliability.

The resulting seven-factor structure of the MAIA-Pb was confirmed by the CFA showing an adequate model fit:  $\chi^2 = 1206.9$ ;  $p < .001$ ;  $\chi^2/df = 2.55$ ; RMSEA = 0.074 (90% CI [.069, .079],  $p$ -close  $<.001$ ); SRMR = 0.072; CFI = 0.82. As shown in the path diagram in Figure 1, all items loaded on the expected factor, and factor loadings ranged from .50 to .97. Only five (1, 2, 4, 8, and 11) of the final 33 items showed factor loadings lower than .60. Table 3 shows means, standard deviations, and Cronbach's alphas for the seven scales, together with scale-scale correlations.

The internal consistencies of the MAIA-Pb scales varied between .61 (Noticing) and .86 (Attention Regulation), demonstrating that the psychometric properties of the Portuguese scales are sufficient to good. In addition, the seven scales of the MAIA-Pb were partly intercorrelated, as expected (Mehling et al., 2012), and showed adequate values of test-retest reliability, particularly for the Emotional Awareness, Self-Regulation, and Trusting scales ( $>.82$ ). Regarding convergent validity, the MAIA-Pb scales correlated positively with FFMQ scales, except scale Noticing. Regarding discriminatory validity, Not-Distracting, Not-Worrying, and Trusting scales correlated negatively with STAI scales, but correlations did not reach statistical significance (Table 4).

## Discussion

In the present study, we developed a Portuguese version of the MAIA and examined its psychometric properties in two nonclinical Portuguese university student samples. To the best of our knowledge, this was the first adaptation and validation of a self-report interoception assessment tool for the Portuguese population. Considering previous concerns about the internal consistency of two MAIA scales—Not-Distracting and Not-Worrying (Mehling, 2016)—in the current study, we worked with six additional items proposed by the Mehling team that added up to a 38-item preliminary version of a Portuguese MAIA-P for our field-test. Following a systematic translation based on a focus



**Table 2.** Exploratory Factor Analysis: Rotated Components Matrix.

Scale name and items	Factors							
	1	2	3	4	5	6	7	8
Noticing								
1	.606							
2	.628							
3	.662							
4					.352			-.386
Not-Distracting								
5		.536						
6		.563						
7		.810						
8		.840						
9		.807						
10		.787						
Not-Worrying								
11			.498					
12			.794					
13		-.313	.670					
14		-.407	.366					.309
15			.707					
16			.702					
Attention Regulation								
17				.545				-.399
18				.708				
19				.575				
20				.737				
21				.759		.309		
22				.546				
23				.557				
Emotional Awareness								
24					.494			
25			-.367		.515			
26					.771			
27					.738			
28					.778			

(continued)

**Table 2.** Continued

Scale name and items	Factors							
	1	2	3	4	5	6	7	8
Self-Regulation								
29				.311		.586		
30				.356		.560		
31				.328		.496		
32						.720		
Body Listening								
33						.653		
34						.776		
35						.763		
Trusting								
36							.835	
37							.838	
38				.406			.642	

Note. Extraction method: principal component analysis. Rotation method: varimax.

group with cognitive interviews, a revision of the questionnaire following the EFA results, and a CFA, we propose this final Portuguese version of the MAIA (MIAIA-P) with 33 items and seven factors showing acceptable to good psychometric properties.

Due to the subjective self-report nature of the information collected by the MAIA (emotions and body sensations), achieving a conceptual equivalence (Sun & Pju, 2009) during the linguistic translation was a challenging process. Therefore, we followed a systematic translation as recommended by recent guidelines of Epstein et al. (2015) that had resulted from a systematic review of the efficacy of the most common and updated translation methods. With this in mind, the translators who participated in the current validation of the MAIA-P had high theoretical and practical knowledge in mind–body concepts and related therapies, and the process involved three independent translations followed by an in-person meeting to create a consensus version. Subsequently, a university student focus group was conducted and moderated by the authors of this study following focus-group moderation and analysis guidelines by Carey & Asbury (2016) and Krueger (2014).

