

Mindfulness-based Stress Reduction (MBSR) as Treatment for Chronic Back Pain – an Observational Study with Assessment of Thalamocortical Dysrhythmia

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Keywords

Chronic back pain · Mindfulness · MBSR · EEG ·
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Summary

Background: A pilot study of an 8-week mindfulness-based stress reduction (MBSR) program on a sample of low back pain patients was conducted in order to assess the feasibility and effectiveness of the intervention as well as changes in an EEG pattern called thalamocortical dysrhythmia which is associated with chronic pain. **Patients and Methods:** 22 patients with chronic low back pain participated in an MBSR program. Effect sizes were measured for psychological functioning, pain severity, and quality of life. Furthermore, 4 parameters of the EEG power spectral density were assessed. **Results:** Medium size effect sizes were found for health-related quality of life (EQ-5D, VAS, $d = 0.43$, $p = 0.02$; SF-12, psychological functioning, $d = 0.50$, $p = 0.05$), health-related life satisfaction (questions on life satisfaction $d = 0.69$, $p = 0.01$), depression (HADS, $d = 0.48$, $p = 0.04$, Brief Symptom Inventory $d = 0.41$, $p = 0.04$), and affective pain perception (pain perception scale $d = 0.50$, $p = 0.04$). The most relevant pain severity measurements improved in the range of $d = 0.45$ – 0.75 ($p = 0.01$ – 0.24). EEG analyses revealed no differences between the pre- and post-intervention. **Conclusion:** MBSR is a feasible intervention for patients with low back pain. They benefit from medium size effects which are comparable to similar behavioral interventions. Randomized controlled trials are needed in order to determine the specificity of these benefits.

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Schlüsselwörter

Chronische Rückenschmerzen · Achtsamkeit · MBSR · EEG ·
Thalamokortikale Dysrhythmie

Zusammenfassung

Hintergrund: In einer Pilotstudie mit Patienten, die an chronischen Rückenschmerzen leiden, wurde ein 8-wöchiges Achtsamkeitsprogramm auf dessen Durchführbarkeit und Wirksamkeit untersucht. Berücksichtigt wurden dabei auch im EEG nachweisbare Veränderungen, die auf thalamokortikale Dysrhythmie schließen lassen, eine neuronale Störung, die mit chronischen Schmerzen in Beziehung steht. **Patienten und Methoden:** 22 Patienten mit chronischen Rückenschmerzen nahmen an einem Kurs in achtsamkeitsbasierter Stressbewältigung (MBSR) teil. Abhängige Variablen waren selbstberichtete Maße zu Psychopathologie, Schmerz und Lebensqualität sowie 4 Parameter aus dem Powerspektrum des EEG. **Ergebnisse:** Mittelmäßige Effektstärken wurden für die Variablen Lebensqualität (EQ-5D, VAS, $d = 0,43$, $p = 0,02$; SF-12, Psychische Summenskala, $d = 0,50$, $p = 0,05$), gesundheitsbezogene Lebenszufriedenheit (Fragebogen zur Lebenszufriedenheit, $d = 0,69$, $p = 0,01$), Depressivität (HADS, $d = 0,48$, $p = 0,04$, Brief Symptom Inventory $d = 0,41$, $p = 0,04$) und affektives Schmerzempfinden (Schmerzempfindungsskala $d = 0,50$, $p = 0,04$) gefunden. Die bedeutsamsten Schmerzmaße (VAS) besserten sich im Bereich von $d = 0,45$ – $0,75$ ($p = 0,01$ – $0,24$). Im EEG konnten keine Unterschiede gefunden werden. **Schlussfolgerung:** MBSR ist eine praktikable Intervention bei chronischen Rückenschmerzen. Die Patienten profitieren von den mittleren Effektstärken, die mit denen ähnlicher, verhaltenstherapeutischer Interventionen vergleichbar sind. Zur Untersuchung der Spezifität der Wirkung müssen randomisierte kontrollierte Studien durchgeführt werden.

Introduction

Mindfulness-based interventions have proved to be moderately effective in the treatment of chronic pain and the accompanying distress and psychological morbidity [1]. Low back pain (LBP) is the most prevalent chronic pain condition, with a major impact on public health and with accompanying economic consequences [2, 3]. Some of the best treatment options for LBP are multidisciplinary pain management programs [4, 5], many of which also contain mindfulness-based or acceptance-based elements. However, evidence for the effectiveness of mindfulness-based interventions is scarce. A recent review [6] identified only 3 randomized controlled trials (RCTs), 2 of which involved a population >65 years [7, 8] of age; 1 assessed a population with failed back pain surgery [9]. Furthermore, there is an observational trial piloting an intervention which combines mindfulness-based and physiotherapeutic elements [10].

