

Self-reported interoceptive awareness in primary care patients with past or current low back pain

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Background: Mind–body interactions play a major role in the prognosis of chronic pain, and mind–body therapies such as meditation, yoga, Tai Chi, and Feldenkrais presumably provide benefits for pain patients. The Multidimensional Assessment of Interoceptive Awareness (MAIA) scales, designed to measure key aspects of mind–body interaction, were developed and validated with individuals practicing mind–body therapies, but have never been used in pain patients.

Methods: We administered the MAIA to primary care patients with past or current low back pain and explored differences in the performance of the MAIA scales between this and the original validation sample. We compared scale means, exploratory item cluster and confirmatory factor analyses, scale–scale correlations, and internal-consistency reliability between the two samples and explored correlations with validity measures.

Results: Responses were analyzed from 435 patients, of whom 40% reported current pain. Cross-sectional comparison between the two groups showed marked differences in eight aspects of interoceptive awareness. Factor and cluster analyses generally confirmed the conceptual model with its eight dimensions in a pain population. Correlations with validity measures were in the expected direction. Internal-consistency reliability was good for six of eight MAIA scales. We provided specific suggestions for their further development.

Conclusion: Self-reported aspects of interoceptive awareness differ between primary care patients with past or current low back pain and mind–body trained individuals, suggesting further research is warranted on the question whether mind–body therapies can alter interoceptive attentional styles with pain. The MAIA may be useful in assessing changes in aspects of interoceptive awareness and in exploring the mechanism of action in trials of mind–body interventions in pain patients.

Keywords: interoception, body awareness, low back pain, questionnaire

Background

Interoception, commonly defined as the sense of the physiologic condition of the body,¹ and interoceptive awareness may play important mediating roles in self-rated health² – particularly in the perception of pain.^{3,4} Pain is intimately entwined with emotions.^{5,6} Craig described the neurological pathways by which pain activates some of the same cortex areas as interoception does.⁷ The close similarities between pain and interoception in their neural connections and activated brain regions led Craig to the notion that pain could be viewed as a “homeostatic emotion.”⁸ Emotions include a felt, somatosensory aspect that may become conscious in interoceptive awareness.^{9,10} As with emotion regulation, attention regulation is a key element of interoceptive awareness. Given the close relationships between pain, emotion, and interoceptive awareness, further exploration of interoceptive awareness in a clinical pain population is warranted.

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A pain patient can focus attention (eg, on her low back pain), in quite different ways: (1) ignore the pain (endurance);¹¹ (2) focus on it with worry and anxiety-driven hypervigilance (fear-avoidance);¹² or (3) focus on it with mindful attention.¹³ These different styles of attention or distraction, respectively, have been found to have a major impact on the perceived intensity of chronic pain.^{14–20} And psychologists studying the effect of mindfulness on emotions and pain have pointed out that:

[...] one problem in chronic pain is not only the pain itself, but [...] the averting of attention from, the regions that give rise to painful sensations, either through deliberate distraction, or by thinking about the pain (conceptually) rather than experiencing the sensations directly.²¹

Attention Regulation thus appears to be a major element of interoception with potential applications for pain management. A recent study showed that focusing on sensory/discriminative aspects of experimental pain might be a useful pain regulation strategy when severe pain is expected.²⁰ The authors suggested that directing attention in specific ways toward sensations of chronic pain may be a promising new way of coping with chronic pain and awaits longitudinal studies in a clinical setting.

Interoceptive awareness has been conceptualized in various ways using different terms (eg, somatic awareness, interoceptive awareness, body awareness [see a detailed discussion in Mehling et al]²²). In psychology and neuroscience, interoceptive awareness has commonly been defined as the sense of the physiological condition of the body.²³ In clinical medicine, body awareness has been defined as the ability to recognize subtle body cues.²⁴ In this study we are using Cameron's conceptualization of interoception (with or without awareness) as "the afferent information that arises from anywhere and everywhere within the body ... [involving] higher mental processes such as emotions, conscious awareness, and behavior."²⁵ This conceptualization broadens the former definition by including higher order psychological processes. In an attempt to integrate the various views from different disciplines, and following suggestions by other authors,²⁶ in this study we use the term in the broader conceptualization by Cameron and consider this as interchangeable with earlier definitions of "body awareness."²⁷

Interoceptive awareness has been examined in its relationship to pain, primarily with objective measures, such as the heartbeat detection task, measuring the interoceptive accuracy of the perception of heartbeat sensations. A major limitation of this objective measure is its inability to detect

changes that can be expected from mindfulness and other mind–body trainings.^{28–30} Interoceptive awareness includes changes in interoceptive-awareness qualities beyond accuracy,³¹ thus a self-report measure that taps into the subjectively experienced aspects of interoceptive awareness in mind–body interventions³² is needed.

Furthermore, interoceptive awareness has been studied, mostly using pain paradigms of acute experimental pain. Few studies have examined interoceptive awareness and attention regulation with directing attention toward pain sensations in clinical pain patients¹⁵ (overview in Johnston et al²⁰ and Flor³³). Clinical trials of mind–body therapies, such as mindfulness meditation, yoga, Tai Chi, and Feldenkrais, for patients with pain, including low back pain, have provided encouraging results for these approaches that claim to improve body awareness as one potential mechanism of action for their purported benefits (Table 1). However, to examine the latter assertion, a measure for body awareness or interoceptive awareness that has been validated with pain patients is needed.

The Multidimensional Assessment of Interoceptive Awareness (MAIA) is a new 32-item multidimensional self-report instrument designed for use in research studies for which there is the need to measure key aspects of mind–body interaction, namely, interoceptive awareness.²² The initial development (focus groups and expert panel) and preliminary validation (field-test sample) of the MAIA was done primarily with individuals familiar with the concept of bodily awareness, either as students, patients, or instructors of therapeutic approaches that explicitly aim to enhance bodily awareness, including meditation,³⁴ yoga, Tai Chi, and Feldenkrais.³² Eight MAIA scales were constructed to measure different modes of attention toward bodily sensations (including pain) with the goal of distinguishing between beneficial and maladaptive interoceptive attention

Table 1 Mind–body therapies purportedly enhancing body awareness and studied in clinical research that use pain as primary outcome

Therapeutic approach	Patients with	References
Yoga	Low back pain	58
Mindfulness/meditation	Chronic pain; fibromyalgia	60–63
Body awareness therapy/program	Low back pain, chronic pelvic pain, fibromyalgia, musculoskeletal pain	64–68
Body-oriented therapy	Chronic pain	69
Alexander method	Low back pain	70,71
Breath therapy	Low back pain	72

styles. The initial item pool was based on therapists' and patients' focus groups and expert consensus using an initial operational definition for bodily awareness that was iteratively developed into a conceptual framework reflected in the eight scales. These scales of three to seven items each, were defined as follows:

- Noticing – awareness of uncomfortable, comfortable, and neutral body sensations
- Not Distracting – tendency not to ignore or distract oneself from sensations of pain or discomfort
- Not Worrying – tendency not to worry or feel emotional distress with sensations of pain or discomfort
- Attention Regulation – ability to sustain and control attention to body sensation
- Emotional Awareness – awareness of the connection between body sensations and emotional states
- Self-Regulation – ability to regulate psychological distress by attention to body sensations
- Body Listening – active listening to the body for insight
- Trusting – experiences of one's body as safe and trustworthy.

