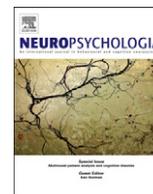




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# Alzheimer's disease can spare local metacognition despite global anosognosia: Revisiting the confidence–accuracy relationship in episodic memory

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## ABSTRACT

Alzheimer's disease (AD) can impair metacognition in addition to more basic cognitive functions like memory. However, while global metacognitive inaccuracies are well documented (i.e., low deficit awareness, or anosognosia), the evidence is mixed regarding the effects of AD on local or task-based metacognitive judgments. Here we investigated local metacognition with respect to the confidence–accuracy relationship in episodic memory (i.e., metamemory). AD and control participants studied pictures of common objects and their verbal labels, and then took forced-choice picture recollection tests using the verbal labels as retrieval cues. We found that item-based confidence judgments discriminated between accurate and inaccurate recollection responses in both groups, implicating relatively spared metamemory in AD. By contrast, there was evidence for global metacognitive deficiencies, as AD participants underestimated the severity of their everyday problems compared to an informant's assessment. Within the AD group, individual differences in global metacognition were related to recollection accuracy, and global metacognition for everyday memory problems was related to task-based metacognitive accuracy. These findings suggest that AD can spare the confidence–accuracy relationship in recollection tasks, and that global and local metacognition measures tap overlapping neuropsychological processes.

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## 1. Introduction

It is well established that the early or mild stages of Alzheimer's disease (AD) impair basic cognitive abilities, but less is known about the effects of AD on metacognition. With respect to basic cognitive abilities, mild AD impairs the ability to consciously recall or recognize recently presented information (episodic memory), and also tends to impair the ability to flexibly control attention in cognitive tasks (executive functions). These are the most frequently studied aspects of cognition in early AD, and significant impairment in these basic cognitive abilities in older adults is the hallmark of AD (Storandt, 2008). In addition to these basic cognitive abilities, AD also can impair metacognition. Metacognition is knowledge about cognition (Flavell, 1979; Nelson & Narens, 1994), including the ability to think about one's own basic cognitive abilities (such as episodic memory or executive functions). It is important to understand how

different aspects of metacognition might be affected by AD, because accurate insight into one's own cognitive decline is needed to realistically adjust one's personal goals and avoid risky behaviors (e.g., Starkstein, Jorge, Mizahi, Adrian, & Robinson, 2007).

The research literature on metacognition in AD can be broadly divided into two different areas of inquiry, depending on the scope of the metacognitive processes under consideration (for reviews, see Pannu & Kaszniak, 2005; Souchay, 2007). One research area is primarily concerned with an individual's awareness of their cognitive abilities and declines at a global level. By the global level, we mean general assessments or beliefs about cognitive abilities as they might apply to various activities of daily living (e.g., "In general, I believe my memory is failing me."). Global metacognitive assessments are thought to involve long-term memory representations that contain information about one's personal abilities or self-efficacy beliefs (Mograbi, Brown, & Morris, 2009). In contrast to research on global metacognition, other research is primarily concerned with an individual's awareness of their cognitive abilities at a more local or task-specific level (Hertzog & Dunlosky, 2011). By local metacognition, we mean the online monitoring of cognitive task performance, as when people are asked to assess their performance

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across different experimental trials using subjective judgments such as confidence ratings (e.g., “I am not very confident in my recall of this particular item on this memory test.”). This distinction between global and local metacognition is based on the object of the metacognitive assessment (i.e., assessing one’s general cognitive abilities versus one’s task-specific cognitive abilities, respectively), but the memory representations that are used to make these different kinds of self-assessment might overlap. For example, global assessments of cognitive ability might be affected by recent experiences with cognitive tasks, and local assessments of task performance might be affected by general representations of self-efficacy.

Deficits in global metacognition are fairly well documented in AD. Many people with AD are thought to have some degree of anosognosia – a relative lack of awareness of the severity of their everyday cognitive declines – although the extent of awareness varies considerably across individuals (Kaszniak & Edmonds, 2010). Evidence for this kind of global metacognitive impairment has come from a variety of sources, including anecdotal reports, clinically structured interviews, and deviations between self-reports and informant-reports on questionnaires that probe everyday problems (Clare, 2004). This kind of metacognition has been investigated most extensively in the clinical research literature, because personal insight into overall cognitive impairments is likely to affect one’s decisions and behaviors in a variety of real-life situations (e.g., avoiding risky driving, Cotrell & Wild, 1999).

