

**Are dimensions of interoceptive awareness the same for everyone? Serbian validation of
MAIA-2 in samples with differing mind-body practice experience**

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Abstract

The Multidimensional Assessment of Interoceptive Awareness (MAIA) is a widely used instrument of interoceptive awareness. The improved version, MAIA-2, has not yet been thoroughly validated. Moreover, the question of MAIA dimensionality remains open, as some studies support the original eight-factor solution while others find fewer factors. To validate the Serbian translation of MAIA-2 and examine its factorial structure, we recruited a sample of 214 participants experienced in mind-body practices, and an additional student sample of 229 participants. Both samples also completed a range of relevant psychological measures. Despite obtaining fewer factors than the original MAIA, our findings support the notion that adaptive and maladaptive aspects of interoceptive awareness should be distinguished. Moreover, the dimensionality of interoceptive awareness may vary based on participants' mind-body experience levels. Notably, mind-body practitioners scored higher in all dimensions compared to students, and those with more experience in mind-body practices exhibited greater interoceptive awareness. Overall, MAIA-2 proves to be a valuable tool for assessing interoceptive awareness, and its scores demonstrated acceptable reliability and meaningful correlations with other constructs.

Interoception, most broadly defined, is a sense of what is happening inside one's own body. During the past decade several attempts have been made to highlight various aspects of interoception, especially those available to awareness (e.g., Garfinkel et al., 2015; Khalsa et al., 2018; Murphy et al., 2019). While *interoceptive accuracy* seems to be clearly defined as performance on interoceptive behavioral tasks (Garfinkel et al., 2015), terms *interoceptive sensibility* and *interoceptive awareness* sometimes overlap in their definition or are used alternatively. Garfinkel et al. (2015) define interoceptive sensibility as self-reported beliefs about personal interoceptive ability and attention, while they view interoceptive awareness as a metacognitive correspondence between interoceptive accuracy and sensibility. Mehling et al. (2012, p.2) define interoceptive awareness as a "...conscious perception of sensations from inside the body that create the sense of the physiological condition of the body, including interpretational and organizing aspects of perception". However, in their later works, Mehling et al. (2016, 2018) used the two terms interchangeably, as we will do in this paper.

The Multidimensional Assessment of Interoceptive Awareness

The Multidimensional Assessment of Interoceptive Awareness (MAIA; Mehling et al., 2018; Mehling et al., 2012) is one of the most frequently referenced self-report instruments in the interoception literature (Desmedt et al., 2022). It has been widely translated and validated (Abbasi et al., 2018; Baranauskas et al., 2016; Bornemann et al., 2015; Cali et al., 2015; Gim et al., 2016; Ferentzi et al., 2020; Fujino, 2019; Lin et al., 2017; Purić & Jokić, 2019; Reis, 2017; Salvador et al., 2020; Shoji et al., 2018; Todd et al., 2020; Valenzuela-Moguillansky & Reyes-Reyes, 2015; Vinni et al., 2020; Willem et al., 2022) and a simple Google scholar search¹ indicates it has been referenced more than 1000 times. The questionnaire was constructed to help differentiate between

¹ The search was made on 2023-08-09.

anxiety-driven and mindful interoceptive styles, and the authors cooperated with practitioners of various mind-body practices (such as meditation, yoga, Tai Chi) during the process. Mehling et al. (2012) developed MAIA to assesses eight distinct aspects of interoception awareness: 1) *Noticing* - awareness of body sensations, 2) *Not-Distracting* - tendency not to ignore or distract oneself from sensations of pain or discomfort, 3) *Not-Worrying* - tendency not to worry or experience emotional distress with sensations of pain or discomfort, 4) *Attention Regulation* - ability to sustain and control attention to body sensation, 5) *Emotional Awareness* - awareness of the connection between body sensations and emotional states, 6) *Self-Regulation* - ability to regulate distress by attention to body sensations, 7) *Body Listening* - active listening to the body for insight, and 8) *Trusting* - experience of one's body as safe and trustworthy.

In line with the idea that mind-body practices can impact interoceptive awareness (Mehling et al., 2012; Mehling et al., 2011), several studies explored the relation between engagement in mind-body practices and MAIA scores (e.g., Bornemann et al., 2015; Ferentzi et al., 2020; Lin et al., 2017; Mehling et al., 2012). For example, more experienced mind-body practitioners have been found to score higher on half (Mehling et al., 2012) or majority (Lin et al., 2017) of MAIA scales compared to their less experienced peers. Furthermore, a correlational study showed that the number of years of mind-body practice and the number of weekly mind-body practice sessions both predicted scores on a general MAIA factor ($\beta = 0.23$ and $\beta = 0.28$, respectively) (Ferentzi et al. 2020). Bornemann et al. (2015) also registered significant changes in most of MAIA scales after a three-month contemplative training. Of course, besides the direct effects of mind-body therapies, various alternative mechanisms could explain the obtained results (such as expectations or biases, Ferentzi et al. 2020).

The original version of the scale, however, had some drawbacks. Reliabilities ranged from unsatisfactory for the Noticing, Not-Distracting, and Not-Worrying scales ($.60 < \alpha < .70$) to good for the Attention Regulation, Emotional Awareness, Self-Regulation, and Body Listening scales ($.80 < \alpha < .90$) (Mehling et al., 2012). Since low reliabilities of the Not-Distracting and Not-Worrying scales were replicated in multiple later studies (see Ferentzi et al., 2020; Mehling, 2016; Todd et al., 2020), the authors tried to improve them by adding additional items. The revised questionnaire, Multidimensional Assessment of Interoceptive Awareness, Version 2 (MAIA-2) showed somewhat improved reliabilities of .74 for Not-Distracting (three added items) and .67 for Not-Worrying (two added items), although the reliability of Noticing was still unsatisfactory at .64 (Mehling et al., 2018). MAIA-2 has, to our knowledge, only been validated in three languages (French: Da Costa Silva et al., 2022; Portuguese: Machorrinho et al., 2019; Turkish: Özpınar et al., 2021) and translated into another two (Italian: Vabba et al., 2023; Ukrainian: Voloshchenko, 2023).

