Klinik für Psychiatrie und Psychotherapie

Klinikdirektor: Prof. Dr. Peter Falkai

Research Festival

Long-term effects of placebo-controlled prefrontal EEG-neurofeedback training in healthy subjects

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Introduction

In this study we evaluated long-term effects of frontal beta EEG-neurofeedback training (E-NFT) in healthy subjects. We hypothesized that E-NFT can change frontal beta activity and that changes in frontal beta EEG activity are accompanied by altered cognitive performance changes.

Methods

19 healthy women and 6 healthy men participated in this study. Three participants dropped out during the study due to personal reasons. The subjects were randomly adjusted to a real E-NFT or a placebo E-NFT (control group). The real E-NFT group consisted of 10 subjects (7women, 3men, average age 19.7±2.6 years) and 12 subjects were in the placebo group (average age 21.08±3.85). Nine of the initial participants showed up for the voluntarily follow-up post-measurement2, three years post training sessions. EEG was recorded by means of a Deymed Truscan 32-channel system in combination with a 19-channel electrode cap before E-NFT (t1), post to the training sessions (t2) and 3-years after E-NFT (t3). Measurements conditions: Resting-state EEG with eyes closed (EC) and eyes open (EO). Cognitive performance was measured by use of a shortened version of the Groninger Intelligentie Test (GIT, Luteijn & Barelds 2004) combined with a digital version of 9 mazes, which are part of the digital testmanager 'Digoloog' (Engelbregt 2004). For E-NFT an average of respectively 14.3 and 13.2 training sessions were completed for experimental and control group. Each trainingsession took approximately 45 minutes, with Baseline EC and EO EEG measurements; training-protocol: increase 12-18 Hz at Fz-electrode, auditory and visual feedback was given if EEG activity was increased at Fz for at least 1second. Subjects in the control group were given the exact feedback of the neighbour subjects that underwent real E-NFT.

Results

Compared to the sham E-NFT, which was used for the control group, real E-NFT increased beta activity in a predictable way (post-measurement1 after NFB training, t2), see **Fig.1)** tables for Real Neurofeedback group and Sham Neurofeedback group and see **Fig. 2, 3** for source/surface visualization. However, regarding our sample of healthy subjects, E-NFT did not result in significantly improved cognitive performance, nor did we find evidence of long-term changes (for the post-measurement 2 after 3years, t3) in EEG.

Discussion

The main finding of the present study was an increase in cortical frontal beta activity after E-NFT. However, we found no evidence of a long-term effect on the basis of a follow-up measurement after three years. The reason therefore might be that only 40% underwent t3. Based on our results we conclude that EEG-NFT can selectively change EEG beta activity, at least in the short term. Past studies found beta EEG changes associated with attention and memory changes. The neuropsychological tests used here might insensitive to detect subtle changes as they only focused on global cognitive capabilities.

1

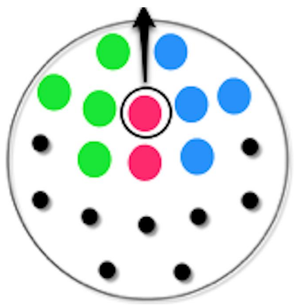
Real Neurofeedback group, Absolute Power (μV²), eyes closed compared to baseline condition, p-values

	Beta (12-25Hz)	High-Beta (25-30Hz)	Beta 1 (12-15Hz)	Beta 2 (15-18Hz)	Beta 3 (18-25Hz)
Left Hemisphere					
Fp1	0.051	0.063	**0.027***	0.067	0.078
F7	**0.026***	0.075	**0.048***	**0.007****	0.069
F3	0.788	0.718	0.394	0.656	0.912
C3	0.156	0.186	0.084	0.130	0.210
Central					
Fz	**0.013***	0.088	**0.007****	**0.010***	**0.037***
Cz	0.519	0.754	0.307	0.307	0.751
Right Hemisphere					
Fp2	**0.023***	**0.033***	**0.007****	**0.0013****	0.145
F8	0.130	0.419	**0.042***	0.168	0.369
F4	0.777	0.678	0.459	0.443	0.944
C4	0.105	0.104	**0.012***	**0.039***	0.391

Sham Neurofeedback group, Absolute Power (V²), eyes closed compared to baseline condition, p-values

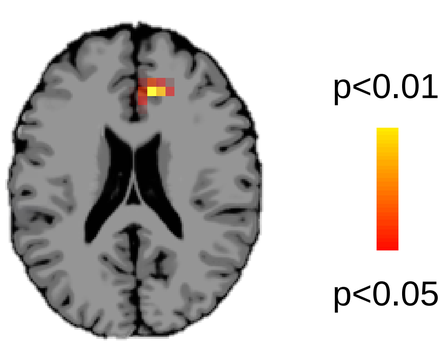
	Beta (12-25Hz)	High-Beta (25-30Hz)	Beta 1 (12-15Hz)	Beta 2 (15-18Hz)	Beta 3 (18-25Hz)
Left Hemisphere					
Fp1	0.345	0.508	0.284	0.259	0.412
F7	0.252	0.326	0.221	0.208	0.308
F3	0.362	0.904	0.481	0.190	0.508
C3	0.692	0.673	0.850	0.700	0.577
Central					
Fz	0.715	0.483	0.834	0.760	0.740
Cz	0.487	0.892	0.488	0.492	0.459
Right Hemisphere					
Fp2	0.224	0.426	0.160	0.186	0.244
F8	0.434	0.398	0.614	0.343	0.405
F4	0.842	0.396	0.700	0.869	0.244
C4	0.245	0.618	0.327	0.552	0.176

E-NF-Training:
Increase 12-18Hz at electrode Fz



2

Source localization post E-NFT (t2): Increased 12-30Hz current density after NFB training at the medial frontal cortex (BA9) and the abterior cingulate (BA 32, 24)



z=20

3

Cortical surfaces post E-NFT (t2)