

Taking the Thumbs off the Multidimensional Scales in the Debate on Semantic Memory and Alzheimer's Disease: A Comment on Storms et al. (2003)

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G. Storms, T. Dirix, J. Saerens, S. Verstraeten, and P. P. De Deyn (2003) bring into focus at least 3 important issues. First, the performance of even simple tasks may be affected by several basic cognitive processes. Second, the statistical variance that these processes contribute to task performance may be different for a group of participants with neuropsychological deficits than for normal control participants. Third, claims regarding the nature of semantic memory in Alzheimer's disease (AD) reflect indeterminacy about the nature and assessment of semantic memory itself. Critically, their analysis suggests that the T. Shallice and E. K. Warrington (1979) criteria widely used to operationalize the semantic memory deficit in AD be carefully scrutinized and reevaluated.

Storms, Dirix, Saerens, Verstraeten, and De Deyn's (2003) incisive analysis of the various studies that have used multidimensional scaling and cluster analysis to compare the structure of semantic memory of patients with Alzheimer's disease (AD) with normal control adults brings into focus at least three important issues: First, it is likely that several basic cognitive processes or components contribute to what appear to be relatively simple cognitive, neuropsychological procedures. For example, tasks that are often used to provide information about semantic knowledge, such as card sorting and word list generation, also require attention, semantic retrieval, decision processes, and perhaps other psychological entities that are not easily or intuitively identified. Although this basic axiom of componentiality drives much of contemporary cognitive psychology, it is not always easy or obvious to tease apart or deconstruct more complex processes into its more elementary components. We are a long way off from a cognitive periodic table to classify and identify the basic structure of cognitive functions. The analysis of tasks used to make inferences about semantic structure are no exception.

Second, even when the literature can agree on at least a heuristic analysis of the processing components of a task

such as card sorting, the greatest source of statistical variance or contribution that these component processes contribute to task performance may be different for a group of individuals with neuropsychological deficits than for normal control persons. For normal control participants (particularly college undergraduate normal control participants) who are performing card sorting or word generation tasks, such processes as attention, retrieval, and decision making may make a trivial contribution to the variance between participants. Hence, these tasks may be used to gauge such constructs as *associate strength* or *semantic structure*, as these factors will represent the largest source of variance in a data set. For neuropsychological populations, however, and particularly for neuropsychological populations that may suffer from multiple or poorly defined deficits, such processes as retrieval and decision making may represent a significant source of statistical variance, decreasing the sensitivity of these tasks to semantic structure.

From these two points we may derive a third more specific lesson regarding the particular theoretical issue of semantic memory and AD. Theoretical claims regarding the nature of semantic memory in AD reflect indeterminacy about the nature of semantic memory, the tasks used to assess semantic memory, the neuropsychology of semantic memory, as well as the specific nature of semantic memory in AD. The debate between advocates of degradation versus retrieval models of the semantic memory deficit was originally introduced in the literature on Wernicke's Aphasia in the mid-1970s and even earlier (e.g., Goodglass & Baker, 1976; Howes, 1967; Zurif, Caramazza, Myerson, & Galvin, 1974). The parallels to the literature reviewed by Storms et al. (2003) are striking. A number of studies had appeared using tasks that were assumed to be sensitive to semantic knowledge and interpreted as supporting the notion that Wernicke's aphasic patients suffered from an erosion of semantic knowledge. The construct of *semantic degradation* was originally offered as a kind of a default position

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that was at least descriptive of aphasic patients' poor performance on various semantic generation and judgment tasks. Although other types of deficits were entertained, it was simply not possible to operationalize a retrieval deficit that could be measured independently of semantic knowledge, *per se*. It was the introduction of the semantic priming paradigm that could detect evidence of semantic relationships while minimizing the attentional and retrieval demands of tasks such as card sorting, that raised the real possibility that deficits other than semantic structure might account for the poor performance by aphasic individuals on semantic tasks (e.g., Milberg & Blumstein, 1981).

