

Recent Advances in Human Neurophysiology

Proceedings of the 6th International Evoked Potentials Symposium held in Okazaki, Japan on 21–25 March 1998

Detection of deception with P300

Yasuhiro Kakigi and Shinya Minamide

Department of Neurophysiology, Faculty of Medicine, Kagoshima University, 8-39, Iriomote Street, Korimoto, Kagoshima City, Kagoshima, 890, Japan

Background: A recent study has shown that the P300 component of the event-related potential (ERP) is sensitive to the detection of deception. The present study was designed to investigate the effect of the P300 component on the detection of deception. Methods: Ten subjects were asked to answer a series of questions. The questions were divided into two groups: 'truth' and 'deception'. The P300 component was recorded for each question. Results: The P300 component was significantly larger for the 'deception' group than for the 'truth' group. Conclusion: The P300 component is sensitive to the detection of deception.

Introduction: The P300 component of the event-related potential (ERP) is a prominent peak that occurs approximately 300 ms after the onset of a stimulus. It is thought to be related to the detection of novel or unexpected stimuli. A recent study has shown that the P300 component is also sensitive to the detection of deception. The present study was designed to investigate the effect of the P300 component on the detection of deception. Methods: Ten subjects were asked to answer a series of questions. The questions were divided into two groups: 'truth' and 'deception'. The P300 component was recorded for each question. Results: The P300 component was significantly larger for the 'deception' group than for the 'truth' group. Conclusion: The P300 component is sensitive to the detection of deception.

Keywords: P300; deception; event-related potential

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Correspondence: Shinya Minamide, Department of Neurophysiology, Faculty of Medicine, Kagoshima University, 8-39, Iriomote Street, Korimoto, Kagoshima City, Kagoshima, 890, Japan. E-mail: minamide@med.kagoshima-u.ac.jp

...nervous system related to information processing rather than emotion-dependent activities of autonomic nervous system, the methods used to escape the detection of traditional techniques will be null [6]. Rosenfeld et al. used P300 as an indicator to detect guilty knowledge [7]. In their experiment, a larger P300 was elicited by an "oddball" stimulus — the item supposed to be stolen by the subjects. N400 component was firstly described by Kutas and Hillyard [8]. They compared ERPs produced in response to words which completed sentences in a semantically anomalous fashion with ERPs produced in response to completions that were semantically normal. For the semantically anomalous completions, a negative-going component in the ERPs, maximal in the central and parietal areas, was elicited approximately 400 ms after the onset of the final critical word. No such negative component was noted for the semantically normal completions. More important for its use in detection of guilty knowledge, the N400 effect has also been associated with the truth value of sentence read by a subject [9]. Doez et al. [10] used the misra

...guilty knowledge can help us to elicit a clear P300 component to distinguish guilt from innocence. Moreover, more clues make it possible to utilize both N400 and P300 effects simultaneously by providing a context whose test word format is different

Ages ranged from 21 to 35 years, and 11 of the subjects were men. All subjects were right-handed and reported having normal or corrected to normal vision. EEG data from two of these subjects were not included in the analysis because of excessive eye movement artifact.

Materials

A piece of diary describing a burglary of an apartment in detail was read by the subjects. Giller²⁰

“j” or “h” on the keyboard. Try your best to appear innocent during this interrogation, even if you were the thief.

Every question was presented for 5,000 ms. Each of the five corresponding items was presented successfully for 300 ms, starting 1,000 ms after the offset of the question. There was an interval of 4,000 ms between the reactions of the trial

120 ms before the presentation of the item and ended 700 ms after the item disappeared. The total time of each item for collecting EEG data was 1,120 ms. After answering every six questions, the subject was instructed to take a 30 s break. Subjects were asked to minimize head and body movements and eye blinks during the trials. After EEG data collection was completed, impedances were rechecked, and the electrodes were removed. The whole experiment took 1 h.

For every subject, EEG data were sorted by trial depending on whether a RI or II was presented, then averaged coherently within each of two classes (RI – 18 times, II – 72 times). Data showing eye movements during recording epoch were discarded. To examine general trends in the data, we used dynamic time warping (DTW) to adjust the latency of components of ERPs for each subjects and calculated the grand average (across all subjects) for RI and II. Paired t test was used to test the amplitude difference of P300 and N400 between RIs and IIs.

Result

Upon visual inspection of averaged ERPs (Fig. 1), it was clear that two large positive peaks following the onset of the item, the first (P200) with a peak latency of about 210 ms and the second (P300) with a latency about 500 ms. A negative component (N400) occurred about 390 ms after the onset of the item and separated these two positive peaks. The mean and standard differences of amplitudes of P300 and N400 for each class (RI, II) and location (F3, F4, Fz) are listed in

