**Controlling a Game using a BCI-SSVEP with Four Commands**

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**Introduction:** BCI (Brain-Computer Interface) is an important modality of Human-Computer Interaction, since it expands the interaction possibilities of people with disabilities [1]. SSVEP (Steady-State Visually Evoked Potentials) is a BCI paradigm that allows the generation of commands through visual stimuli that flicker at different frequencies [2], each one related with a specific command. In this abstract, we discuss a game with four commands controlled by BCI-SSVEP. This game is intended to teach the use of BCI-SSVEP to possible users who will need to manipulate this technology, so that they gradually gain confidence and ability before interacting with more complex applications, such as controlling a wheelchair or manipulating a prosthesis.

**Materials and Methods:** A game whose goal is to collect coins distributed by a board has been developed in Unity3D. The game has four movement commands that allow a ball to move across the board to collect the coins. The movement commands of the ball are related to four visual stimuli that blink at frequencies: 6 Hz (left), 10 Hz (right), 12 Hz (down) and 15 Hz (up). These frequencies were chosen as multiples of the monitor refresh rate to ensure the accuracy of the stimulus. The stimuli consist of black and white squares positioned in the center region of the left, right, top and bottom ends of the screen. The brain signal was monitored by an electroencephalography (EEG) device using 16 dry electrodes positioned at O1, O2, Oz, POz, Pz, PO4, PO3, PO8, PO7, P2, P1, Cz, C1, C2, CPz, FCz, according to the 10-10 system. An experimental study has been conducted with 2 healthy subjects to analyze their interactions with the game. Each volunteer played four matches with the task of collecting four coins in a maximum of two minutes. A questionnaire regarding their perception about the game was applied. Both subjects were informed about the experiment and agreed to the approved consent form (Ethics Committee of UNICAMP, 791/2010 CAAE 0617.0.146.000-10).

**Results:** Both subjects successfully managed to control the game through BCI-SSVEP. Considering four matches, subject 1 collected an average of 3.75±0.50 coins, collecting all the coins in three of the four matches. Subject 2 collected an average of 2.25±0.96 coins, collecting all coins in only one of the four matches. Subjects reported that the control of ball movement in the game was intuitive. Despite the need for a continued concentration on the visual stimuli, neither of the subjects reported fatigue caused by the game. However, subject 2 reported that his eyes watered. Subjects did not report discomfort about the use of the EEG cap. Considering the hit rate calculated with training data, subject 1 has an information transfer rate (ITR) of 60 bits/min and subject 2 has an ITR of 13.53 bits/min. However, during the game, the transition times to change command and the distraction caused by interaction with the game tend to reduce the hit rate and consequently the ITR.

**Discussion:** The results show that both subjects adapted satisfactorily to the control of the game, and showed that it is possible to achieve the goal of the game, which was to collect the four coins distributed by the scenario. During the experiment, it was possible to perceive that the users were motivated to collect all the coins and that there was a bit of frustration when this goal was not achieved. We believe that for training applications this motivation is important as it encourages the subject to maintain concentration and increases their abilities with BCI controls.

**Conclusion:** A game controlled by BCI-SSVEP has been developed and tested with two subjects. The results have shown that the control of four commands proved to be efficient, causing minimal discomfort to the user. However, a more detailed experimental study should be conducted before the game is made available to the training and conditioning stage of BCI-SSVEP applications.

**References:** [1] Wolpaw JR et al. Clin. Neurophysiol, 113: 767-791, 2002; [2] Middendorf M et al. IEEE Trans. Rehabil. Eng. 8(2): 211-214, 2000.