

Working memory related gamma oscillations in schizophrenia patients

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Abstract

Recent reports show that the capability of neural networks supporting high-frequency synchronization is reduced in the brain of schizophrenia patients. Specifically, deficits in gamma activity have been shown in schizophrenia patients during perception and simple cognitive tasks. However little is known about alterations in gamma responses during complex and higher cognitive processing. The main objective of this study was to investigate modulation of event-related gamma responses in tasks varying working memory (WM) load in schizophrenia patients ($N=10$) and healthy controls ($N=10$). Gamma amplitude values were obtained for a simple choice reaction task, a low WM demand task, and a high WM demand task. During all three tasks schizophrenia patients showed significantly slower reaction times and higher error rates than controls. A gradual increase of gamma amplitudes after stimulus onset was associated with increase of WM load in controls. In contrast, high amplitude gamma oscillations remained constant regardless of task difficulty in patients. These results suggest that healthy subjects used various cognitive strategies depending on task difficulty, while schizophrenia patients needed to initiate complex cognitive processes similar to those used during processing of novel contexts or stimuli even for the simple choice reaction task with low cognitive demand.

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1. Introduction

One of the crucial cognitive processes which are affected in schizophrenia are processes related to working memory (WM). WM refers to a limited, attention-demanding capacity to hold and manipulate information in the mind for several seconds in the context of cognitive activity (Baddeley and Hitch, 1974). Evidence from human lesion studies suggests that WM depends on the activity of a number of cortical regions, primarily the prefrontal and parietal regions (Petrides and Milner, 1982; Frisk and Milner, 1990; Owen et al., 1996). Neuroimaging studies have

also confirmed that the prefrontal regions, as well as other areas of association cortex, are active during WM tasks (Smith et al., 1996; Braver et al., 1997; Cohen et al., 1997; Courtney et al., 1998; Romanski, 2004). Event-related potential (ERP) studies suggest that WM is a function of a distributed system with both task specific and task independent components (Gevins et al., 1997; Kusak et al., 2000; Halgren et al., 2002; Herrmann et al., 2004a, 2004b). It appears that abnormalities in such a distributed system, especially the abnormal temporal integration of brain networks, may account for the core disturbance in schizophrenia (Lee et al., 2001, 2003). Many other studies support this hypothesis and show abnormalities in neural circuitry, especially in functional gamma activity in schizophrenia (Haig et al., 2000; Spencer et al., 2003, 2004; Herrmann and Demiralp, 2005). It has been suggested that the impaired functional (inter- and intra-hemispheric) neuronal connectivity is reflected in reduced phase synchrony as well as reduced and delayed evoked

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