The most widespread meditation-based intervention is the structured 8-week course Mindfulness-based Stress Reduction (MBSR) by Jon Kabat-Zinn [11]. This program was applied in many chronic pain conditions [12], such as fibromyalgia [13, 14] and rheumatoid arthritis [15].

The effects of MBSR are highest with respect to stress and psychological problems, such as depression and anxiety [16, 17]. In this program, the patients learn, among other things, a different approach to their illness with respect to self-regulation capacities for pain and negative emotions in order to improve the experience of control. It is assumed that such a change of attitude towards one's illness can in turn also influence pain perception and may also break up psychological chronification patterns.

To date, little is known about the accompanying neural mechanisms of chronic pain, [18]. Recent studies have identified a relationship between severe neurogenic pain and the presence of a specific EEG pattern called thalamocortical dysrhythmia (TCD) [19–22]. Sarnthein et al. [23] compared the EEG spectrum of 15 patients with severe chronic pain with matched healthy controls, and found marked differences both with respect to the power in the theta and beta domains and in the frequency of the peak of the power spectral density. We replicated this study with a more general sample of LBP patients by comparing their EEG patterns to matched healthy controls [24] but found no differences in TCD patterns. This was most likely due to the fact that LBP patients have pain of nociceptive and psychogenic origin rather than of neurogenic source. Nevertheless, we are interested whether a longitudinal design with intervention changes and subjective pain reports will result in changes in TCD-related patterns.

Since to date no simple trial has been carried out assessing the effects of an MBSR program with a self-selected LBP population, we conducted a pilot study with the following objectives: (1) assessing changes of EEG patterns in relation to changes of pain experience after a behavioral intervention; (2) estimating effect sizes with respect to psychological morbidity and coping aspects in LBP; and (3) testing the feasibility of the MBSR program for patients suffering from LBP.

Methods

Design

We conducted an observational pilot trial. Measurements were taken at enrolment (t_0 , EEG and questionnaire), directly before (t_1 , questionnaire), and after the intervention (t_2 , EEG and questionnaire). The total recruitment period was 6 months. The 8-week MBSR course started 4 months after the end of the recruitment. At t_0 , results of the EEG assessment of the TCD pattern were compared to a healthy gender- and age-matched control. This part of the study has previously been published [24] and will not be reported here. The study was approved by the ethics committee of the Medical Center – University of Freiburg and registered before the start of recruitment with clinicaltrials.gov (NCT00744575).

Participants

For the EEG diagnostic study [24] and an optional MBSR intervention, the participants were recruited via public announcements and via pain specialists. The applicants were screened on the phone followed by an intake interview which was conducted by a medical doctor.

Inclusion criteria were chronic back pain for at least 1 year, daily complaints about back pain, an average pain rating of at least 5 for the last 12 months on a Visual Analog Scale (VAS) ranging from 0 to 10, age from 18 to 70 years, and command of the German language. Exclusion criteria were the presence of psychiatric conditions, including substance dependence, immunosuppressive treatment, life-threatening disease, and participation in other clinical trials. Patients were informed of all aspects of the study and gave written informed consent.

Intervention

The MBSR intervention was closely based upon the original program by Jon Kabat-Zinn [25]. It comprised an 8-week structured group program, with groups of up to 12 patients. Participants took part in one 2.5-h session every week, one additional all-day session, and an individual pre- and post-intervention interview with the trainer. Each session covered specific exercises and topics within the context of mindfulness practice and training, including various types of formal mindfulness practice, mindful awareness of dynamic yoga postures, and mindfulness during stressful situations and social interactions. Participants were asked to commit themselves to daily homework assignments of 45–60 min. The MBSR instructors were 2 male medical doctors (MDs) with expertise in psychosomatic and psychiatric medicine who had conducted MBSR training programs in the past and are approved by the German MBSR/MBCT association.

Measures

EuroQol Quality of Life Questionnaire (EQ-5D) [26]: This is a simple 5-item questionnaire for health-related quality of life (HRQoL). It includes a VAS regarding general state of health.

