Altered Visual and Auditory Processing in Sunyata Meditation: A combined NIRS and EEG Experiment

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Introduction

The word meditation describes practices that self-regulate the body and mind. Sunyata (emptiness) meditation stems from the Buddhist philosophy that signifies the impermanent nature of form; meaning that objects in the world do not possess essential or enduring properties. Sunyata meditation practice is aimed to develop an ability to avoid discursive (wandering, long-winded) thought, and instead acquire insight into the nature of reality through direct perception of the internal (bodily) and external (sensory) states.

The present study, we conducted our experiments with fNIRS as it allows for noise-free measurements and upright, sitting position during meditation.

Methods

In the main study 8 participants with different extents of meditation experience (5-30 years) were measured using fMRI and in some sessions with simultaneous fMRI and EEG.

One of the meditators participated in this pilot experiment with combined NIRS (Hitachi ETG-6000, Hitachi Medical Co., Japan) and EEG (24 channel BrainAmp, Brain Products, Germany) measurement (for subsequent simultaneous NIRS/EEG measurements, cf. Ehlis et al., 2009).

Two configurations of the NIRS optode sets were used: a 3x11 array (52 channels) placed on the occipital pole for visual stimulation on a LED monitor and two 3x5 arrays (44 channels) incorporated in an EEG EASYCAP and covering parieto-frontal parts of the head for auditory stimulation with earphones.

Task design and stimuli:

The experimental protocol comprised 4 blocks of baseline involving normal day-to-day discursive thinking (duration=2min) that were alternated with 3 blocks of meditation (duration=3min).

The meditation methods were natural seeing with constant visual stimulation (same pictures for corresponding baseline and meditation blocks) and natural hearing with auditory stimulation (sound of singing bowl every 12s).

In addition to the tasks with continuous stimulation, 8 alternating shorter on-off blocks of 30s were used, both for continuous thinking (natural) and continuous meditation.

Data evaluation:

NIRS data were analysed with SPM5 and the NIRS_SPM toolbox (Ye et al., 2009), the EEG data with SPM8 and the FAST toolbox (Leclercq et al., 2010).

Results of NIRS analysis (see Fig. 1) show enhanced activation in meditation compared to normal thinking with continuous stimulation (1st row) in the primary visual areas (occipital cortex) and parietal regions, with a distinct left-lateralization. Switching stimulation on-off mainly activated the primary visual areas (2nd row, 3rd row) with additional activations in the parieto-lateral regions in the meditation task (3rd row).

A similar pattern of activation was found for auditory stimulation (see Fig. 2).

Questions:

- Is it possible to measure similar effects with fNIRS as with fMRI?
- Is a NIRS Experiment a more suitable environment for Meditation than fMRI?

Subjects:

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Conclusion

As in the previous study with fMRI measurement we found enhanced perception of external stimuli reflected by heightened activations in sensory areas.

Increased activation in parieto-lateral regions can be related to an enhancement of the self-conscious state.

EEG results consistently showed higher power in low frequency bands for meditation indicating a deeper relaxation in meditation state.

The subject reported a much more pleasant measurement environment and a more experienced meditators.

References: