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ORIGINAL PAPER

The Effect of a Short Mindfulness Meditation on Somatosensory Attention

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Abstract

Objectives Mindfulness training has been theorised to have beneficial effects on mental health through initially changes in attention mechanisms. The aim of the present study was to assess the impact of a short mindfulness meditation on the P300 event-related potential (ERP), a neural marker of attention, in meditation-naïve participants.

Methods As mindfulness practice is based on monitoring bodily sensations and breathing, we applied somatosensory stimuli to investigate attention changes. We employed an oddball paradigm with frequent tactile stimuli delivered to the tip of the index finger and infrequent stimuli to the base of the index and the little finger of the right hand to elicit the somatosensory P300. Forty-six participants counted the infrequent stimuli in two separate sessions before and after a 10-min guided meditation, or a control audio clip. We also measured participants' trait mindfulness (FFMQ) and anxiety (STAI-T) to ensure similar levels in the meditation and control group prior to the intervention.

Results In line with previous research, we show decreased somatosensory P300 amplitudes to infrequent tactile target stimuli after compared to before the audio clip in the control group. Such a decrease in P300 amplitudes was not present in the mindfulness meditation group as confirmed in a significant group by time interaction.

Conclusions Even a short mindfulness meditation leads to preservation of attention resources in meditation-naïve participants. The preservation (or lack of habituation) of the amplitude of the somatosensory P300 across repeated presentations may reflect the underlying, early neural mechanism by which mindfulness meditation training modulates executive attention.

Trial Registration Open Science Framework: https://osf.io/pkxm3.

Keywords Mindfulness · Somatosensory · Attention · Oddball · P300 · ERP

Mindfulness practice can bring benefits to several aspects in life, such as education (Mrazek et al., 2013), and work (Dane & Brummel, 2013). Moreover, mindfulness-based therapies have gained credibility as wellbeing-enhancing practices and as treatments for numerous neuropsychological conditions (Didonna, 2009; Lovas & Schuman-Olivier, 2018; Maxwell & Duff, 2016). Mindfulness practices consist of exercises heightening awareness for the recognition of rising mental events at the current moment without elaborating the experience by discursive thoughts. It is often practised by orienting attention on bodily sensations of each region of the body or sustaining attention on breathing. Once a current sensory experience is acknowledged, attention is directed back to newer, present moment experiences. This continuous attention switching prevents further elaboration of passing experiences; thus, it may also function as cognitive inhibition (Bishop et al., 2004) and allows for sustained focus on the current goal.

It is assumed that the regular practice of sustaining attention on the present moment can improve attentional control capacity and enable heightened awareness (Chiesa et al., 2011; Lutz et al., 2008). Such awareness may deter automatic reasoning and may lead to metacognitive insight, which is the realisation that thoughts are simply mental events rather than the representations of reality. This insight aids the practitioner in decentering the self from the content of consciousness and also prevents elaborative negative thought processing (Kang et al., 2013).

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Mindfulness practices gradually enable the practitioner to orient towards experiences and stimuli in the field of awareness with acceptance and a non-judging perspective (Kang et al., 2013; Shapiro et al., 2006). This special way of orientating towards experiences is as fundamental in the concept of mindfulness as the attentional set which it is based on. However, empirical results are not consistent regarding the improvement of attentional functions caused by mindfulness despite being a fundamental building axiom of its working mechanism (e.g. Chiesa et al., 2011 for review).

The inconsistency in findings whether attentional functions are changed by mindful practises might be due to differences in definitions of mindfulness practice, the high variety of techniques employed, the context of the practice, the level of experience of participants, and the type of attention investigated (Incagli et al., 2020; Leonard et al., 2013; Quickel et al., 2014; Tang et al., 2007; van den Hurk et al., 2010; Zeidan et al., 2010). Furthermore, changes in attention and associated brain functions may not be linearly related to the duration and intensity of mindfulness training with possibly greater changes seen during an earlier phase of mindfulness skill development including even brief introductory mindfulness meditations (Lutz et al., 2008).

