Targeting ADHD with a Noninvasive System to Improve Concentration Based on Electroencephalogram and Neurofeedback Methodology

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Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder that affects approximately 366 million adults and 129 million children and adolescents worldwide (CHADD; Song et al., 2021). However, prescription ADHD medication is prone to causing adverse side effects such as sleep disorders, reduced appetite, and stunted growth in children (CDC). This project aims to address ADHD with a noninvasive system through interactive games that use neurofeedback principles to promote proper regulation of brainwaves, as symptoms of ADHD are correlated with abnormal brainwave activity (Enriquez-Geppert et al., 2019). An electroencephalogram (EEG) was used to measure brainwaves, which were filtered by high pass, low pass, and notch filters within a circuit to isolate wave frequencies of interest. The resulting brainwaves were converted to a digital signal by an analog-to-digital converter, analyzed by a Raspberry Pi, and used as the method of progression in two video games played solely with brainwaves. After a calibration that determined a unique threshold between relaxed and focused states for each participant through mathematical algorithms, the games provided visual and auditory feedback as real-time positive reinforcement for focusing brainwaves to create a new memory of optimal functioning, and ultimately train the brain to self-regulate its activity. The amount of time consumed for successful completion and the accuracy rate were measured for an improvement in self-regulation. Results of data collection and t-tests showed a statistically significant improvement in participants' completion time due to more focused states after 10 days ($p = 0.004$), supporting that the system effectively improves concentration.

Awards Won:
Fourth Award of $500
University of Arizona: Renewal Tuition Scholarship
Arizona State University: Arizona State University ISEF Scholarship (valued at up to $58,000 each)
The University of Texas at Dallas: Scholarship awards of $5,000 per year, renewable for up to four years