This validation study was conducted with native Portuguese speakers with similar demographic characteristics to those of previous studies, in terms of age (mean and range) and application context (academic; Abbasi et al., 2015; Cali et al., 2015). Overall, the EFA factor loadings of the items were very similar to

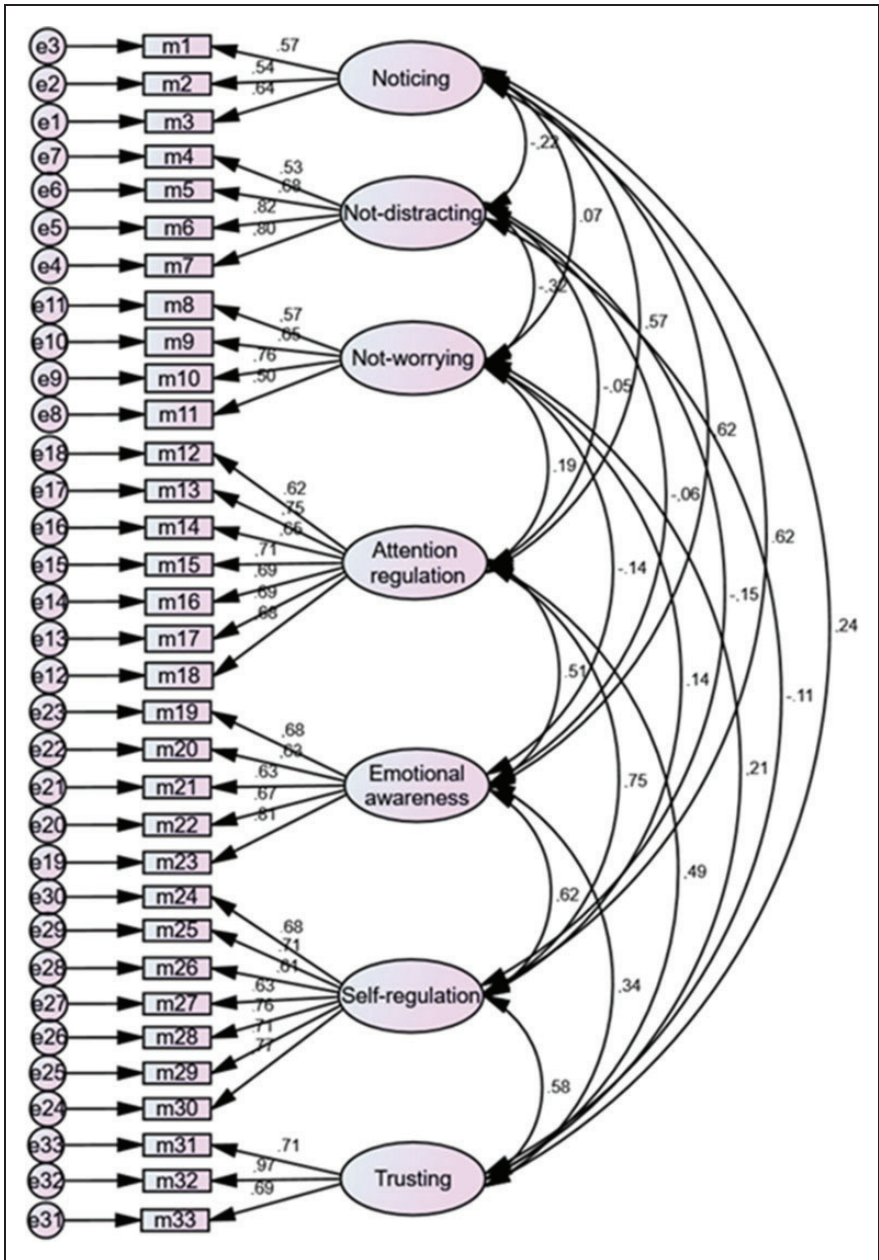


Figure 1. Path diagram for the confirmatory factor analysis of the final MAIA-P.

**Table 3.** Means With Standard Deviation, Consistency and Test-Retest Reliability, and Scale-Scale Correlations of the Portuguese MAIA-P.

	N = 286		N = 20		Scale-scale correlations (n = 286)						
	M	SD	Cronbach's alpha	Number of items	Retest reliability	Not-Distracting	Not-Worrying	Attention Regulation	Emotional Awareness	Self-Regulation	Trusting
Noticing	3.4	0.8	.61	3	.574**	-.165**	.031	.402**	.435**	.435**	.204**
Not-Distracting	1.8	0.9	.81	4	.521*		-.255**	-.009	-.051	-.106	-.023
Not-Worrying	2.6	0.9	.74	4	.698**			.094	-.119	.098	.134*
Attention Regulation	2.9	0.8	.86	7	.590**				.433**	.639**	.427**
Emotional Awareness	3.7	0.8	.80	5	.826**					.510**	.281**
Self-Regulation	2.6	0.9	.87	7	.826*						.516**
Trusting	3.5	1.0	.81	3	.830**						

Note. All scales scored from 0 to 5. Test-retest reliability assessed through intraclass correlation coefficient with values between 0 and 1. Pearson correlations between scales for N = 282. MAIA-P = Portuguese version of the Multidimensional Assessment of Interoceptive Awareness. \*Correlation significant at  $p < .05$ , \*\*at  $p < .01$ .

