

Brain Electrical Oscillation Signature Profiling (BEOS)

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ABSTRACT

This article shows the development of techniques for deception detection has reached a stage of extreme complexity as the information sought must be extracted from the brain of suspects, instead of making inferences about it from the emotional effects produced during the traditional lie detection tests. This includes the presentation of concealed information and oral or behavioral responses by the individual are necessary requirements for use of these techniques. The new technique described here extracts information directly from memory, without having the individual respond to the statements - probes presented. It measures the components of electrical oscillations generated during remembrance of autobiographical episodes, which can occur only when one has acquired the experiences through participation in the said activities.

KEYWORDS

Autobiographic Episodes, Brain Electrical Oscillations, Experiential Knowledge, Frequency, Remembrance, Time Domain Analyses

INTRODUCTION

Retrieval of information from memory takes place for two different processing requirements. One for recognition of the entities of the external world, which must happen rapidly as the individual's efficiency to deal with the world depends on quick detection of the changes in the world. The other retrieval is related to remembrance of autobiographical episodes, which are experiences of the individual. Several studies have shown the involvement of different neural structures during the activation of the two retrieval processes. The process of recognition of an external stimulus is associated with several signal-processing stages viz., sensory registration, arousal of attention followed by detection of the stimulus.

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The neurocognitive processes are best represented by electrophysiological changes in the brain, which can be easily recorded using surface electrodes placed on the head (Mukundan, 1986a, 1986b, 1995; Khanna et al., 1989; Mukundan et al., 1989, 1990). Of these stages, the detection or recognition of the stimulus is accompanied by the P300 event related potential (Donchin, 1981; Neville et al., 1986; Donchin and Coles, 1988; Annet & Mukundan, 1996; Mukundan & Rohrbaugh, 1998; Sudha & Mukundan, 1998; Mukundan et al., 1999; Silva et al., 2007). However, the P300 response can be produced only presentation of a brief stimulus lasting not more than 200 ms. The P300 response represents the detection or recognition of a new stimulus and the amplitude of the potential is a function of the special or change in the meaning, unexpected familiarity, or novelty in the stimulus. The P300 potential can be produced by the infrequent stimulus in an oddball paradigm consisting of two stimuli one frequently and the other infrequently presented, every stimulus when a set of different stimuli (Mukundan & Rohrbaugh, 1998) are presented one after the other, or when the same stimulus is presented with varying intertrial interval (Gonsalvez et al., 1995, 1999, 2002, 2007; Mertens & Polich, 1997; Polich & Heine, 1996; Polich et al., 1994).

Farwell (Farwell & Donchin, 1991, Farwell & Smith, 2001) used the oddball paradigm of generating P300 potential and used two sets of stimuli assigned as Irrelevant and Target and presented then one after the other on a computer monitor, with the Target as the rare stimulus. The suspect, who knew the nature of the stimuli, was to differentially respond to two stimuli. The average P300 amplitude was greater than the average P300 amplitude to irrelevant stimuli. A third stimulus called the probe was also presented without the knowledge of the subject. The probe contained a piece of concealed information which the examiner/investigators considered was known only to the suspect was presented along with the other two. The suspect who had guilty knowledge related to the probe produced higher P300 amplitude comparable to the Target stimuli, which were related to the crime investigated and already known to the suspect. If the suspect was innocent, he viewed it as another irrelevant stimulus and produced P300 amplitude accordingly. He interpreted the higher amplitude elicited by the probe as indication of knowledge of the crime, which he argued must render him guilty. However, it was of paramount importance that the probe was known only to the suspect other than the examiner and the investigators, as the knowledge of relationship caused greater P300 amplitude even in innocent persons. If the probe or any of the irrelevant stimuli were of any special meaning unconnected to the crime, to the suspect, they too caused higher P300 amplitude even in an innocent suspect. Further the entire exercise of relating the stimulus to the subject's participation must be inferentially and hypothetically interpreted by the examiner.

Rosenfeld et al. (2009, 2008) has developed a modified P300 paradigm in which the entire suspect's participation was made more complex in terms of detection and responding to the stimuli. He presented two separate sets of stimuli with a brief interval in each trial and required differential responses to each stimulus from the subject. The modifications were justified in terms of need to compensate for countermeasures which a suspect may use. There is no data available about the findings in forensic

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