Preparatory visuo-motor cortical network of the contingent negative variation estimated by current density

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Abstract

The present report studied the intracerebral current density of the contingent negative variation (CNV) during a visuo-manual task using the gap paradigm. The CNV is usually obtained during preparatory periods for perception and action. In this experiment right-hand responses were required. The CNV potential was obtained during the preparatory period from electrodes placed at 58 scalp sites. The CNV showed an early and a late phase. Scalp voltage and source current density maps showed that the early phase was focused on frontal midline sites. The late phase had two foci, one overlying the primary motor cortex and one over occipital sites. When analyzed by low-resolution tomography, the early phase of the CNV showed activations in the supplementary motor area (SMA), the anterior cingulate cortex (ACC), and some posterior areas. The late phase had anterior activations in the left prefrontal cortex, middle frontal cortex, primary motor cortex, ACC, and SMA; and several posterior activations including those in the medial occipital cortex, middle inferior occipital cortex, posterior cingulate cortex, and temporal and parietal areas. Results from the activated areas and their temporal dynamics during the preparatory period suggest that the ACC and the SMA areas recruit the action- and perception-related areas needed to process the expected subsequent imperative task.

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Introduction

When two subsequent stimuli S1-S2 are presented, the preparation for an imperative stimulus (the S2) induced by the warning stimulus (S1) generates the contingent negative variation (CNV) (Walter et al., 1964; Rockstroh et al., 1982). CNV is not only relevant in basic neurobiological terms, but has proved sensitive to various neural disorders such as attention-deficit/hyperactivity disorder (Perchet et al., 2001), schizophrenia (Heimberg et al., 1999; Klein et al., 2000), depression (Heimberg et al., 1999), and anorexia nervosa (Torigoe et al., 1999).

From a functional perspective it has been proposed that the S1 acts as a warning stimulus that triggers the activation of areas needed for the subsequent processing of the S2 stimulus (Gómez et al., 2001). Traditionally, use of event-related potentials (ERPs) has led to the suggestion that the CNV has at least two phases: an early one relating to orientation and induced by the warning stimulus (Weerts and Lang, 1973), and the late phase relating to the motor preparation for the response (Loveless and Sanford, 1974). In the above-mentioned studies the early phase has a frontal bilateral distribution. Different ERPs and lesion studies suggest that the supplementary motor area (SMA) and the anterior cingulate cortex (ACC) are the sources for this component of the CNV (Cui et al., 2001; Zappoli et al., 2000; Gómez et al., 2001). In addition, it has been proposed that the early phase of the CNV during time-estimation tasks has its origin in the SMA and plays a major role in timing processes (Vidal et al., 1995; Macar et al., 1999).

The late CNV phase is contralateral to the hand to be...