Meditation and Body Awareness: Lower prestimulus alpha activity in meditators modulates response bias in somatosensory signal detection task

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Introduction

Mindfulness is believed to alter mechanisms of body awareness and changes in interoception have been suggested as potential mechanisms for its salutary effect. However, findings relating mindfulness to measures of body awareness are scarce. Mirams et al. (2013) found an increase in accuracy in the widely used somatosensory signal detection task (SSDT) after body-scan meditation training. Kerr et al. (2011) suggest higher prestimulus alpha modulation in meditation practitioners after an 8-week meditation program. We have compared the somatosensory accuracy of regular meditators with regular readers in the SSDT with simultaneous EEG recording investigating prestimulus alpha activity.

Our main hypothesis was that meditators show increased accuracy within the SSDT indicating higher somatosensory accuracy, simultaneously expecting neural correlates of increased selective alpha modulation over the somatosensory cortex in meditators, measured through EEG.

Methods

Participants

64 participants either practising body-based meditation (*n* = 31, 12 women, 19 men; age: 25 - 57 years, mean = 34.71, SD = 7.21,) or reading (*n* = 33, 11 women, 22 men; age: 21 – 46 years, mean = 31.52, SD = 7.22) for at least 5h/week starting at least two years ago.

Materials

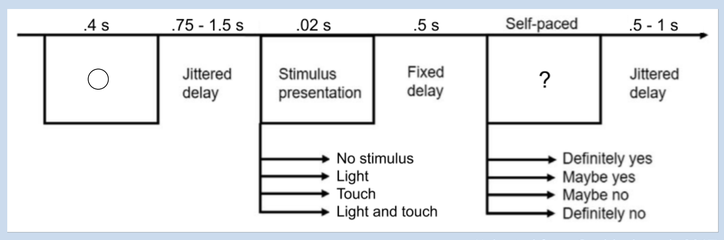
Online questionnaires: Mindfulness Attentional Awareness Scale (MAAS), Multidimensional Assessment of Interoceptive Awareness (MAIA-2), Patient Health Questionnaire somatic symptom severity scale (PHQ-15), Toronto Alexithymia Scale (TAS), Emotion Regulation Questionnaire (ERQ)

Apparatus:

The participant received electrical stimulation via two ring electrodes placed on the left index finger. Near-threshold electrical impulses with a duration of 0.3 ms were delivered through the DT-8912 (Data Translation®) waveform generator.

A 5 mm red light-emitting diode (LED) was fixed next to the left index finger and was illuminated for 20 ms. Simultaneously, EEG was recorded with 64 electrodes, EOG and ECT. Prestimulus alpha activity was investigated at 11Hz, 600-200ms before stimulus onset over contralateral S1 and central V1.

Procedure

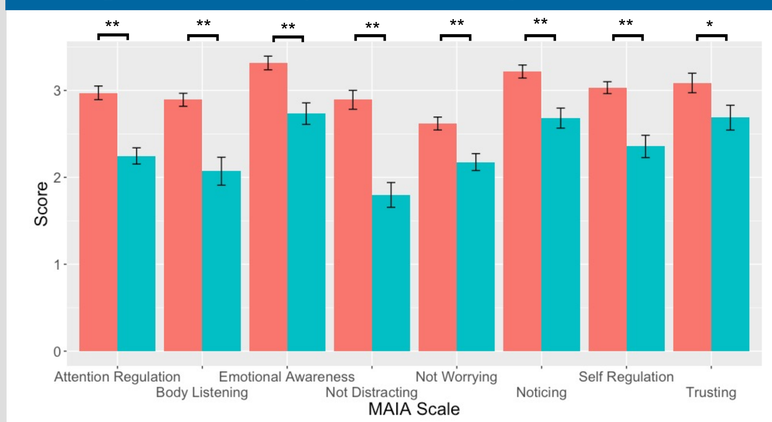


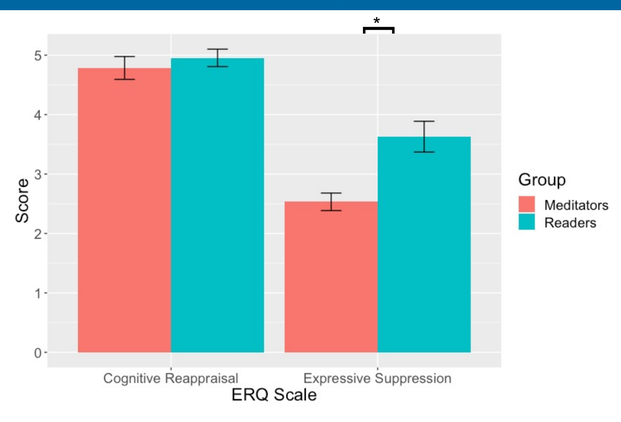
(Adopted from Craddock et al., 2017)

The trial began with a visual cue followed by a blank screen. In the event period, one of the four stimulus conditions (*no stimulus*, *light*, *touch*, or *light and touch*) was delivered followed by a fixed delay period before the onset of the response screen with a question mark. After a jittered delay period with a blank screen, the next trial started with the presentation of a fixation cue.