A recent meta-study has shown that even a short mindfulness training can modestly reduce negative affectivity (Schumer et al., 2018); yet, the underlying mechanisms for this change are not clear. Indication that changes in attention may be a possible mechanism comes from studies showing a reduction of habitual responding on the Stroop task after a 20-min (Wenk-Sormaz, 2005) and a reduction of attentional bias towards emotionally negative information after a 15-min (Wu et al., 2019) mindfulness meditation.

The P300 event-related potential (ERP) is a neurophysiological marker of attention (Polich, 2012). The P300 is a positive deflection that reaches its peak amplitude approximately 300 ms post-stimulus (Picton, 1992). The distribution of the P300 is symmetrical and broad over the scalp, the amplitude tends to be the highest over the midline at the centro-parietal region (Wood et al., 1980). The P300 is known to be highly dependent on expectancy; thus, employing the classical oddball paradigm—which consists of the presentation of frequently occurring non-target and randomly intermixed, infrequent target stimuli (also called oddballs)—is a reliable trigger. The P300 is most pronounced when participants attend to the targets/oddballs (Luck, 2014) and mirrors the changes in attentional resources when it is produced over a period of time (Polich & Kok, 1995).

Kida et al. (2012) showed a decrease in the somatosensory P300 with increased block number. Such a decrease has been suggested to reflect the task becoming 'too easy' or not demanding enough with the participant's mind starting to wander (Picton, 1992). Similarly, P300 amplitudes have been shown to reflect attention and resource allocation in line with task demands and work load; for example, studies on dual-task performance (Isreal et al., 1980; Wickens et al., 1983) have shown that P300 amplitudes elicited in a secondary task are decreased with increased task difficulty of the primary task, while increases in task demands in single tasks have been shown to increase P300 amplitudes (Horst et al., 1984; Wickens et al., 1977). Therefore, these studies support the notion that task repetition may lead to a depletion of attentional resources on the task with attention being diverted away from the task. In contrast, mindfulness meditation can improve attentional control capacity and redirect attention to the current task (Chiesa et al., 2011).

The few studies that investigated the relationship between the P300 and mindfulness, have shown enhanced P300 amplitudes (Atchley et al., 2016; Delgado-Pastor et al., 2013; Telles et al., 2018; but see Payne et al., 2020) or changes in P300 topography (Wang et al., 2020) in mindfulness meditation experts. Enhanced P300 amplitudes have also been reported in meditation-naïve participants after a 6-min meditation induction (Lakey et al., 2011). However, the latter study employed only a small sample ($n=9$ per meditation and control group) and lacked any baseline/pre-meditation measures to confirm that the group differences reported were due merely to the mindfulness intervention. The abovementioned P300 mindfulness studies all used either visual or auditory stimuli, but as mindfulness practice requires attention towards bodily sensations, the examination of its effect on somatosensory attention might be more sensitive (c.f. Kerr et al., 2013).

The aim of the present study was to replicate the task repetition effect on the somatosensory P300 and investigating the effect of a short mindfulness meditation on the P300 component. We hypothesised that after a short mindfulness meditation task repetition will not lead to a reduction of the P300 component.

Methods

Participants

Fifty paid volunteers (20 females, 30 males) participated in the study, ranging in age between 19 and 58 years ($M=30.3$ years). Four participants were left-handed. They were recruited at City, University of London, through the Psychology Department's research participation management software (Sona System, Ltd.) and were a mix of university students, staff and people from the local community. None of the participants had practised mindfulness meditation or yoga regularly and none of them had participated in formal mindfulness training before the experiment. We originally planned to recruit 60 participants; however, due to time constraints of the research students involved in the study, we ended recruitment earlier. All participants gave written informed consent before participation. Four participants did not complete the experiment and the data of 8 participants was excluded from analysis due to low trial numbers after EEG artifact rejection.

