Psychophysiological Data Acquisition in Digital Games

Faculty: Robert West, Stephen Gilbert, Brian Mennecke
Mentors: Kira Bailey, Wutthigrai Boonsuk
Interns: Mina Choi, Michael K. Curtis, Hamadi McIntosh

Motivation

EEG measurements may provide an improvement over previous methods of measuring an individual's experience during game play (i.e., the questionnaire method). One limitation of the questionnaire method is that players may not accurately report their experience. GameScience Lab refers to this phenomenon as "*subconscious distortion*." An additional disadvantage of the questionnaire method is "*perceptive discrepancy*" that results from the player forgetting important events within the game. Real-time "logging" (the process of monitoring and recording the player's activities during play) may address both these problems.

Existing video game software does not accommodate real-time integration with EEG recording. Therefore, one purpose of this project was to develop a first-person shooter (FPS) digital game using the Torque Advanced game engine where game events were integrated with EEG data acquisition in real-time. This application provides a method for the rapid development of digital games for psychological experiments using EEG. This increases one's ability to conduct quantitative studies using digital games. The use of digital games may provide a more realistic environment for psychological experiments.

Method

The game had three artificial intelligence (AI) targets for the player to kill. A different number of hits was required to kill each target. In the learning phase, the player learned the kill contingencies. In the test phase, the kill contingencies were reversed for two of the targets on 30% of the trials. The player had unlimited ammo and health during the game.

Figure 1: Matrix showing three enemy targets and numbers corresponding to how many shots it takes to kill the target. The first part of the experiment was the learning stage. The second portion was the actual test stage with the contingencies applied.

Results: Target Difficulty

Target difficulty was associated with sustained activity over the left parietal and medial frontal regions beginning at roughly 500 ms after termination of the target (91%, p = .01). This reflected a linear decrease in neural activity from the easy (red) to hard (blue) target.

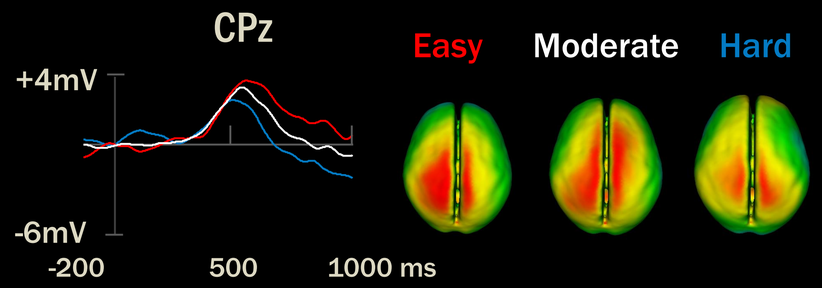

Figure 2: Average ERP amplitude at electrode CPz beginning at target termination and cortical current density for the easy, moderate, and difficult targets.

Funded by NSF Grant IIS-0851976

Results: Expectancy

Red targets elicited a MFN between target termination and 300 ms (69%, p = .02). The MFN was attenuated for Blue targets. Red targets elicited slow wave activity over left central-parietal region and Blue targets elicited slow wave activity over the frontal polar region (78%, p = .001).

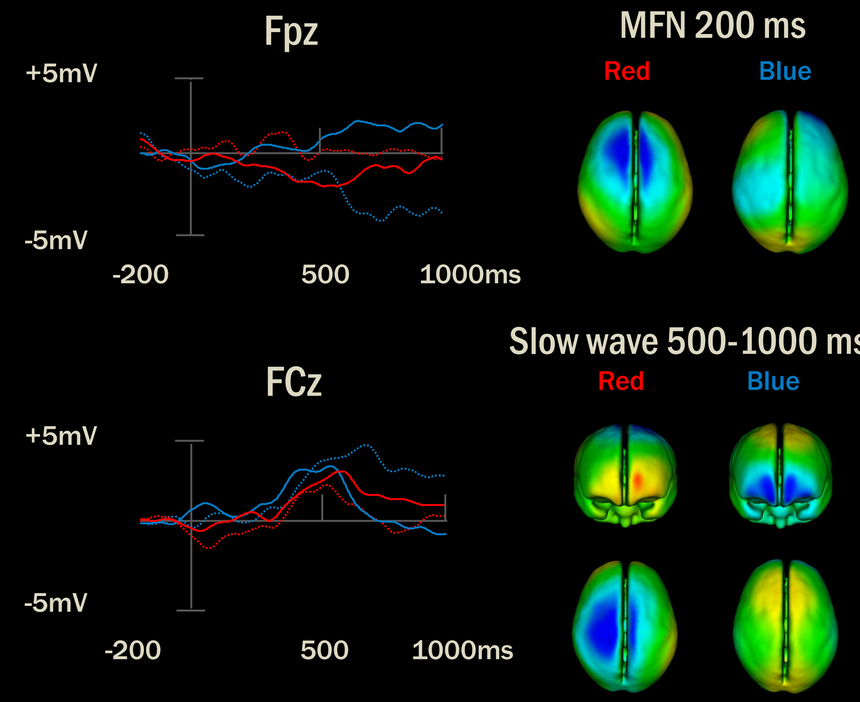

Figure 3: Average ERP amplitude at electrodes Fpz and FCz beginning at target termination and cortical current density for the violation minus expectancy Red and Blue targets.

Discussion

In this experiment, we demonstrated ERPs associated with reinforcement learning in subjects playing a FPS digital game. This supports the utility of using digital games in psychological studies. New data logging functionality in digital games was also achieved by obtaining real-time communication between the game and the EEG.

References

Gehring WJ, W. A. (2002). The medial frontal cortex and the rapid processing of monetary gains and losses. *Science* , 2279-2282.

Sasse, D. B. (2008). A Framework for Psychophysiological Data Acquisition in Digital Games. *Otto-von-Guericke-University Magdeburg* , 1-109.