PhD Thesis Title: Decision Making and Puzzled Response Assessment Using Visual Evoked and Event Related Potentials

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Graduation Date: 8 September 2015
Available Online: N/A

ABSTRACT:

Brain mechanisms are the most complicated and challenging issues in the human body, due to the superiority of brain behavior. Understanding the decision-making process is beneficial for diagnosing brain disorders, as well as, reducing errors and improving the accuracy for a brain-computer interface. The brain processes information and decides on a variety of choices in daily life, which are based on the internal and external parameters. Perceptual decision making, from a physiological view, is conceded. It is also related with the difficulty of decision making. The term "puzzled response" is proposed to describe the extracted brain response during the moments of confusion in the brain. Hence, the experimental task is designed on purpose to confuse the participant involved in the experiment. Illusion pictures are used in the puzzle task in order to be a source of confusion. Simultaneously, the brain responses are recorded during these moments. Electroencephalogram, visual evoked and event related potential techniques, were used to investigate the decision-making process in the brain and track brain behavior during puzzled moments in different task conditions and age groups. The pattern reversal checkerboard with grid illusion and task paradigm of 50% target probability with Rorschach inkblot figures, were designed as brain stimulations. The overall recording system was calibrated by following the International Society for Clinical Electrophysiology of Vision (ISCEV) standard. The recorded signals were processed by calculating the grand average brain response and the power gradient brain topography on the scalp. Time-frequency analysis and cross coherence were used to study the frequency domain rhythms and the relationship between the right- and left-brain hemispheres, respectively. Furthermore, spatial analyses of dipole fitting source localization in a head model were used to estimate the neuron generator in the brain, followed by exploring the brain domains anatomically using the measure projection analysis clustering method. The results of brain response were found in two main components: early puzzled component N130 and the late trusted decision component N240. Different brain responses were seen from the variation of amplitudes, latency, and morphology as a function of different ages and maturity. Time-frequency analysis and cross coherence indicated the difficulty and accuracy of the decision making. The coherency between the right and left hemispheres increased with the difficulty of the task. The neural generator was estimated from different brain sources. The flow of information related to the puzzled and the decision process in the brain formed a multimodal complex region, which includes supramarginal gyrus,

postcentral gyrus, and angular gyrus. Then it reached the temporal gyrus with respect to trusted decisions. The processes related to decision making were all found to be processed in the left hemisphere of the brain. ANOVA statistics showed significant results of a trusted decision component (N240) in the matured age group. However, the response component (N130) based on the puzzle was more significant in the young age group.

References to author publications that relate specifically to the dissertation:

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3. **Ahmed Almurshedi** and A. Ismail, Independent Component Analysis of EEG Dipole Source Localization in Resting and Action State of Brain, Perfik-2014, AIP Conf. Proc. 1657, 060002 (2015). http://aip.scitation.org/doi/abs/10.1063/1.4915254

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