Procedure

At the start of the study, participants completed the short form of the Five Facet Mindfulness Questionnaire (FFMQ) and the trait half of the State Trait Anxiety Inventory (STAI-T), which assess mindfulness and anxiety traits (Gu et al., 2016 and Spielberger et al., 1983, respectively). In addition, we measured participants' interoceptive abilities; we assessed body awareness by use of the short form of the body perception questionnaire (Porges, 1993), and interoceptive accuracy (see details below) through the peak flow test (Murphy et al., 2018) and the heartbeat counting task (Schandry, 1981). EEG electrodes, imbedded in an elastic cap, were placed on the participants' heads. Standard impedance reduction techniques (applying alcohol to degrease the skin including mechanical abrasion of the scalp and parting of the hair below the electrodes) were employed to reduce impedances below, at least, 10kOhm, and conductive gel was applied under each of the 64 active electrodes (Easycap GmbH).

For the experimental task, participants sat in a dimly lit, acoustically and electrically shielded room at a table with a monitor placed approximately 60 cm away from the participant. Three small 12 V solenoid mechanical tactile stimulators were used to deliver painless 10-ms taps to participants' right hand by popping a metal rod with a blunt conical tip onto their skin. The right hand rested in a comfortable position on the mechanical tactile stimulators, which were imbedded in plastic foam. One stimulator was placed under the tip of the participants' index finger (standard), one under the base of their index finger (oddball1) and the third one under the tip of their little finger (oddball2).

Participants were instructed to count the oddballs, regardless of location, and ignore the more frequent standard stimuli. They were asked to stay still and fixate on a white cross in the middle of a black computer screen. White noise (approximately 60db) was played throughout the task to mask any sounds made by the tactile stimulators.

Prior to starting the first oddball task, participants were presented with 31 trials to familiarise them with the oddball task and the tactile stimulation. The inter-stimulus interval between successive taps was 600 ms. The oddball task consisted of 1000 trials in total with a short break after half of the stimuli. The ratio between the non-target and the target stimulations was 80:20 with an equal amount of target stimuli at both oddball locations. The order of the tactile stimulations was pseudo-randomised: at least two standard stimulations occurred between oddballs. At the end of the task, a message box appeared on the screen, asking the participants to report how many oddballs they had counted.

Participants were randomly assigned to either meditation or control group. After completing the first oddball task, the meditation group was instructed to listen and engage in a 10-min-long audio clip, which contained a breathing meditation (Kabat-Zinn, 2017). The control group listened to a 10-min-long educative, fast-spoken audio clip on philosophy (CrashCourse, 2016). After participants listened to the recording with the monitor switched off, the oddball task was repeated by both groups. As the participants had to perform the task twice, they counted tactile oddball stimuli for 20 min in total.

Measures

EEG Recording Continuous EEG was recorded unfiltered during the oddball tasks from 60 equidistant scalp electrode sites with a right earlobe reference electrode plus two electrodes at the outer canthi of the eyes (i.e. HEOG) and one electrode on the left earlobe (M10 layout, Easycap GmbH). The EEG was amplified (BrainProducts GmbH) and digitised at 500 Hz. Off-line EEG analysis of the waveforms was performed using Vision Analyzer 2 software (BrainProducts GmbH), firstly applying a low pass filter of 30 Hz before re-referencing waveforms at all electrodes against the averaged signal of the right and left earlobes (e.g. Forster et al., 2016). To generate somatosensory ERPs, EEG and HEOG were epoched into periods from 100 ms before to 500 ms after the onset of tactile stimuli. Trials with eye movements (HEOG exceeding ± 60 µV relative to the 100-ms pre-stimulus baseline), blinks or other artifacts measured in this interval (voltage exceeding ± 80 µV at any electrode relative to baseline) were excluded from analysis (Forster et al., 2016). Participants' data with 30 trials or lower after artifact rejection in any of the conditions were excluded from further analyses.