Twelve-Item Short Form Health Survey (SF-12) [27]: The SF-12 is a 12-item scale for the assessment of HRQoL. 2 subscales are constructed from the data (psychological and physiological functioning) which can be compared to the population values.

Brief Symptom Inventory (BSI) [28, 29]: This is the 53-item symptom check list functioning as screening instrument to assess psychopathology. The BSI allows for the calculation of 9 subscales and a Global Severity Index (GSI) reflecting overall burden.

Hospital Anxiety and Depression Scale (HADS) [30]: This is a short 14-item screening instrument for anxiety and depression disorder which has 2 subscales.

Pain Perception Scale (PPS) [31]: A German questionnaire measuring subjective pain perception on 2 subscales: sensory (10 items) and affective pain (14 items).

Visual Analogue Scales (VAS) assessing pain severity: VAS comprised the anchor points 'no pain at all' and 'worst pain possible'. We assessed average pain in the previous 4 weeks, 3 months, and 12 months respectively. We also asked for the 'strongest' and 'lowest pain intensity within the previous 4 weeks'. Furthermore, we assessed changes in pain severity by retrospective one-point measurements at t_1 and t_2 ('How is your pain today compared to ...') referring

to the enrolment (at t_1) or referring to enrolment and to the start of the course (at t_2). These questions had a 7-step numeric rating scale ranging from -3 (worse) to 0 (unchanged) to +3 (better).

Questions on Life Satisfaction (FLZ) [32]: This is a 32-item German questionnaire assessing generic as well as health-related life satisfaction in 8 different dimensions. Each dimension needs to be weighted regarding both individual importance and individual satisfaction. Based on this information, an individually weighted sum score for generic and health-related life satisfaction respectively was computed.

EEG

EEG was recorded in a sound- and electromagnetically-shielded, dimly lit chamber, with a 72-channel amplifier (Quickamp, Brain Products, Munich, Germany, bandpass filtered 0–200 Hz; A/D rate 1000 Hz) according to the international 10/10 system, from 60 electrode sites plus diagonal EOG. We used an ActiCap System (Brain Products, Munich, Germany) that includes a cap with active electrodes. Electrode impedances were kept under 5 k Ω . All measurements were performed before noon in order to avoid sleepiness. Patients were required to abstain from caffeine on the day of measurement since caffeine is known to influence theta activity [33].

Statistics and Data Analysis

EEG Data

All data analyses were performed with Brain Vision Analyser 2.0 (Brain Products, Munich, Germany) and custom scripts in MatLab (MathWorks, Natick, MA, USA). After artefact inspection and elimination data were bandpass-filtered (1–30 Hz) and segmented into 4-s epochs (with 2 s overlapping). For each patient, 100 free-of-artefact segments were included in further analyses. A discrete 4000-sample Fast Fourier Transformation (FFT) was computed for each segment. The topographic distribution of power spectral density (PSD) was obtained by averaging across all 100 epochs. We then averaged the log-transformed spectra across all channels for each participant.

From this PSD the frequency of the dominant peak (peak frequency) and the log-transformed PSD values at this frequency (peak power) was determined. For each patient a region of interest (ROI) was defined by ± 2 standard deviations (SD) of the mean peak frequency. Within this ROI the overall power and its center of gravity was computed. By this procedure we arrived at 4 different variables (peak frequency, peak power, center of gravity, and overall power) for subsequent analyses. For a more detailed account of the EEG data processing see Schmidt et al. [24].

Questionnaire data were entered into SPSS software (Version 17 and 19) by hand. The questionnaires of a randomly selected subsample of 10 patients were entered a second time by a different person to control for coding errors. Missing items were replaced according to the respective questionnaire manual (replacement by means). In the analysis, we only included patients who had completed the intervention per protocol which was defined as attending at least 6 of the 8 sessions.

Intervention effects were assessed by t-tests for dependent data if variables were normally distributed; in all other cases Wilcoxon signed-rank tests were used. We calculated pre-post effect sizes (Cohen's d) by computing the difference of the respective means divided by their pooled SD.

Results

Patients

Overall 62 patients with LBP were screened on the phone, 38 of which participated in the preceding EEG diagnostic study [24]. 22 of them volunteered to participate in the MBSR intervention. One participant visited only one session and then dropped out. The remaining 21 participants (95%) completed the study per protocol and were subject to the further analyses (table 1).

