

Short communication

A pilot randomized control trial investigating the effect of mindfulness practice on pain tolerance, psychological well-being, and physiological activity[☆]

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Abstract

Objective: To investigate the effect of mindfulness training on pain tolerance, psychological well-being, physiological activity, and the acquisition of mindfulness skills. **Methods:** Forty-two asymptomatic University students participated in a randomized, single-blind, active control pilot study. Participants in the experimental condition were offered six (1-h) mindfulness sessions; control participants were offered two (1-h) Guided Visual Imagery sessions. Both groups were provided with practice CDs and encouraged to practice daily. Pre–post pain tolerance

(cold pressor test), mood, blood pressure, pulse, and mindfulness skills were obtained. **Results:** Pain tolerance significantly increased in the mindfulness condition only. There was a strong trend indicating that mindfulness skills increased in the mindfulness condition, but this was not related to improved pain tolerance. Diastolic blood pressure significantly decreased in both conditions. **Conclusion:** Mindfulness training did increase pain tolerance, but this was not related to the acquisition of mindfulness skills.

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Introduction

Mindfulness is a form of meditation that has been described as purposefully attending to the present moment in a manner that is dispassionate and non-evaluative of any mental events or physical sensations that may arise [1,2]. Theorizing posits that mindfulness is *not* a self-relaxation technique [1], but rather a form of *mental training* that facilitates more adaptive responding to stress [3].

Research suggests that training in mindfulness, or related treatment approaches, may help to improve pain tolerance (e.g., Refs. [4–6]), increase psychological well-being

(e.g., Refs. [7–9]), and improve physiological activity [10]. Two recent meta-analyses on mindfulness-based interventions [1,11] have reported medium estimated effect sizes ($d=0.59$ and $d=.50$, respectively). However, a more critical review highlights several methodological weaknesses that complicate inferring efficacy [3]. Specifically, the efficacy of mindfulness is inferred from trials on multifaceted interventions, which have not implemented active controls and which fail to investigate the relationship between mindfulness skills and health benefits.

Addressing these limitations, this study investigated the effect of mindfulness practice (per se) on pain tolerance, psychological well-being, and physiological activity [diastolic blood pressure (DBP), systolic blood pressure (SBP), and pulse] in a randomized, single-blind, active control trial. The central component of mindfulness is purported to be moment-to-moment awareness [2]. Control participants

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were therefore trained in guided visual imagery (GVI), a self-relaxation strategy that directs attention away from the present moment [12], but that shares several common components with mindfulness (e.g., restful alertness, mental activity, and physical inactivity).

Predictions

Compared to GVI, mindfulness training will increase participants' pain tolerance, psychological well-being, and decrease physiological activity; the mindfulness skills of mindfulness-trained participants will significantly increase from pre–post testing, and this will be significantly related to any observed health benefits.

Method

Participants

Forty-five asymptomatic students were recruited from a UK University. Sample size was determined using a priori power calculations.¹ Undergraduates received course credits. Participants were excluded if they had previously practiced meditation and/or had Raynaud's disease.²

Measures

Pain tolerance was measured using a circulating cold water tank (VTRC 620; recommended by Mitchell et al [13]) retained at 0.2°C. A digital stopwatch recorded submersion time, and pain intensity was measured using a single-item rating scale: "Please indicate how painful this task was on a scale of 1 (*no pain*) to 10 (*pain as bad as it could be*)." Pain intensity was measured either 45 s into the task or, if the participants' hand was submerged for less than 45 s, at point of hand retraction. Blood pressure (BP) and pulse were recorded using an automated, 767 BP cuff (British Hypertension Society-approved) from the nonwriting arm at rest. No instructions were given regarding strategies to be used during the task.

Mood was measured using the 20-item Positive and Negative Affect Schedule [14]; mindfulness was measured using the 39-item Kentucky Inventory of Mindfulness Skills [15]; and intervention credibility and health improvement expectancy were measured using the 6-item Credibility/Expectancy Questionnaire [16]. All questionnaires were administered at pre- and posttesting except the Credibility/Expectancy Questionnaire, which was administered at mid and posttesting. At posttesting, participants rated the average number of days per week they practiced. This did

not affect credit allocation. Both groups received a 20-min meditation/GVI CD for home practice.