The research literature is more mixed with respect to the possible effects of the early stages of AD on more local metacognitive abilities. Some cognitive tasks reveal impaired metacognition in AD relative to controls. For example, Schacter, McLachlan, Moscovitch, and Tulving (1986) found that AD participants overestimated their predicted recall abilities prior to a word recall task, and Souchay, Isingrini, and Gil (2002) found that AD impaired feeling-of-knowing judgments on a word recognition memory task. Moreover, some studies have found that individual variability in local metacognitive measures was related to more global metacognitive measures in AD, suggesting that these two kinds of metacognitive measures might tap overlapping processes or representations (Cosentino, Metcalfe, Butterfield, & Stern, 2007; Schmitter-Edgecombe & Seelye, 2011). In contrast to these studies, several other cognitive tasks demonstrate intact local metacognition in AD participants relative to controls. For example, Bäckman and Lipinska (1993) found that AD did not impair feeling-of-knowing judgments on a general knowledge task, and Moulin, Perfect and, Jones (2000) found that AD did not impair judgments-of-learning on a word recall task. AD participants also can accurately recalibrate their metacognitive ratings immediately after taking an episodic memory test (e.g., Schmitter-Edgecombe & Seelye, 2011; Stewart, McGeown, Shanks, & Venneri, 2010), suggesting relatively intact metacognitive performance once there is some degree of exposure to the task. These latter findings are inconsistent with the findings of impaired global metacognition in AD, and they suggest a discontinuity between local and global metacognitive measures.

There are several possible reasons for these discrepancies in the literature on local metacognition in AD, including the kinds of metacognitive judgments used and the aspects of cognition that were assessed by the task. Along these lines, Dodson, Spaniol, O’Connor, Deason, Ally, and Budson (2011) recently suggested that local metacognitive measures obtained during episodic memory tasks might be particularly sensitive to AD impairments, because episodic memory decline in the early stages of AD may make monitoring performance on these kinds of tasks particularly challenging (also see Pannu & Kaszniak, 2005). More specifically, Dodson et al. (2011) argued that AD participants have difficulty making accurate confidence judgments on a memory test due to increased susceptibility to false recollections that drive high-

confidence errors. As described in the next section, however, relatively few studies have investigated the confidence–accuracy relationship in AD and the results have been mixed.

## 2. Episodic memory confidence

To our knowledge only three studies have investigated the effects of mild AD on the confidence–accuracy relationship in episodic memory retrieval (i.e., metamemory). The first two studies did not find impaired metamemory in AD. Pappas, Sunderland, Weingartner, Vitiello, Martinson, and Putnam (1992) found that AD participants and controls were equally accurate at using confidence judgments to assess their ability to recall the final word from studied sentences. A study by Moulin, James, Perfect, and Jones (2003) also found an intact confidence–accuracy relationship in AD participants. In this study, episodic memory was assessed using a two-alternative forced-choice test (2AFC), in which a studied word was paired with a nonstudied word. Unlike the recall test used by Pappas et al. (1992), which was potentially sensitive to group differences in response bias, the 2AFC test eliminated this kind of bias, demonstrating that AD participants can have intact metamemory in a very different kind of testing situation.

In contrast to the two studies showing a preserved confidence–accuracy relationship in episodic memory in AD, Dodson et al. (2011) found impairment in AD participants relative to controls. In this task, participants first studied sentences spoken by a male or a female. On a subsequent test, they were visually presented with studied and nonstudied sentences and needed to make four judgments: an old–new recognition decision, a confidence judgment corresponding to this recognition decision, a male–female source memory decision (for items recognized as “old”), and a confidence judgment corresponding to this source memory decision. Dodson et al. (2011) found a reduced confidence–accuracy relationship in the AD group compared to the control group, for both recognition and source memory measures. This metamemory impairment was obtained when memory accuracy was lower in the AD group compared to controls (as in Pappas et al., 1992; Moulin et al., 2003), and also when the task procedures were varied so that memory accuracy could be artificially matched across groups. They also found that the source memory deficit in AD participants was most pronounced at the highest levels of confidence, suggesting that AD participants were especially prone to high-confidence false recollections.

The addition of the source memory decision in Dodson et al. (2011) is a significant advance in metamemory research, because unlike the recognition decision (as well as the tests used in Pappas et al., 1992; Moulin et al., 2003), accuracy on this source test required the recollection of specific details from the study phase. The targeting of recollection is theoretically important, because many memory impairments in AD outside the laboratory are likely to involve the recollection of specific details for personally important or salient events (e.g., Budson, Simons, Waring, Sullivan, Hussion, & Schacter, 2007). Targeting recollection also avoids ambiguities inherent to recognition memory tasks, which can be influenced by vague feelings of “oldness” towards a retrieval cue (familiarity) in addition to the conscious retrieval of specific details (recollections) that are associated with that retrieval cue (i.e., the dual-process framework, see Yonelinas, 2002). Because AD impairs the recollection of specific details or associated information more than it impairs general feelings of familiarity towards test items (e.g., Budson, Dodson, Daffner, & Schacter, 2005; Dalla Barba, 1997; Gallo, Sullivan, Daffner, Schacter, & Budson, 2004), the failure to control for these different memory processes can complicate the interpretation of metacognitive judgments. For example, a greater reliance on familiarity in AD participants might impair the confidence–accuracy

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