

Juan P. Aristizabal MSc.

Av. Parque Aguas Claras, Lote 25, Brasília, Brazil

juparistizabalga@gmail.com

Basic Psychological Processes Department, University of Brasília.

Wânia Cristina de Souza, PhD.

Campus Universitário Darcy Ribeiro, N°: s/n., *Asa Norte* 70910900 - Brasília, DF – Brazil,

wcsouza@unb.br

Psychology Institute, University of Brasília

Olivia Morgan Lapenta

Rua da Universidade, 4710-057, Braga, Braga, Portugal

olivialapenta@psi.uminho.pt

Center for Investigation in Psychology, University of Minho

Antonio Pereira Junior, PhD.

Institute of Technology. Campus of Guamá, Augusto Côrrea street, 01, Guamá 66075110 - Belém, PA – Brazil

apereira@ufpa.br

Informatics and Electrical Engineering Laboratory, Federal University of Pará

Bruno Duarte Gomes, PhD.

Neurophysiology Laboratory Eduardo Oswaldo Cruz, Guamá, 66075110 - Belém, PA – Brazil

brunodgomes@yahoo.com.br

Biological Sciences Institute, Federal University of Pará

Paulo Roney Kilpp Goulart, PhD.

University Campus of Guamá, Augusto Côrrea street, 01, Guamá 66075110 - Belém, PA – Brazil

goulartprk@gmail.com

Behavioral Theory and Research Center, Federal University of Pará

Fernando A. Rocha, PhD.

University Campus of Guamá, Augusto Côrrea street, 01, Guamá 66075110 - Belém, PA – Brazil

rochaf@ufpa.br

Neuroscience and Behavior Program, Federal University of Pará

Neurofeedback Beta Down-Training in Women with High State-Trait Anxiety: A Pilot Study

Introduction: According to the World Health Organization (WHO), anxiety and depression rank as the most prevalent mental disorders worldwide. WHO's 2015 estimate was that around 3.6% of the global population were affected by some form of anxiety disorder. Moreover, females tend to be more susceptible to anxiety disorders compared to males. Considering the high prevalence of anxiety disorders, various strategies have been employed in their treatment. Among those strategies, Neurofeedback is increasingly recognized as a promising intervention, particularly for individuals exhibiting heightened beta amplitude patterns in Quantitative Electroencephalography (qEEG) assessments.

Objective: This pilot study aimed to investigate the effectiveness of Neurofeedback beta down-training in alleviating anxiety symptoms in women exhibiting high state-trait anxiety and elevated beta amplitude patterns in temporal lobes.

Methods: The study involved six right-handed female university students with high state-trait anxiety levels (mean age of 25.2 ± 4.9). Employing a single-factor within-subject pre- and post-test experimental design, each participant served as their own control. The study comprised four phases: Pre-test 1 (baseline), Pre-test 2 (control condition), Intervention, and Post-test. Participants underwent evaluation using the State-Trait Anxiety Inventory (STAI) and resting-state qEEG in all phases. EEG recordings were conducted under two conditions: one minute with eyes closed and one minute with eyes open. Twelve EEG points were measured using a monopolar assembly. The Intervention phase involved five Neurofeedback sessions over two weeks, targeting beta amplitude reduction (19-38 Hz) focused on the left (T3) and right (T4) temporal lobes. Changes in qEEG beta band amplitude in T3 and T4, as well as STAI scores, were compared to baseline, allowing for pre- and post-intervention outcome comparisons.

Results: No significant changes were observed in STAI or qEEG measurements following the control condition. In turn, there was a significant reduction in State ($t = 3,154$, $p = 0,013$) and trait ($t = 2,488$, $p = 0,028$) values in STAI scores after the intervention, indicating a potential therapeutic effect of Neurofeedback in alleviating anxiety symptoms. Additionally, the study revealed intriguing alterations in brain rhythms, notably a decrease in the relative power of beta (12-23 Hz) and high-beta (23-38 Hz) frequency bands during the experimental condition. Statistical significance was observed in the beta band within both T3 ($t = 4.070$, $p = 0,005$) and T4 ($t = 2.393$, $p = 0,031$), and in the high-beta band within T3 ($t = 2.215$, $p = 0,038$), suggesting targeted modulation of neural activity in regions associated with anxiety regulation.

Conclusions: The study's findings have significant implications for the use of Neurofeedback in anxiety treatment, indicating that targeted beta down-training effectively modulates beta patterns in individuals with high anxiety reducing symptomatology. These findings contribute to the growing evidence supporting Neurofeedback as a non-invasive, personalized intervention for anxiety disorders. Further research is needed to replicate these findings in larger and more diverse samples for result generalizability. Additionally, exploring the long-term effects of Neurofeedback Beta Down-Training on anxiety management and quality of life outcomes could provide valuable insights into sustained intervention benefits.

Keywords: Neurofeedback; State-Trait Anxiety; Temporal lobes; Electroencephalogram

Topic: Neurotechnology and Cognitive Rehabilitation: Barriers to Implementation into Practice