Table 1. Sociodemographic data of the sample

N = 21	
Age (SD)	47.8 (10.27)
Sex (m/f)	(5/16)
Education level (%)	
9 years	2 (9.5)
11 years/GCSE	10 (47.6)
A-level/college entry level	9 (42.9)
Marital status	
Married, living together	9 (42.9)
Widowed	1 (4.8)
Divorced	3 (14.3)
Single	8 (38.1)
GCSE = General Certificate of Secondary Education.	

Psychological Health

Table 2 displays the data of the 6 self-report scales applied to measure psychological health.

Patients showed a significant improvement both in HRQoL ($d = 0.43$, $p = 0.02$) and on the psychological dimension of the SF-12 ($d = 0.50$, $p = 0.05$) with a medium effect size. There was scant change on the physiological dimension of the SF-12. Regarding general life satisfaction, patients showed a small increase ($d = 0.29$) but medium to large increase in health-related life satisfaction ($d = 0.69$, $p = 0.01$).

Regarding psychological morbidity, patients showed only small non-significant improvements in 7 of 9 scales of the BSI, including GSI. The only exception was the subscale depression, with a significant medium-sized improvement of $d = 0.41$ ($p = 0.04$). This finding is supported by a similar improvement on the depression subscale of HADS ($d = 0.48$; $p = 0.01$), while there is a non-significant improvement of $d = 0.33$ on the anxiety subscale. Finally, there is a significant medium-sized improvement on the affective dimension of the pain perception scale ($d = 0.50$, $p = 0.04$), but not in the sensory dimension.

Pain

Subjective pain was measured with VAS at 3 time points (table 3): upon enrolment (t_0), immediately before the start of the course (t_1 , 6–10 months later), and immediately after the course (t_2 , 8 weeks after t_1).

The average pain during the previous 4 weeks showed an improvement at t_2 , with a medium effect size of 0.48 ($p = 0.056$) compared to enrolment (t_0) and of 0.46 ($p = 0.03$) compared to t_1 , immediately before the start of the course. The improvement was similar for the average pain score of the previous 3 months, with $d = 0.46$ compared to t_1 , but differed regarding t_0 with a smaller effect size of $d = 0.21$. Of note, for the variable 'average pain in the previous 12 months', patients reported an increase in severity by $d = -0.44$ compared to t_0 , in contradiction to all other pain measurements. The maximum and minimum pain showed an improvement of $d = 1.15$ and $d = 0.64$ respectively (all highly significant).

The additional retrospective one-point measurement at t_1 referring to enrolment revealed a mean change of $d = -0.15$ indicating

Table 2. Means, standard deviations (SD), test parameters, p-values, and effect size (Cohen's d) for health-related parameters. Positive effect sizes indicate improvement

	t ₀	t ₂	T	df	p	d
HRQoL, n = 21						
EQ-5D VAS scale	55.81 (20.22)	64.57 (19.92)	2.54	20	0.019	0.43
SF-12, n = 19						
Physiological functioning	33.73 (9.87)	35.47 (9.61)	1.04	18	0.31	0.18
Psychological functioning	41.08 (12.31)	47.25 (10.58)	2.12	18	0.048	0.50
BSI						
GSI, n = 21	0.80 (0.56)	0.72 (0.47)	0.82	20	0.42	0.14
Somatization, n = 20	0.91 (0.66)	1.02 (0.59)	-1.19	19	0.25	-0.17
Obsessive-compulsive disorder, n = 21	1.19 (0.75)	1.06 (0.79)	0.74	20	0.47	0.17
Depression, n = 21	0.83 (0.76)	0.52 (0.50)	2.26	20	0.035	0.41
Anxiety, n = 21	0.85 (0.68)	0.80 (0.66)	0.47	20	0.64	0.07
Phobic anxiety, n = 21*	0.70 (0.93)	0.56 (0.62)	-0.51**	-	0.61	0.15
Interpersonal sensitivity, n = 21	0.88 (0.93)	0.76 (0.68)	0.73	20	0.475	0.13
Hostility, n = 21	0.62 (0.56)	0.69 (0.61)	-0.48	20	0.64	-0.13
Paranoid ideation, n = 21*	0.72 (0.72)	0.57 (0.64)	-1.37**	-	0.17	0.21
Psychoticism, n = 21	0.44 (0.55)	0.36 (0.36)	0.59	20	0.56	0.15
FLZ						
General life satisfaction, n = 21	27.36 (35.57)	37.71 (39.82)	2.10	20	0.049	0.29
Health-related life satisfaction, n = 21	22.51 (27.47)	41.33 (39.76)	3.04	20	0.007	0.69
HADS						
Anxiety, n = 21	8.71 (3.65)	7.52 (4.11)	-1.37	20	0.19	0.33
Depression, n = 21	7.75 (4.45)	5.62 (3.06)	-2.86	20	0.010	0.48
PPS						
Affective, n = 20	32.6 (9.56)	27.79 (8.33)	-2.24	19	0.038	0.50
Sensory, n = 21	18.59 (5.75)	17.33 (5.49)	-0.87	20	0.40	0.22

