

Neurofeedback implementation in subjective attention deficits accompanied with depressive symptoms: a case study

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Background Neurofeedback is a brainwave biofeedback method (Hammond, 2011) relying on operant conditioning of bioelectrical neuroregulation (Butnik, 2005). In practice, neurofeedback introduces the development of self-control skills over EEG patterns deriving from self-regulation strategies and implementing this skill into daily life (Heinrich et al., 2007). Many neurofeedback studies have shown promising improvements in attentional processing (Egner and Gruzelier, 2004), cognitive performance (Hanslmayr et al., 2005; Vernon et al., 2003), sleep and memory (Berner et al., 2006; Hoedlmoser et al., 2008; Nan et al., 2012) as well as in depressive symptoms' alleviation (Dias and van Deusen, 2011; Hammond, 2005; Peniston and Kulkosky, 1991).

Objectives A 21-years old man referred to Northern Greece Neurofeedback Centre with complaints of self-reported attention deficits, daydreaming and depressive symptomatology, including poor sleep, and memory complaints. Neurofeedback training was used for symptoms' alleviation along with psychological counselling once a week.

Methods He completed a battery which included the following psychological tools for the assessment of attention (Wechsler Memory Scale, Digit symbol, Digit span, Trail A & B, TEA 6 and ROCFT) as well as the Beck Depression Inventory (BDI), the Beck Anxiety Inventory (BAI) and the scale of subjective memory complaints both before and after neurofeedback training. He completed 26 neurofeedback sessions including Theta/Beta, SMR and Alpha-Theta Training. During the training procedure, pre and post EEG recordings of 1,5 minutes have been made by Nexus-10 placing the active electrode to the Cz. All the training sessions were performed in Cz according to the International 10-20 system and with average frequency two times per week.

Results Non parametric Wilcoxon signed-rank test was used since mean amplitude of brain rhythms did not meet the normality assumption in order to detect possible differences in pre-post mean amplitude of EEG rhythms and ratios. The level of significance was set at .05. In eyes open resting-state, significant increase have been found in SMR ($z = -2.096$; $p = 0.036$) and Beta ($z = -3.328$; $p = 0.001$) mean amplitudes whereas marginal significant alteration was found in Theta ($z = -1.930$; $p = 0.054$). Furthermore, no significant differences were mentioned in Alpha rhythm ($z = -0.165$; $p = 0.869$) and Theta/Beta ratio ($z = -1.613$; $p = 0.107$). In eyes-closed resting-state, statistical analysis revealed significant increase in the mean amplitude of Theta ($z = -2.083$; $p = 0.037$), SMR ($z = -3.924$; $p = 0.000$), Beta ($z = -4.077$; $p = 0.000$) and Theta/Alpha ratio ($z = -3.061$; $p = 0.002$) whereas mean amplitude of Alpha rhythm decreased significantly ($z = -2.156$; $p = 0.031$). The analysis of the pre and post psychometric tests was performed by comparing their scores, which have been converted to z scores using the

following calculation [(raw score-mean score)/standard deviation], with their normative data (Benvenuti et al., 2011; Blanchard and Andrasik, 1987; Unterrainer et al., 2014). Specifically, we followed the current pattern to do the comparison [(pre-training - post-training)/pre-training]*100 (Benvenuti et al., 2011). According to the comparisons with the norms, we observed significant improvements within the normative data in general memory capacity, attention, executive function, and visual memory. Additionally, following the same analysis formula, the depressive symptomatology and the subjective memory complaints were significantly decreased. Finally, according to subjective comments he realized that not only the attentional problems became manageable but also his mood and sleep were normalized.

Conclusion Neurofeedback training enclosing different protocols seems to be effective while dealing with attentional deficits and depressive symptoms in adults. In our case study, our client showed improvement in both cognitive and emotional domains verifying the EEG results. However, one limitation of the study is that the possible involvement of psychological counselling in the positive outcome could not be ruled out. Therefore, neurofeedback training combined with psychological counselling or other behavioral approaches could be a promising therapeutic modality while dealing with attention deficits and depressive symptoms in adults.

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