Procedure

Pre–post testing sessions were conducted as follows: consent, BP and pulse reading 1; questionnaires, BP and pulse reading 2; instructions for the cold pressor test, BP and pulse reading 3; the cold pressor test; and randomization.³

Interventions

Interventions were described as stress reduction classes. Mindfulness was taught by a clinical psychologist and a psychiatrist. Guided visual imagery was taught by a (different) clinical psychologist. All trainers were experienced at teaching the technique to clinical and nonclinical groups (minimum history of 4 years teaching), and used the technique themselves for independent home practice (minimum of 8 years). There were six 1-h mindfulness sessions (twice weekly), and two 1-h GVI sessions (Weeks 2 and 3). Interventions developed across sessions.

Mindfulness practice began by grounding awareness in the body, through a brief 2-min body scan, and subsequently in the sensations of breathing. Participants were encouraged to allow awareness to move naturally to other sensations (e.g., sounds and thoughts), to note these (e.g., hearing), allow them to pass without reacting, and return to the breath. Sessions were divided between a brief introduction, formal practice (always 20 min per session), and reflective discussion. This format has been used with National Health Service patients and university students. Guided visual imagery sessions were divided between introducing GVI, practicing GVI, and reflective discussion. Each GVI practice began by centering participants with 2 min of guided deep breathing. Participants were then encouraged to evoke mental images of the scenes described by the group trainer (e.g., walking through a garden). Guided visual imagery practice lasted 20 min per session. All participants were asked to practice daily using the 20-min CD provided.

Results

Participants

Forty-two participants completed training (21 per condition; 33 female; mean age, 23 years). There were no

¹ For an effect size of 0.5, with an α of .05 and power of 0.85, a sample of 38 was required (calculations based on Refs. [1] and [11]).

² Due to the use of the cold pressor test.

³ Schedules of where and when the sessions would be held were sealed in envelopes and picked from a box by the participant. Half contained times and venues for the mindfulness sessions and half for GVI. This information did not tell participants which of the two groups they had been randomized to, and no information could be seen without unsealing the envelope. Participants opened these after leaving the session to protect single-blinding of the researcher.

Table 1
Descriptive statistics for study variables

	Pain tolerance		Mood (PANAS)		Psychological activity			Mindfulness skills
	Submersion time	Pain intensity	Positive affect	Negative affect	SBP	DBP	Pulse	(KIMS)
<i>Preintervention</i>								
Mindfulness								
Mean	50.02	7.00	3.05	2.01	115.94	69.79	74.71	3.06
SD	39.93	1.38	0.58	0.68	9.78	8.50	11.24	0.33
GVI								
Mean	60.11	6.62	3.22	1.93	115.76	72.62	75.48	3.23
SD	38.08	1.53	0.57	0.71	10.70	7.83	13.80	0.27
<i>Postintervention</i>								
Mindfulness								
Mean	64.01	6.19	3.20	2.10	115.19	67.95	73.60	3.29
SD	42.39	1.66	0.58	0.88	12.51	6.99	11.60	0.27
GVI								
Mean	60.57	6.43	3.26	1.81	114.41	69.90	76.79	3.26
SD	41.40	1.75	0.65	0.75	8.23	9.08	11.60	0.37

Scale length and polarity: submersion time (in seconds), pain intensity (1=“no pain,” 10=“pain as bad as it could be”), positive affect (1=infrequent positive affect, 5=frequent positive affect), negative affect (1=infrequent negative affect, 5=frequent negative affect), and KIMS (1=low in mindfulness skills, 5=high in mindfulness skills). KIMS, Kentucky Inventory of Mindfulness Skills; PANAS, Positive and Negative Affect Schedule.

significant differences between groups on baseline measures, nor between completing vs. attrition participants.