Another issue with the original MAIA were the relations between dimensions. Specifically, Not-Distracting and Not-Worrying were only weakly related to the rest of the scales, which were highly mutually correlated. Ferentzi et al. (2020) highlighted these intercorrelations as problematic in terms of construct validity and further suggested that, with the exception of Not-Worrying (which mainly assesses neuroticism) and Not-Distracting (which does not seem to capture a coherent construct), all other MAIA scales assess the construct of interoceptive awareness in a manner which does not allow for finer differentiation. Similarly, in their summary of studies examining the factorial structure of MAIA (a majority conducted using the first MAIA version)

Todd et al. (2020) found that, although the original or modified eight-factor models were retained in many of the studies², models with fewer (three to seven) factors were also frequently identified.

Nevertheless, these issues were identified mainly using the original MAIA scale, while MAIA-2 was constructed precisely to improve upon the psychometric properties of the first version. However, even in MAIA-2, multiple scale intercorrelation coefficients were still below .20 and few were at or above .50 (Mehling et al., 2018). Moreover, all three studies on MAIA-2 revealed fewer than eight factors (six or seven; Da Costa Silva et al., 2022; Machorrinho et al., 2019; Özpınar et al., 2021). Thus, our study sought to provide a significant contribution to ascertaining whether MAIA-2 has indeed improved upon the problematic aspects of the original version, both in terms of reliability and structural validity.

Psychological correlates of interoceptive awareness

Since MAIA was developed with the idea of differentiating between anxiety-driven and mindful interoceptive attention styles, at least some of its scales should correlate positively with mindfulness. This has been confirmed empirically, both using multidimensional (e.g., Bornemann et al., 2015; Da Costa Silva et al., 2022; Ferentzi et al., 2020; Mehling et al., 2012; Machorrinho et al., 2019; Shoji et al., 2018; Todd et al., 2020; Willem et al., 2022), as well as unidimensional mindfulness operationalizations (Ferentzi et al., 2020; Jokić & Purić, 2020; Todd et al., 2020).

Theoretically, interoceptive sensitivity may have both a beneficial (e.g., positive relation with emotion regulation) or a maladaptive (e.g., links to various disorders) role in the broad context of well-being (Erle et al., 2021; Ferentzi et al., 2019; Mehling et al., 2012). However, the few studies that empirically explored these relations registered positive correlations, ranging from .20 to .40, between most MAIA scales and wellbeing (Hanley et al. 2017; Jokić & Purić, 2020).

² It should also be noted that Todd et al. (2020) identified several problems in various factorial studies of MAIA, such as using eigenvalue > 1.0 as the factor retention criterion or retaining models with problematic indices of fit.

Conversely, since MAIA does not merely assess anxiety-driven interoceptive attention, typically, negative correlations, up to $r = -.50$ (for Trusting), are registered between MAIA and STAI-T (Spielberger, 1983) (e.g., Bornemann et al., 2015; Ferentzi et al., 2020; Mehling et al., 2012; Machorrinho et al., 2019; Shoji et al., 2018; Willem et al., 2022). And while different interoceptive patterns have been registered for symptoms of depression, anxiety and stress, at least some MAIA scales were negatively related to each of the symptomatology dimensions (Jokić & Purić, 2021).

Relations between MAIA and basic personality traits have so far, to our knowledge, only been explored in three studies - two using the original MAIA (Ferentzi et al., 2020; Pearson & Pfeifer, 2020), and one using MAIA-2 (Da Costa Silva et al., 2022). Pearson and Pfeifer (2020) registered several low to moderate correlations between MAIA scales and Eysenck's Neuroticism (with the highest value of $r = -.53$ for Trusting), and none with Extraversion. Ferentzi et al. (2020) also obtained mostly low correlations between MAIA and HEXACO traits (below .30), although some correlations with Emotionality and Extraversion were higher, up to $r = -.49$). Finally, all correlations between MAIA-2 scales and the Big Five Inventory (BFI) dimensions were below .30, except for the $r = -.44$ correlation between Trusting and Neuroticism (Da Costa Silva et al., 2022). We decided to supplement the “personality space” by including a recently conceptualized broad personality trait of psychosis-proneness and psychotic-like experiences, i.e., Disintegration (Knežević et al., 2017), expecting similarly low correlations. Barbato et al. (2021) found lower scores on Not-Distracting, Not-Worrying, Attention Regulation, and Trusting, and higher scores on Emotional Awareness and Body Listening to be risk factors for psychosis. However, schizotypy did not predict interoceptive awareness assessed by MAIA (Torregrossa et al., 2022).

Previous studies demonstrated that higher interoceptive awareness was related to fewer difficulties in emotion regulation (e.g., Mehling et al., 2012; Shoji et al., 2018; Willem et al., 2022). The correlations were mostly low to moderate in intensity (up to .54, Mehling et al., 2012). Additionally, in a recent study by Schuette et al. (2020), Noticing was a significant positive predictor of emotion regulation.

Current study

Our main goal was to validate the Serbian version of MAIA-2 on a sample of individuals with experience in mind-body practices (e.g., yoga, Tai chi, martial arts) by examining its 1) factorial structure, 2) reliability, 3) relations with mind-body experience and, 4) relations with relevant psychological constructs. Since mind-body approaches were significant in the original questionnaire development process, we opted to assess MAIA-2 on a mind-body experienced sample.

In terms of factorial validity, according to the original MAIA model, we should expect an eight-factor solution (H1), however, taking empirical evidence into account, a solution with fewer factors would also not be unexpected (e.g., Fujino, 2019; Ferentzi et al., 2020; Machorrinho et al., 2019; Özpınar et al., 2021; Purić & Jokić, 2019; Salvador et al., 2020; Shoji et al., 2018; Todd et al., 2020). We planned to assess reliability of MAIA-2 dimensions via Cronbach's alpha coefficients.

Drawing on previous studies, we expected that mind-body experience will predict scores on at least some MAIA-2 scales, with small effect sizes (less than 25% of explained variance) (H2, Ferentzi et al., 2020). We further hypothesized that at least some MAIA-2 scales will have a positive correlation (up to .30) with mindfulness (H3, e.g., Ferentzi et al., 2020; Jokić & Purić, 2020; Todd et al., 2020), most will show positive correlations (in the range of $.10 \leq r \leq .40$) with

well-being (H4, Hanley et al. 2017; Jokić & Purić, 2020), negative correlations (in the .20-.50 range) with measures of anxiety (H5, Mehling et al., 2012), and mostly modest correlations (up to .30) with personality traits (H6, Da Costa Silva et al., 2022; Ferentzi et al., 2020; Pearson & Pfeifer, 2020). On an exploratory level, we wanted to see whether the same pattern of results typically obtained for anxiety would be replicated for depression and stress and to examine the relation between interoceptive sensibility and usage of emotion regulation strategies.

Finally, to reach a better understanding of potential specificities of the practitioner sample, we aimed to compare the results from the main study with those from a student sample. In this sample we tested factorial validity of MAIA-2, its reliability (Cronbach's alpha complemented with test-retest reliability), as well as the relations with wellbeing and personality traits, expecting the same pattern of results as for the practitioner sample. We also expected to observe differences between the two samples in terms of interoceptive awareness such that participants who are more experienced with mind-body practices obtain higher scores on MAIA-2 scales (H7³, Ferentzi et al., 2020).

Method

Open science

Both the hypotheses and the analytic strategy of the main study on the mind-body practitioner sample were preregistered (https://osf.io/zeq94?view_only=a0136e6574b441aa91e1b1b4ca9da9b6). We did not preregister the collection of an additional student sample, however we used the same materials and analytic procedures to test corresponding hypotheses. A separate file on the OSF project page

³ This hypothesis was not preregistered.

(https://osf.io/wjd6s?view_only=2c087da9c77a4db59d4b14e47037bc33) lists all (minor) deviations from the preregistration.

Power analysis

Since MAIA-2 comprises 37 items, a sample of $N = 185$ individuals results in a 5:1 participant-to-item ratio recommended for performing exploratory factor analysis (Norris & Lecavalier, 2010). To detect low correlations ($r = .20$, two-tailed), with a power of 80% and $p = .05$, a sample of $N = 193$ individuals is required (G*Power; Faul et al., 2009). Therefore, we set the minimum sample size for both the practitioner and the student sample at 200. Our stopping rule was observing ten consecutive days without a new input in the database after the day of reaching the minimum sample size.

Procedure and participants

Mind-body sample

Participants over the age of 18 and with past or present experience with mind-body training were eligible for participation in the study. Mind-body training was defined as "training which is focused on a combination of mental and physical activity (such as yoga, meditation, martial arts...)". We used a snowball method to recruit participants, with invitations being sent out via 1) posting Facebook advertisements and posts on groups/pages dedicated to mind-body practices, 2) inviting mind-body clubs to share the study link with their members, 3) using the listserv of the Serbian Association for Body Psychotherapy, as well as 4) contacting personal acquaintances with mind-body experience. There was no compensation for participation and the data was collected online, from April to December 2021. The study was approved by the IRB of the Department of Psychology, Faculty of Philosophy, University of Belgrade (protocols #2021-20 and #2021-63). All participants provided informed consent prior to taking part in the study.

In total, 220 individuals completed the questionnaires. Participants with no mind-body experience ($n = 5$) and one participant with an impossible age-years of experience combination were removed from study. Thus, the final sample included $N = 214$ participants (79% female) with a mean age of 41.0 ($SD = 12.3$) and median education of 16.0 years ($M = 16.1$, $SD = 2.9$). Most participants had experience with yoga (67.8%), followed by meditation or prayer (59.3%), and Eastern martial arts (24.3%), while other categories were represented with less than 15% of participants (Table A1, Appendix A). More than 40% of participants listed yoga as the modality with which they had the longest experience, followed by meditation or prayer (22.4%), and Eastern martial arts (18.7%).

A large range was observed for years of mind-body experience (from less than 1 to 48), with participants having a median of 9 and mean of 10.3 ($SD = 9.1$) years of experience. A majority of the sample (71.96%, $n = 154$) participated in mind-body training at the time of the testing, with around three training sessions weekly ($Mdn = 3.0$, $M = 3.82$, $SD = 3.11$).

Student sample

Two generations of psychology students from University of Belgrade were invited to take part in the study in exchange for course credit. The data was collected online from December 2020 to December 2021. The study was exempt from approval as a low risk study and the data were collected in accordance with the Declaration of Helsinki, with all participants providing informed consent.

A total of 229 students (83% females) with the mean age of 20.2 ($SD = 2.2$) completed the study. Students had little experience with meditation, an important aspect of various mind-body practices, $Mdn = 1.0$, $M = 1.7$, $SD = 1.6$ (on a 0-5 scale), with 53% of participants indicating options 0 and 1. A subsample of participants ($n = 71$, female 87.3%, $M = 20.6$, $SD =$

3.2) retook MAIA-2 approximately three months later: the mean difference between the two time points was 86 days ($SD = 8.7$, min = 70 and max = 107 days).

Instruments

Both samples filled out MAIA-2, SHS, HEXACO, and DELTA questionnaires and provided information on their age and gender. The mind-body sample also completed MAAS, DASS-21, SWLS, and ERQ and answered a set of questions regarding their mind-body experience and socio-demographics. The questionnaires were presented in a fixed order with MAIA-2 in the first place, and all MAIA-2 items were set to mandatory.

