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The Word-Frequency Mirror Effect in Young, Old, and Early-Stage Alzheimer's Disease: Evidence for Two Processes in Episodic Recognition Performance

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Two experiments address the nature of the word-frequency mirror effect in episodic recognition performance and the underlying cognitive changes that occur in both healthy aging and in early-stage Dementia of the Alzheimer's Type (DAT). In Experiment 1, five groups of participants (young, healthy old, healthy old-old, very mildly demented individuals, and mildly demented individuals) studied lists of high- and low-frequency words and were given a yes/no episodic recognition test. The results indicated that there was a dramatic decrease in hit rate for low-frequency words across age and DAT, but no decrease for high-frequency words, thereby eliminating the low-frequency advantage typically found in recognition performance for the DAT individuals. For the distractor items, there was a clear advantage in rejecting low-frequency words compared to high-frequency words, and the size of this advantage was constant across groups of participants. This between-group pattern was replicated in a second experiment, in which only young adults were required to respond either under short or long response deadlines. The results are discussed with respect to an attentional control framework in which cognitively impaired groups of participants, and young adults at a short response deadline, rely more on baseline familiarity processes than on recollection-based processes. Discussion focuses on the nature of the recollection- and familiarity-based processes.

Key Words: aging; mirror effect; recognition memory; word frequency; two-process model.

Individuals with Dementia of the Alzheimers Type (DAT) produce breakdowns in a wide variety of memory tasks. Indeed, the major diagnostic criterion used by most clinicians is a deterioration in declarative/episodic memory performance (e.g., Nebes, 1992). However, the memory breakdowns are not limited to declarative/episodic memory tasks. There is also some evidence suggesting that there are breakdowns in semantic memory knowledge (e.g., Butters et al., 1987) along with impairment in procedural learning tasks in the mild form of dementia (see, e.g., Ferraro, Balota, & Conner, 1993).

Although there are a wide variety of memory changes in DAT, it is also clear that some processes appear to be relatively intact, at least early in the disease process. For example, these individuals appear to produce normal levels of repetition priming (see Balota & Duchek, 1991; Balota & Ferraro, 1996; Gabrieli et al., 1999). Interestingly, both Ferraro et al. and Gabrieli et al. have provided evidence that one will find breakdowns in early-stage DAT individuals when the implicit memory tasks place a relatively high demand on attentional systems. This attentional account is consistent with accumulating evidence that DAT individuals produce breakdowns in the attention demanding aspects of Stroop (e.g., Fisher, Freed, & Corkin, 1990; Spieler, Balota & Faust, 1996), reading with distraction (Duchek, Balota, & Thessing, 1998), spatial attention tasks (Simone & Baylis, 1997a, 1997b), and homograph disambiguation (Balota & Duchek, 1991; Faust et al., 1997). The role of attentional processes is also relevant to the changes that have been found in semantic memory tasks. For example, the large changes that are found in category fluency and Boston naming tasks in early-stage DAT individuals may be due to the attentional demands of the tasks instead of

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the integrity of the semantic memory structure *per se* (see, e.g., Balota, Watson, Duchek, & Ferraro, 1999; Nebes, Martin, & Horn, 1984; Ober & Shenaut, 1995a, 1995b). This is supported by evidence which suggests that when one minimizes the attentional demands of semantic tasks (e.g., via semantic priming procedures) very mild and mildly demented individuals produce relatively normal levels of semantic processing, even across varying levels of prime–target strengths (see Balota et al., 1999; Ober & Shenaut, 1995a, for a review).

Based on the above results, one might argue that the memory deficits observed in DAT individuals are accentuated by the attention demanding aspects of tasks, whereas more automatic operations appear to be relatively intact (see Balota & Faust, 2001; Jorm, 1986, for reviews). Similar arguments have been made regarding the cognitive changes in healthy older adults (e.g., Hasher & Zacks, 1988). It is in this light that the present experiments explore two interrelated issues: First, we attempt to take advantage of the memory profile exhibited in healthy aging and in DAT individuals to provide leverage on understanding one of the basic principles of human memory performance, referred to as the mirror effect in episodic recognition performance. Second, we use the mirror effect in episodic recognition performance to provide a better understanding of the underlying mechanisms that produce the observed episodic memory breakdowns in both healthy older adults and in individuals with early-stage DAT. We now turn to a brief discussion of the mirror effect and recent work regarding episodic memory performance in healthy older adults and in DAT individuals.

Mirror Effect in Episodic Recognition Performance

Glanzer and Adams (1985) coined the term "mirror effect" and argued that this pattern is so ubiquitous that it appears to reflect a basic principle of human episodic recognition performance. The mirror effect refers to the finding that "if there are two classes of stimuli, and one is more accurately recognized than the other, then the superior class is *both* more accurately recognized as old when old *and also* more accurately recognized as new when new" (Glanzer & Adams, 1990, p. 5). Consider, for example, the word-frequency effect in episodic recognition performance. Low-frequency words produce both a higher hit rate and a higher correct rejection rate than high-frequency words. The mirror pattern across hits and correct rejections is found across a number of quite distinct variables such as concreteness, list length, meaningfulness, pictures vs words, and other variables (see Glanzer & Adams, 1985, for a review).

Although there are a number of variables that produce the mirror effect in episodic recognition performance, we will primarily focus on word frequency in the present article. This finding is of interest for a number of distinct reasons: First, unlike many of the other variables that produce the mirror effect in recognition memory, the word-frequency effect is either eliminated (see Watkins, LeCompte, & Kim, 2000) or reversed in recall performance (e.g., Balota & Neely, 1980; Glanzer & Bowles, 1976). This dissociation between word-frequency effects as a function of retrieval task has provided a testbed for memory models. Second, although a number of models can accommodate the higher hit rate for low-frequency words compared to high-frequency words, it is more difficult to accommodate the lower false alarm rate to low-frequency words compared to high-frequency words (see Stretch & Wixted, 1998a, 1998b, for a discussion of this issue). Specifically, why should word frequency influence performance on items that were not presented during study?

Joordens and Hockley (2000) and Reder et al. (2000) have both recently developed two-process accounts of the word-frequency mirror effect. Although there are clear differences in their theoretical perspectives, there are also some important similarities. For example, both models suggest that for hit rates, there are opposing influences of a type of item-specific recollective process (which benefits low-frequency words) and a baseline familiarity process (which benefits high-frequency words). In the absence of any study episode, subjects rely primarily on baseline familiarity and so produce higher false