**Table 4.** Pearson Correlations for Convergent (FFMQ) and Discriminatory (STAI) Validity.

	FFMQ					STAI	
	Nonjudge	Observe	Act with awareness	Describe	Nonreact	Trait-anxiety	State-anxiety
Noticing	.153	.282	-.136	.292	.274	.386*	.301
Not-Distracting	-.127	-.086	-.172	.090	-.323*	.037	-.144
Not-Worrying	-.440**	-.203	-.021	-.177	.138	-.098	.044
Attention Regulation	.011	.409**	-.150	.345*	.484**	.477**	.459**
Emotional Awareness	.193	.466*	-.181	.273	.322	.457**	.165
Self-Regulation	-.045	.485**	-.248	.423**	.531**	.341	.373*
Trusting	-.270	.339*	-.421**	.069	.545**	-.208	.139

Note. Convergent and discriminatory validity assessed for a subgroup of sample B ( $n = 40$ ). FFMQ = Five Facets of Mindfulness Questionnaire; STAI = State and Trait Anxiety Inventory.

\*Correlation significant at  $p < .05$ , \*\* at  $p < .01$ .

the original English MAIA version. Furthermore, the combination of Items 29–35 into a single factor (named *Self-Regulation*) as suggested in the present study by EFA is in line with the theoretical development of MAIA (Mehling et al., 2012), which pointed out five major dimensions for organizing the eight scales, and Self-regulation (Items 29–32) and Body listening (Items 33–35) were included in the same dimension *Mind–Body Awareness*. In our study, the EFA results showed that Item 4 had low and crossed factor loadings and was, therefore, excluded from the MAIA-P, similar to the Chilean version (Valenzuela-Moguillansky & Reyes-Reyes, 2015). Other items (17, 19, 22, 23, 24, 25, 29, 30, and 31) also had low (below .60) and crossed factor loadings, but their exclusion would not represent improvements in scales' internal consistencies, and a minimum loading value (.49) was accepted. At the same time, an improved combination of items for Not-Distracting and Not-Worrying scales was achieved by analyzing their factor loadings (greater than .60), item-scale correlation, and internal consistency of the scales if items were deleted. The exclusion of Items 5, 6, 11, and 14 appeared to improve the scales, but this interpretation should be considered carefully as, to our knowledge, this is the first time these new MAIA items were tested.

The seven-factor model structure was confirmed as adequate in the CFA. In fact, Lithuanian (Baranauskas et al., 2016) and Korean (Gim et al., 2016) validations also accepted adequate model fits with fewer factors than the original MAIA. In the Korean validation of the MAIA, the Items 29–35 also loaded on the same single factor, but the authors labeled that scale “Return to Body” (Gim et al., 2016, p.182). In our study, Items 29–31, which originally belonged to the Self-Regulation scale, also loaded (with low cross-loadings) on Factor 4, which corresponds to the Attention Regulation scale. This may be explained by the fact that the Portuguese expressions used in the Self-Regulation items are somehow similar to the ones used in the Attention Regulation scale, which indicate control of attention through a behavioral or internal self-regulation.

Scale-scale intercorrelations confirmed that the scales were relatively independent, except the Attention Regulation and Self-Regulation scales ( $r = .64$ ). One should note that this correlation value is comparable with the higher inter-scale correlation values reported in the original English version ( $r = .60$ ) and in the Italian and Chilean-Spanish validations of the MAIA ( $r = .62$  and  $r = .68$ , respectively; Calí et al., 2015; Valenzuela-Moguillansky & Reyes-Reyes, 2015). As shown on the path diagram (Figure 1), the correlations between scales and specially those between Attention Regulation and Self-Regulation scales ( $r = .75$ ; even though our Self-regulation scale is an aggregation of original Self-Regulation and Body Listening scales) are comparable with the results of Valenzuela-Moguillansky and Reyes-Reyes (2015) and Gim et al. (2016;  $r = .66$  and  $r = .83$ , respectively). Regarding the descriptive statistics of the Portuguese MAIA, we found that Items 2, 21, 22, and 23 presented higher means in

comparison with the other items, which led to higher values of positive kurtosis. We think that this may have been caused by the fact that all of these items refer to positive body sensations and positive emotions, which can possibly be more easily noticed and expressed than negative ones.

