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Playing Action Video Games a Key to Cognitive Enhancement

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Abstract

In this paper, we aim to analyse the impact of training on improvement in cognitive abilities and performance of the subjects playing single player action video game. Recent research indicates that playing Action video games improve cognitive abilities. However no study has exploited the novel technique, Empirical Mode Decomposition in the field of action video games. Empirical mode decomposition was used to extract various features by decomposing EEG data into intrinsic mode functions. Intrinsic mode functions were used to calculate linear features like standard deviation, phase and energy. K- Nearest Neighbour & Linear Discriminant Analysis classifiers were used to classify the subject based on the changes in features extracted due to the impact of training. Psychological tests conducted before and after the training, positively affirm that training improves cognitive abilities like reaction time and reduces stress level.

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1. Introduction

We live in an era of information and technology. Technologies like Action Video Game (AVG) have become very popular among the young generation. The researchers and neuroscientists around the world have been trying to explore the impact created by technologies like Action video games on human brain and its cognitive functions. Recent studies have shown that playing AVG augment a person's ability to perform multitasking [18,19], exhibit better attention across space and time [15,17], improves attention blink [11], multiple object tracking [11,12] and faster reaction time [16]. A recent study (Green et al. 2010) demonstrated the increasing speed of processing with AVG [21]. Further studies have also found evidence for greater speed of processing and enhanced visual short-term memory in AVGPs (action video game players) when compared to NVGP (non video game players) [22]. Our research has shown that AVG players have faster reaction time and reduced stress level, although no significant

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change was found in the memory of trained AVG players when compared to players without any training. Enhancement in psychomotor skills like hand eye coordination was also observed during psychological assessment tests conducted for cognitive abilities.

The measurement of the electrical potential from the scalp using electroencephalography (EEG) opened up new possibilities in studying brain function in normal subjects. EEG, a noninvasive and safe technique is employed in this study to record the potentials from brain while participants played AVG. Electrodes were placed according to internationally recognized 10–20 system of electrode placement. Artifacts corrupt EEG signals with noise. Artifact caused by impedance of the system, eye blink artifacts, movement artifacts, are common artifacts, which contaminate EEG signals. Independent Component Analysis (ICA) is a computational method used to remove eye blink artifacts and muscle artifacts from EEG signals. ICA is a blind source separation technique. The EEG is composed of electrical potentials arising from several sources. Hilbert-Huang transform (HHT) has been used in the field of biomedical signal processing [20] for EEG analysis since brain waves are non-linear and non-stationary in nature. Recently HHT have become a suitable tool in signal processing of biomedical signals, which can be used to obtain various features when compared to conventional tools like wavelet transform and Fast Fourier Transform (FFT). Hilbert-Huang transform (HHT) is an analytic proposed by Huang *et al.* [3] for the non-linear and non-stationary signal processing. Empirical Mode Decomposition (EMD) is a time-frequency based method, which decomposes signals into a number of intrinsic mode functions (IMF), which are oscillatory components [2]. EMD is adaptive and therefore is a highly efficient method. EMD decomposes complex signals into high frequency and low frequency components. The process of decomposition is called sifting which generate components called IMF. The instantaneous frequency and amplitude of each IMF is derived by Hilbert transformation. Then the instantaneous responses of the IMFs are arranged to construct the Hilbert spectrum HS i.e. time-frequency space corresponding to the time domain signals [1].

Linear features like energy, phase and standard deviation were calculated from the IMF's. Linear discriminant analysis (LDA) and K nearest neighbor (KNN) classification techniques were used to classify the experimental group as trained (pre session) and untrained groups (post session) and the features that we have extracted reflected this difference. Linear discriminant Analysis searches for a linear combination of variables/ predictors that best separates two classes/ targets. Classification is based on covariance matrix. LDA is a dimensionality reduction technique that reduces the number of predictors while preserving class discrimination. KNN algorithm is a simple algorithm that classifies based on similarity measures. Similarity measure is simply a distance function. A data is assigned to a class which is most common amongst its K nearest neighbors based on distance measurement. A decision rule is devised by comparing a test data with the training data and by assigning the unknown test data to most frequently appearing training data in the neighborhood.

In this study we chose the action game 'Tom Clancy's Rainbow Six: Vegas 2' a first-person shooter video game, which demands players to have skills like strategic planning, concentration, and coordination. The aim of our study was to examine the effect of training on the performance of the subject. In young adults, several studies have shown that video game playing enhances attention resources leading to better performance on a number of attention demanding visual tasks (Castel et al., 2005; Feng, Spence, & Pratt, 2007; Green & Bavelier, 2003, 2006a, 2006b, 2007). No studies have explored novel techniques like EMD to study the impact of video game training. Neuropsychological tests are employed in our study as an attempt to measure cognitive functioning of individuals. Reaction time, memory and stress levels were analyzed using various tools like PEBL, VISGED etc. that are explained in detail in the following sections. The psychological tests accurately established the enhanced cognitive abilities after training.

2 Hypothesis

The participant's performance after training should be better than that of the control group who does not undergo training. The time spent on training game will affect their overall performance and cognitive abilities [11-19] like speed of processing leading to faster reaction time and reduced stress levels.

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