MAIA-2 (Mehling et al., 2018) assesses interoceptive awareness through eight scales: Noticing (four items), Not-Distracting (six), Not-Worrying (five), Attention Regulation (seven), Emotional Awareness (five), Self-Regulation (four), Body Listening (three), and Trusting (three). Responses are provided on a (0 - 5) Likert type scale. We used the official Serbian version of MAIA-2 (<https://osher.ucsf.edu/research/maia>), translated using a systematic forward-backward procedure (Jokić et al., 2021). Reliabilities registered for the Serbian translation of the first MAIA version ranged from .41 (Not-Distracting) to .77 (Attention Regulation), with five scales below the .70 benchmark (Jokić & Purić, 2020).

The Mindful Attention Awareness Scale (MAAS, Brown & Ryan, 2003) assesses the disposition towards a mindful mindset with 15 items. Answers are given on a (1 - 6) Likert type scale. Reliability is good, both for the original version ($.80 \leq \alpha < .90$, Brown & Ryan, 2003) and the Serbian translation ($\alpha = .83$, Jokić & Purić, 2020).

The Depression Anxiety Stress Scales-21 (DASS-21, Lovibond & Lovibond, 1995) is a 21-item short version of the DASS questionnaire, which assesses symptoms of depression, anxiety, and stress. Responses are given on a (0 - 3) Likert type scale. We used the Serbian

version of the scale, which previously demonstrated good reliability ($\alpha = .81$ to $.92$, Jovanovic et al., 2014).

The Emotion Regulation Questionnaire (ERQ, Gross & John, 2003) consists of the Reappraisal (six items) and the Suppression (four) scales. Answers are given on a (1-7) Likert type scale. Both scales showed satisfactory reliability in the original report (average $\alpha = .79$ for reappraisal and $.73$ for suppression, Gross & John, 2003). Reliabilities for the Serbian version were poor for reappraisal, $\alpha = .64$, and satisfactory for suppression, $\alpha = .71$ (Popov et al., 2016).

The Subjective Happiness Scale (SHS, Lyubomirsky & Lepper, 1999) consists of four items. Answers are given on a (1 - 7) Likert type scale. The authors reported good reliability in the original article ($\alpha \sim .80-.90$ for most samples, Lyubomirsky & Lepper, 1999). Reliability of the Serbian version of SHS was good, $\alpha = .83$ (Jovanović, 2014).

The Satisfaction With Life Scale (SWLS, Diener et al., 1985) comprises five items. Answers are given on a (1 - 7) Likert type scale. The reliability of the instrument is good, both for the original ($\alpha = .87$, Diener et al., 1985), and the Serbian version ($\alpha = .83$, Vasić et al., 2011).

HEXACO (Ashton & Lee, 2009; Lee & Ashton, 2018) is a personality inventory assessing six broad personality dimensions: Honesty-Humility (H), Emotionality (E), eXtraversion (X), Agreeableness (A), Conscientiousness (C), and Openness to Experience (O). We used the 60-item version of the inventory (Ashton & Lee, 2009) for the mind-body practitioner sample and the 100-item version (Lee & Ashton, 2018) for the student sample. Answers to both versions are given on a (1 - 5) Likert type scale. Reliabilities for the 60-item version ranged from satisfactory to good in the original analysis ($.70 < \alpha \leq .80$, Ashton & Lee, 2009) and were good ($.80 < \alpha < .90$) for the 100-item version (Lee & Ashton, 2018). Both

versions previously showed adequate reliabilities for the Serbian translations as well - from .67 to .79 for the 60-item version (Dinić & Wertag, 2018) and from .78 to .84 for the 100-item version (Mededović et al., 2019).

DELTA9 (Knežević et al., 2017) assesses the broad personality trait of disintegration. Answers are given on a Likert (1 - 5) type scale. The student sample completed the full 110-item version and the mind-body practitioner sample completed the short 20-item version of DELTA9. Reliability of both the 110-item version ($\alpha = .96$; Šoljaga & Knežević, 2023) and the 20-item version ($\alpha = .93$; Stojković et al., 2018) were previously very high.

Data analysis

We used IBM SPSS (version 23) and R (version 4.3.1; R Core Team, 2023) for data analysis. For a full list of used R packages see Appendix B. To make the scores on different scales more easily comparable, we calculated all scores by averaging the corresponding items.

Results

Factorial structure of MAIA-2

To explore the factorial structure of MAIA-2 we performed an exploratory factor analysis (EFA), using Principal axis factoring with Promax rotation, separately for the mind-body sample and the student sample. To determine the number of factors we used Parallel analysis, Velicer's MAP criterion and Scree plot. Although several items in the practitioner sample had high skewness and/or kurtosis ($> |2|$), the assumptions for EFA were met - Bartlett's test was significant ($p < .001$ for both samples) and KMO high (.88 for the mind-body sample and .82 for the student sample).

For the mind-body practitioner sample, parallel analysis suggested nine factors should be retained, MAP suggested six factors, and the scree plot three or six (see Figures C1-C2 in

Appendix C). Thus, we examined the three-, six-, nine-, as well as the originally proposed eight-factor solution (see Tables C1-C8 in Appendix C). The 6-factor solution was superior to other solutions in terms of interpretability and identified the following six factors: 1) *Attention regulation*, 2) *Listening and trusting*: comprising all Body Listening, all Trusting and two Self-Regulation items, 3) *Noticing*, 4) *Not-Distracting*, 5) *Emotional Awareness*: all Emotional Awareness and two Self-Regulation items, and 6) *Not-Worrying*. All factors, except for Not-Distracting and Not-Worrying, were mutually positively correlated, with all but one correlation being .50 or higher (Table C9, Appendix C). Therefore, we decided to perform a second-order EFA on the six identified factors. The higher-order, general MAIA factor (gMAIA) had strong loadings of all first order factors, except for Not-Distracting and Not-Worrying (see Figures C3-C4 and Table C10 in Appendix C).

