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 experiment presented here is a continuation of our study described last year (Sitaram et al., 2010) investigating state changes in fMRI and EEG signals during Sunyata meditation.
In 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-4000, Hitachi Medical Co., Japan) and EEG (24 channel BrainAmp, Brain Products, Germany) measurement (for previous 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.

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 normal thinking and continuous meditation.

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:

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).

Figure 3 depicts spectra and power in frequency bands from EEG data analysis of the hearing experiments. The block experiment with constant stimulation shows enhanced power in the low frequency bands (delta, theta, alpha) while the participant was in a meditative state (peak at 8.25 Hz: 15 vs. 8.5; peak at 4 Hz: 4 vs. 2). The two runs were auditory stimulation was switched on and off every 30s resulted in an activation peak at 8.25 Hz with a higher value (12) in the meditation condition compared to that of the normal thinking condition (7). The direct stimulus effect is only visible in frequencies below 4 Hz. Here we found increased power in the periods without stimulation, which was again higher in the meditation run.

Conclusions:

As in the previous study with fMRI measurement we found enhanced perception of external stimuli reflected by heightened activations in sensory areas. The subject reported a much more pleasant measurement environment and a more familiar meditation position resulting in improved meditation.

Fig.1: Change of O2Hb concentration with visual tasks

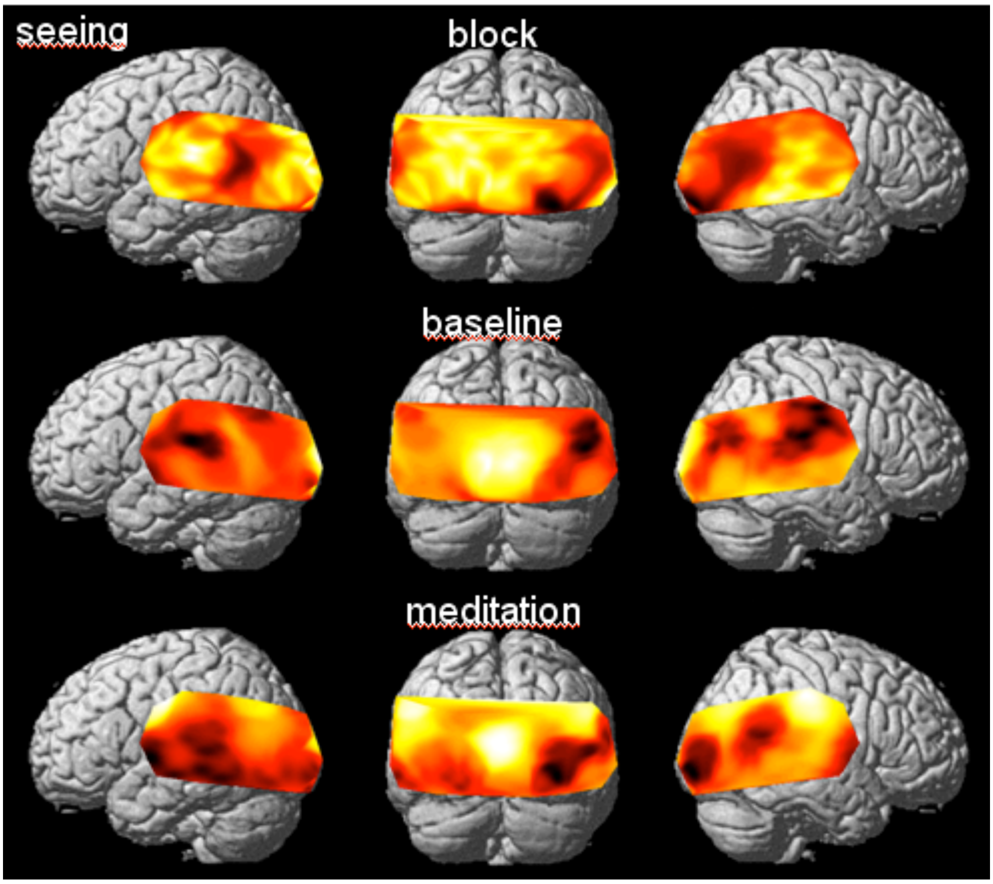
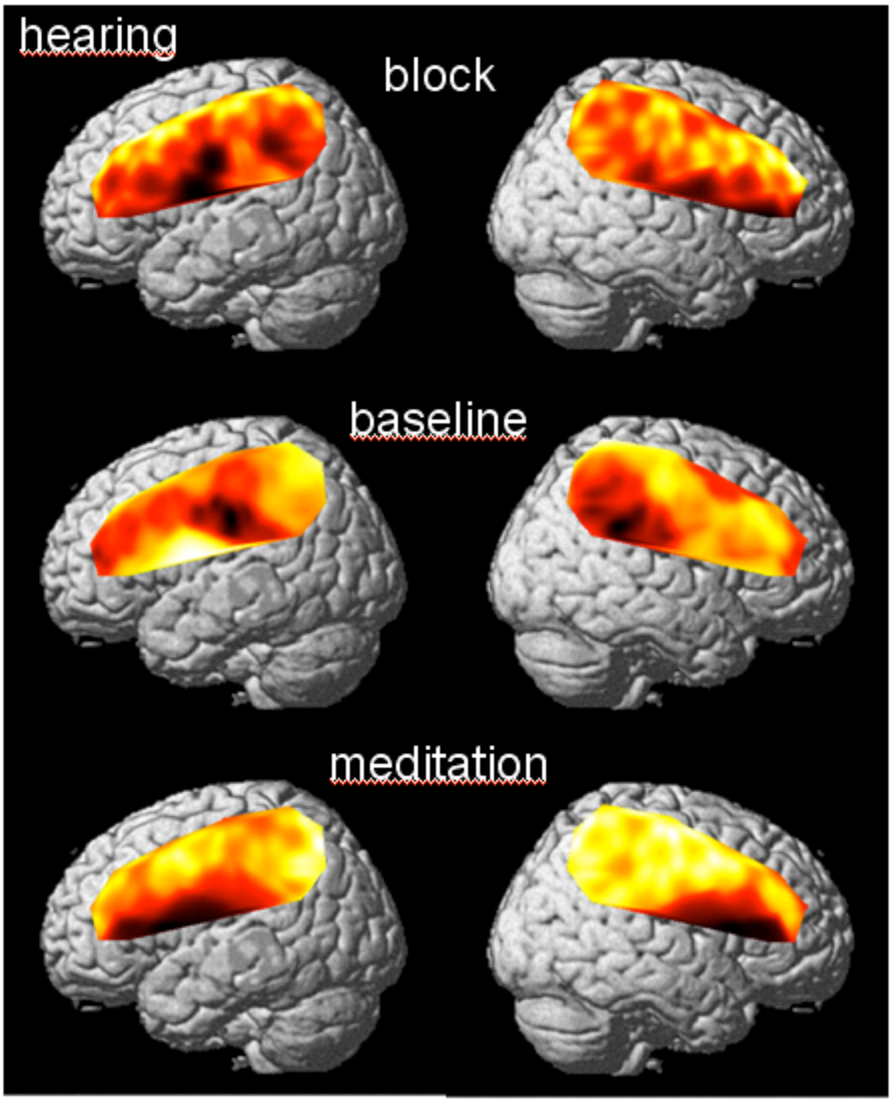
