

Eyes open or eyes closed? A comparison to optimise future neurofeedback protocols including mindfulness-based meditation

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Introduction

Frontal Alpha Asymmetry (FAA) is an EEG-derived measure of the relative difference in alpha activity between the left and right frontal cortex, associated with approach–avoidance motivation and affective processing. Greater left frontal activity is linked to positive affect and greater right frontal activity to negative affect. Aiming to upregulate frontal alpha asymmetry (FAA), we designed an experimental paradigm combining mindfulness-based meditation with an auditory neurofeedback protocol. This approach was motivated by evidence indicating that mindfulness practice alone can increase FAA, suggesting that its integration with neurofeedback may facilitate successful FAA upregulation. A pilot study with experienced meditators revealed that achieving and maintaining a meditative state with eyes open is challenging while fixating on a cross displayed on the screen. Although meditation studies are conducted almost exclusively using eyes-closed designs, related meditation-based neurofeedback studies exhibit considerable heterogeneity in the visual modalities employed, and no consensus has emerged regarding which modality is most effective. Hence, we were aiming at comparing the subjective experience and FAA distribution of a group of experienced meditators while they meditate either with eyes open or closed. We hypothesized that participants will confirm the preference observed in the pilot sample (eyes closed) and demonstrate greater FAA upregulation relative to baseline in their preferred modality, potentially due to enhanced emotional immersion and reduced interference from the surrounding laboratory environment, thereby promoting more effective engagement with the mindfulness-based meditation intervention.

Methods

We recruited 34 healthy female meditators and asked them to: first listen to a pre-recorded introduction about mindfulness, then undergo an 8-minute resting-state baseline recording consisting of alternating eyes-open and eyes-closed periods and finally complete four identical 5-minute meditation blocks: two with eyes open and two with eyes closed. During the meditation blocks, the participants listened to an auditory recording derived from a meditation-based neurofeedback session of a participant from the previous pilot study. This was chosen to keep the sounds identical to the to-be-conducted study that will include FAA neurofeedback. The order of the meditation blocks was randomized. After each block, participants completed several questions assessing meditation depth and the "Mind" subscale of the German version of the State Mindfulness Scale for Physical Activity (SMS-PA). At the end of the session, participants took part in a brief interview during which they were asked to indicate whether they preferred one condition over the other and to explain their choice. EEG was recorded using 64 active electrodes. EEG data were initially bandpass-filtered between 1 and 70 Hz and continuous baseline and meditation recordings were segmented into 5-s epochs. The resulting epochs were then preprocessed and cleaned using GEDAI. Subsequently, the data were re-referenced using the current source density (CSD) transformation and bandpass-filtered between 1 and 40 Hz. Power spectral density (PSD) at electrodes F3 and F4 was estimated using Welch's method (Hamming window, 50% overlap), and alpha power was extracted and log-transformed. Frontal alpha asymmetry (FAA) was calculated as the difference between log-transformed alpha power at electrode site F4 (right frontal hemisphere) and electrode site F3 (left frontal hemisphere), i.e., $FAA = \log(F4) - \log(F3)$. Standardized alpha values were then derived from the 5-s epochs, and their distributions were visualized using box and strip plots.

Results

To date, 13 subjects were recorded. Preliminary examinations of the questionnaires and interviews support the suggested preference of eyes-closed condition. Further results are not reported in this abstract to not introduce a processing bias, but will be available and reported at the time of the conference.

Conclusions

Incorporating meditation into neurofeedback protocols may be a challenging task due to competing eyes-open – preferred in the neurofeedback context - and eyes-closed – preferred in the meditation context – conditions. Our study provides a rigorous comparison of meditation with eyes open and eyes closed, and will, thus, provide useful guidance for future neurofeedback research combining meditation with FAA upregulation or related neurophysiological markers sensitive to affective and motivational processes.