For the student sample, parallel analysis suggested an 11-factor solution, MAP suggested four or six factors, and the biggest drop on the scree plot was observed after the third factor (see Figures D1-D2 in Appendix D). We explored all of the suggested solutions, as well as the original 8-factor solution (see Tables D1-D10 in Appendix D). Solutions with fewer factors were more convincing in terms of factorial simplicity and interpretability and we chose to retain the three-factor solution as it was the best in terms of Thurstone's simple structure. Not-Worrying and Not-Distracting formed separate factors, while all remaining MAIA items loaded on a general interoceptive awareness factor, gMAIA; the three factors were essentially orthogonal (with the highest correlation being .10, Table D11, Appendix D).

Subsequent analyses were performed on factor scores obtained by averaging items with primary loadings on each factor. For gMAIA we averaged all items save for Not-Worrying and Not-Distracting.

Descriptive statistics and psychometric properties of instruments

With the exception of Not-Distracting and Not-Worrying, which had mean values below the scale midpoint, participants in both samples were generally prone to agree with MAIA-2 items (Tables 1 and 2) and all MAIA-2 distributions deviated from normality (except gMAIA on the student sample). Cronbach's alpha internal consistency values were satisfactory to good in both samples. Test-retest reliability was overall acceptable, Pearson $r(69) = .72, p < .001$ for Not-Worrying, $r(69) = .69, p < .001$ for gMAIA, and $r(69) = .50, p < .001$ for Not-Distracting, considering the type of reliability coefficient (Matheson, 2019).

Internal consistencies of other constructs were also good. Since most of the distributions deviated from normality only slightly (the values of Skewness and Kurtosis were mostly within the range of ± 1), we did not perform any transformations but rather used non-parametric analytic procedures.

[Table 1 around here]

[Table 2 around here]

Relation of interoceptive awareness with mind-body experience

We examined the relation of mind-body experience and interoceptive awareness both by comparing the scores of the practitioner and the student sample, and by testing the predictive power of years of experience and number of weekly sessions on practitioners' MAIA-2 scores.

A two-tailed Welch's t -test (Delacre et al., 2021) indicated higher scores for mind-body experienced individuals compared to students on all MAIA-2 dimensions (H7): the general MAIA score ($t(440.662) = 12.34, p < .001$, Cohen's $d^* = 1.17^4$, 95% CI [0.97, 1.37]), Not-

⁴ Since we performed Welch's t -test, to assess the magnitude of differences between groups, instead of classical Cohen's d , we used an effect size estimator based on the sample mean difference divided by the square root of the non pooled average of both variance estimates, as recommended by Delacre et al., 2021.

Worrying ($t(438.82) = 3.56, p < .001$, Cohen's $d^* = 0.34$, 95% CI [0.15, 0.53]), as well as Not-Distracting ($t(400.38) = 4.68, p < .001$, Cohen's $d^* = 0.45$, 95% CI [0.26, 0.64]).

Confirming our expectations, years of experience with mind-body practices, and especially the number of weekly sessions, were related to the level of interoceptive awareness (H2, Table 3)⁵. Interestingly, years of mind-body experience only contributed to the prediction of Noticing and Not-Distracting, while the number of weekly sessions was relevant for all MAIA-2 aspects except Noticing and Not-Worrying.

[Table 3 around here]

Relations with relevant psychological variables

In line with our hypotheses, we found that in mind-body experienced individuals higher MAIA-2 scores corresponded to a higher frequency of mindfulness states (H3), higher well-being (H4) and fewer negative emotional states (H5) (Table 4). The positive correlation with well-being was found in the student sample as well (Table 5). Correlations were mostly in the expected range, although some mindfulness and wellbeing correlations were higher than .30 and .40, respectively. Overall, higher interoceptive awareness was related to a higher use of the reappraisal, and a less frequent use of the suppression emotion regulation strategy. Not Distracting in particular was strongly associated with less emotion suppression.

[Table 4 around here]

[Table 5 around here]

With few exceptions, interoceptive awareness was unrelated or only moderately related to personality traits (H6), in both mind-body practitioners and in students (Tables 6 and 5). The

⁵ Body psychotherapists were excluded from this analysis to avoid the confounding effect of psychotherapy sessions. This decision was made due to the potential variability in the implementation and the extent of mind-body techniques employed by certain body therapists during sessions with their clients.

highest (negative) correlation in both samples was observed between Not-Worrying and Emotionality.

[Table 6 around here]

Discussion

The construct of interoceptive awareness has garnered substantial research attention over the years; however, its assessment remains a significant challenge. The original MAIA and its latest version, MAIA-2, propose an eight-factor structure, confirmed in many but not all validation studies. In the current paper, we addressed the question of MAIA-2 dimensionality in a sample of mind-body practitioners, comparing them with a student sample. Additionally, our results on the role of experience with mind-body practices and relations with relevant psychological constructs further our understanding of the nature of interoceptive sensibility.

How many interoceptive dimensions does MAIA-2 assess?

One of the major controversies regarding multidimensional assessment of interoceptive awareness is precisely its (multi)dimensionality. By comparing the factor structure of MAIA-2 in a sample of mind-body practitioners with that in a sample of students, we were in a unique position to investigate whether its dimensionality varies depending on mind-body experience, and our results indeed provide several important insights.

Firstly, we did not find support for the originally proposed, and occasionally replicated eight-factor solution (e.g., Bornemann et al., 2015; Lin et al., 2017; Valenzuela-Moguillansky & Reyes-Reyes, 2015) in either of the samples. Even more importantly, the number of retained factors was different for the two samples. In the practitioner sample we obtained six first-order factors which either matched the original MAIA-2 scales or were their combinations (see also Shoji et al., 2018). However, a second-order “general” interoceptive awareness factor was

isolated as well, and it comprised all MAIA-2 scales except for Not-Distracting and Not-Worrying, similarly to what Da Costa Silva et al. (2022) identified as the best model. The same general interoceptive awareness factor, along with Not-Distracting and Not-Worrying emerged in the three-factor solution on the student sample (see also Desmedt et al., 2022). In other words, as Ferentzi et al. (2020) suggested, regardless of the level of experience with mind-body practices, being “resistant” to distractions and worry are latent dimensions separate from one another, as well as from the general sensibility to internal states. These three main factors appear to be “robust”, however individuals more experienced in mind-body practices appear to have a more differentiated interoceptive awareness compared to individuals with no or little such experience.

