Negative brain potentials predict performance in reaction tasks

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Abstract

Event-related brain potentials (ERPs) are a potential tool for the analysis of cognitive processes and performance deficits in human factors research. We earlier identified two subcomponents of the P300 complex in 2-way choice tasks, called P-SR and P-CR, which are related to stimulus evaluation and response selection, respectively. In addition, the slow brain potential preceding the stimuli (SPN) is assumed to reflect preparatory processes. Large differences in SPN amplitude were observed, which depended on the error rate in choice tasks: subjects with few errors (GOOD) had a large SPN, while subjects with many errors (POOR) had virtually no SPN. Moreover the P-CR of POOR subjects was much smaller, and delayed in comparison with GOOD subjects, regardless of response latency, which was similar for both groups. It is concluded that POOR subjects did not sufficiently prepare for the task (small SPN), which delayed and weakened their response selection (late and small P-CR), thus causing their higher error rate.

Introduction

Cognitive processes are accompanied by the mass activity of specific brain areas, particularly the cortex. Such activity can even be measured on the scalp as phasic or tonic electrical changes, the event-related potential (ERP). Hence it appears feasible to use the ERP as a direct physiological measure of cognitive processes during information processing.

ERPs have several advantages over other physiological measures:

1) they are noninvasive;

2) they do not interfere with the task;

3) they can measure different cognitive processing stages in real time;

4) they can measure the dynamics of those processes in time;

5) they can potentially yield information about the effort or expenditure of resources for a given task, i.e. elucidate the ratio of effort to outcome.

An ERP consists of different components that are separated in time. The single ERP components usually have distinct maxima on the scalp (Fig.1) that are spatially and temporally separable.