The internal consistency of the Portuguese MAIA scales was good (Noticing and Not-Worrying scales) to very good. Also, the model found in the present study has moderate or good test–retest reliability, in four and three scales, respectively. In addition, we found good values for convergent validity of Portuguese MAIA but not for its discriminatory validity, contrasting with previous studies that showed stronger negative associations between MAIA and STAI-T (especially with the Not-Worrying scale). Still, the correlations between MAIA and FFMQ scales and the lack of an association between MAIA scales and STAI-T confirm that the MAIA scales are assessing a mindful style of interoceptive bodily awareness rather than an anxiety-driven style. We suggest the application of the Portuguese MAIA in samples with a high number of mind–body practitioners to assess criterion validity and discrimination between groups, as well as using the MAIA questionnaire in intervention studies so we can analyze its sensitivity to change for assessing intervention effects. Finally, we would like to note that, although the present validation included a relatively large sample (total  $n=486$ ) with fair sex distribution (total 59% females), the sample was not representative of the general Portuguese population.

## Conclusions

This study showed that this Portuguese version of the MAIA (the MAIA-P) has acceptable psychometric properties. EFA suggested a seven-factor model with 33 items, which was confirmed by CFA in a separate sample with satisfactory goodness of fit indices. Furthermore, the MAIA-P shows good reliability (internal consistency and test–retest reliability) and acceptable convergent validity, and for discriminatory validity, it has no correlation with an anxiety inventory. In summary, the present study showed that the MAIA-P (available online at <https://www.osher.ucsf.edu/maia/>) is an appropriate tool to assess interoceptive awareness in the Portuguese population and can be applied in research and further assessed for its validity in clinical settings.


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**References**

- Abbasi, M., Ghorbani, N., Hatami, J., & Lavasani, M. G. (2015). *Validity and reliability of multidimensional assessment of interoceptive awareness in Iranian students* (Unpublished report). Faculty of Psychology and Educational Sciences, University of Tehran. Retrieved from [https://www.osher.ucsf.edu/wpcontent/uploads/2012/10/MAIA\\_Persian\\_validation.pdf](https://www.osher.ucsf.edu/wpcontent/uploads/2012/10/MAIA_Persian_validation.pdf)
- Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*(1), 27–45. doi:10.1177/1073191105283504
- Baranauskas, M., Grabauskaitė A., & Griskova-Bulanova, I. (2016). Psychometric characteristics of Lithuanian version of Multidimensional Assessment of Interoceptive Awareness (MAIA LT). *Neurologijos Seminarai, 20*(70), 202–206. doi:10.3389/fpsyg.2015.00120
- Bornemann, B., Herbert, B. M., Mehling, W. E., & Singer, T. (2014). Differential changes in self-reported aspects of interoceptive awareness through 3 months of contemplative training. *Frontiers in Psychology, 5*, 1504. doi:10.3389/fpsyg.2014.01504
- Brown, T. (2015). *Confirmatory factor analysis for applied research* (second.). New York, NY: The Guilford Press.
- Brown, T., Berner, L., Jones, M., Reilly, E., Cusack, A., Anderson, L. K., . . . Wierenga, C. E. (2017). Psychometric evaluation and norms for the Multidimensional Assessment of Interoceptive Awareness (MAIA) in a clinical eating disorders sample. *European Eating Disorders Review, 25*(5), 411–416. doi:10.1002/erv.2532
- Brytek-Matera, A., & Koziel, A. (2015). The body self-awareness among women practicing fitness: A preliminary study. *Polish Psychological Bulletin, 46*(1), 104–111. doi:10.1515/ppb-2015-0014
- Calí, G., Ambrosini, E., Picconi, L., Mehling, W., & Committeri, G. (2015). Investigating the relationship between interoceptive accuracy, interoceptive awareness, and emotional susceptibility. *Frontiers in Psychology, 6*, 1202. doi:10.3389/fpsyg.2015.01202
- Carey, M., & Asbury, J. (2016). *Focus group research*. New York, NY: Routledge.
- Ceunen, E., Vlaeyen, J., & van Diest, I. (2016). On the origin of interoception. *Frontiers in Psychology, 7*, 743. doi: 10.3389/fpsyg.2016.00743
- Craig, A. (2008). Interoception and emotion: A neuroanatomical perspective. In M. Lewis, J. M. Haviland-Jones & L. F. Barrett (Eds.), *Handbook of emotions* (3rd., pp. 272–288). New York, NY: Guilford Press.
- Daubenmier, J. (2005). The relationship of yoga, body awareness, and body responsiveness to self-objectification and disordered eating. *Psychology of Women Quarterly, 29*, 207–219. doi:10.1111/j.1471-6402.2005.00183.x
- de Jong, M., Lazar, S. W., Hug, K., Mehling, W. E., Hölzel, B. K., Sack, A. T., . . . Gard, T. (2016). Effects of mindfulness-based cognitive therapy on body awareness in patients with chronic pain and comorbid depression. *Frontiers in Psychology* (Vol. 7, p. 967) doi:10.3389/fpsyg.2016.00967