MAIA-2 reliability

Satisfactory or good Cronbach’s alpha values were registered for all retained MAIA-2 dimensions in both samples, implying that the authors did succeed in improving on the metric properties of MAIA in the second version (Mehling et al., 2018). Expectedly, test-retest reliability (assessed on the student sample only) was somewhat lower for all dimensions, especially Not-Distracting, implying that MAIA-2 may assess state aspects of interoceptive awareness to a certain degree.

The relevance of experience with mind-body practices for interoceptive awareness

A fundamental idea for the construction of the MAIA questionnaire was that it is important to distinguish between anxiety-driven and mindful interoceptive styles, with the latter presumably promoted by participation in various mind-body practices. Individuals with more mind-body practices experience have, indeed, been found to score higher on MAIA-2 scales (e.g., Ferentzi et al. 2020; Lin et al., 2017; Mehling et al., 2012), results our study replicates in

two ways. Firstly, besides being more generally interoceptively aware, the mind-body experienced sample in our study was also less likely to react with either distracting or worrying to unpleasant bodily sensations, compared to students. Secondly, we found that, taken together, the overall number of years of experience and the current (typical) number of weekly sessions of mind-body practices predicted around 5% to 10% of variance of all MAIA-2 dimensions, except Not-Worrying. Interestingly, for Attention regulation, Listening and Trusting, and Emotional Awareness, only the number of weekly sessions was a significant predictor. On the other hand, the reverse situation was registered for Noticing. It is possible that state aspects are more prominent for some MAIA dimensions, compared to others. As for the negative relation between years of practicing and Not-Distracting, there is no straightforward explanation of this finding. However, since Not-Distracting is practically uncorrelated with other (g)MAIA dimensions, it is plausible that this dimension also encompasses certain responses associated with age-related bodily changes, which should be further explored.

Relations between interoceptive awareness and relevant psychological constructs

In line with their conceptual similarities, observed also in past research (e.g., Hanley et al., 2017; Jokić & Purić, 2020), all MAIA-2 dimensions were positively related to mindfulness in the current study - although the majority of correlations were stronger than we expected. One of the key differences between our study and previous studies that explored the relation between MAIA and MAAS (Ferentzi et al., 2020; Jokić & Purić, 2020; Todd et al., 2020) is that our results are obtained on a mind-body experienced sample. Although conceptually there is a difference between the two constructs (e.g., mindfulness is not necessarily related to interoception, but can refer to external stimulation as well), there are also some similarities.

Namely, interoceptive awareness might incorporate aspects of mindfulness, and mind-body practices mainly insist on that.

As we hypothesized, dimensions of interoceptive awareness were mostly negatively related to anxiety (Bornemann et al., 2015; Ferentzi et al., 2020; Mehling et al., 2012; Machorrinho et al., 2019; Shoji et al., 2018; Willem et al., 2022), with the exception of Noticing and Emotional Awareness, and the pattern of correlations with depression and stress was similar to that of anxiety. The correlations were somewhat lower than in past research, possibly reflecting methodological differences, i.e., we used DASS, while past studies mainly used STAI. Overall, our results indicate the theoretically expected adaptive role of interoceptive sensibility, which is further supported by its positive relation to well-being in both samples. It should be noted, though, that in the student sample the only substantial correlation with well-being was registered for the general interoceptive awareness factor.

Finally, our exploratory analysis of the relation between interoceptive awareness and emotion regulation strategies revealed a differential pattern. Namely, a majority of interoceptive awareness dimensions were related to more frequent usage of the reappraisal strategy, while, conversely, higher interoceptive awareness was related to less frequent usage of suppression. This result further highlights the adaptive role of interoceptive awareness: suppression of emotions is related to experiencing less positive emotions, worse relationships, and a reduced quality of life, while the opposite pattern is typical for reappraisal (Kelley et al., 2019).

While, as predicted, most of the correlations between interoceptive awareness and basic personality traits were low, we observed some stronger relations for Attention regulation, Not-Worrying, Listening, and Trusting. The highest correlations, of $r_s = -.50$ (mind-body sample) and $r_s = -.40$ (student sample), were registered between Not-Worrying and Emotionality, which

corresponds well with the recent suggestion (Ferentzi et al., 2020) that Not-Worrying can represent a measure of Emotionality. That is also exactly in line with the primary intention of MAIA authors to differentiate between adaptive and maladaptive interoceptive awareness. Specifically, empirical data shows that enhanced interoceptive awareness and somatosensory amplification are typical for anxiety, panic attacks/disorder, and hypochondriasis (Cioffi, 1991; Mehling et al., 2009), while attenuated/reduced perception of bodily signals is found in eating disorders (Pollatos et al., 2008; Herbert & Pollatos, 2014), and maladaptive rumination on interoceptive signals is noticed in depression (Watkins & Teasdale, 2004). On the other hand, it seems that the ability to recognize subtle body signals may help a person deal with different (psycho)somatic issues, such as fibromyalgia, chronic pain or eating disorders (Daubenmier, 2005; Gard, 2005; Mehling et al., 2005). Taken together with the above mentioned findings on well-being, it should be stressed again that adaptive interoceptive sensibility is not necessarily about the quantity (“the more the better”), but also about the quality and the ability to capture subtle signals, or not be worried or disturbed by signals coming from inside the body (Mehling et al., 2012).

Limitations

Since for some of the analyses (e.g., predicting MAIA-2 scores based on mind-body experience, test-retest reliability analysis) samples were moderate to small, the presented results should be taken as preliminary and further replicated. Also, a majority of our participants were female, so future studies should attempt to include more males in the sample.

