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Source monitoring in Alzheimer's Disease

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ABSTRACT

Source monitoring is the process of making judgments about the origin of memories. There are three categories of source monitoring: reality monitoring (discrimination between self- versus other-generated sources), external monitoring (discrimination between several external sources), and internal monitoring (discrimination between two types of self-generated sources). We investigated whether Alzheimer's Disease (AD) patients, when compared with young and older adults, are impaired at the same level on the three source monitoring categories. We designed three tasks, one for each source monitoring category. In the first task, aimed at reality monitoring, participants had to remember whether objects were previously placed in a bag by themselves or by the experimenter. In the second task, assessing external monitoring, participants had to remember whether the experimenter had previously placed objects in the bag with a black or white gloved hand. In the third task, measuring internal monitoring, participants had to remember whether they had previously placed or imagined themselves placing objects in the bag. Participants showed worse performances in the external and internal monitoring tasks, when compared with reality monitoring. The external monitoring deficit was even more pronounced in AD patients. Regression analyses showed that variation in the external monitoring performances was reliably predicted by inhibition. Our results emphasize the role of inhibitory processes in AD patients' source monitoring decline. The close relation between source and inhibitory decline in AD is interpreted in terms of a common neural base for both concepts.

1. Introduction

Source monitoring is the processes of making judgments about the origin or the source of an information (Johnson, Hashtroudi, & Lindsay, 1993). Johnson et al. (1993) describe three categories of source monitoring: reality, external, and internal source monitoring. Reality monitoring refers to the ability to discriminate between memories of self- versus other-generated sources (e.g., "Did I close the door or did John close it?"). External source monitoring indicates the ability to discriminate between memories derived from at least two external sources (e.g., "Did John close the door or did Jim close it?"), whereas internal source monitoring refers to the ability to discriminate between at least two types of self-generated sources ("Did I close the door or am I imagining that I closed the door?").

Source monitoring has been traditionally linked to prefrontal cortex functioning. Clinical neuropsychological research suggests that patients with frontal lobe lesions have particular difficulties remembering the episodic source from which information has been acquired (Schacter, Harbluk, & McLachlan, 1984). Recent neuroimaging studies show that the prefrontal cortex can be further functionally fractionated with respect to the processes involved in source monitoring. For instance, during source monitoring retrieval, dorsolateral prefrontal cortex is subjacent to evaluation processes, whereas mid ventrolateral prefrontal cortex may be more involved in the active retrieval and selection of information from posterior regions (Mitchell & Johnson, 2009).

There is growing evidence that AD patients show impairments of source monitoring (Fairfield & Mammarella, 2009). AD patients are known to have progressive brain damage, which predominantly affects temporoparietal regions at the early stages of the disease, with more temporal neocortex damage as the disease progresses (Allain et al., 2008). In parallel, resting state measurements of regional cerebral blood and glucose metabolism by single-photon emission computerized tomography (SPECT) and positron emission tomography (PET) imaging, have shown early frontal perfusion changes in the development of the disease (see for example, Morris, 1996). Frontal dysfunctioning in AD patients is thought to be related to their source monitoring failures. Mitchell, Sullivan,

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Schacter, and Budson (2006), for example, argue that misattribution errors in these patients may be attributable to their frontal impairments.

Although several studies have investigated source monitoring in AD patients, no attempt was made to simultaneously assess the three categories of source monitoring, as described by Johnson et al. (1993). In order to clarify our own research question, we will describe the tasks used in previous studies investigating AD patients' source monitoring ability. We will also classify these tasks according to the one of the source monitoring categories (i.e., reality, external, and internal tasks).

The first source monitoring category is reality monitoring, or discrimination between self- versus other-generated memories. Four studies dealing with reality monitoring in AD could be found. Multhaup and Balota (1997) asked AD patients either to complete sentences with the first word that came to their mind or to watch the experimenter completing other sentences. Afterwards, participants had to decide whether words were self- or experimenter-generated. The results showed that AD patients had difficulties to attribute words to the correct source, suggesting a decline in reality monitoring. The same conclusion was drawn by Fairfield and Mammarella (2009), who asked AD patients either to imagine or to watch the experimenter performing actions and to later decide whether these actions were self-imagined or experimenter-performed. Poor reality monitoring in AD patients was also found by Goldman, Winograd, Goldstein, O'Jile, and Green (1994) and Dalla Barba, Nedjam, and DuBois (1999). In the first study, AD patients were asked to judge whether facts were originally self- or experimenter-read, whereas in the second study AD patients had to determine whether drawings of objects were originally self-imagined or exposed by the experimenter.