The prefix “not” for the labels “Not Distracting” and “Not Worrying” is owed to our intention that, for every scale, higher scores mean higher levels of awareness. For further details, we refer readers to the original publication.²² Because several MAIA scales may contribute to the assessment of patients with pain and their pain-related emotions, coping styles, and interoceptive attention styles, and because the conceptual framework and specific items were designed to reflect awareness of pain, we decided to apply the MAIA scales and explore their performance among primary care patients who had experienced low back pain (LBP).

Measuring key aspects of interoceptive Attention Regulation may be essential to move forward research on therapies for chronic pain patients. The purpose of this study is twofold: (1) describe results of a confirmatory factor analysis of the scale structure and the psychometric characteristics of the MAIA in primary care patients with past or current LBP, including internal-consistency reliability, item-scale correlations, variability, and scale-scale correlations; and (2) explore the construct validity of the MAIA scales by comparing levels of self-reported interoceptive awareness between the mind-body therapy-naïve primary care patients with past or current LBP and mind-body therapy-experienced individuals from the original validation study²² and by examining correlations of the MAIA scales with several validity variables.

Methods

Setting and population

The study took advantage of an ongoing prospective cohort study conducted by the first author and used the follow-up assessment of patients who had presented with narrowly defined acute LBP with or without sciatica in primary care clinics 2 years earlier, the Prognosis of Pain (POP) study.³⁵ Briefly, the population originally surveyed was a sample of patients seen in primary care clinics of a large health maintenance organization (Kaiser Permanente Northern California, CA, USA), which represented the socioeconomic and ethnic diversity of the San Francisco Bay area. Using electronic medical records, patients seen for LBP in a primary care clinic around the area were sent a written invitation to join the study, by mail the next day. Respondents were interviewed over the phone at baseline (N = 605) and 6 months (N = 521). For the 2-year follow-up, POP study participants had agreed to be contacted again and, when reached (N = 443), were given a choice between a phone interview and an Internet-based survey using Health Insurance Portability and Accountability Act-compliant SurveyGizmo.³⁶ Approved by the Institutional Review Board of the University of California, San Francisco, the survey was conducted between July 2010 and November 2010.

Because one aim is to compare results to the sample on which the MAIA was developed, we briefly describe that sample here, although details on that sample are published elsewhere.²² Using international listservs from leading mind-body therapy teaching institutions, invitations were sent by email to participate in a Web-based survey using SurveyGizmo between November 2010 and December 2010. The recruitment was organized in a way that we obtained two subgroups: About one-half of the surveyed individuals had at least 20 hours of teaching in meditation, yoga, Tai Chi, Feldenkrais, or other mind-body approaches; the other half had been teaching one of these methods for at least 5 years and was highly experienced in one of these methods.

Measures

Pain-related measures

We first ascertained the pain status of the participants using several pain-related self-report measures: General perceived recovery, with six answering options – fully recovered, much improved, slightly improved, same, slightly worse, and much worse;³⁷ average LBP in the past week by an 11-point numeric rating scale, and identified three subgroups of respondents: (1) Recovered; patients who are fully recovered by self-report

after an episode of acute LBP (answered “fully recovered” on the general perceived recovery); (2) Not recovered without pain; patients who are not recovered by self-report but are without LBP in the past week (all other answers on general perceived recovery [GPR] and 0 on the numeric rating scale); and (3) Current pain; patients who report current pain (all other answers on GPR and >0 on the numeric rating scale), having either recurrent or persistent pain after an episode of acute LBP 2 years earlier.

Prespecified pain-related and psychological questions were skipped if participants self-rated as fully recovered. Participants were asked whether they had practiced a mind–body therapy, such as yoga or meditation, during the follow-up period to be able to separate these individuals from mind–body therapy-naïve participants in the analyses.

MAIA

For further details about the systematic development of this measure we refer readers to the original publication.²² In the original mind–body-experienced sample, the MAIA showed acceptable psychometric properties of internal consistency reliability (alphas for the eight scales: 0.69; 0.66; 0.67; 0.87; 0.82; 0.83; 0.82; 0.79) and relatively low scale–scale correlations indicating independence (0.16 to 0.60).²² Confirmatory factor analysis showed a good model fit, and evidence of construct validity was obtained by confirmation of hypotheses regarding comparisons between known groups (less versus highly experienced in mind–body therapies), correlations with validity scales of related constructs, such as mindfulness, anxiety sensitivity, catastrophizing, body responsiveness, body connection, and emotion regulation, and associations with a clinical outcome, trait anxiety.

Psychological measures (Table S1) were originally chosen at inception two years earlier to assess score changes in items included to measure changes in predictors of chronic pain. However, several measures provided an opportunity to explore the construct validity of the MAIA scales. These included: (1) the four-item Perceived Stress Scale (PSS);³⁸ (2) depression by a single item from the Örebro Musculoskeletal Pain Screening Questionnaire (ÖMPSQ)³⁹/Heidelberger Kurz-Fragebogen (HKF);⁴⁰ (3) fear-avoidance beliefs by one item from Fear-Avoidance Beliefs Questionnaire (FABQ);⁴¹ (4) catastrophizing by a single item from the Coping Strategies Questionnaire (CSQ)⁴² asked of all participants; (5) catastrophizing by a five-item composite measure we created, including the single item as well as four items asked only in the Current Pain subgroup, two from the Pain Catastrophizing Scale (PCS)⁴³ and two

from HKF; (6) ignoring coping style and positive distracting coping style by single items from the CSQ; and (7) recovery expectancy by a single item from the ÖMPSQ. Patients who were fully recovered were asked these questions using past tense (eg, “when you had pain”).