Another important limitation is that we didn’t have detailed information about students’ experience with mind-body practices, as we only asked about their experience with meditation, since it is implicitly or explicitly present in practically all mind-body practices. Nevertheless, it is

reasonable to assume that some, though likely few, of the students have previously practiced or still practice mind-body activities. Moreover, including participants with mind-body experience in the sample of non-practitioners should theoretically lead to obtaining smaller effect sizes, i.e., disconfirming our initial hypothesis on group differences. Future studies comparing practitioners and non-practitioners should strive to obtain more detailed information about all participants' involvement with mind-body practices.

Finally, even though it is assumed that experience with mind-body practices leads to changes in interoceptive awareness, the design of the study prevents us from making claims about causal relations between the variables. Since we only included self-report questionnaire measures, to put our results in a broader context, future studies could complement these measures with neuro-physiological indicators of interoceptive awareness.

Conclusion

Our study suggests that interoceptive awareness, as measured by MAIA-2, is best explained by fewer than the theoretically proposed eight dimensions. Apart from a general interoceptive awareness factor, Not-Worrying (closely, but inversely related to HEXACO Emotionality) and Not-Distracting (closely, but inversely related to the suppression strategy of emotion regulation) emerged as independent dimensions. This finding is in line with a number of previous studies as well as the overarching idea behind the development of MAIA - that adaptive and maladaptive aspects of interoceptive awareness need to be distinguished from one another.

In terms of metric properties, MAIA-2 has demonstrated adequate reliability in both samples and expected relations with relevant psychological constructs. Moreover, we were able to establish a clear relation with mind-body experience, in terms of both group differences (practitioners scoring higher than students) and the amount of experience with mind-body

practices (years of practicing and number of weekly sessions both positively predicted interoceptive awareness). Taking all of this into consideration, we recommend MAIA-2 for future studies in the Serbian language.

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Disclosure statement

The authors report there are no competing interests to declare.

Data availability statement

The data supporting the results reported in this paper can be found on the project OSF page: https://osf.io/txn2y/?view_only=2c087da9c77a4db59d4b14e47037bc33 All materials and all data analytic scripts are also stored on the project OSF page (https://osf.io/em3wf/?view_only=2c087da9c77a4db59d4b14e47037bc33).

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Table 1*Descriptive statistics and psychometric properties of the questionnaires for the mind-body sample*

Scale	<i>n</i>	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Sk</i>	<i>Ku</i>	<i>S-W</i>	α	KMO	H1
MAIA-2											
gMAIA	214	4.00	0.69	1.54	5.00	-0.75	0.22	0.954***	.94	.91	.37
Attention regulation	214	3.93	0.85	0.71	5.00	-0.81	0.37	0.933***	.90	.88	.57
Listening and trusting	214	3.76	0.92	0.75	5.00	-0.80	0.16	0.941***	.90	.87	.54
Noticing	214	4.23	0.77	0.50	5.00	-1.62	3.87	0.847***	.76	.77	.46
Emotional awareness	214	4.20	0.75	0.00	5.00	-1.65	4.83	0.863***	.84	.80	.46
Not-Distracting	214	2.42	1.17	0.00	5.00	0.01	-0.65	0.986*	.87	.85	.52
Not-Worrying	214	2.97	1.06	0.00	5.00	-0.22	-0.54	0.982**	.78	.70	.42
MAAS	204	4.28	0.76	1.40	5.67	-0.63	0.47	0.973***	.89	.90	.35
DASS Depression	199	0.67	0.65	0.00	3.00	1.24	1.18	0.870***	.89	.90	.54
DASS Anxiety	199	0.66	0.50	0.00	2.71	1.06	1.58	0.921***	.71	.76	.28
DASS Stress	199	1.11	0.63	0.00	3.00	0.46	-0.05	0.973***	.86	.90	.47
ERQ Reappraisal	198	3.59	0.72	1.00	5.00	-0.65	0.69	0.963***	.82	.77	.43
ERQ Suppression	198	2.45	0.90	1.00	5.00	0.34	-0.64	0.966***	.80	.72	.49
SHS	199	5.20	1.12	2.00	7.00	-0.45	-0.28	0.970***	.79	.78	.53
SWLS	199	4.91	1.26	1.20	7.00	-0.38	-0.33	0.976**	.88	.86	.61
Honesty-Humility	130	3.85	0.66	1.50	5.00	-0.64	0.62	0.967**	.78	.75	.26
Emotionality	130	2.98	0.61	1.20	4.30	-0.32	0.07	0.987	.72	.71	.20
eXtraversion	130	3.38	0.58	1.90	4.60	-0.38	-0.26	0.982	.73	.72	.22
Agreeableness	130	3.38	0.61	1.50	4.80	-0.58	0.54	0.973*	.76	.73	.24
Conscientiousness	130	3.77	0.60	2.20	5.00	-0.33	-0.41	0.981	.77	.72	.26
Openness	130	4.07	0.51	2.00	5.00	-0.91	1.22	0.948***	.69	.63	.19
Disintegration	122	2.06	0.65	1.10	5.00	1.11	2.18	0.929***	.90	.88	.32

Notes. gMAIA = general MAIA factor; SHS = Subjective Happiness Scale; SWLS = Satisfaction With Life Scale; S-W = Shapiro-Wilk Test for Normality; α = Cronbach's alpha; KMO = Kaiser-Meyer-Olkin index; H1 = average inter-item correlation.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2*Descriptive statistics and psychometric properties of the questionnaires for the student sample*