HRQoL = questionnaire for health-related quality of life ; EQ-5D = EuroQol Quality of Life Questionnaire; SF-12 = 12-Item Short Form Health Survey; BSI = Brief Symptom Inventory; GSI = Global Severity Index; FLZ = Questions on Life Satisfaction; HADS = Hospital Anxiety and Depression Scale; PPS = Pain Perception Scale;

*Wilcoxon test.

**Z-score.

Table 3. Pain ratings on a Visual Analog Scale (VAS) at t₀ (enrolment), t₁ (before intervention), and t₂ (after intervention). Positive effect sizes indicate improvement

	t ₀	t ₁	t ₂	t ₀ -t ₂		t ₁ -t ₂		t ₀ -t ₂	
	mean (SD)	mean (SD)	mean (SD)	n	p	d	n	p	d
Pain VAS									
Average 4 weeks	5.86 (2.15)	5.40 (1.54)	4.55 (2.09)	21	0.056	0.48	20	0.034	0.46
Average 3 months	5.25 (1.45)	5.63 (1.42)	5.00 (1.41)	20	0.437	0.21	19	0.08	0.45
Average 12 months	5.55 (1.74)	6.17 (1.62)	6.39 (1.34)	19	0.039	-0.44	18	0.50	-0.15
Maximum 4 weeks	8.19 (1.32)	7.91 (1.66)	6.67 (1.77)	21	0.003	1.15	21	0.24	0.75
Minimum 4 weeks	3.12 (1.52)	3.10 (1.64)	2.14 (1.49)	21	0.002	0.64	21	0.009	0.59

Table 4. Means, standard deviations (SD), test parameters, p-values, and effect size (Cohen's d) for 4 EEG parameters indicative for thalamocortical dysrhythmia (TCD)

	t ₀	t ₂	t	df	p	d
Peak frequency, Hz	10.35 (1.27)	9.90 (1.21)	1.20	20	0.24	0.35
Peak power, $\mu V^2/Hz^*$	1834.75 (2852.91)	1901.14 (2271.50)	-0.24	20	0.81	0.02
Center of gravity, Hz	10.06 (0.48)	9.89 (0.46)	2.19	20	0.040	0.35
Overall power, $\mu V^2/Hz^*$	8304.49 (11302.26)	9883.72 (11082.18)	-1.48	20	0.15	0.14

*Log-transformed.

that there was no change in pain between study enrolment and start of the intervention. At t₂ patients reported an improvement of 1.08 (SD = 1.08, t = 4.25, df = 18, p < 0.001, d = 1.00) on the applied 7-point scale, as compared to t₀ (enrolment), and of 1.11 (SD 1.20, t = 4.03, df = 19, p = 0.001, d = 0.92) as compared to t₁.

With respect to the minimum clinical important difference (MCID) a change of at least 2.5 points on a numeric rating scale for pain should be found [34]. For the average pain in the last 4 weeks, this level was reached in the present study by 6 out of 21 patients (29%), 10 patients (48%) reported a change of 2 points.

EEG

According to the theory of TCD, an improvement in pain should correlate with a shift of the peak frequency and center of gravity towards a higher frequency and a general lower overall power and peak power. Table 4 shows that all 4 parameters shift opposite to the estimated direction, none of which is statistically significant.

We also correlated change in average pain perception during the last 4 weeks with changes in TCD-related EEG variables between the 2 measurements (t_0 and t_2). Here, all correlations headed towards the intended direction, with pain improvement resulting in lower overall power (Spearman's $r = 0.54$, $p = 0.01$) and lower peak power ($r = 0.19$, n.s.) on the one hand and an increase in peak frequency ($r = -0.41$, $p = 0.06$) and center of gravity ($r = 0.35$, n.s.) on the other. However, if these results are corrected for multiple analyses no significant correlations remain.