On the other hand, the poor monitoring in AD patients was not found with tasks tapping external monitoring. Goldman et al. (1994) asked AD patients to determine, within a 30-s or a 1-week retention delay, whether memories were previously acquired via the experimenter or someone else. The authors found that, in comparison with an earlier reported experiment assessing reality monitoring, AD patients had no difficulties on the external source task.

Just as with external monitoring, several studies have shown normal performances of AD patients in internal source monitoring tasks. In the above-mentioned study of Fairfield and Mammarella (2009), for example, AD patients were also asked either to perform actions or to imagine performing actions and to later decide whether these actions were originally self-performed or self-imagined. In contrast with the task assessing reality monitoring, the authors found better performances of patients with AD on the internal source monitoring task. The same conclusion was also drawn in the above-mentioned study of Multhaup and Balota (1997). In this study, AD patients were also asked either to complete sentences or to read other sentences to later decide whether sentences were self-completed or self-read. AD patients had less difficulty attributing words to the correspondent source than in the task assessing reality monitoring.

In summary, neither a simultaneous comparison of the three source monitoring categories nor a comparison of external and internal source monitoring has been investigated in AD patients up to now. However, the reported studies suggest better performance of AD patients in external and internal tasks than in tasks tapping reality monitoring.

Poor source monitoring in older adults and AD patients might be related to their poor executive resources. Craik, Morris, Morris, and Loewen (1990), for example, have suggested a relationship between age-related source monitoring decline and executive dysfunction. These authors exposed participants to experimenter-made-up facts added to true facts about celebrities. The participants were later asked to recall where the facts had been learned (e.g., television, newspaper, or the experiment). Additionally to this external source monitoring task, the participants were administered two executive tasks: the Wisconsin Card Sorting Test (WCST, Grant & Berg, 1948) and a verbal fluency task. The authors found significant correlations between the performance on the source monitoring and the executive tasks.

1.1. Our paper

To better understand source monitoring in AD patients, we investigated the performance of these patients in the three source monitoring categories. As mentioned earlier, several studies showed better performance of these patients in external and internal tasks than in tasks tapping reality monitoring (Fairfield & Mammarella, 2009; Goldman et al., 1994; Multhaup & Balota, 1997). Therefore, we expected better performances of AD patients in external and internal monitoring tasks rather than reality monitoring tasks. Although no comparison between external and internal source monitoring with AD patients has been made to date, we hypothesize that AD patients will perform worse with internal than external monitoring tasks. This hypothesis is based on the idea that AD patients have distinctive difficulties to use cognitive operations accompanying internal processes (Fairfield & Mammarella, 2009).

Taking into account executive deterioration in AD (e.g. Perry & Hodges, 1999), and also the suggested link between age-related source monitoring decline and executive dysfunction (Craik et al., 1990), we expect significant correlations between executive and source monitoring impairments in AD patients. More specifically, and considering the method of Craik et al. (1990), we expect significant correlation between executive and external source monitoring performances in these patients.

2. Method

2.1. Participants

Eighteen patients with AD, 18 healthy older and 18 healthy young adults voluntarily participated in this study. Demographical data of the three participant groups are described in Table 1.

AD patients were recruited from local retirement homes and their score on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) ranged from 21 to 26 points. Their referring neurologists diagnosed probable AD on the basis of the research criteria of the National Institute of Neurological and Communicative Disorders and Stroke–Alzheimer's Disease and Related Disorders Association (McKhann et al., 1984). The patients were all in the mild stage of dementia severity. Their age and sociocultural level in terms of years of education was matched with those of a group of older adults, $t(34) = 1.38$, $p > .10$, and, $t(34) = 1.64$, $p > .10$, respectively. These older participants were often the spouses, relatives, or friends of the AD patients. The

Table 1
Means (and Standard Deviations) of characteristics of participants in the three study groups.

Number of participants	Young 18	Older 18	AD 18
Sex (m/f)	6/12	6/12	5/13
Age in years	21.78 (3.56)***	73.28 (6.35)n/s	76.11 (5.92)
Education in years	14.17 (2.26)***	10.67 (3.05)n/s	9.06 (2.77)
Mill Hill	33.83 (7.62)n/s	36.39 (7.52)	–
MMSE	–	28.28 (1.32)***	23.23 (1.59)

Note. AD = Alzheimer's Disease.
n/s The difference with the adjacent group was non-significant.
*** The difference with the adjacent group was significant at $p < .001$.