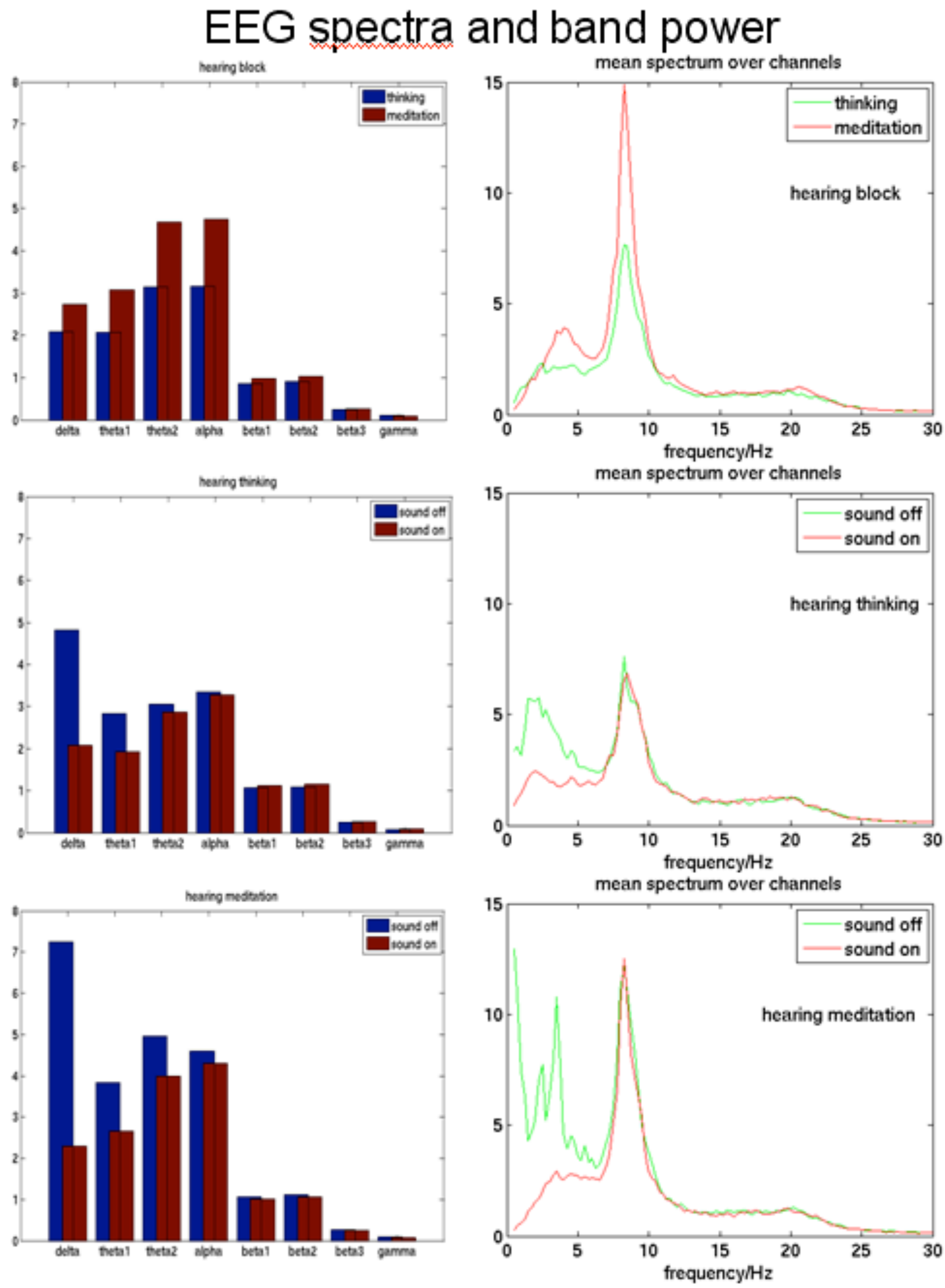


Fig.2: O2Hb change with auditory tasks





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Abstract Information

References

Ehlis, A.-C. (2009), ‘Cortical correlates of auditory sensory gating: A simultaneous near-infrared spectroscopy event-related potential study’, Neuroscience, vol. 159, pp. 1032-1043.

Leclercq, Y. (2010), ‘FAST - a “fMRI Artefact rejection and Sleep scoring Toolbox”’, OHBM Barcelona 2010, Poster 1321 WTh-AM. (http://www.montefiore.ulg.ac.be/~phillips/FAST.html)

Sitaram, R. (2010), ‘Neuroelectric and hemodynamic correlates of Sunyata meditation: a combined EEG and fMRI study’, OHBM Barcelona 2010, Poster 171 MT-AM. (http://ww3.aievolution.com/hbm1001/index.cfm?do=abs.viewAbs&abs=2598)

Ye, J.C. (2009), ‘NIRS_SPM: Statistical parametric mapping for near-infrared spectroscopy’, NeuroImage, vol. 44, pp. 428-447.