Analyses

Confirmatory factor analysis (CFA) on the MAIA scales was done by Mplus Version 5.21 (Muthén and Muthén, Los Angeles, CA, USA).⁴⁴ All other statistical analyses were conducted using SAS (SAS Institute Inc, Cary, NC, USA). To understand the CFA results better, we also conducted exploratory item cluster analyses using SAS PROC VARCLUS, a method of principal components analysis with quartimax rotation for splitting of the item pool into clusters. For a more detailed description, see Mehling et al.²²

Internal consistency reliability of the MAIA was assessed with Cronbach’s alphas. Scale–scale correlations were assessed by Pearson’s coefficients.

Construct validity was explored by examining correlations between the MAIA scales and measures of the LBP-related clinical and psychological parameters described above. We expected several correlations: the Not Worrying scale to be negatively correlated with catastrophizing, perceived stress, depression, and fear-avoidance; the Not Distracting scale to be negatively correlated with ignoring coping style; the Self-Regulation and Trusting scales to be correlated negatively with perceived stress. We assessed correlations in the total sample as well as for the three pain-related subgroups to explore whether current pain patients differ from past pain patients in this primary care population.

In addition, we compared MAIA scale means between the POP sample of primary care patients³⁵ and the original validation sample of experienced mind–body trainees²² by *t* tests and analysis of covariance to account for differences in sample characteristics. All MAIA scales are scored such that higher scores indicate higher degrees of awareness. Thus, for the two negatively labeled scales (Not Distracting; Not Worrying), higher scores mean more awareness, eg, less distracting. We expected that mind–body experienced subjects would score higher on all MAIA scales, with larger differences for Not Distracting, Emotional Awareness, Attention Regulation, and Self-Regulation. Improvements in these dimensions had been suggested by instructors for mind–body approaches and their patients.^{22,32,34} We also compared MAIA scale means between the three subgroups – Recovered; Not recovered but without pain; Current pain – by *t* tests and analysis of covariance.

Here, we had no clear hypotheses and wanted to explore whether these pain-related subgroups differed on MAIA scale scores. We were particularly interested to learn more about the subgroup of patients who, despite not having any current pain, declared that they had not completely recovered. Lastly, we did sensitivity analyses to see whether the primary care patients, who had practiced yoga, were confounding these analyses.

Results

Demographics and clinical parameters of the sample of 443 primary care patients (POP Study) and the 318 students and teachers of mind–body therapies (original study) are summarized in Table 2 and published in more detail elsewhere.^{22,35} The primary care sample was slightly older, less female, more ethnically diverse, and less educated than the original validation sample.

Table 2 Subject characteristics in two samples

Characteristic	POP total sample ("Pain") N = 435	"Mind–body" sample N = 325
Sex (% female)	53	79
Average age, mean ± SD	54 ± 12	48 ± 12
Race/ethnicity (%)		
Asian American	11	5
African American	8	2
Latino	6	4
White	68	88
Other	7	<1
Education (%)		
High school	10	<1
Some college	26	<1
College degree	36	37
Graduate school	28	52
Disability due to back pain, mean ± SD^a		
Total sample ^c	4.4 ± 5.3	–
Recovered ^d	1.1 ± 2.4	–
Not recovered without pain ^e	3.0 ± 3.9	–
Current pain ^f	8.3 ± 5.6	–
Pain level at time of survey, mean ± SD^b		
Total sample ^c	1.5 (2.3)	–
Fully recovered ^d	0 ^g	–
Not fully recovered, no current pain ^e	0 ^g	–
Current pain ^f	3.7 (2.2)	–

Notes: Subject characteristics in POP total sample and in original measurement development sample ("mind–body" sample). Pain measures not applicable to mind–body sample. ^aRoland-Morris Disability Scale, range 0–24, higher is more disability; ^baverage pain in past week by numeric rating scale 0–10; ^ctotal sample (N = 435); ^drecovered (N = 166; 38%); ^enot recovered without pain (N = 97; 22%); ^fcurrent pain (N = 172; 39%); ^ga zero was inferred for fully recovered and no current pain subsamples.

Abbreviations: SD, standard deviation; POP, Prognosis of Pain study.

The 443 participants in the POP follow-up sample were patients who had suffered an episode of acute LBP and had sought medical advice for LBP 2 years prior. The final sample, those who responded to at least half of all MAIA items, was reduced to 435. Of these, 166 Recovered; 97, Not recovered but were without pain; and 172, Current pain. One hundred sixty-five participants provided answers in phone interviews and 270 via a parallel online survey.

Confirmatory factor and exploratory cluster analyses

Different from the original validation sample, the CFA did not converge for the entire POP sample or for any of the recovery-related subgroups. However, CFAs did converge when we separately assessed participants responding to the survey by Internet or those responding by phone interviews. To further clarify the reason for nonconvergence of the CFA in the total sample, we applied the oblique exploratory item cluster analysis (EICA) method of splitting the item pool into clusters that are comparable to exploratory factors and found that the scale of Not Distracting as a whole, and within that scale primarily Item 5, was causing the convergence problem for the CFA. This item loaded negatively on its factor in the phone sample (–0.10) and positively in the Internet sample (0.32).

Phone interviewers had reported that participants had difficulty with the language of Item 5 ("I do not notice physical tension or discomfort until they become more severe"). In the covariance matrix for the latent variables, the Not Distracting scale was independent of all other MAIA scales. Excluding this scale (Item 5–Item 7), a CFA conducted in the total sample on items from the seven remaining scales converged and is shown in Table 5, with comparative fit index (CFI) of 0.88 and root mean square error of approximation (RMSEA) of 0.07. When we compared the EICAs between our samples, we found that items related to ignoring pain or discomfort (Not Distracting) clustered with items related to worry (Not Worrying) in mind–body trained individuals but clustered separately in pain patients.

Allowing items to split into clusters with an eigenvalue of at least 1.0, the EICA delivered a seven-factor model, generally consistent with the original scales but without the separate Body Listening scale, of which one item drifted toward the Emotional Awareness and two to the Self-Regulation scale. All other scales were confirmed in their integrity with exception of the single "homeless" Item 5, attaching itself to Noticing but essentially without real contribution to this cluster ($R^2 = 0.16$). The entire EICA cluster model explained 0.61 of the total variance. Conducting the cluster analysis

separately on the three recovery-related subsamples provided identical results, with the exception of Item 5 moving between various clusters (results not shown).

Means and internal consistency

MAIA scale means with standard deviations, range of observed values, and Cronbach's alphas are presented in Table 3. Values are presented for the entire sample as well as for the three subgroups, according to recovery and pain. In the total sample, Cronbach's alphas for six of the eight MAIA scales ranged from 0.74 to 0.90, however, alphas were low for Not Worrying (0.58), and Not Distracting scale (0.48). For each scale, alphas were generally similar in the subgroups to the total sample. Phone survey interviewers had noted that some participants had difficulties with responding to negatively worded items of the Not Distracting and Not Worrying scales. In contrast, Internet survey participants saw the item response scales for each item with numeric ratings and labeled endpoints, reducing potential confusion in responding to negatively worded items. Therefore, we calculated separate alphas by administration method: For the least-reliable Not Distracting scale, alphas were 0.24 in the phone and 0.59 in the Internet samples.

