

Workshop “Individualized Neurofeedback”.

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Introduction.

Considerable interest has been, and still is, generated by the potential performance enhancing benefits of EEG biofeedback or Neurofeedback training (NFT). A plausible rationale for such training, with an aim to improve mood and/or enhance cognition, can be made based upon what is already known of the links between EEG activity and behavior. We had found that NFT applied in order to increase or decrease power of individual EEG frequency ranges is more efficient than NFT of standard EEG frequency ranges (Bazanova and Aftanas, 2008; 2010). However, designing an optimal NFT paradigm remains difficult because a number of methodological factors that may influence the outcome of such training remain largely unexplored.

Method.

This presentation focuses on these methodological factors in an attempt to highlight some of the unanswered questions and stimulate future research. "What is Individualized Neurofeedback?" presentation will answer the following questions

Which individual upper or low frequency alpha sub-bands to train?

We could outline a number of reasons why amplitude across a fixed frequency range of 8-12Hz should not be the sole measure of alpha activity. Indeed overall EEG power spectrum frequency Principal Component Analysis (fPCA) yields low and upper frequency range alpha factors with identical peak frequencies, which relate to different neuronal functions (Tenke & Kayser 2005). Following this, we promote the idea that alpha activity can be measured using individual alpha peak frequency separately in low and upper alpha frequency ranges (Klimesch et al., 2007; Bazanova, Vernon, 2014). This is important because it can help shed light on various brain activation models as well as provide insights for studying cognitive behavior and devising EEG based neurofeedback training (NFT) protocols.

Individuality and Neurofeedback.

It could be proposed that differences in alpha peaks frequency in resting condition as an endophenotypic trait reflects different mechanisms of brain activation and alpha waves generation (Tumyalis and Aftanas, 2014). So healthy subjects with either low (individual alpha peak frequency-(IAPF)<10 Hz and high (IAPF≥10 Hz) are differed in their ability to respond to NFT (Bazanova and Aftanas, 2010).

How is neurofeedback training efficiency evaluated?

It may seem obvious to suggest that the method of assessing training efficiency can influence the perceived outcome. However, when examining the efficacy of NFT a variety of measures have been used, begging the question. Which measure(s) provides the best index, or indices, of learning and how can those that exhibit learning best be identified?

Role of EMG contamination in NFT efficiency?

Muscle or electromyogenic (EMG) artifact poses a serious risk to the inferential validity of NFT in the frequency-domain owing to its amplitude, broad spectrum, and sensitivity to psychological processes of interest (McClelland et al., 2012). Moreover, cognitive task performance often activates EMG in scalp electrical recordings making it difficult to differentiate EEG from EMG signals in the theta, beta and gamma ranges. This finding reinforces the importance of the upper alpha and beta range EEG-EMG coherence levels during sensorimotor integration (Chakarov et al., 2009; McClelland et al., 2012). Hence, it is possible that lower levels of EMG contamination enhances efficiency of NFT when it provided with

simultaneous voluntary decreasing forehead muscle EMG. Furthermore, we suggest that a bidirectional NFT regime may be more effective compared to unidirectional training.

How hormonal cycled conditions influence the NFT efficiency?

"Women" or ovulation related hormonal influences on the alpha activity and NFT efficiency. Women's reproductive age is characterized by ovulation-related hormonal cyclicity that is associated with physical, mental, and cognitive changes. Sex hormones might play an important role in modulating functional brain organization and EEG indices (Bazanov et al., 2014) that has an impact on the NFT efficiency.

What is the role of instructional recommendations in the NFT efficiency

Social and psychophysiological factors that define success in learning to control alpha waves are yet to be studied. Sometime the efficacy of alpha-stimulating training was determined largely by the instructions that patients received before training session, than by the use of biofeedback. (Prewett, 1976; Plotkin, 1980) The aim of this workshop section is to demonstrate the efficacy of the NFT in dependence on the type of instruction (behavioral techniques).

Results.

Specifically, this workshop examines the NFT training schedule; the variety, basis, the nature and modality of the feedback signal provided; the establishment of a target frequency range of EEG, whether NFT should be conducted with eyes open or closed and the impact of the neurohumoral condition, instructional recommendations on the NFT efficiency; unidirectional as compared to bidirectional NFT

Conclusions.

Throughout, the workshop provides a number of suggestions and possible directions for future research.

Keywords: Neurofeedback training efficiency, Individually adjusted alpha EEG range, EMG artifacts, eyes open, eyes closed, baseline neurohumoral condition.

References

- Bazanov, O.M., and Aftanas, L.I. (2008). Individual measures of electroencephalogram alpha activity and non-verbal creativity. *Neuroscience and Behavioral Physiology*, 38 (3), 227-235.
- Bazanov, O.M., and Aftanas, L.I. (2010). Individual EEG alpha activity analysis for enhancement neurofeedback efficiency: Two case studies. *Journal of Neurotherapy*, 14, 244-253.
- Bazanov, O.M., Kuzminova, O.I., Nikolenko, E.D, and Petrova, S.E. (2014). EEG activation response under different neurohumoral conditions. *Human Physiology*, 40(4) 375-382.
- Bazanov, O.M., Vernon, D. (2014). Interpreting EEG alpha activity. *Neuroscience and Biobehavioral Reviews*, 44, 94-110.
- Chakarov, V., Naranjo, J. R., Schulte-Mönting, J., Omlor W., Hueth, F., Kristeva, R. (2009). Beta-range EEG-EMG coherence with isometric compensation for increasing modulated low-level forces. *J. of Neurophysiology*, 102 (2), 1115-1120.
- Klimesch, W., Sauseng, P., Hanslmayr, S. (2007). EEG alpha oscillations: The inhibition-timing hypothesis. *Brain Res. Rev*, 2007. 53, 63-88.
- McClelland, V.M., Cvetkovic, Z., Millsa, K.R. (2012). Rectification of the EMG is an unnecessary and inappropriate step in the calculation of corticomuscular coherence *J. Neuroscience Methods*, 205(1), 190-201.
- Plotkin, W. (1980). The Role attribution of responsibility in the facilitation of unusual experimental states during alpha training: An analysis of the biofeedback placebo effect. *J. Abnorm. Psychol.*, 89(1), 67.

Prewett, M.J., Adams, H.E. Alpha activity suppression and enhancement as a function of feedback and instructions . *Psychophysiology*, 13(4), 307.

Tenke, C.E., Kayser, J. (2005). Reference-free quantification of EEG spectra: combining current source density (CSD) and frequency principal components analysis (fPCA). *Clin Neurophysiol.*, 116(12), 2826-2846.

Tumyalis, A.V., and Aftanas, L.I. (2014). Contribution of neurophysiological endophenotype, individual frequency of EEG alpha oscillations, to mechanisms of emotional reactivity. *Bull Exp Biol Med.*, 156(6), 711-716.

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