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The effect of healthy aging and mild cognitive impairment on semantic ambiguity detection

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ABSTRACT

Individuals with Mild Cognitive Impairment (MCI) display cognitive deficits that distinguish them from healthy elders, but are not yet severe enough for a diagnosis of dementia. Some researchers report subtle language impairments in individuals with MCI when the required tasks rely on executive function. The present study used an on-line decision task to examine how semantic processing is affected by MCI. Thirty healthy young adults, 20 healthy older adults, and 11 individuals with MCI were administered an ambiguity decision task. Participants saw words and decided if each word had one meaning or more than one meaning. The words ranged in number of meanings (NOM: Few Meanings or Many Meanings) and intra-word meaning relatedness (Low Related or High Related). Correct response times and accuracy were measured. Overall, the MCI group responded slower than the other two groups. There was a significant NOM × Group interaction reflecting a stronger NOM effect for the MCI group than for the other two groups. A post-hoc discriminant analysis correctly classified 77.4% of the participants and was statistically significant. In making ambiguity decisions, individuals with MCI seem to experience additional semantic interference likely due to mild executive dysfunction. The observation of intra-word relatedness effects in the MCI group suggests that the semantic representations in these individuals are relatively intact and it is executive driven access to these representations that is impaired.

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1. Introduction

Mild Cognitive Impairment (MCI) characterizes a stage at which an individual displays cognitive deficits that distinguish them from healthy elders, but are not yet severe enough for a diagnosis of dementia. Individuals diagnosed with MCI are more likely to progress to Alzheimer's disease (AD), with conversion rates ranging from lower than 15% per year to up to 41% after the first year (e.g., Geslani, Tierney, Herrmann, & Szalai, 2005; Petersen et al., 2001). However, there is disagreement among researchers as to whether MCI inevitably progresses to AD (see Chertkow, 2002; Mitchell & Shiri-Feshki, 2009; Morris et al., 2001). Some studies even report subgroups of individuals, originally classified as MCI, that subsequently revert to "unimpaired" status (e.g., Ravaglia et al., 2006). Many individuals with MCI present with the same neuropathological characteristics as individuals with AD, including the presence of neurofibrillary tangles and neuritic plaques (e.g., Morris et al., 2001; Price & Morris, 1999; Sabbagh et al., 2006). Neuroimaging studies suggest similar sites of neuropathology associated with AD and MCI. The degree of hippocampal atrophy has been found to be similar in MCI and AD patients (Du et al., 2001; Jack et al., 1997) and imaging studies that demonstrate neuroanatomical distinct profiles still reveal overlapping areas (Jhoo et al., 2010; Sexton et al., 2010).

The early characterization of MCI was episodic memory impairment with other cognitive functions relatively preserved (Morris et al., 2001; Petersen et al., 1999). Petersen et al. (1999) reported that individuals with MCI resembled patients with AD in memory tests and confrontation naming, while scoring more like healthy older adults in tests of general cognition. Given differences in individual cognitive profiles, several researchers have proposed further classification of individuals with MCI into specific subgroups, such as single-domain amnestic MCI (a-MCI), multiple-domain amnestic-MCI (a-MCI+), single-domain nonamnestic-MCI (na-MCI), and multiple-domain nonamnestic-MCI (na-MCI+) (e.g., Petersen & Morris, 2005). Other researchers have questioned the diagnostic utility and reliability of these subtype classifications and report evidence that such classifications are often unstable over time (Summers & Saunders, 2012). Recent studies suggest that single-domain amnestic MCI is relatively rare and most individuals with MCI display deficits across multiple domains (e.g., Saunders & Summers, 2010). Adults with MCI have shown impaired performance in many areas, including learning, working memory, and semantic encoding (e.g., Grober et al., 2008; Price et al., 2010; Rapp & Reischies, 2005; Twamley, Ropacki, & Bondi, 2006). Executive dysfunction in individuals with MCI has been reported in a range of tasks (e.g., Belleville, Bherer, Lepage, Chertkow, & Gauthier, 2008; Brandt et al., 2009; Traykov et al., 2007). Further, there is evidence that degree of executive dysfunction may predict later progression to dementia in individuals with MCI (e.g., Albert, Blacker, Moss, Tanzi, & McArdle, 2007; Belanger & Belleville, 2009).

It is unclear whether language processing is significantly impaired in MCI. There are reports of MCI associated deficits in confrontation/object naming and semantic processing tasks (e.g., Grundman et al., 2004; Joubert et al., 2010; Petersen et al., 1999). Additionally, several studies show verbal fluency deficits in individuals with MCI (e.g., Murphy, Rich, & Troyer, 2006; Petersen et al., 1999; Wang, Lirng, Lin, Chang, & Liu, 2006; see Taler & Phillips, 2008, for a review), although the reported impairments are less severe than those associated with AD. Other researchers, however, report intact verbal fluency performance in adults with MCI (e.g., Albert et al., 2007; Collie, Maruff, & Currie, 2002; Lambon Ralph et al., 2003).

Given that individuals with MCI exhibit impaired performance in some language tasks, but not in others, some researchers propose that the effect of MCI is dependent on the nature of the experimental task. MCI is associated with deficits in working memory and executive function, thus, the deficient performance observed in language tasks may be due to underlying executive dysfunction. Duong, Whitehead, Hanratty, and Chertkow (2006) proposed that the effect of MCI on lexical processing would be most evident in tasks that require intentional, conscious processing, such as verbal fluency, confrontation naming, and semantic decision tasks. Tasks that rely on more automatic access of lexical or semantic information, such as lexical decision, should be less sensitive to the deficits associated with MCI. Although a parsimonious account, there are findings that conflict with this hypothesis. Taler and Jarema (2006) studied the effect of semantic ambiguity on lexical decision responses. A response time advantage for ambiguous words has been previously observed in healthy young adults (e.g., Millis & Button, 1989; Rubinstein, Garfield, & Millikan, 1970; see also Azuma & Van Orden, 1997). Taler and