Scale	<i>n</i>	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Sk</i>	<i>Ku</i>	<i>S-W</i>	α	KMO	H1
MAIA-2											
gMAIA	229	3.17	0.72	0.77	4.69	-0.38	0.11	0.988	.91	.85	.28
Not-Distracting	229	1.95	0.90	0.00	5.00	0.34	0.08	0.986*	.81	.79	.41
Not-Worrying	229	2.61	1.05	0.00	5.00	-0.15	-0.55	0.986*	.85	.82	.54
MAIA-2 T2											
gMAIA T2	71	3.16	0.81	1.31	4.73	0.00	-0.58	0.985	.93	.80	.34
Not-Distracting T2	71	1.94	0.87	0.50	5.00	0.89	1.34	0.947**	.76	.62	.35
Not-Worrying T2	71	2.61	1.14	0.00	5.00	-0.25	-0.52	0.979	.87	.82	.57
SHS	229	4.49	1.33	1.00	7.00	-0.32	-0.35	0.981**	.85	.81	.61
Honesty-Humility	217	3.59	0.60	1.44	4.88	-0.62	0.49	0.975***	.78	.76	.18
Emotionality	217	3.48	0.62	1.88	4.88	-0.32	-0.19	0.988	.81	.82	.21
eXtraversion	217	3.23	0.77	1.31	4.75	-0.21	-0.70	0.983*	.90	.90	.36
Agreeableness	217	3.07	0.72	1.31	4.75	-0.14	-0.49	0.989	.87	.85	.29
Conscientiousness	217	3.69	0.66	1.94	4.94	-0.48	-0.31	0.973***	.86	.83	.29
Openness	217	3.91	0.60	1.69	4.88	-0.98	1.09	0.941***	.82	.81	.24
Disintegration	218	2.22	0.50	1.10	3.81	0.43	0.15	0.987*	.96	.81	.18

Notes. gMAIA = general MAIA factor; T2 = retest sample; SHS = Subjective Happiness Scale; S-W = Shapiro-Wilk Test for Normality; α = Cronbach's alpha; KMO = Kaiser-Meyer-Olkin index; H1 = average inter-item correlation.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3

Results of a robust (MM-type estimator) regression predicting MAIA-2 scores based on mind-body experience

Model	R^2	R^2_{adj}	p	Predictors			
				Years of experience		Weekly sessions	
				r	β	r	β
gMAIA	.13	.12	< .001	.07	0.10	.38***	0.28**
Attention regulation	.13	.12	< .001	.21*	0.12	.38***	0.30**
Listening and trusting	.12	.10	.004	.09	-0.02	.35***	0.33**
Noticing	.08	.07	.007	.03	0.17**	.18*	0.11
Emotional Awareness	.06	.04	.012	-.14	-0.00	.24**	0.17*
Not-Distracting	.12	.10	< .001	-.16	-0.27***	.23**	0.32***
Not-Worrying	.03	.02	.100	.07	0.04	.19*	0.16

Notes. gMAIA = general MAIA factor; p = p value of the difference between a tested model and an intercept only model.

$N = 130$.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4

Spearman correlations of MAIA-2 with mindfulness, negative emotionality, well-being, and emotion regulation for the mind-body sample

MAIA-2	MAAS ^a	DASS-D ^b	DASS-A ^b	DASS-S ^b	SHS ^b	SWLS ^b	ERQ-R ^c	ERQ-S ^c
gMAIA	.47***	-.30***	-.25***	-.34***	.49***	.36***	.45***	-.18**
Attention regulation	.47***	-.28***	-.29***	-.38***	.41***	.29***	.37***	-.11
Listening and trusting	.43***	-.31***	-.24***	-.34***	.51***	.40***	.43***	-.18*
Noticing	.33***	-.15*	-.15*	-.20**	.24***	.19**	.25***	-.18*
Emotional Awareness	.36***	-.19**	-.11	-.19**	.39***	.24***	.34***	-.23**
Not-Distracting	.34***	-.21**	-.17*	-.27***	.23**	.25***	-.09	-.45***
Not-Worrying	.34***	-.37***	-.40***	-.45***	.35***	.25***	.17*	-.15*

Notes. gMAIA = general MAIA factor; DASS-D = Depression; DASS-A = Anxiety; DASS-S = Stress; SHS = Subjective Happiness Scale; SWLS = Satisfaction With Life Scale; ERQ-R = Reappraisal; ERQ-S = Suppression.

^a $n = 204$. ^b $n = 199$. ^c $n = 198$.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5*Spearman correlations of MAIA-2 with well-being and personality traits for the student sample*

MAIA-2	SHS ^a	H ^b	E ^b	X ^b	A ^b	C ^b	O ^b	D ^c
gMAIA	.35***	.06	.002	.24***	.03	.15*	.08	-.06
Not-Distracting	.15*	-.03	.12	.17*	.20**	.05	.07	-.19**
Not-Worrying	.18**	.16*	-.40***	.10	.07	.24***	.12	-.21**

Notes. gMAIA = general MAIA factor; SHS = Subjective Happiness Scale; H = Honesty-Humility; E = Emotionality; X = eXtraversion; A = Agreeableness; C = Conscientiousness; O = Openness to Experience; D = Disintegration.

^a $n = 229$. ^b $n = 217$. ^c $n = 218$.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6*Spearman correlations of MAIA-2 with personality traits for the mind-body sample*

MAIA-2	H ^a	E ^a	X ^a	A ^a	C ^a	O ^a	D ^b
gMAIA	.18*	-.29***	.38***	.26**	.15	.28**	-.18
Attention regulation	.11	-.29***	.36***	.19*	.19*	.29***	-.18*
Listening and trusting	.20*	-.28**	.45***	.29***	.15	.24**	-.19*
Noticing	.18*	-.13	.05	.19*	.09	.16	-.17
Emotional Awareness	.11	-.15	.31***	.14	.12	.25**	-.08
Not-Distracting	.13	-.13	.22*	.04	.05	.05	-.19*
Not-Worrying	.35***	-.50***	.26**	.32***	.07	-.003	-.40***

Notes. gMAIA = general MAIA factor; H = Honesty-Humility; E = Emotionality; X = eXtraversion; A = Agreeableness; C = Conscientiousness; O = Openness to Experience; D = Disintegration.

^a $n = 130$. ^b $n = 122$.

* $p < .05$. ** $p < .01$. *** $p < .001$.