ERPs elicited in response to tactile oddball stimuli were averaged separately for the oddball tasks before and after the mindfulness and control tasks. Based on prior research, statistical analysis was then conducted for 5 separate electrode sites along the midline (Fz, FCz, Cz, CPz, Pz) (Cohen et al., 1996; Herbert et al., 2007; Picton, 1992) using amplitude averages for the 250–500-ms time window post-stimulus (Cohen et al., 1996; Lei et al., 2019; Pollatos et al., 2005). Since the location of the oddball stimuli was not relevant to the hypotheses, the ERPs elicited by stimuli from the tip of the little finger and base of the index finger were averaged for the analysis. The oddballs generated a clear positive P300 component. Averaged across all participants for the first oddball task, this showed a centro-parietal maximal P300 peak ($M = 6.85$, $SD = 3.16$) with a mean latency of 362 ms (scalp distribution of amplitude: Pz < CPz > Cz > Fcz > Fz;

see Fig. 1). Peak latency was determined by use of the peak detection transformation in Brain Vision Analyzer 2.

Interoceptive Measures (a) Peak flow test: participants were first required to perform a large exhalation into a peak flow metre. This first exhalation was taken as their standard (100%). They were then given a target exhalation of 30%, 50%, 70%, or 90% of the first exhalation, with the order of targets randomised. Participants could not see the measurement gauge while performing the task. For each trial, absolute error scores (absolute [(actual second exhalation as a percentage of the standard—participant's estimate)/actual second exhalation as a percentage of the standard]) were computed and for each participant mean error scores were calculated. (b) Heartbeat counting task: for this task, an EEG electrode was placed on their chest to record participants' heartbeat. Participants were instructed to look at the fixation cross on the monitor in front of them and count their heartbeats, without feeling their pulse, when the cross turned from red to green for four randomly intermixed intervals of 20, 35, 45 and 100 s. At the end of each interval, participants were asked to state the number of heartbeats. Brain Vision Analyzer 2 EKG detection macro was applied to the ECG trace recorded to identify R-peaks for each counting interval. Three participants had to be excluded as no R-peaks were detected. Heartbeat counting accuracy was then calculated based on the number of counted (HBc) and recorded (HBr) heartbeats per interval with the following formula: $1/4\sum(1-|HBr-HBc|/HBr)$.

Data Analyses

Measurements Taken Prior to the Short Interventions First, we calculated participants' personality trait levels and their interoception abilities. Pearson correlations were conducted to explore the relationships between these personality trait measures (STAI-T and FFMQ and facets of the FFMQ) regardless of which intervention group they were allocated to. In addition, Pearson correlations were also conducted to explore the relationship between the STAI-T and the FFMQ scores (including facets of the FFMQ) and interoception measures, and sustained oddball accuracy and P300 amplitudes. Significance levels for these explorative analyses were not adjusted for multiple comparisons.

The Impact of a Short Mindfulness Meditation on the P300 Firstly, to ensure there were no differences between control and meditation group in trait mindfulness (FFMQ scores including its facets) and anxiety (STAI-T scores), independent *t* tests were conducted. Secondly, to investigate our main hypothesis on the impact of the short interventions on P300 amplitudes, mean P300 amplitude data was subjected to a three-factor repeated measures analysis of variance (ANOVA) with group (mindfulness, control) as the between-subject factor, and time (pre, post) and electrodes (Fz, FCz, Cz, CPz, Pz) as the within-subject factors. To follow up the group by time interaction, mean amplitudes were averaged across electrodes and subjected separately to (a) paired *t* test for each group, and, in addition (b), they were also submitted separately to Welch *t* tests (as Levenes' test suggested the violation of equal variances assumption) for each measurement time point to contrast any group differences before and after the interventions. To account for multiple follow-up comparisons, significance levels for these *t* tests were Bonferroni adjusted (i.e. $p < 0.0125$). Thirdly, to explore whether mindfulness meditation influenced the latency of the P300, a three-way ANOVA was conducted