Nebes, Martin, and Horn (1984) used these observations to test the then-emerging claim that patients with dementia suffered from a differential deficit in semantic knowledge (e.g., Weingartner, Kaye, Smallberg, & Ebert, 1981). The introduction of the semantic priming paradigm into the debate began what was to become a strange parallel universe of studies representing the degradation view (e.g., Chan, Salmon, Butters, & Johnson, 1995; Grober, Buschke, Kawas, & Fuld, 1985) and the impaired-access view of the semantic deficit of AD (e.g., Balota & Duchek, 1991; Nebes & Brady, 1991; Ober & Shenaut, 1988). As we have discussed elsewhere (Milberg, McGlinchey-Berroth, Duncan, & Higgins, 1999), these views, with a few interesting exceptions (e.g., Chertkow & Bub, 1990), have almost entirely been bound to the use of explicit versus implicit measures of semantic memory, and have not produced theoretical positions that account for much data outside of the paradigmatic choices of the investigators. Storms et al. (2003) note that a number of studies have used the Warrington and Shallice (1979) criteria for choosing between impaired access and degraded storage. They conclude that many of the multidimensional scaling studies provide data that is ultimately indeterminate *vis-à-vis* these criteria. Most studies (reviewed by Storms et al., 2003; but see also Milberg et al., 1999) that make direct reference to these criteria also tend to use tasks requiring explicit judgments or discriminations (which require the contribution of other critical processes such as attention). Evidence of semantic priming, a potentially critical piece of evidence regarding the integrity of semantic knowledge, is not part of these criteria, which may in part explain how paradigm and theory have been so exclusively aligned.

Therefore, the most important issue raised by Storms et al.'s (2003) re-analysis and critique of what have become centrally important studies of semantic deficits in AD using the Warrington and Shallice (1979) criteria is that these criteria themselves deserve further scrutiny and discussion. These criteria were first derived to describe a patient with aphasia who was assumed to represent a face-valid example of a semantic storage deficit. As we noted above, the observation that patients with aphasia may show normal semantic priming in the face of semantic judgment deficits undermined the claim of semantic storage deficits in these patients. Unfortunately, these studies appeared in the literature a few years after Warrington and Shallice's seminal article. The analysis presented by Storms et al. (and others) suggests that Warrington and Shallice's original rationale

for deriving these criteria may have been somewhat circular and premature. Without some independent verification of the presence of the state of semantic degradation in the original defining population, these criteria should have been considered only tentative and descriptive, rather than defining. Even without considering the existence of implicit evidence of semantic storage, there is an inherent logical problem with the assumption of performance-knowledge equivalence that underlies these criteria for semantic degradation. The implicit assumption of performance-knowledge equivalence depends on the affirmation of the null hypothesis. The burden of proof to accept the hypothesis that a knowledge structure is absent or altered is very difficult to achieve. Just as in any signal detection problem, a failure to detect a knowledge structure could be due to the sensitivity of the measure or the criterion being used. This is a similar problem to that of assuming lack of conscious processing in the literature on unconscious information processing (Merikle & Reingold, 1991). As we have discussed, this logical problem is also an empirical one: Most tasks assessing semantic knowledge require the participation of a number of different psychological functions (judgment, retrieval, attention, rule application, etc.), any of which could be the culprit in the failure of a task. Warrington and Shallice's criteria of frequency and category relationship sensitivity and consistency could also be applied to models of these functions. Retrieval errors may be guided by frequency and may be made consistently to the extent that different tasks required the use of this function. All of this is underscored by the fact that AD patients, at least under some circumstances (i.e., such as implicit tasks), do show evidence of preserved structures (e.g., Nebes et al., 1984).

Other classes of processing models have been proposed that do not put the locus of the semantic deficit in AD at either the storage or retrieval of representations (e.g., Milberg et al., 1999). Such models offer an alternative to these classic accounts. These models can account for consistency of deficits, differential loss of features, as well as preserved priming. The basic assumptions adopted in multidimensional scaling studies of semantic memory in AD may set up conditions that are necessary but not sufficient for choosing between degradation and access models, or they may simply not provide a sufficient basis for choosing between these two theoretical positions.

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