

On the efficiency of individualized theta/beta ratio Neurofeedback combined with forehead EMG Training in ADHD Children

Olga M. Bazanova, Tibor Auer, Elena Sapina

Front. Hum. Neurosci. 2018

doi: 10.3389/fnhum.2018.00003

Background

Neurofeedback training (NFT) to decrease the theta/beta ratio (TBR) has been used for treating hyperactivity and impulsivity in attention deficit hyperactivity disorder (ADHD); however, often with low efficiency. Individual variance in EEG profile can confound NFT, because it may lead to influencing non-relevant activity, if ignored. More importantly, it may lead to influencing ADHD-related activities adversely, which may even result in worsening ADHD symptoms. Electromyogenic (EMG) signal resulted from forehead muscles can also explain the low efficiency of the NFT in ADHD from both practical and psychological point-of-view. The first aim of this study was to determine EEG and EMG biomarkers most related to the main ADHD characteristics, such as impulsivity and hyperactivity. The second aim was to confirm our hypothesis that the efficiency of the TBR NFT can be increased by individual adjustment of the frequency bands and simultaneous training on forehead muscle tension.

Methods

We recruited 94 children diagnosed with ADHD (ADHD) and 23 healthy controls (HC). All participants were male and aged between six and nine. Impulsivity and attention were assessed with Go/no-Go task and delayed gratification task, respectively; and 19-channel EEG and forehead EMG were recorded. Then, the ADHD group was randomly subdivided into (1) standard, (2) individualized, (3) individualized+EMG and (4) sham NFT (control) groups. The groups were compared based on TBR and EEG alpha activity, as well as hyperactivity and impulsivity three times: pre-NFT, post-NFT and six months after the NFT (follow-up).

Results

ADHD children were characterized with decreased individual alpha peak frequency, alpha bandwidth and alpha amplitude suppression magnitude, as well as with increased alpha1/alpha2 ($a1/a2$) ratio and scalp muscle tension when compared with healthy peers ($\eta^2 \geq 0.212$). All contingent TBR NFT groups exhibited significant NFT-related decrease in TBR not evident in the control group. Moreover, we detected a higher overall alpha activity in the individualized but not in the standard NFT group. Mixed MANOVA considering between-subject factor GROUP and within-subject factor TIME showed that the individualized+EMG group exhibited the highest level of clinical improvement, which was associated with increase in the individual alpha activity at the six months follow-up when comparing with