Discussion

The results of our pilot trial demonstrate that MBSR is a feasible intervention for LBP patients. Of 22 patients, 21 completed the course per protocol, with only one dropout due to time constraints. The patients reported improvements with medium to large effect size for health-related life satisfaction and medium size effect sizes for HRQoL, psychological functioning, depression, and for affective pain perception.

Furthermore patients stated a medium-size improvement in pain severity, with effect sizes of $d = 0.45$ for average pain ratings after the intervention. These effect sizes were slightly higher for maximum and minimum pain ratings ($d = 0.59$ – 0.75) and for the retrospectively estimated improvement ($d = 0.92$ – 1.00). Of note, after the intervention patients reported an increase in 'average pain intensity during the last 12 months', which is contradictory to the other estimates. One interpretation of this mismatch might be that some patients chose an internal anchor of a 12-month interval with an onset before the start of the study. This would mean that patients remember the average pain at a specific time point, namely one year ago rather than the average pain during the last year.

Overall our results demonstrate that after visiting an MBSR course patients report improved coping abilities, better psychological functioning, and reduced pain. These findings are in accordance with meta-analyses of MBSR in general [35, 36] and effects found for MBSR regarding chronic pain [1]. The effect sizes reported here are also compatible with or even higher than effect sizes of other behavioral or psychological interventions in chronic pain [37].

We did not collect systematically safety data in order to assess risk-benefit ratio of MBSR. In the post-intervention interviews of the MBSR teachers no major adverse events were reported. There are hardly any reports of safety issues related to MBSR, but some concerns regarding meditation in general [38].

Overall, none of the behavioral approaches for the treatment of chronic pain are solely satisfying as are any other treatment modalities.

Evidence indicates that only multimodal treatment programs combining different treatment options can be recommended [39, 40]. Our results indicate that it should be considered to include also mindfulness-based approaches into these programs.

With respect to the EEG data no pre-post changes could be found. There are slight indices that TCD variables correlate with pain ratings but these are very limited findings and need to be followed up. This lack of evidence is less surprising if one considers that even after comparing chronic pain patients with healthy controls at baseline only minimal differences could be found. From this first analysis [24], we concluded that TCD found in patients with very severe chronic pain (VAS 9–10) is not comparable to the population assessed in this study with an average VAS score of 5–6.

One of the largest limitations of our pilot study is that it is not controlled. A control group has several functions with respect to the interpretations of the results. The function of a wait-list control is to control against natural trends. Natural trends may occur due to e.g. seasonal effects, or due to course of disease. Our study took one year and consisted of a 6-month recruitment period and a 4-month waiting period until the start of the 2-month course. Variables were compared from enrolment (t_0) to the end of the intervention (t_2). Thus, a potential bias due to seasonal trends is quite unlikely. Regarding the natural course of LBP, a review reports that patients at baseline show relative stable LBP over time [41]. It therefore seems unlikely that in our case the reported improvements are due to a natural improvement of the condition. The function of an active control group is to control for the specificity of the MBSR effects. Thus, our observational trial does not reveal if the effects occurred due to specific mindfulness elements in the MBSR course or due to the many unspecific aspects of the intervention. From a scientific perspective which tries to nail down causally effective elements our results are not satisfying, and demand a consecutive RCT with an active control group or a comparative effectiveness trial. However, we should not forget the patients' perspective in these considerations. If there is an improvement of half a SD in effect size in pain severity and quality of life after visiting an MBSR course, patients might be happy about that and less interested in the complex causal interdependence of specific and unspecific effects. Furthermore, from the current findings in placebo research we know that unspecific effects are also 'real' improvements which can be found in objective assessments [42, 43] and therefore are not mere suggestive effects. From patients' perspective we demonstrated that MBSR is a valid treatment option in order to improve their situation.

Conclusion

MBSR is a feasible intervention for LBP. Patients participating in the course reported improved psychological functioning, improved coping abilities, and a moderate reduction in pain which is comparable to other behavioral interventions. Based on these findings, MBSR and similar mindfulness-based interventions might play an important role in the multimodal treatment of chronic

back pain. Future research should focus on the contribution of mindfulness-based interventions in these programs as well as on RCTs assessing the specific effects of MBSR. With respect to TCD future research should target patients suffering from pain with neuropathic origin and with very severe pain ratings.

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The authors declare that no competing interests exist.

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