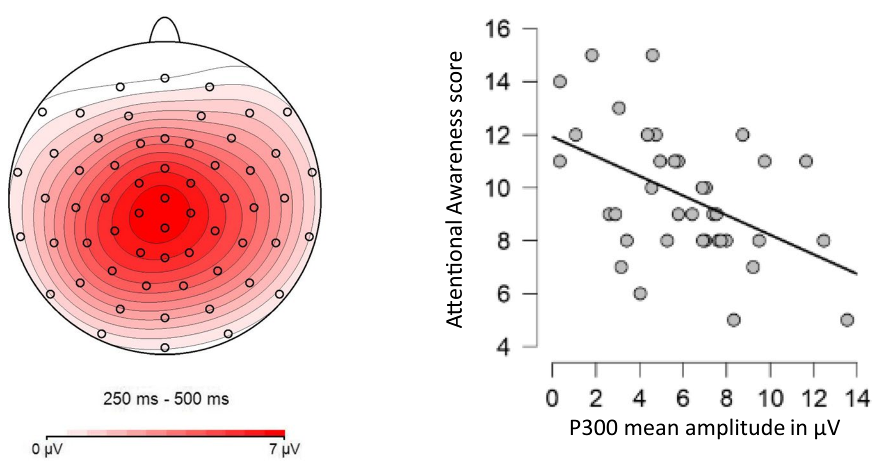

Fig. 1 The averaged P300 amplitude distribution and its relationship with the FFMQ attentional awareness score prior to the intervention tasks. Left panel: showing the topographic map of the somatosensory P300 component, that is the mean amplitude in the 250–500-ms time window after onset of tactile oddballs; right panel: showing a scatterplot of the mean P300 amplitude at electrode CPz and the attentional awareness score of the FFMQ for each participant (grey circles), also including a trendline representing the strength of the correlation

with the same factors as for the P300 mean amplitude analysis. Finally, we also explored whether there were any group differences in the oddball counting accuracy, an ANOVA was conducted with the within-subject factor time (pre, post) and between-subject factor group (mindfulness, control).

Results

Measurements Taken Prior to the Short Interventions

The overall average of participants' trait anxiety level (STAI-T score; M = 39.3 SD = 10.5) was comparable to the average working adult population (Spielberger et al., 1983). Likewise, the mean FFMQ score (M = 50.7 SD = 6.6) and the mean of the scores of the FFMQ subscales were aligned with the non-mindfulness-trained population (Gu et al., 2016). There was a significant negative correlation between the STAI-T and FFMQ (r(38) = −0.51, $p = 0.001$), indicating that more mindful people are less anxious and vice-versa. The negative association was the most prominent between STAI-T and the FFMQ 'Acting with awareness' subscale (r(38) = −0.56, $p < 0.001$), and between STAI-T and the FFMQ 'Non-judging' subscale FFMQ (r(38) = −0.48, $p < 0.001$), while the correlation did not reach significant level between the STAI-T and other FFMQ subscales. Therefore, the mindfulness facets of 'acting with awareness' and 'non-judging' of experiences seem to be the most opposing anxiety levels.

Participants scored on average 61.53 (SD = 23.47) on the body awareness scale of the Body Perception questionnaire, and their average interoceptive accuracy on the heartbeat counting and respiratory task was 35.2 (SD = 0.18) and − 14.3 (SD = 0.29), respectively. There was no significant correlation between any of the interoceptive and personality trait measures.

Participants performed almost at ceiling in counting the oddballs in the first oddball task (M = 91.2; SD = 1.91). Correlations between the behavioural performance and P300 amplitudes in the first oddball task and personality traits showed only a significant negative correlation between the FFMQ 'acting with awareness' subscale and P300 amplitudes ($r = -0.42$, $p = 0.009$; see Fig. 1); this reflects that participants scoring higher on the acting with awareness FFMQ subscale had lower P300 amplitudes and vice versa.

