Neuroadaptive EEG-Based Neurofeedback Systems for Attention Regulation

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Online platforms such as social media and video games are designed to stimulate reward mechanisms in the brain, which can lead to excessive use and reduced attention control. This project investigated whether an EEG-based neurofeedback system could be used to detect neural patterns associated with reward-driven engagement and provide adaptive feedback aimed at improving self-regulation. A two-stage brain–computer interface system was developed and tested. In the first stage, EEG data were obtained using private and public dataset. These signals were preprocessed and analyzed using a deep learning model trained to estimate relative changes in neural activity associated with dopamine-related responses, based on metrics from existing literature. In the second stage, a personalized neurofeedback module adapted visual and auditory stimuli in real time using reinforcement learning, encouraging neural patterns associated with sustained attention rather than reward-seeking behavior. The system successfully identified distinct EEG patterns during high-engagement and low-engagement states. When adaptive neurofeedback was applied, participants showed more stable attention-related EEG features and reduced variability associated with reward-driven stimulation compared to baseline sessions without feedback. These results suggest that adaptive EEG-based neurofeedback can support improved attention regulation during digital interactions. This approach demonstrates the potential of combining brain–computer interfaces, machine learning, and virtual environments to address problematic digital engagement in a non-invasive and personalized manner.

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