Scale–scale correlations

The MAIA scale–scale correlations are presented in Table 4. The highest correlations were between Self-Regulation and Body Listening (0.72) and between Emotional Awareness and Body Listening (0.66). Not Distracting and Not Worrying scales did not correlate with each other ($r = -0.10$) or with any other MAIA scale ($r_s \leq 0.16$). Compared with the original validation sample, correlations were similar. One difference between the samples involved the Not Distracting and Not Worrying scales, which in mind–body trained individuals²² had correlated positively with each other ($r = 0.33$) and three other MAIA scales, Attention Regulation, Self-Regulation, and Trusting ($r = -0.19$ to -0.35 ; $P < 0.001$).

For the Not Distracting scale, item-scale correlations were between 0.31 and 0.52 in the Internet sample and between 0.01 and 0.22 in the phone sample. Similarly, the scale's item–item correlations were between 0.19 and 0.44 in the Internet sample and between 0.02 and 0.32 in the phone sample.

Correlations with psychological and pain-related variables

Table 6 shows the correlations between the MAIA scales and psychological and pain-related variables (with expected correlations shaded in gray). Results are shown for the entire sample and for the three subgroups. As expected,

Not Worrying was moderately negatively correlated with catastrophizing (single item as well as five-item composite), perceived stress (PSS), and depression (ÖMPSQ/HKF). Also as expected, the Not Distracting scale strongly negatively correlated with ignoring coping style (CSQ). The highest magnitude of correlations of Not Distracting and Not Worrying with these quasi-validity measures was in the current pain subsample. Not Worrying also showed a moderate negative correlation with fear-avoidance, but only in the nonrecovered without pain subgroup.

The Trusting scale was significantly negatively correlated with perceived stress (PSS) and depression. Self-Regulation correlated significantly negatively with perceived stress and positively with the positive distracting style of coping. MAIA scales' correlations with recovery expectations were very small (all < 0.20). Body Listening, Emotional Awareness, Attention Regulation, and Noticing MAIA scales were not related to any of the psychological or pain-related measures.

For the correlations between MAIA scales and the above described validation measures, the subgroup of patients, who described themselves as not recovered, despite not having any current pain, stood out in several ways: Across the three pain- and recovery-related subgroups, this not recovered group scored lowest on Not Worrying (highest in worrying) and had the strongest negative correlations across groups for Not Worrying with catastrophizing and fear-avoidance, and for Self-Regulation with perceived stress and depression. This group had the lowest negative correlations between Not Worrying and depression as well as for Ignoring and Not Distracting.

Differences between known groups

Comparing the primary care POP study sample with the mind–body experienced sample, scores in the latter sample were significantly higher on all eight scales (Table 7, unadjusted means). Adjusting for demographic differences in age, sex, ethnicity, and education provided similar means and P -values (data not shown).

Seventy-one POP study participants reported having an ongoing mind–body practice, such as yoga. The differences with the original mind–body sample were generally more pronounced when we excluded those with an ongoing mind–body practice from the primary care POP study sample. Primary care POP study patients who reported a regular practice of a mind–body technique showed overall MAIA scores either similar to the original mind–body experienced sample or somewhere between the original mind–body experienced sample and the nonpracticing participants of the POP

Table 3 Reliability, item-scale correlations, and descriptive statistics for MAIA scales in total sample and three pain group subsamples

Scale	# of items	Alpha	Range of item-scale correlations	Mean (SD)	Observed range ^a	N
Noticing	4					
Total sample		0.74	0.48–0.60	3.58 (1.16)	0–5	301 ^b
Recovered		0.74	0.51–0.62	3.60 (1.17)	0–5	122
Not recovered without pain		0.73	0.42–0.65	3.68 (1.10)	0.8–5	66
Current pain		0.75	0.47–0.61	3.49 (1.19)	0–5	113
Not Distracting	3					
Total sample		0.48	0.18–0.40	1.91 (1.00)	0–5	434
Recovered		0.38	0.10–0.30	2.03 (1.00)	0–5	166
Not recovered without pain		0.62	0.36–0.48	1.88 (1.07)	0–5	96
Current pain		0.46	0.16–0.46	1.82 (0.96)	0–4.7	172
Not Worrying	3					
Total sample		0.58	0.32–0.51	2.91 (1.08)	0–5	434
Recovered		0.52	0.27–0.43	2.80 (1.01)	0–5	166
Not recovered without pain		0.55	0.28–0.55	2.69 (1.09)	0–5	96
Current pain		0.63	0.37–0.55	3.16 (1.10)*	0–5	172
Attention Regulation	7					
Total sample		0.88	0.60–0.73	3.04 (1.05)	0–5	433
Recovered		0.87	0.60–0.76	3.11 (1.04)	0–5	165
Not recovered without pain		0.87	0.55–0.76	2.93 (1.05)	0–5	97
Current pain		0.89	0.59–0.78	3.03 (1.07)	0–5	171
Emotional Awareness	5					
Total sample		0.90	0.63–0.84	3.42 (1.20)	0–5	434
Recovered		0.92	0.76–0.89	3.36 (1.27)	0–5	165
Not recovered without pain		0.87	0.45–0.84	3.49 (1.17)	0–5	97
Current pain		0.87	0.59–0.81	3.45 (1.15)	0–5	172
Self-Regulation	4					
Total sample		0.86	0.64–0.76	2.93 (1.19)	0–5	432
Recovered		0.87	0.67–0.78	2.96 (1.22)	0–5	165
Not recovered without pain		0.80	0.58–0.66	3.07 (1.04)	0.3–5	96
Current pain		0.86	0.64–0.79	2.82 (1.22)	0–5	171
Body Listening	3					
Total sample		0.83	0.65–0.74	2.51 (1.28)	0–5	433
Recovered		0.84	0.64–0.76	2.52 (1.29)	0–5	164
Not recovered without pain		0.84	0.70–0.73	2.66 (1.26)	0–5	97
Current pain		0.81	0.56–0.73	2.43 (1.30)	0–5	172
Trusting	3					
Total sample		0.78	0.56–0.65	3.91 (0.97)	0–5	432
Recovered		0.82	0.56–0.76	3.99 (1.02)	0–5	163
Not recovered without pain		0.72	0.48–0.64	4.00 (0.83)	1.3–5	97
Current pain		0.77	0.58–0.65	3.78 (0.97)	0.3–5	172

Notes: ^aPossible range 0–5; ^bdue to administrative error, 135 participants were not asked the 4 items of the Noticing scale, resulting in a lower N for this scale. *Significant subgroup differences (analysis of variance: $P < 0.001$).

Abbreviations: SD, standard deviation; MAIA, Multidimensional Assessment of Interoceptive Awareness.

sample. The exception was scores for the Not Distracting scale, for which there was no difference between practicing and nonpracticing POP study primary care patients.

When we compared the three subgroups of Recovered, Not recovered without pain, and Current pain, differences

were insignificant for seven of eight scales. On the Not Worrying scale patients, who reported not being fully recovered, despite having no current pain, scored lower than patients with recurrent or persistent chronic pain since 2 years ($P = 0.0005$), indicating a higher tendency to worry about

Table 4 Pearson product moment correlations among MAIA scales in total sample (N = 301–434)

Scale	Noticing*	Not Distracting	Not Worrying	Attention Regulation	Emotional Awareness	Self-Regulation	Body Listening	Trusting
Noticing	–							
Not Distracting	0.05	–						
Not Worrying	–0.03	–0.10	–					
Attention Regulation	0.36	–0.01	0.06	–				
Emotional Awareness	0.45	0.03	–0.13	0.44	–			
Self-Regulation	0.42	–0.02	0.13	0.57	0.60	–		
Body Listening	0.44	0.06	–0.07	0.56	0.66	0.72	–	
Trusting	0.26	–0.07	0.16	0.41	0.29	0.50	0.44	–

Notes: *Due to administrative error, 135 participants were not asked the four items of the Noticing scale, resulting in a lower N for correlations with this scale. Correlations are significant if >0.22 at $P < 0.0001$; >0.19 at $P < 0.001$; >0.16 at $P < 0.005$.

Abbreviation: MAIA, Multidimensional Assessment of Interoceptive Awareness.

sensations of pain and discomfort. This subgroup showed only a mildly elevated disability score (3.0 ± 3.9), higher than the one in the fully recovered group (1.1 ± 2.4), but clearly below the current pain group (8.3 ± 5.6).

Discussion

This is the first assessment of self-reported interoceptive awareness in a clinical sample of patients with past or current LBP by application of the MAIA scales. We tested the performance of the MAIA scales in a population of primary care patients who had experienced a new episode of acute LBP 2 years earlier. Of these, 38% were fully recovered at the time of the survey, whereas 22% reportedly had not fully recovered but were without current pain, and 40% were still suffering chronic or recurrent pain.

Construct validity

The Not Distracting scale includes an item (Item 5) that in exploratory cluster analysis did not group with any of the scales. For the CFA, in which items are forced into a scale, the Not Distracting scale prevented the convergence of the eight-factor model. After excluding the Not Distracting scale, the CFA converged with acceptable factor loadings and model fit. As mentioned above, our interviewers noted that some participants had difficulties answering the negatively worded items over the phone and speculated that it was easier for participants taking the survey online. Online, it was easier simply to reread the question and have a visual for all answering options. We therefore conducted CFAs separately for the phone interview and Internet subsamples: Once separated, both subsample CFAs converged, even with the Not Distracting scale included. Exploratory cluster analysis, in which items are free to cluster with each other across scales, confirmed the MAIA scales for this population, again with

the exception of Item 5, suggesting this item may have to be dropped or reworded in any future studies.

The two scales of Not Distracting and Not Worrying are the only scales with negatively worded and reverse scored items (all three Not Distracting items; two of three Not Worrying items). Consistent with the observation of phone interviewers regarding the difficulties in answering Item 5, the EICA showed a strong modification index (0.23) for Item 5 only in the phone sample.

Means and internal consistency

Scale means and observed ranges indicated fairly good variability in the entire sample and the three pain and recovery-related subgroups. Cronbach's alphas were acceptable for six of the eight scales. For the three-item scales with low alphas – Not Distracting and Not Worrying – lower alphas for phone participants compared to the Internet participants were consistent with what interviewers had suspected; namely, that questions presented over the phone with difficult or negative wording (eg, Item 5, discussion follows), and without visual cues for answering options, may have been more difficult to answer. We note, however, that despite low internal consistency, there were numerous substantial correlations between these two scales and several validity measures (Table 6), and the two scales discriminated between some of our known groups (Table 7). Thus, the low reliability did not, in fact, limit the magnitude of their associations with other measures. Nonetheless, as in our earlier study, these two scales warrant further attention to improve their reliabilities.²²

Convergent validity

Scale–scale correlations were in the desired range except that the Not Distracting and the Not Worrying scales had the lowest correlations with each other and all other MAIA

Table 5 Items and standardized CFA loadings for MAIA scales in total sample

	Standardized loading	SE
Noticing		
1. When I am tense, I notice where the tension is located in my body.	0.69	0.04
2. I notice when I am uncomfortable in my body.	0.62	0.04
3. I notice where in my body I am comfortable.	0.66	0.04
4. I notice changes in my breathing, such as whether it slows down or speeds up.	0.58	0.04
Not Distracting		
5. I do not notice (I ignore) physical tension or discomfort until they become more severe.	Dimension not included	
6. I distract myself from sensations of discomfort.		
7. When I feel pain or discomfort, I try to power through it.		
Not Worrying		
8. When I feel physical pain, I become upset.	0.49	0.05
9. I start to worry that something is wrong if I feel any discomfort.	0.83	0.06
10. I can notice an unpleasant body sensation without worrying about it.	0.44	0.05
Attention Regulation		
11. I can pay attention to my breath without being distracted by things happening around me.	0.61	0.03
12. I can maintain awareness of my inner bodily sensations even when there is a lot going on around me.	0.72	0.03
13. When I am in conversation with someone, I can pay attention to my posture.	0.62	0.03
14. I can return awareness to my body if I am distracted.	0.78	0.02
15. I can refocus my attention from thinking to sensing my body.	0.79	0.02
16. I can maintain awareness of my whole body even when a part of me is in pain or discomfort.	0.71	0.03
17. I am able to consciously focus on my body as a whole.	0.80	0.02
Emotional Awareness		
18. I notice how my body changes when I am angry.	0.63	0.03
19. When something is wrong in my life, I can feel it in my body.	0.66	0.03
20. I notice that my body feels different after a peaceful experience.	0.88	0.01
21. I notice that my breathing becomes free and easy when I feel comfortable.	0.86	0.02
22. I notice how my body changes when I feel happy/joyful.	0.92	0.01
Self-Regulation		
23. When I feel overwhelmed I can find a calm place inside.	0.74	0.02
24. When I bring awareness to my body I feel a sense of calm.	0.85	0.02
25. I can use my breath to reduce tension.	0.68	0.03
26. When I am caught up in thoughts, I can calm my mind by focusing on my body/breathing.	0.82	0.02
Body Listening		
27. I listen for information from my body about my emotional state.	0.79	0.02
28. When I am upset, I take time to explore how my body feels.	0.82	0.02
29. I listen to my body to inform me about what to do.	0.75	0.02
Trusting		
30. I am at home in my body.	0.64	0.04
31. I feel my body is a safe place.	0.78	0.03
32. I trust my body sensations.	0.75	0.03