The Effect of a Short Mindfulness Meditation on the P300

Firstly, we ensured that there were no differences between control and meditation group in trait mindfulness (FFMQ: $t(36) = 1.21$; $p = 0.23$; $d = 0.40$) and anxiety levels (STAI-T: $t(36) = 1.19$; $p = 0.24$; $d = -0.40$). Secondly, we proceeded with the analysis of mean P300 amplitudes. This analysis yielded no significant main group effect ($F(1,36) < 0.01$; $p = 0.99$; $\eta^2 < 0.01$), but significant main effects of time ($F(1,36) = 18.29$, $p < 0.001$, $\eta^2 = 0.34$) and electrode ($F(4,144) = 29.72$, $p < 0.001$, $\eta^2 = 0.45$), and importantly, a significant interaction of time and group ($F(1,36) = 4.75$, $p = 0.036$, $\eta^2 = 0.12$. Because Mauchley's test of sphericity was significant, results are reported based on the Greenhouse–Geisser correction. We followed up the significant group by time interaction in two ways; (a) the follow-up separate by group confirmed a significant decrease in P300 amplitudes to oddballs from before the listening task (M = 6.08, SD = 1.73) compared to after (M = 4.41, SD = 2.11) in the control group ($t(16) = 4.22$, $p < 0.001$; $d = 1.02$). In contrast, in the mindfulness group, paired t test showed no significant difference of P300 amplitudes before ($M = 5.55$, SD = 3.08) compared to after mindfulness meditation ($M = 5.00$, SD = 2.37) ($t(20) = 1.59$, $p = 0.126$; $d = 0.35$). For the follow-up (b) contrasting groups, Welsh two-sample t tests were conducted. These did not show significant group differences in P300 amplitudes before ($t(32.47) = -0.67$, $p = 0.507$; $d = -0.21$), or after the interventions ($t(35.64) = 0.82$, $p = 0.417$; $d = 0.26$). Figure 2 shows the ERP waveforms separately for the two groups.

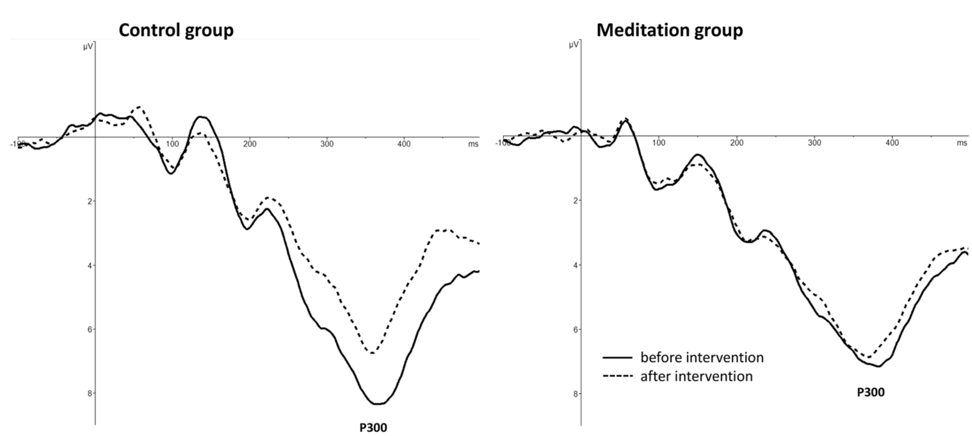

Fig. 2 Somatosensory ERPs averaged across midline electrodes elicited by tactile oddballs before the intervention (solid lines) and after the intervention (dotted lines) separate for the control (left panel) and mindfulness meditation group (right panel)

