The Nature of Automatic Semantic Retrieval in Individuals with Mild Cognitive Impairment

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Alzheimer's disease (AD), a progressive and terminal dementia, is expected to impact an estimated 14 million Americans by 2050 (Alzheimer's Association, 2019). Before an AD diagnosis, many individuals are diagnosed with mild cognitive impairment (MCI) and have similar, but less severe, symptoms compared to those with AD (Carter et al., 2012). A common occurrence in even early AD is word finding deficits (Crowe et al., 1997), which significantly impacts effective communication. Semantic priming studies have shown that word finding deficits in AD may partly be due to limitations in the automaticity of semantic retrieval. However, it is unknown if the automaticity of semantic retrieval underlies word finding difficulties in individuals with MCI or if the deficit in semantic retrieval occurs later in the AD continuum.

Semantic priming tasks are considered the gold standard for assessing the organization of semantic memory. Participants see a written word (a prime) on a computer screen followed by another written word (a target). Upon seeing the target, participants make a lexical decision (Neely, 1991) by determining if the target is a real word or not. Importantly, the speed of the lexical decision is influenced by the semantic relationship between the prime-targets. Participants respond more rapidly to semantically related prime-targets (e.g., *cat – dog*) than they do to semantically unrelated prime-targets (e.g., *cup – pen*) because of spreading activation (Laisney et al., 2011; Neely, 1977). Spreading activation occurs when a word (e.g., *cat*) automatically activates other related words including members of the same category (e.g., *dog*), attributes of the target word (e.g., *whiskers* or *feet*), etc.

Spreading activation occurs unconsciously, therefore participants cannot be aware of the relationship between prime and target (McNamara, 2005). To achieve this, the amount of time between the presentation of the prime and target, known as the *stimulus onset asynchrony* (SOA), must be relatively short (400 milliseconds or less; Giffard et al., 2005; Neely, 1977).

Historically, most semantic priming tasks have been completed with healthy younger adults. These studies have shown that healthy younger adults exhibit priming for category coordinates (i.e., members of the same semantic category; e.g., *pig – horse*; Perea & Rosa, 2002). Semantic priming occurs for both distinctive attributes (e.g, *zebra – stripe*; Cree et al., 2006) and shared attributes (e.g., *lizard – tail*; Frenck-Mestre & Bueno, 1999), and also for abstract words (e.g., *comfort – peace*; Kousta et al., 2011). Though slower at responding overall, healthy older adults consistently exhibit comparable priming effects to healthy younger adults (Bennett & McEvoy, 1999; Ratcliff et al., 2004).

Individuals with mild to moderate AD typically show comparable semantic priming to healthy older adults for category coordinates (Laisney et al., 2011; Silveri et al., 1996) with a few exceptions. Individuals with AD show hypopriming (i.e., reduced priming compared to healthy

older adults; Predovan et al., 2014) for distinctive attributes even at the early stages of the disease (Laisney et al., 2011). Individuals with AD show no difference for shared attribute priming compared to healthy older adults in the earlier stage of the disease (Laisney et al., 2011; Silveri et al., 1996), but hypopriming in later stages (Giffard et al., 2002). In an examination of emotional versus emotionally neutral concrete versus abstract words, Giffard and colleagues (2015) found hypopriming for neutral abstract concepts.

Examination of semantic priming in individuals with MCI for distinctive attributes (e.g., *zebra – stripe*), shared attributes (e.g., *pigeon – wing*), category coordinates (e.g., *cat – dog*), and abstract words with neutral arousal levels (e.g., *motive – reason*) utilizing a short SOA has not occurred previously. The current study examined the semantic retrieval for healthy older adults and individuals with MCI in each of the 4 semantic relationship categories while utilizing an SOA of 250 milliseconds.

Prime-target word pairs belonged to one of three categories: (a) semantically related (e.g., *spider – web*); (b) semantically unrelated (e.g., *puddle – lesson*); or (c) nonword (e.g., *stove – loes*). Semantically related pairs (a total of 18 word pairs each) had one of four relationships: (a) distinctive attribute (e.g., *spider – web*); (b) shared attribute (e.g., *poplar – leaf*); (c) category coordinate (e.g., *trout – bass*); or (d) abstract (e.g., *policy – rule*). Semantically related targets did not differ on word length compared to semantically unrelated targets, $t(358) = 0$, $p = .50$. or on written word frequency, $t(97) = 0.86$, $p = .39$. Words were divided into six blocks of 120 word pairs each. Within each block, 50% of the words were real English words and 50% were nonwords to reduce possible postlexical attentional process effects (Laisney et al., 2011). The task was completed using SuperLab Remote (Cedrus Corporation, 2020).

The study was completed virtually due to the COVID-19 pandemic. Nineteen participants with MCI, with an ICD-10 diagnosis of MCI, and 19 demographic matched healthy older adult controls completed the study. The groups did not differ on age, $t(18) = 1.09$, $p = .29$, or education, $t(18) = 0.24$, $p = .81$. Participants with MCI had lower Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005) scores, $t(24) = 4.58$, $p < .001$ indicating a greater level of cognitive impairment.

Due to the known slower response times for individuals with MCI compared to healthy older adults (Brambati et al., 2012), raw response times were transformed to a priming percentage utilizing Laisney et al. (2011)'s transformation formula. Raw data showed priming for individuals with MCI on only shared attributes, $t(18) = 3.03$, $p = .004$ (one-tailed), $p = .007$ (two-tailed), $d = 0.69$; however, when data was transformed due to slowing, individuals with MCI demonstrated priming for shared attributes ($t(18) = 3.14$, $p = .003$ [one-tailed], $p = .006$ [two-tailed], $d = 0.72$), category coordinates ($t(18) = 1.86$, $p = .04$ [one-tailed], $p = .08$ [two-tailed], $d = 0.43$), and abstract words ($t(18) = 1.87$, $p = .04$ [one-tailed], $p = .08$ [two-tailed], $d = 0.43$) which was the identical pattern presented by healthy older adults. These findings suggest individuals with MCI exhibit functional automaticity of semantic retrieval within a wide range of word relationships. They also demonstrate the importance of transforming data for individuals with MCI even if their presenting cognitive symptoms are mild.

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