Abbreviations: SE, standard error; CFA, Confirmatory factor analysis; MAIA, Multidimensional Assessment of Interoceptive Awareness.

scales, which, in part, could be attributed to the low reliability of these two scales. However, in assessing convergent validity, the MAIA scale Not Distracting was (negatively) well-converging with an ignoring coping style, and Not Worrying was (negatively) well-converging with catastrophizing, perceived stress, and depression. These correlations appear to be strongest in the current pain subsample (patients who considered themselves not fully recovered after 2 years and reported pain in the past week). Thus, despite lower internal consistency, these scales appear to have some construct validity, particularly in individuals with recurrent or chronic pain.

Differences between known groups

When comparing POP study primary care patients with our original validation sample of individuals who were experienced in mind–body therapies, mind–body trained individuals scored significantly higher on all eight scales, suggesting they may be more often aware of body sensations, tend to ignore or distract themselves less often from pain or discomfort, tend to worry less often with sensations of pain and discomfort, are more often able to sustain and control attention to body sensation, are more often aware of the connection between body sensations and emotional states, listen more often to the

Table 6 Correlations of MAIA scales with selected psychological variables included in POP study: total sample and 3 pain subgroups

Parameter (item/scale) (alpha)	Meaning of high score	Sample	Mean (SD)	Total N	Correlation with MAIA scales			Attention Regulation	Emotional Awareness	Self-Regulation	Body Listening	Trusting
					Noticing	Not Distracting	Not Worrying					
Perceived stress (4 items PSS) (0.77)	More perceived stress	All	2.7 (2.1)	434	-0.04	-0.06	-0.31**	-0.13	-0.05	-0.22**	-0.05	-0.30**
		Recovered	2.3 (1.9)	166	-0.02	-0.03	-0.19	-0.21*	0.00	-0.19	-0.11	-0.28**
		NRWP	2.9 (2.1)	97	0.03	-0.00	-0.34**	-0.20	-0.03	-0.36**	-0.04	-0.27*
		Current pain	3.0 (2.1)	171	-0.08	-0.10	-0.46**	-0.2	0.13	-0.17	-0.01	-0.31**
Depression (1 item ÖMPSQ/HKF) (n/a)	More depression	All	1.5 (2.2)	435	-0.02	-0.00	-0.23**	-0.03	0.06	-0.13	0.01	-0.20**
		Recovered	1.2 (2.1)	166	0.05	0.01	-0.19	-0.06	0.08	0.01	-0.00	-0.17
		NRWP	1.1 (1.9)	97	-0.10	0.08	-0.15	-0.12	-0.07	-0.32*	-0.04	-0.17
		Current pain	2.0 (2.4)	172	-0.03	-0.02	-0.40**	0.02	0.09	-0.15	0.06	-0.21*
Fear-avoidance (1 item FABQ) (n/a)	More fear of harm	All	4.6 (3.5)	385	-0.05	-0.04	-0.12	-0.09	0.07	-0.07	-0.04	-0.12
		Recovered	2.9 (3.2)	119	-0.12	0.02	-0.16	-0.07	0.06	0.00	-0.01	-0.07
		NRWP	4.3 (3.4)	97	0.12	-0.03	-0.33*	-0.13	0.10	-0.25	-0.05	-0.19
		Current pain	6.0 (3.1)	169	-0.05	-0.01	-0.19	-0.06	0.07	0.02	0.01	-0.06
Catastrophizing (1 item CSQ) (n/a)	More catastrophizing	All	3.2 (3.2)	387	-0.05	0.08	-0.33**	-0.01	0.00	-0.08	0.06	-0.04
		Recovered	4.0 (3.5)	119	-0.20	0.11	-0.31**	-0.13	-0.15	-0.22	-0.09	0.06
		NRWP	3.5 (3.2)	96	0.01	0.27	-0.40**	-0.09	0.11	-0.10	0.10	-0.21
		Current pain	1.9 (2.2)	172	0.06	-0.12	-0.26**	0.13	0.09	0.02	0.15	-0.10
Catastrophizing (composite 5 items) (0.83)	More catastrophizing	All	2.9 (3.0)	170	-0.04	0.18	-0.39**	-0.01	0.12	-0.09	0.12	-0.14
		Recovered	3.7 (2.4)	390	-0.02	-0.32**	0.19*	0.03	0.02	0.04	-0.03	-0.05
		NRWP	3.1 (2.3)	121	0.03	-0.24	0.21	0.04	-0.13	-0.01	-0.14	-0.11
		Current pain	3.9 (2.4)	172	-0.06	-0.44**	0.19	-0.01	0.11	0.05	0.08	-0.07
Positive distracting (1 item CSQ) (n/a)	More positive distraction	All	6.4 (3.1)	370	0.20*	-0.18*	0.02	0.11	0.08	0.18*	0.13	0.13
		Recovered	6.5 (3.1)	117	0.15	-0.27*	0.15	0.04	-0.03	0.07	-0.07	0.06
		NRWP	6.7 (2.9)	92	0.29	-0.20	0.13	0.09	0.16	0.22	0.25	0.21
		Current pain	6.0 (3.2)	161	0.20	-0.12	-0.07	0.17	0.13	0.23*	0.20	0.13
Recovery expectancy (1 item ÖMPSQ) (n/a)	Higher risk will not go away	Current pain	6.0 (3.2)	164	-0.03	-0.19	-0.06	0.07	0.11	0.00	0.05	0.02

Notes: Lower N on Noticing scale, due to error in administration. Measures asked only of current pain group have no further correlations. Expected correlations are shaded in grey. *P < 0.01, **P < 0.001.

Abbreviations: MAIA, Multidimensional Assessment of Interoceptive Awareness; SD, standard deviation; PSS, Perceived Stress Scale; NRWP, not recovered without pain; ÖMPSQ, Örebro Musculoskeletal Pain Screening Questionnaire; HKF, Heidelberg Kurz-Fragebogen; FABQ, Fear-Avoidance Beliefs Questionnaire; CSQ, Coping Strategies Questionnaire.