Results

1 Higher interocepive sensibility and lower emotional suppression in meditator group

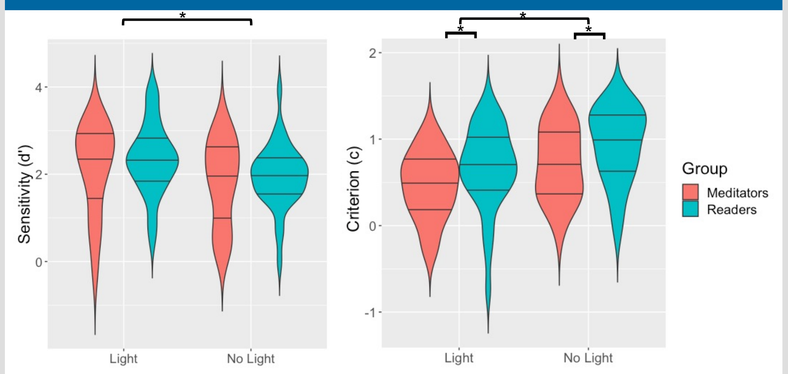




Significant difference between groups on all MAIA subscales reporting higher interoceptive sensibility. Lower reported expressive suppression in meditators. No sig. difference in MAAS, PHQ-15, and total TAS.

*: *p* < *.05, **:* p < .001 Error bars represent standard error of the mean

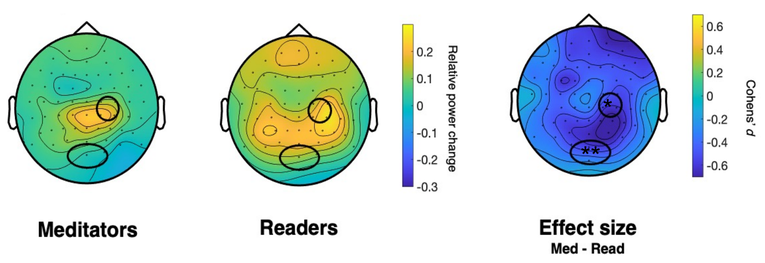
2 Lower signal detection criterion

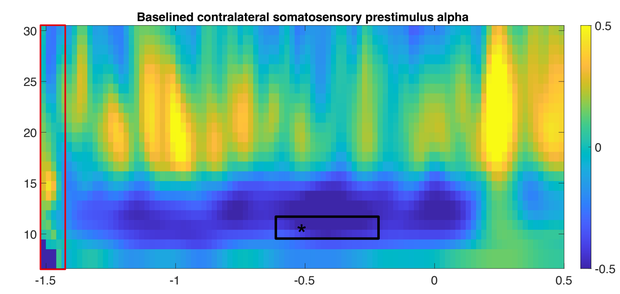


No significant difference in sensitivity (d') between groups, but significant difference in criterion (c).

*: *p* < .05, *Horizontal lines indicate median and inter-quartile ranges*

3 Group differences in prestimulus alpha

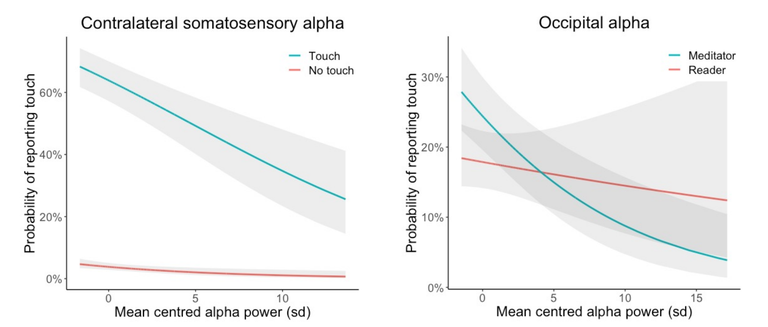




Significant difference between groups in prestimulus alpha activity. Left: Topoplots of baselined alpha power and difference in cohen's d over pre-defined regions of interest. Right: Time-frequency difference for baselined alpha over contralateral somatosensory ROI in cohen's d.

*: *p* < *.05, **:* p < .001 *Black circles and rectangles indicate pre-defined regions of interest, and red rectangle indicates baseline window*

4 Trial by trial prestimulus alpha analysis



Left: Contralateral prestimulus alpha power is significant predictor for reporting touch.

Right: Significant interaction between occipital prestimulus alpha and group on reporting touch was found.

Discussion

In self-report measures, higher interoceptive sensibility and lower emotional suppression were found in the meditator compared to the readers' group. No higher mindfulness was found on the MAAS scale. Instead of the expected group difference in accuracy in the SSDT, the criterion was lower in the meditator group. Lower prestimulus alpha in the meditator group was present over the somatosensory and the occipital region of interest. The trial-by-trial analysis revealed a negative relationship between prestimulus alpha and the probability of reporting touch over both regions of interest for both groups.

The negative relationship between lower alpha activity and report of touch provides a potential mechanism for the increase in response rate, hence the lowering of the criterion in meditators. Potential explanations for lower prestimulus alpha activity in meditators could be decreased mind-wandering (Arnau et al., 2020), decreased top-down predictions (Carhart-Harris & Friston, 2019) or higher attention regulation through alpha modulation (Kerr et al., 2011).

Conclusion

This study indicates that meditation practice alters body awareness as shown by higher self-reported interoceptive sensibility and lower prestimulus alpha activity, thereby potentially decreasing the filter function over the somatosensory cortex. Even though attention may be increased over the somatosensory cortex, an increase in sensitivity could not be found.

References

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