



The first independent study on the complex trial protocol version of the P300-based concealed information test: Corroboration of previous findings and highlights on vulnerabilities

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ABSTRACT

More than a dozen studies of the Complex Trial Protocol (CTP) version of the P300-based Concealed Information Test have been published since its introduction (Rosenfeld et al., 2008), and it has been fairly consistently proven to provide high accuracy and strong resistance to countermeasures (Rosenfeld et al., 2013). However, no independent authors have verified these findings until now. In the present, first independent study, we corroborate the accuracy and countermeasure-resistance of the CTP, when the probe item (critical presented information, e.g., crime detail; P) vs. all irrelevant items (Iall) comparison is used for classifying participants as guilty or innocent, but we also show that the CTP is severely vulnerable to countermeasures, when the P vs. the irrelevant item with the largest P300 responses (Imax) comparison is used. This latter measure can be defeated by creating “oddball” items among the irrelevant items (through targeting them with covert responses), and thereby making their P300 responses statistically indistinguishable from those of the probe item. Practical implications are discussed.

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1. Introduction

Undetected deception may have high costs in certain scenarios, for example in connection with legal cases or counterterrorism – however, meta-analyses show that humans, without special aid, are rarely able to reliably discriminate lies from the truth, most usually demonstrating judgment accuracies similar to pure chance (Bond and DePaulo, 2006; Hartwig and Bond, 2011; Kraut, 1980). Moreover, no significant individual differences can be found; neither experience nor training improves the accuracy of judgments (Bond and DePaulo, 2008; Meissner and Kassin, 2002). As a technological aid, the polygraph was invented just about a century ago, and is today widely used in many countries all over the world. While it provides higher than chance accuracy, it suffers from various limitations, including severe vulnerability to countermeasures (National Research Council, 2003).

1.1. The P300 as a tool for detecting concealed information

A prominent alternative under development is the P300-based deception detection that is based on analyzing neural activity recorded

by electroencephalography (EEG). In an EEG examination, electrodes are placed on the scalp, through which electrical activity in the brain can be detected. The P300 is an event-related potential with a positive peak arising most prominently above the parietal lobe, beginning usually around 300 ms after stimulus presentation (review: Polich, 2007). It is typically obtained through the “oddball” paradigm: when presenting a random sequence of stimuli, an infrequent stimulus will evoke the P300 wave if it is task-relevant and requires an overt or covert response that is different from the rest of the stimuli (so-called “standards”). Importantly, the probability with which a stimulus occurs robustly influences the magnitude of the P300: infrequent salient stimuli evoke larger P300 waveforms – an effect which is considered to reflect the involvement of limited-capacity cognitive processes in the generation of the P300 (Polich, 2007). According to the influential context-updating theory of the P300 (Donchin, 1981; Donchin and Coles, 1988), this waveform represents the updating of stimulus representations in working memory, a process that is highly context-dependent, i.e., is influenced by both immediate stimulus history and task demands (previous knowledge, expectation, selective attention, etc.). Alternatively, the P300 has been linked to the formation of decisions, reflecting the gradual accumulation of evidence until a decision boundary is reached (O’Connell et al., 2012; Twomey et al., 2015). Finally, more recent accounts of the P300 emphasize the reactivation of previously established stimulus-response associations, a process that also depends on stimulus frequency (Verleger et al., 2014, 2015).

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