

# Impairment of source memory in patients with obsessive–compulsive disorder: Equivalent current dipole analysis

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## Abstract

We examined memory performance and cortical source localization of old/new effects in a source memory task in obsessive–compulsive disorder (OCD) patients by employing an equivalent current dipole (ECD) model using EEG and a realistic head model. Event-related potentials (ERPs) were recorded while 14 OCD patients and 14 age-, sex-, handedness-, and educational level-matched healthy control subjects performed recognition tasks for spoken words (items) or for the voice of the speaker of spoken words (sources). In the item memory task, both groups showed ERP old/new effects at 300–700 ms. In the source memory task, the controls showed ERP old/new effects at 400–700 ms, whereas the OCD patients did not. Compared with the controls, the OCD patients showed significantly lower source accuracy and prolonged reaction times to the old words with accurate voice judgments. There were no differences between the OCD and control groups with regard to the locations of the ERP generators elicited by source correct and correct rejection conditions. The OCD patients showed significantly altered hemispheric asymmetry of ECD power in the frontal lobe during source memory retrieval, compared with the controls. These results indicate that OCD patients have preserved item memory about content, but impaired source memory about context.

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## 1. Introduction

There is growing evidence for cognitive impairment in obsessive–compulsive disorder (OCD) related to an

underlying frontal–striatal dysfunction (Mataix-Cols and van den Heuvel, 2006; Purcell et al., 1998). It has been reported that OCD patients show impaired memory and abnormal brain activation compared with normal controls while performing memory tasks (Kathmann et al., 2005; Roth et al., 2004). Most studies of verbal explicit memory have reported preserved verbal memory in OCD patients (Schmidtke et al., 1998), but many studies have shown a nonverbal memory deficit in OCD patients (Penades et al., 2005). Several reports have also

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described verbal and/or nonverbal episodic memory deficits, and have suggested that these memory impairments are associated with impaired strategic processing in OCD patients (Savage et al., 2000; Deckersbach et al., 2004).

Episodic memory refers to memory of events that occurred in a particular place at a particular time and includes information about the context of an experience (source memory), as well as its content (item memory). In a commonly used paradigm, subjects are required to study word items during study phase. These items can be presented, for example, in two different lists, or by male and female voices. The test of both item and source memory included all of the old (studied, repeated) words mixed with an equal number of new (unstudied, novel) words. At item memory test, subjects are asked to make old/new recognition decisions to presented words. At source memory test, for items judges old, subjects make a subsequent source (i.e., list or voice) judgment.

Disruptions of episodic memory may contribute to clinical OC symptoms such as chronic doubt and repetitive behaviors (Savage, 1998; Savage et al., 2000). Several researchers have suggested that repeated checking becomes increasingly alike, blurring the distinctiveness of a current episode (Coles et al., 2006). Ecker and Engelkamp (1995) showed that OCD-checkers experienced greater confusion between actual and imagined behaviors than did low checking controls; the OCD patients also exhibited deficits in their vivid recall of memory episodes. Savage et al. (2000) reported the possibility that OCD patients focus on details without appreciating the larger perceptual or semantic context when presented with complex ambiguous situations. Rubenstein et al. (1993) investigated source memory of personal actions in college students with subclinical checking symptoms and healthy control subjects. When required to judge the source of an action, checkers were more confused as to whether they had performed, written, or observed the perceived action.

Previous neuropsychological and functional neuroimaging studies have shown that the prefrontal cortices play a pivotal role in the retrieval of source memory (Glisky et al., 1995; Johnson, 1997). Several studies using fMRI have demonstrated that recollection of source information is associated with left frontal cortex activity (Dobbins et al., 2004; Rugg et al., 1999). Owing to the high temporal resolution available for the study of brain activity, event-related potential (ERP) in particular has been widely used to study source memory. Numerous studies of source memory using ERP have revealed two major electrophysiological correlates, which have temporally and topographically distinct effects in differentiating

old from new items (Smith et al., 2004; Wegesin et al., 2002; Wilding and Rugg, 1997). First, the early posterior old/new effect comprises a positive shift in the waveforms from approximately 400 to 800 ms and has been interpreted as being closely tied to processes necessary for recollection (Friedman and Johnson, 2000; Wilding, 2000). Second, the late frontal old/new effect starts at around 600 ms and continues through to the end of the recording epoch. Studies have suggested that this second old/new effect reflects processes that operate on the products of successful retrieval (Wilding and Rugg, 1996; Wilding and Rugg, 1997).

At present, it is unclear whether the poor performance in source memory tasks observed in OCD patients is the result of memory impairment per se or metamemory (confidence) dysfunction, or is secondary to an impairment of organizational strategy. Considering the frontal dysfunction of OCD pathology and frontal function in source memory, OCD patients may undergo impairment of source memory per se. As the exact nature of the source memory deficit in OCD patients is still elusive, we examined whether there is a source memory deficit per se in OCD patients and investigated the localization of cortical generators in OCD patients during the performance of a source memory task. For these purposes, we recorded the ERPs resulting from item and source memory tasks in OCD patients and matched healthy control participants. For the analysis of the cortical source, we used equivalent current dipole (ECD) models with the subjects' own 3D MRI as a realistic head model. In addition, we investigated the relation between cognitive confidence and behavioral data of item and source memory tasks in order to measure the degree of interference in cognitive confidence during the performance of episodic memory tasks. To our knowledge, no prior study has directly measured source memory using ERP in OCD patients.

## 2. Methods

### 2.1. Subjects

Fourteen right-handed patients with OCD (males 7, females 7) were recruited from Seoul National University Hospital, OCD outpatient clinic and had a DSM-IV diagnosis of OCD. Patients were excluded if they had a comorbid DSM-IV diagnosis of major depressive disorder or dysthymia. Symptom severity and level of functioning were rated with the Yale–Brown Obsessive–Compulsive Scale (Y–BOCS; Goodman et al., 1989), the Maudsley Obsessive Compulsive Inventory (MOCI; Hodgson and Rachman, 1977), Beck Depression

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