Expectancy/credibility

No significant Time × Condition interaction was found [expectancy, $F(1,40)=0.564$, $P=.73$; credibility, $F(1,40)=0.055$, $P=.82$]. There was no significant difference in how skilled participants felt [$t(1,40)=-0.664$, $P=.51$] or the amount of home practice over the 3-week period [mean number of home practices per week: mindfulness=3.81 and GVI=3.71; $t(1,40)=0.182$, $P=.86$].

Pain tolerance, mood, and physiological activity

The descriptive statistics for study variables are presented in Table 1. Analysis of variance (ANOVA) assumptions were tested and met. Repeated-measures ANOVA (Table 2) indicated a significant main effect of time on both pain intensity and hand submersion time; pain intensity significantly decreased, and hand submersion time significantly increased, from pre- to posttesting. As predicted, there was a

significant Time × Condition interaction for pain intensity and hand submersion time. Bonferroni-adjusted simple comparisons indicated that these changes from pre- to posttesting were significant for participants in the mindfulness condition ($P<.001$, and $P<.005$, respectively), but not for participants in the GVI condition ($P=.36$ and $P=.92$). There were no main effects or interactions on mood scores, SBP, or pulse, but the effect of time on DBP approached significance; DBP decreased from pre- to posttesting for participants in both conditions.

Mindfulness skill

There was a significant main effect of time on mindfulness scores, and the predicted Condition × Time interaction approached significance (Table 2). Simple comparisons indicated that mindfulness scores significantly increased for mindfulness-trained participants only ($P<.005$). However, Pearson product moment correlations showed that change in mindfulness skills was not related to change in pain intensity ($r=.099$, $P=.532$), change in pain tolerance ($r=.037$, $P=.816$), or change in DBP ($r=.093$, $P=.559$).

Table 2
Repeated-measures ANOVA for outcome measures

Source of variation	Main effect of condition			Main effect of time			Time × Condition interaction		
	SS	F	P	SS	F	P	SS	F	P
Pain intensity	0.107	0.024	.879	5.253	10.924	.002	2.012	4.183	.047
Submersion time	231.401	0.079	.781	1096.011	5.032	.030	959.511	4.405	.042
Mean SBP	4.762	0.026	.872	23.053	0.654	.423	1.910	0.054	.817
Mean DBP	119.841	1.148	.290	108.952	3.892	.055	4.001	0.143	.707
Mean pulse	82.012	0.405	.528	0.224	0.002	.961	30.960	0.342	.562
Positive affect	0.274	0.518	.476	0.190	1.154	.289	0.058	0.349	.558
Negative affect	1.658	1.752	.193	0.252	1.187	.282	0.002	0.009	.925
KIMS	0.105	0.753	.391	0.345	5.894	.020	.216	3.680	.062

$df=1,40$. Mean square is equivalent to sums of squares (SS) as there is only 1 df .

Discussion

Consistent with previous research, pain tolerance (submersion time and pain intensity) significantly improved for mindfulness-trained participants only. However, contrary to prediction, this was not related to the acquisition of mindfulness skills. Two possible interpretations are considered. It is possible that improved pain tolerance is nothing more than an artifact of experimental confounds such as varying intervention duration and trainer contact. Alternatively, it could be that the Kentucky Inventory of Mindfulness Skills, which was devised for borderline personality-disordered patients undergoing dialectical behavioral therapy, was not a suitable measure. Mindfulness is a multifaceted concept [17], and researchers may need to select from extant measures the one most suited to purpose.

Contrary to prediction, mindfulness training did not affect mood, pulse, or SBP. Strong trends suggested that both interventions decreased DBP, but this was also unrelated to mindfulness skill acquisition. This finding could be attributed to slower and deeper breathing control, which may have been a by-product of both interventions, and which has been shown to decrease BP in hypertensive patients [18]. Alternatively, this finding may be attributable to adaptation to the laboratory environment.

Conclusions from the current research are tentative. Limitations include varying intervention duration and number of group facilitators, and the potential for response bias on subjective measures. However, the findings complement a growing field of research that associates mindfulness and acceptance-based strategies with effective pain management. Future research should aim to articulate this relationship using controlled research trials, charting processes of change at more regular intervals, with longer intervention duration and with follow-up assessments.

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