- Duquette, P. (2017). Increasing our insular world view: Interoception and psychopathology for psychotherapists. *Frontiers in Neuroscience, 11*, 135. doi:10.3389/fnins.2017.00135
- Epstein, J., Santo, R. M., & Guillemín, F. (2015). A review of guidelines for cross-cultural adaptation of questionnaires could not bring out a consensus. *Journal of Clinical Epidemiology, 68*(4), 435–441. doi:10.1016/j.jclinepi.2014.11.021
- Farb, N., Daubenmier, J., Price, C. J., Gard, T., Kerr, C., Dunn, B. D., . . . Mehling, W. E. (2015). Interoception, contemplative practice, and health. *Frontiers in Psychology, 6*, 763doi:10.3389/fpsyg.2015.00763
- Fissler, M., Winnebeck, E., Schroeter, T., Gummersbach, M., Huntenburg, J. M., Gaertner, M., & Barnhofer, T. (2016). An investigation of the effects of brief mindfulness training on self-reported interoceptive awareness, the ability to decenter, and their role in the reduction of depressive symptoms. *Mindfulness, 7*(5), 1170–1181. doi:10.1007/s12671-016-0559-z
- Garfinkel, S., & Critchley, H. (2013). Interoception, emotion and brain: New insights link internal physiology to social behaviour. Commentary on: “Anterior insular cortex mediates bodily sensibility and social anxiety” by Terasawa et al. (2012). *Social Cognitive and Affective Neuroscience, 8*(3), 231–234. doi:10.1093/scan/nss140
- Garfinkel, S., Seth, A., Barrett, A., Suzuki, K., & Critchley, H. (2015). Knowing your own heart: Distinguishing interoceptive accuracy from interoceptive awareness. *Biological Psychology, 104*, 65–74. doi:10.1016/j.biopsycho.2014.11.004
- General Assembly of the World Medical Association. (2014). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *The Journal of the American College of Dentists, 81*(3), 14.
- Gim, W., Sim, K., & Cho, O. (2016). Korean Multidimensional Assessment of Interoceptive Awareness (K-MAIA): Development and validation. *Korean Journal of Stress Research, 24*(3), 177–192. doi:10.17547/kjrs.2016.24.3.177
- Gregório, S., & Gouveia, J. (2011). Facetas de mindfulness: Características psicométricas de um instrumento de avaliação [Facets of Mindfulness: psychometric characteristics of an assessment instrument]. *Psicologica, 54*, 259–280.
- IBM Corp.. (2017). *IBM SPSS Statistics for Windows, Version 24.0*. Armonk, NY: Author.
- Kabat-Zinn, J. (2008). *Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness* (15th.). New York, NY: Random House.
- Khalsa, S. S., Adolphs, R., Cameron, O. G., Critchley, H. D., Davenport, P. W., Feinstein, J. S., . . . Paulos, M. P. (2018). Interoception and mental health: A roadmap. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging, 3*(6), 501–513. doi:10.1016/j.bpsc.2017.12.004
- Kline, R. (2005). *Principles and practice of structural equation modeling* (second edition.). New York, NY: The Guilford Press.
- Koo, T., & Li, M. (2016). A guideline for selecting and reporting intra-class correlation coefficients for reliability research. *Journal of Chiropractic Medicine, 15*(2), 155–163. doi:10.1016/j.jcm.2016.02.012
- Krueger, R. (2014). *Focus groups: A practical guide for applied research*. London, England: Sage.

