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Category and letter fluency in semantic dementia, primary progressive aphasia, and Alzheimer's disease

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Abstract

This study examined the impact of various degenerative dementias on access to semantic knowledge and the status of semantic representations. Patients with semantic dementia, primary progressive aphasia, and Alzheimer's disease were compared with elderly controls on tasks of category and letter fluency, with number of words generated, mean lexical frequency and errors recorded. The findings are consistent with the view that category and letter fluency rely on both common and unique cognitive processes. Fluency tasks, with the richness of data obtained, are valuable in distinguishing different dementia syndromes from one another.

Keywords: Alzheimer's disease; Semantic dementia; Primary progressive aphasia; Category fluency; Letter fluency

1. Introduction

Verbal fluency tasks consist of generating words from a semantic category (e.g., animals) or words beginning with a given letter (e.g., the letter 'S') within a specified time limit, such as 60 seconds. Although, both category and letter fluency are impaired similarly by degenerative dementias or various drugs, there are some differences in performance on these two types of tasks, suggesting that letter and category fluency tasks rely on both some common and some distinct cognitive processes (Pompeia, Rusted, & Curran, 2002; Rende, Ramsberger, & Miyake, 2002). The category task may rely more heavily on access to lexical representations of semantic concepts, whereas the letter task may rely more heavily on the central executive component of working memory (Baddeley, 1992; Baddeley, Thomson, & Buchanan, 1975), and this distinction appears to have anatomical correlates (Gold & Buckner, 2002).

In the assessment of various degenerative dementias, the examination of cognition is often carried out with brief tests such as the Mini-Mental Status Examination (MMSE) (Folstein, Folstein, & McHugh, 1975). While the MMSE has been shown to be a useful and popular instrument, it appears insensitive to the earliest changes in individuals with dementia, particularly in high-functioning individuals. Furthermore, the MMSE or even longer mental status examinations, such as the Dementia Rating Scale (DRS), often appear to be insufficient to distinguish between various degenerative dementias (Kertesz, Davidson, McCabe, Takagi, & Munoz, 2003). A recent study suggested that the category and letter fluency tests could be brief cognitive measures that can be used to address this concern. The investigators compared patients with Alzheimer's disease (AD) and vascular dementia (VaD) to normal controls with a one-minute category test (naming as many animals as possible) and a one-minute letter fluency test (naming as many words that begin with the letter "F" as possible). The patient groups generated fewer animal names compared to normal elderly controls. Furthermore, letter fluency scores differentiated AD from VaD, with patients with AD able to generate more "F" words compared to patients with VaD

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(Duff Canning, Leach, Stuss, Ngo, & Black, 2004). The success of this approach has led to the suggestion that the fluency test might be a powerful test to aid in diagnostic decisions and could be deemed the one-minute mental status examination (Cummings, 2004).

Use of the fluency task as a one-minute mental status exam is not only appealing in its brevity to administer but also in the potential richness of the data acquired. Responses can provide several kinds of information of interest: (1) the raw number of words generated within the 60 second trial, (2) the actual word frequencies of the words generated, based on published norms of the English language, and (3) the number of errors of repeating a word within the 60 second trial. However, investigators have not capitalized on the richness of the fluency task as previous studies just recorded the number of words produced by the patient in a trial (Duff Canning et al., 2004). For instance, the number of errors (when there is at least one intervening item) could indicate deficits of working memory when the patient 'forgets' that they have already produced a particular exemplar from a category. Furthermore, the word frequencies indicate access to lexical representations with impairment indicated by failures to generate lower frequency exemplars. For example, a generated three word animal list of zebra, squirrel, and frog, includes lower frequency exemplars from the English language in comparison to a generated three word animal list of horse, dog, and bear. While matched in the number of words generated, the two lists are different in access to lexical representations.

If category fluency relies more heavily on access to lexical representations and letter fluency relies more heavily on the central executive component of working memory, one can make various predictions about the hypothesized performance of various degenerative dementias. The purpose of this current study was to compare how patients with semantic dementia (SD), primary progressive aphasia (PPA), and AD would perform on the category and letter fluency tasks. While it was predicted that all these dementia patients should perform more poorly on both types of fluency tasks compared to normal elderly controls, there are more specific predictions about differences in performance between the groups that can be made based on the previous literature.

Semantic dementia is characterized by a pattern of profound deterioration of semantic memory that disrupts the meaning, recognition, and comprehension of objects (Hodges, Patterson, Oxbury, & Funnell, 1992; Snowden, Goulding, & Neary, 1989). For example, a patient may no longer know what a 'steak' or a 'tool' or a 'vehicle' is (Kertesz, Davidson, & McCabe, 1998). This lexicosemantic language impairment is in striking contrast to the relatively preserved syntactic and phonological processes of language (Hodges, Patterson, & Tyler, 1994). The progressive deterioration of lexical and semantic aspects of the representation appears to occur in a frequency dependent manner with the loss of lower frequency words first. As the disease progresses, the higher frequency words are then increasingly lost (Bird, Lambon Ralph, Patterson, & Hodges, 2000). The neuropsychological profile of these patients contrasts greatly with other dementias (such as AD), as the patients have well-preserved episodic memory and visuospatial skills (Graham & Hodges, 1997). As such, one could hypothesize that SD patients should produce the fewest numbers of words in a category task and produce more words in a letter task that relies more on the central executive. The words generated in a category task should be higher in word frequency as the lower word frequency words have been lost due to the disease process. Finally, errors of repeating a word within a list should occur infrequently as SD patients have well-preserved working memory and would be less likely then AD patients to forget that they had just generated a particular word within a 60 second trial.

PPA is characterized by an isolated and gradual dissolution of language function, starting with anomia (word finding difficulty) and later progressive loss of fluency to eventual mutism (Kertesz et al., 2003; Mesulam, 1987). As anomia can also be a feature of AD, the operational definition of PPA includes a period of two years of progressive aphasia with relative perseveration of other functions and activities of daily living (Weintraub, Rubin, & Mesulam, 1990). One could hypothesize that PPA patients should produce the fewest numbers of words in both the category and letter fluency tasks as fluency is significantly impaired in PPA. In particular, letter fluency might be dramatically impaired as patients with PPA have a defect in accessing phonemes (the sound-based representation of speech) (Mendez, Clark, Shapira, & Cummings, 2003). The mean word frequencies produced should be lower in PPA compared to the SD patients, as the disease process of PPA impairs speech production more than access to lexical representations. Furthermore, errors of repeating words within list would be unlikely, as episodic and working memory remains relatively intact.

In contrast to SD and PPA described above, the core features of AD include episodic memory deficits and visual-spatial deficits. Word finding difficulties in AD are often present, at times quite early on in the disease process (Appell, Kertesz, & Fisman, 1982). Impaired verbal and semantic fluency has been documented in AD patients compared to controls (Chertkow & Bub, 1990; Diaz, Sailor, Cheung, & Kuslansky, 2004; Duff Canning et al., 2004; Martin & Fedio, 1983; Nebes, 1989). Low letter fluency scores discriminate AD patients from controls and constitute a reliable predictor of subsequent dementia status in elderly patients (Hodges & Patterson, 1994; Small, Herlitz, Fratiglioni, Almkvist, & Backman, 1997). However, previous investigations would suggest that AD patients would generate more words in category and letter tasks compared to PPA patients (Kertesz et al., 2003; Mendez et al., 2003). Mean word frequencies should be lower in AD compared to SD, as semantic retrieval deficits are primary in SD and secondary in AD (Hodges et al., 1999; Kramer et al., 2003). Finally, it is hypothesized that errors of repeating words