Table 7 Mean scores on MAIA scales of POP and mind–body samples

MAIA scale	POP total sample N = 304–435 ^a	POP sample without practice N = 253–364	POP sample with practice N = 51–71	Mind–body sample N = 318–325
Noticing	3.58 (1.16)**	3.49 (1.21)**	4.03 (0.79) ^b	3.94 (0.59)
Not Distracting	1.91 (1.00)**	1.90 (1.00)**	1.96 (1.72)**	3.20 (0.87)
Not Worrying	2.91 (1.08)**	2.90 (1.08)**	3.02 (1.14)	3.27 (0.84)
Attention Regulation	3.04 (1.05)**	2.95 (1.06)**	3.37 (0.93)* ^b	3.79 (0.64)
Emotional Awareness	3.42 (1.20)**	3.34 (1.22)**	3.90 (0.98) ^b	4.16 (0.64)
Self-Regulation	2.93 (1.19)**	2.80 (1.18)**	3.60 (0.99) ^b	3.86 (0.74)
Body Listening	2.51 (1.28)**	2.38 (1.28)**	3.14 (1.16) ^b	3.50 (0.87)
Trusting	3.91 (0.97)**	3.84 (0.98)**	4.22 (0.81) ^b	4.13 (0.74)

Notes: All scales are scored so that a higher score is more positive interoceptive awareness; possible range is from 0 to 5. * $P < 0.01$; ** $P < 0.001$, for comparisons with mind–body sample by *t* test for unadjusted means. (Adjustment for age, sex, ethnicity, and education left all $P < 0.001$, except Trusting, $P = 0.003$.) ^aDue to an administrative error, 135 participants were not asked the four items of the Noticing scale, resulting in a lower N for this scale. ^b $P < 0.001$, for comparisons of the two POP subsamples with and without ongoing mind–body practice, by *t* test for unadjusted means.

Abbreviations: MAIA, Multidimensional Assessment of Interoceptive Awareness; POP, Prognosis of Pain study.

body for insight, and experience their body more often as safe and trustworthy. The between-sample difference is particularly large on the Not Distracting scale. All primary care patients who had experienced pain, even those with an ongoing mind–body practice, appear to see more value in a distraction style of coping with pain and discomfort than mind–body therapy-trained individuals. Thus, the MAIA showed good ability to discriminate between these two samples.

We noted differences in responses to questions related to coping with pain. Irrespective of mode of administration (phone versus Internet), for primary care participants, scores on the Not Distracting scale were clearly lower than in the original validation sample study of mind–body experienced participants, and the Not Distracting scale was independent of all other MAIA scales.

However, in the original validation sample study with mind–body experienced participants, Not Distracting was positively correlated with the other aspects of interoceptive awareness.²² These findings appear to be consistent with the above suggestion that, contrary to the original validation sample of mind–body therapy-trained respondents, participants with a past or current experience of pain may or may not use distraction, independent of other aspects of interoceptive awareness; but training in mind–body therapies appears to be associated with the tendency to less often distract oneself from sensations of pain or discomfort, which, in turn, is associated with increased scores for all other aspects of interoceptive awareness.

The difference between these two samples in regard to their view of distraction is reflected in different opinions in current psychological pain research. Attentional strategies of diversion, distraction, or experiential avoidance, although commonly used,^{45,46} have yielded contradictory results.^{15,20,47–50} As they are explored in more detail, particularly with

chronic pain, it appears that distracting oneself may not always be helpful, although participants in our primary care POP study sample reportedly used it more often than the mind–body trained participants of our original validation sample. Neuroimaging studies have shown that mindfulness meditators may be able to downregulate painful stimuli by increased sensory processing of the pain sensation itself, rather than by distraction away from it, and by replacing attempts to exert more cognitive control over the pain with a distinct brain state of cognitive disengagement.¹⁹ This is consistent with the view presented above that “turning away” from pain can be a problematic coping style with chronic pain.²¹ It is hypothetically possible that with training in mind–body therapies, some of which encourage direct experience of pain rather than thinking about it or averting attention, primary care patients may find that using mindful interoceptive awareness can be an advantageous coping style for pain and discomfort. This suggestion is consistent with recent experimental research²⁰ and needs longitudinal assessment in a clinical setting.

MAIA scales appear to differentiate (1) between mostly mind–body therapy-naïve primary care patients and mind–body therapy-experienced individuals and (2) between primary care patients with and without ongoing mind–body practice, rather than between subgroups of primary care patients in different states of recovery from pain. There was one intriguing exception: The group of patients who declared themselves as not recovered, despite reporting no pain and relatively low functional disability scores (Table 2), exhibited a significantly higher degree of worry compared to the group with recurrent or chronic pain. This could indicate that a relatively large group (22%) of patients, having no pain and minimal disability after an episode of acute LBP, may fail to feel recovered because of worries about

potential future pain. Only in this subgroup, Not Worrying was correlated with fear-avoidance; in addition, this subgroup showed the strongest correlation between Not Worrying and catastrophizing, which may distinguish this group from chronic pain patients. For example, in a study of chronic pain, it was found that worry was associated with an increased vigilance toward pain sensations rather than an increased disposition to general worry and anxiety.⁵¹ Our results suggest that in this subgroup, worry was not related to depression, and the severities of perceived stress and depression were more closely associated with deficits in emotion regulation. Furthermore, as we found only differences in scale scores between pain recovery-related subgroups for one of the eight MAIA dimensions, current pain status among previously diagnosed pain patients does not appear to have a major influence on self-reported levels of interoceptive awareness.

As it is long known in survey research,⁵² phone interviewing is biased toward social desirability⁵³ and agreement response set,⁵⁵ and, accordingly, our phone sample scored consistently higher than the Internet sample on the MAIA scales. Differences between subsamples were markedly smaller than the differences between the entire POP sample and the mind–body-trained sample. Removing the POP phone sample would have increased these differences for most scales and further strengthened our results.