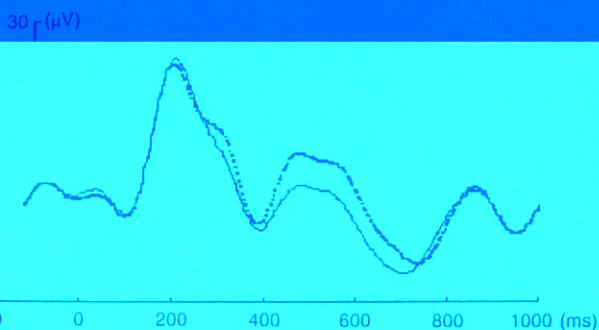
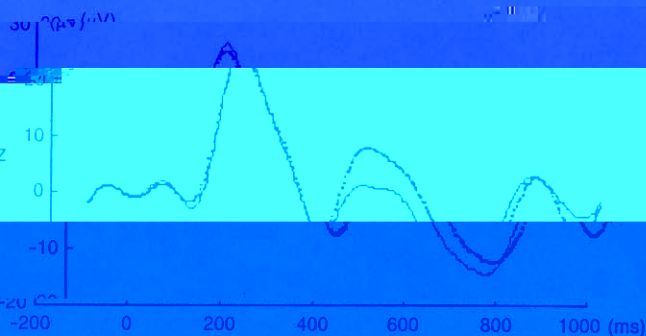
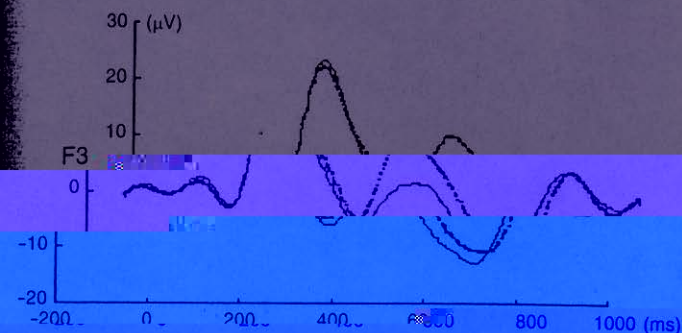


Fig. 1. Grand average ERPs elicited by P1 (solid line) and P2 (dashed line) at F3, Fz and F4 ($n = 18$).

000 has been hypothesized to reflect updating of memory or surprise. Its amplitude is determined by subjects' attention and small probability of significant information to subjects. All subjects learned new information in the laboratory and in that information was constructed. Among the five items (including one relevant item and four irrelevant items) following a question, only relevant items were semantically congruous with the question, so it was significant to subjects. While, its probability was 20%.

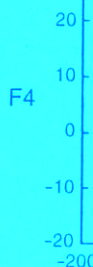


Fig. 1. Grand average ERPs elicited by P1 (solid line) and P2 (dashed line) at F3, Fz and F4 ($n = 18$).

The P2 amplitude is determined by subjects' attention and small probability of significant information to subjects. All subjects learned new information in the laboratory and in that information was constructed. Among the five items (including one relevant item and four irrelevant items) following a question, only relevant items were semantically congruous with the question, so it was significant to subjects. While, its probability was 20%.

Table 1. Amplitudes of the ERP peaks.

	F3	Fz	F4
P300			
RI	9.31 (7.52)*	7.59 (6.31)*	5.94 (6.80)*
II	1.66 (4.40)	1.49 (5.76)	1.46 (5.66)
N400			
RI	-5.09 (6.54)	-7.51 (5.33)	-6.60 (5.66)
II	6.79 (3.97)	-8.02 (4.34)	-7.26 (4.04)

Note: mean (SD) (μ V) peak-to-baseline amplitudes of P300 and N400 elicited by RI and II at F3, Fz and F4 ($n = 18$). * $p < 0.001$ (paired t test between RIs and IIs).

N400 reflects semantic processing of words in context. N400 component was also observed for false sentences pertaining to episodic information learned by subjects in the laboratory (e.g., "Diane is a lawyer") in which the sentence endings are not incongruous in any way [12]. In our experiment, irrelevant items were semantically incongruous with the question according to the information learned by subjects. According to Boaz et al.'s hypothesis, N400s ought to be elicited in subjects by irrelevant items (I1) and I2, as well as by the relevant items, but neither component could be elicited in innocence [10]. The combination of two indicators — P300 and N400, to detect guilty knowledge was our purpose in the present experiment. It will be more effective than using only one indicator. The result of our experiment could not confirm this point. There was a difference in the design of the experiment between Boaz et al.'s study and ours. In our study, first question-answers format, rather than strict context phrase-test word format or sentence completion format was used. Secondly, the question followed by five answers was presented only once, rather than before every answer.

In the views of application, the larger the difference in P300 amplitudes between relevant items and irrelevant items, the easier it is to detect deception. The difference in P300 amplitude at F3 was the largest and that at F4 was the smallest. Moreover, the difference in P300 amplitudes at Fz and F4 reached a significant level. These results suggest that if the visual stimuli evoking P300 component are semantic to right-handed subjects, F3 was a better location to record ERPs for detecting guilty knowledge than F4 and Fz. Because multiple clues were utilized in this experiment, a clear positive peak with a latency of 50–700 ms poststimulus in ERPs elicited by the repeated presentation of a single cue as described by Rosenfeld et al. [17]. Although they were both defined as P300, our design could avoid subjects' attention to stimuli and would be detection easy.

In the present study, the presence of guilty knowledge was detected with ERPs of a certain word significantly better than of the ERP method. The ERP method in this study reflects the automatic cognitive processes for decision making and conscious measures were avoided. Moreover, it minimizes the effects of potentially

founding variables and examiner bias. Thus ERPs show promise as a method for detecting the presence of guilty knowledge.

Acknowledgements

This research was supported by the National Academic Committee. The grant number is 96-919-08.

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