In the mindfulness meditation group, ERPs in response to tactile oddballs are almost matching before and after listening to the brief mindfulness meditation. In contrast, there is a marked difference in the P300 amplitudes in the control group showing the expected decrease in amplitudes with oddball task repetition. Thirdly, analysis of the P300 latency showed no significant main effects or time by group interaction (all $F(1,36) < 0.1$, $p > 0.75$). Fourthly, analysis of the behavioural performance (counting of oddballs) for both the meditation and control group, increased from on average 91% correct before the interventions to 99% correct after the interventions ($F(1,36) = 433.09$, $p < 0.001$, $\eta^2 = 0.95$). There was no time and group interaction ($F(1,36) = 2.41$, $p = 0.129$, $\eta^2 = 0.01$) confirming that counting accuracy similarly increased in both groups post-intervention. This latter result may reflect a general learning effect due to task repetition.

Discussion

Mindfulness meditation has been shown to have several positive cognitive outcomes, which are reflected not only in behavioural performance (Chiesa et al., 2011; Sauer et al., 2013) but some studies have also shown changes to the underlying neural networks (Marchand, 2014; Vignaud et al., 2018). While most studies have focused on changes in long-term meditators or meditators having undergone mindfulness training for several weeks or months, little is known about the effects of brief mindfulness meditation in novices. Moreover, it has been argued that changes in attention may already be present with brief mindfulness meditations (Lutz et al., 2008).

In line with this notion, we found that in meditation-naïve participants, a short mindfulness meditation protects from the attenuation of the somatosensory P300 seen with task repetition (Datta et al., 2007; Kida et al., 2012; Lammers & Badia, 1989; Nakata et al., 2015). This suggests that even a short mindfulness meditation prevents the depletion of attentional resources on the task. In the current study, participants were asked to count infrequent tactile oddballs presented to locations different from the frequent touch location. This task was monotonous and easy, as reflected in participants' near ceiling oddball counting performance. The P300 has been suggested as a marker of boredom and waning attention (Datta et al., 2007; Picton, 1992); likewise, we found a significant decrease in the somatosensory P300 amplitude with task repetition in the control group suggesting that participants could not keep their attention on the oddballs and their mind wandered away from the task. In contrast, a short mindfulness meditation protected against the diversion of attention from the task as reflected in stable P300 amplitudes despite task repetition. This finding of reduced habituation seen on a neural level is in line with reduction of habitual responding reported on a behavioural level (Wenk-Sormaz, 2005).

The task in the current study (silent oddball counting) did not probe habitual responding which may explain a lack of group differentiation on a behavioural level. We even found improved counting performance in both groups when doing the task for the second time, possibly reflecting general task repetition effects. Nevertheless, the expected attenuation of somatosensory P300 amplitudes with task repetition in the control group does suggest a habituation effect with attention being diverted away from the task (Isreal et al., 1980; Wickens et al., 1983). Such an effect was absent in the mindfulness meditation group which may indicate changes in attention mechanisms, or, alternatively, no change but a preservation of attention mechanisms against such habituation effects. Yet, this effect on attention mechanisms in meditation-naïve participants may be the steppingstone to benefits seen in a wide range of cognitive functions with more longer-term practice (Chiesa et al., 2011; Lutz et al., 2008).

In addition to investigating the effect of a short mindfulness meditation on the P300 in response to task repetition, we also explored the relationship between the P300 of the first oddball task and self-reported trait mindfulness and anxiety prior to the mindfulness meditation intervention. Trait mindfulness was measured using the Five Facet Mindfulness Questionnaire including five subscales capturing the different facets of mindfulness (Baer et al., 2006), and trait anxiety was measured using the State Trait Anxiety Inventory (Spielberger et al., 1983). In line with previous research (Deng et al., 2011; Walsh et al., 2009), self-report measures were negatively correlated. Moreover, further explorative analyses showed that the acting with awareness subscale of the FFMQ appears to be negatively correlated with P300 amplitudes in the first oddball task. This subscale measures the degree of attentional awareness to current activities. Therefore, our results suggest that meditation-naïve participants who show higher levels of attentional awareness have lower P300 amplitudes. In line with the notion that the P300 amplitude reflects attentional resource allocation, this suggests lower allocation of attentional resources in the oddball task.