Challenge of assessing learning processes

The problem in measuring concepts such as interoceptive awareness is that gaining such awareness involves a learning process in which people at baseline do not know and are not yet able to understand or articulate fully the skills they will acquire. Questions in self-report instruments that aim at measuring skills for which respondents have not yet developed appropriate concepts and language present the challenge that the concepts may be understood in different ways before experiencing a mind–body therapy compared to after. A good example of where this challenge was encountered and well described is the validation of the Five-Facets Mindfulness Questionnaire (FFMQ), in which the authors used a validation sample of mostly mindfulness-naïve students.⁵⁵ They found that the items of one of the FFMQ's subscales, Observing, did not fit the CFA for the entire sample and that in nonmeditating individuals, relations between Observing and psychological adjustment were insignificant or in the opposite direction. The authors suggested that these items may not adequately capture the experience that is characteristic of mindfulness, or that this subscale is particularly sensitive to changes with meditation experience and represents a clear facet of mindfulness

only as mindfulness skills further develop. Subsequent application in samples with meditation experience supported the validity of the Observe subscale for a population which had learned to meditate.⁵⁶ In our study, it is thus possible that the aspect of Not Distracting oneself from the perception of pain or other sensations of discomfort may only become a dimension of interoceptive awareness when developed with a mind–body therapy.¹⁹ Clearly, this problem of a change in the understanding of questionnaire items – from before to after an item-related learning process occurs – remains and may be but one example of a general limitation of self-report measures for these types of phenomena, a methodological problem for any self-report measure of a parameter that changes with learning and new experiences.

Suggestions for further refinement

Despite the difficulties the Not Distracting scale created for the CFA in the entire study sample, we would not suggest eliminating this scale from the multidimensional MAIA instrument. The striking difference between the body awareness-naïve primary care pain patient sample and the original mind–body validation sample in the understanding of the items for this dimension appears particularly interesting and warrants further scale refinement. Instead of its elimination, we suggest that Item 5 be rephrased (“I ignore” instead of “I do not notice”), and that a few positively worded items be added to the three-item scale to potentially improve its reliability. Second, we suggest that respondents be given the questionnaire in writing, with visual reference for the response options, rather than have items presented verbally without accompaniment. Assessing attentional strategies for their role in the complex management of pain is becoming a key element for pain research and will require refinement that goes well beyond the scope of this study.

With these suggestions for further refinement, we believe that the strong confirmation of six of the eight MAIA scales in this mind–body therapy-naïve sample of patients with past or current pain provides sufficient validity for the MAIA to suggest its application in longitudinal studies of mind–body therapies for pain patients.

Limitations

Several limitations need to be acknowledged: first, as already discussed, the inclusion of the MAIA scales into the 2-year follow-up survey of the POP cohort study was different from an earlier follow-up interview and, therefore, was somewhat unexpected for the participants. Second, the survey was conducted in two different modes of application, over the phone

or online. As stated above, items presented over the phone did not have a visual reference and may have been more difficult to answer. Participants who did not fully understand a question would have to interrupt the flow of the survey to ask the interviewer for clarification, whereas participants reading a confusing question online could simply reread it. We had not anticipated that these survey styles could potentially lead to different levels of clarity in the item presentation. However, the observed differences provided important suggestions for future applications of the MAIA scales. Third, we are not able to compare the two groups on other psychological parameters to test whether differences in the MAIA scale scores are due to differences in other factors, such as catastrophizing, and whether the MAIA provides additional value above a measure of catastrophizing. Fourth, to make space for the MAIA, we reduced the number of psychological items we had used in this cohort in earlier surveys. Additional validity measures one would have chosen to assess the comparative and incremental validity of the scales (Pain Catastrophizing Scale;⁴³ Pain Vigilance Awareness Questionnaire⁵⁸) further could not be included in the ongoing cohort study, so we were limited in conducting additional, more detailed construct validity assessments for this population. Fifth, self-report of a construct that one may not be aware of is particularly sensitive to beliefs, social desirability, and bias and therefore will need to be validated against objective measures. Lastly, sensitivity to change of the MAIA scales, in particular with interventions claiming to enhance body awareness, needs to be assessed in longitudinal studies. These studies are currently under way.

Conclusion

The data presented in this cross-sectional study suggest a hypothesis for further research with pain patients, namely the notion that training in mind–body approaches may lead to a different coping style with pain, possibly based on a different style of interoceptive attention regulation. This notion is not new and has been suggested by research with experimental acute pain.²⁰ Longitudinal studies in a clinical population are necessary to determine whether a less distracting and more mindful style of attention, as suggested in the mind–body therapy experiences sample, may be feasible and superior to the more commonly practiced distracting-attention style in the treatment and prevention of chronic pain. The MAIA may help in answering this important question and be a valid instrument for the quantitative assessment of some of the qualities and skills individuals may experientially learn when undergoing mind–body therapies. Due to the complexity of the construct and the

inherent challenges in its assessment, we view the MAIA scales as a starting point for further refinement through additional research rather than as a finished product. This multifaceted instrument has the potential of serving an important function for psychosomatic research, when therapeutic interventions, eg, for the management of pain, directly aim at the interface of body and mind. Key applications for the MAIA scales would be in studies of nonpharmacological approaches for the treatment or prevention of chronic LBP to assess changes in interoceptive awareness as a potential mechanism of action.

Disclosure

The authors report no conflicts of interest in this work.

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Supplementary material

Table S1 Psychological measures (All scales, 0–10)

Parameter	Item(s)	Source
Perceived stress	<ul style="list-style-type: none"> – In the last month, how often have you felt that you were unable to control the important things in your life? – In the last month, how often have you felt that things were going your way? – In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? – In the last month, how often have you felt confident about your ability to handle your personal problems? 	PSS ¹
Depression	How much have you been bothered by feeling down or depressed in the past week?	ÖMPSQ, ² HKF ³
Fear-avoidance beliefs	Do you feel bending, lifting, walking, or driving might harm your back?	FABQ ⁴
Catastrophizing	<p>A. – You think it is terrible and you feel it is never going to get any better.</p> <p>B. – You think it is terrible, and you feel it is never going to get any better.</p> <ul style="list-style-type: none"> – You wondered whether something serious may happen. – You feel you can't go on. – You wondered whether you have the same bad disease as somebody you know. – You wondered whether there is a bad disease behind all this pain. 	CSQ ⁵ CSQ ⁵ PCS ⁶ PCS ⁶ HKF ³ HKF ³
Recovery expectancy	In your view, how large is the risk that your current pain may not go away?	ÖMPSQ ²
Ignoring coping style	When you feel back pain, on a scale of 0 to 10, how much do you do the following: When you feel pain you ignore it?	CSQ ⁵
Positive distraction	You do something you enjoy, such as watching TV or listening to music.	CSQ ⁵

Abbreviations: PSS, Perceived Stress Scale; ÖMPSQ, Örebro Musculoskeletal Pain Screening Questionnaire; HKF, Heidelberger Kurz-Fragebogen; FABQ, Fear-Avoidance Beliefs Questionnaire; CSQ, Coping Strategies Questionnaire; PCS, Pain Catastrophizing Scale.

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