

## Introduction

The patient is a 52 year-old male with anxiety and depression. The PHQ-9 (Depression) showed a score of 26, which indicates severe depression. The GAD-7 (Anxiety) showed a score of 17, which indicates severe anxiety. The Short-PSQI (Sleep) showed a score of 7, which is higher than the clinical threshold. The patient indicated using cannabis more than 3 times a week. A resting-state EEG was recorded for both the eyes open and eyes closed condition, with a duration of 5:17 minutes for the eyes open condition and 6:05 minutes for the eyes closed condition.

## EEG Assessment

EEG is a non-invasive neuroimaging technique that measures the electrical activity of the brain using electrodes placed on the scalp. It provides a valuable tool to assess brain function and has been used to investigate a wide range of neurological and psychiatric disorders. Quantitative EEG (qEEG) is a technique that compares the EEG characteristics of a patient with a normative database to assess deviations in brain activity. It can provide useful information about the underlying neural mechanisms of a disorder and inform treatment decisions.

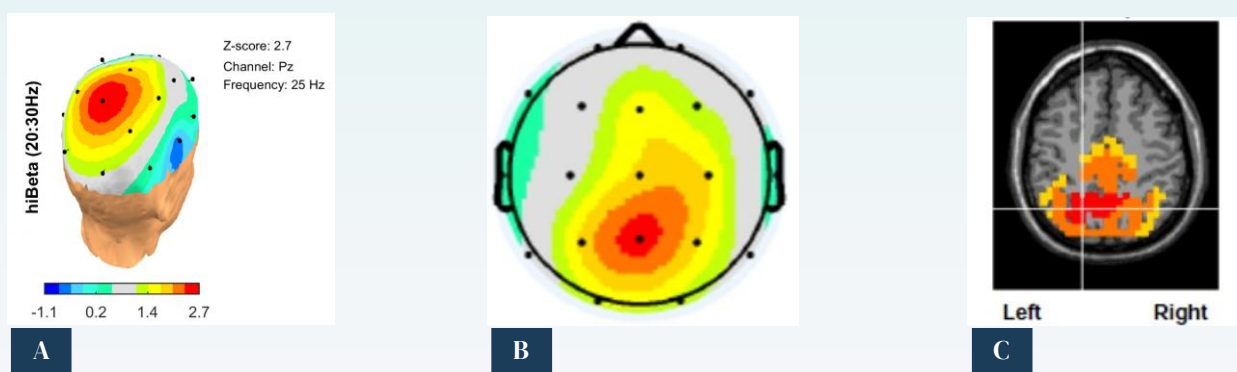
## QEEG Analyses

The signal quality was excellent. For the eyes open condition, 26% of the data was rejected due to artifacts, leaving 3:55 minutes for further analyses. For the eyes closed condition, 5% of the data was rejected, leaving 5:47 minutes for further analyses. Inspection of the raw signal revealed dominant Alpha activity in the eyes open condition.

The results of the qEEG analyses corresponded with this observation: There was an excess in Alpha activity in the eyes open condition. Alpha activity should only be dominant during the eyes closed condition and dominant Alpha activity in the eyes open condition can be related to drowsiness or fatigue. This is often caused by a lack of (quality) sleep and/or prolonged periods of psychological stress. Second, an excess in Beta activity was detected. Beta waves, typically ranging from 13 to 30 Hz, are associated with active thinking, problem-solving, and focused mental activity. They play a crucial role in maintaining alertness, concentration, and engagement with the external environment. However, an excess of Beta activity can indicate a state of heightened arousal, often linked to stress, anxiety, and overthinking. Clinically, elevated Beta levels have been observed in individuals with conditions such as generalized anxiety disorder (GAD) and obsessive-compulsive disorder (OCD). Additionally, excessive Beta activity can interfere with relaxation and may contribute to difficulty winding down, leading to challenges in

achieving restful sleep. Conversely, reduced Beta activity may be associated with attention deficits or symptoms of depression, highlighting its importance in balancing cognitive and emotional regulation. Source localization showed that this excess is likely to originate from the parietal lobe. The parietal lobe is essential for a range of cognitive and sensory processes, particularly in relation to attention, spatial awareness, and sensory integration. It works closely with the frontal lobe in regulating attention, where the frontal lobe directs the attentional “spotlight,” and the parietal lobe maintains and represents this focus, allowing for efficient processing of relevant stimuli. Beyond attention, the parietal lobe plays a critical role in processing sensory information from various parts of the body. It integrates visual, auditory, and somatosensory inputs to form a coherent perception of the environment, which is crucial for tasks such as spatial orientation and navigation. It helps us understand where our body is in space (proprioception) and enables coordinated movements. Additionally, the parietal lobe is involved in higher-order functions such as mathematical reasoning, object recognition, and language processing, particularly in understanding and organizing spatial relationships. By integrating sensory information and supporting cognitive functions like attention, spatial reasoning, and sensory-motor coordination, the parietal lobe plays a pivotal role in how we interact with and interpret the world around us. Dysregulation of brain activity in this region may result in impairment of these functions. Finally, a slow Alpha Peak Frequency (APF) was found. The APF is highly hereditary, but can also be modulated by arousal, where low arousal can lead to a relatively low APF. Moreover, a low APF is associated with early cognitive decline, mild cognitive impairment and poor treatment response.

## Figure 1. qEEG Results



**Figure 1A:** Excess parietal Beta activity at 25Hz; 3D Headplot, **Figure 1B:** Excess parietal Beta activity at 25Hz; Surface, **Figure 1C:** Excess parietal Beta activity at 25Hz; Source localization using sLORETA.

## Treatment Protocol Recommendation

The recommended rTMS protocol is to apply a continuous 1Hz train of pulses for 20 minutes per session at the Pz electrode site, at least 3 times per week. This is often recommended for individuals experiencing anxiety, restlessness, or difficulty relaxing, as excessive Beta activity can be associated with heightened arousal and mental tension. Reducing Beta activity can help calm the nervous system, promote relaxation, and alleviate symptoms of overarousal, such as anxiety and agitation. This protocol is commonly used to encourage a more balanced and peaceful mental state, improving the ability to relax and reduce stress. This rTMS protocol can be combined with relaxation exercises (breathing exercises or a 'body scan' meditation exercise) before or after the rTMS session. It's important to note that the patient's cannabis use could significantly affect brain activity and may be contributing to the dysregulation observed in the qEEG results. Acute cannabis use typically results in increased Alpha and Gamma power. However, with long-term use, there is an increase in frontal Alpha power, a decrease in Alpha Peak Frequency, reduced posterior Alpha power, and a decrease in Gamma power. Excessive cannabis use could impact both the symptoms and the effectiveness of the treatment. It is strongly recommended that the patient gradually reduces their cannabis use.

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