Understanding the P300 and Its Components in a Three-Stimulus Visual Oddball Task

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The P300 is an electrical signal that is a neural correlate of prediction error and surprise. Recent studies show the P300 is made of distinct subcomponents that correlate with cognitive mechanisms the brain uses in responding to the unexpected. The P3A component is generated in the frontal region of the brain, an area associated with attention and cognitive control, in response to novel irrelevant stimuli. Conversely, the P3B component is generated in the parietal region, a brain area that is active during encounters that involve learning and memory, in response to novel task-relevant stimuli. Our experiment explores these signals using a visual three-stimulus oddball paradigm in which frequent non-target stimuli occur with 80% probability, novel irrelevant stimuli 10%, and novel task-relevant stimuli 10%. We record electrical signals from the brain with scalp electroencephalography (EEG) while subjects complete the oddball task, allowing us to examine neural responses to three types of stimuli. Based on a context-updating theory that the brain responds to an unexpected stimulus by making comparisons to prior expectations, we expect to observe a robust P300 effect with a frontal P3A in response to novel irrelevant stimuli, indicating higher demands on attention and effortful processing. We also expect novel task relevant stimuli to produce a parietal P3B, showing activity related to working memory. Exploring these signals allows further understanding of how the brain processes unexpected information with varying demands on attention and memory.

Keywords: P300, P3A, P3B, electroencephalography (EEG), visual oddball, context updating, attention, working memory