The acting with awareness facet of the FFMQ is measuring a trait that manifests during everyday activities, by statements about habits with higher scores indicating awareness of less distractibility and daydreaming. Together with our finding of reduced P300 amplitudes, this may suggest that those participants require less attentional resources to focus on the task at hand as they get less distracted. Likewise, Bailey et al. (2020) have reported smaller P300 amplitudes concurrent with enhanced behavioural performance in a working memory task in experienced meditators arguing for greater neural efficiency in meditators. However, this recent study did not measure trait mindfulness, and other studies of experienced meditators have reported enhancement of the P300 component (Delgado-Pastor et al., 2013; Telles et al., 2018). Taken together, further research is required to elucidate the link between trait mindfulness, especially the acting with awareness subscale of the FFMQ, and its link to the P300 component in meditation-naïve and experienced meditators.

Most studies to date, investigating the effect of mindfulness on attention mechanism, have used either visual or auditory stimuli (Makowski et al., 2019; Sanger & Dorjee, 2016; Zeidan et al., 2010). In contrast, the current study assessed a short mindfulness meditation's neurophysiological effect in people with no mindfulness experience by testing somatosensory attention. We employed the somatosensory P300 elicited by tactile stimuli to the hand to reveal the impact of a short mindfulness intervention on attention. Mindfulness exercises usually involve the focusing on different aspects of the body, its sensations, and changes. Kerr et al. (2011) showed enhanced attentional regulation of alpha in primary somatosensory cortex after 8 weeks of mindfulness training. They further proposed that changes in attention induced by mindfulness interventions may be first visible in neural correlates of somatosensory attention (Kerr et al., 2013). Likewise, we found changes in somatosensory attention after a short mindfulness intervention.

Limitations and Future Research

In the current study we asked participants to focus on tactile stimulation delivered to their hands to investigate the effect of a short mindfulness meditation on attention. However, it is not clear whether the preservation of the P300 with task repetition is a general attention effect or specific to somatosensory attention. Future research may directly contrast the use of somatosensory and other modality (e.g. auditory or visual) stimuli to investigate which are more effective in revealing the effects of mindfulness on attention. If mindfulness initially starts with modulation of attention to the body (Kerr et al., 2013), changes to somatosensory attention should be found, as in the current study, after a short mindfulness intervention but no such modulation should be present for attention directed to other modalities.

Furthermore, in the current study both groups listened to an audio clip in between tasks with one group listening to a short mindfulness intervention instructing participants to focus their attention on bodily sensations of breathing while the other, control group listen to a fast-paced audio clip provoking thoughts about free will and inviting to imagine sceneries. To further disentangle effects of mindful attention from body-focused attention, future studies may employ body-centred exercises, like for example progressive muscle relaxation to be contrasted with the mindful meditation intervention. Therefore, if the preservation of the P300 with task repetition in the mindful meditation group, as shown in the current study, was merely due to an effect of mindfulness on somatosensory attention—and not body-focused attention—such an effect should be absent when participants engage in a purely body-centred exercise.

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Author Contribution OB: codesigned and executed the study, performed data analyses, and wrote the first draft of the manuscript. BF: supervised OB, codesigned the study, oversaw data collection and analyses, and wrote and edited the final manuscript.

Data Availability The data are available at Figshare 10.25383/city.20102876.

Declarations

Conflict of Interest The authors declare no competing interests.

Ethics Approval The study was approved by the Psychology Research Ethics Committee, School of Arts and Social Sciences, City, University of London (approval code: ETH1819-1050), in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Consent to Participate Written informed consent was obtained from all participants prior to participation in the study.

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