- Leech, N., Barrett, K., & Morgan, G. (2005). *SPSS for intermediate statistics: Use and interpretation*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Lin, F., Hsu, C., Mehling, W., & Yeh, M. (2017). Translation and psychometric testing of the Chinese version of the multidimensional assessment of interoceptive awareness. *Journal of Nursing Research*, 25(1), 76–84. doi:10.1097/jnr.000000000000182
- Lourenço, A., & Parreira, P. (2012). Ansiedade dos estudantes perante o ensino clínico [Students anxiety towards clinical teachings]. *International Journal of Developmental and Educational Psychology – INFAD Revista de Psicología*, 4(1), 203–212. Retrieved from <http://dehesa.unex.es/handle/10662/3591>
- Mehling, W. (2016). Differentiating attention styles and regulatory aspects of self-reported interoceptive sensibility. *Philosophical Transactions of the Royal Society B*, 371(1708), pii: 20160013. doi:10.1098/rstb.2016.0013
- Mehling, W., Gopisetty, V., Daubenmier, J., Price, C., Hecht, F. M., & Stewart, A. (2009). Body awareness: Construct and self-report measures. *PLoS One*, 4(5), e5614. doi:10.1371/journal.pone.0005614
- Mehling, W., Price, C., Daubenmier, J., Acree, M., Bartmess, E., & Stewart, A. (2012). The Multidimensional Assessment of Interoceptive Awareness (MAIA). *PLoS One*, 7(11), e48230. doi:10.1371/journal.pone.0048230
- Mehling, W. E., Chesney, M. A., Metzler, T. J., Goldstein, L. A., Maguen, S., Geronimo, C., ... Neylan, T. C. (2017). A 12-week integrative exercise program improves self-reported mindfulness and interoceptive awareness in war veterans with posttraumatic stress symptoms. *Journal of Clinical Psychology*, 74(4), 554–565. doi:10.1002/jclp.22549
- Muir, K., Madill, A., & Brown, C. (2017). Individual differences in emotional processing and autobiographical memory: Interoceptive awareness and alexithymia in the fading affect bias. *Cognition and Emotion*, 31(7), 1392–1404. doi:10.1080/02699931.2016.1225005
- Mul, C. L., Stagg, S. D., Herbelin, B., & Aspell, J. E. (2018). The feeling of me feeling for you: Interoception, alexithymia and empathy in autism. *Journal of Autism and Developmental Disorders*, 48, 2953–2967. doi:10.1007/s10803-018-3564-3
- Porges, S. W. (1993). *Body perception questionnaire: Laboratory of Developmental Assessment*. Maryland: University of Maryland.
- Shields, S., Mallory, M., & Simon, A. (1989). The body awareness questionnaire: Reliability and validity. *Journal of Personality Assessment*, 53, 802–815. doi:10.1207/s15327752jpa530416
- Silva, D. (2003). O Inventário de Estado-Traço de Ansiedade (S.T.A.I.) de Spielberger-Forma Y [The State and Trait Anxiety Inventory (STAI) of Spielberger – Y Form]. In M. M. Gonçalves, M. R. Simões, L. S. Almeida & C. Machado (Eds.), *Avaliação psicológica, Volume I* (pp. 45–63). Coimbra, Portugal: Quarteto.
- Spielberger, C. D. (1983). *Manual for the State-Trait Anxiety Inventory: STAI (Form Y)*. Palo Alto, CA: Consulting Psychologist Press.
- Sun, C. W., & Pju, K. (2009). Questionnaire translation and psychometric properties evaluation. *SEGi University College*, 2(2), 45–51.
- Tsakiris, M. (2010). My body in the brain: A neurocognitive model of body-ownership. *Neuropsychologia*, 48(3), 703–712. doi:10.1016/j.neuropsychologia.2009.09.034

- Tsakiris, M. (2017). The multisensory basis of the self: From body to identity to others. *The Quarterly Journal of Experimental Psychology*, 70(4), 597–609. doi:10.1080/17470218.2016.1181768
- Valenzuela-Moguillansky, C., & Reyes-Reyes, A. (2015). Psychometric properties of the multidimensional assessment of interoceptive awareness (MAIA) in a Chilean population. *Frontiers in Psychology*, 6, 1–13. doi:10.3389/fpsyg.2015.00120
- Zamariola, G., Vlemincx, E., Luminet, O., & Corneille, O. (2018). Relationship between interoceptive accuracy, interoceptive sensibility, and alexithymia. *Personality and Individual Differences*, 125, 14–20. doi:10.1016/j.paid.2017.12.024.

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