



Naming in semantic dementia—what matters?

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(Received 31 July 1997; accepted 21 November 1997)

Abstract—One of the major symptoms of semantic dementia (or progressive fluent aphasia) is profound word-finding difficulties. We present here a cross-sectional study of the factors affecting picture naming in semantic dementia based on data obtained from eight patients, together with a longitudinal analysis of naming in another patient.

Various properties and attributes of the objects were entered into a series of regression analyses in order to predict which items the patients could or could not name. The analyses showed that object familiarity, word frequency and age-of-acquisition predicted naming success for the group and, in most cases, for each individual patient, irrespective of lesion site or overall naming success.

We propose that the pattern of naming in semantic dementia is best described in terms of reduced semantic activation within a cascading/interactive speech production system. We suggest that object familiarity, and possibly word frequency, reflect the inherent robustness of individual semantic representations to the decay process in terms of both quantity and quality of experience. Age-of-acquisition and word frequency (at a phonological–lexical level) predicts naming success, because frequent, early-acquired words are relatively easy to activate even with reduced semantic “input”. © 1998 Elsevier Science Ltd. All rights reserved.

Key Words: semantic dementia; progressive fluent aphasia; semantic memory; anomia; speech production.

Introduction

Semantic dementia, or progressive fluent aphasia [26, 41] is a disorder associated with progressive atrophy of the anterior temporal lobes, particularly of the inferior temporal gyrus. The atrophy typically involves the left side [24, 26] although the disease eventually leads to bilateral damage [24].

The progressive loss of temporal structures is associated with an inexorable loss of knowledge about the meanings of words, objects and concepts. The semantic deficit is present when tested in all sensory modalities [26, 41] and is accompanied by a profound anomia. The vast majority of patients manifest features of surface dyslexia (although see [6]). Despite sometimes severe semantic impairment, the patients demonstrate a relative preservation of performance on tests of auditory-verbal short-term memory, non-verbal reasoning, perceptual and spatial skills, have good single-word phonology and syntax, and excellent day-to-day (episodic) memory [26,

41] although recent research has shown relatively poor recall of events that occurred in the distant past [19].

To date, there have been few analyses of the factors which affect the cognitive performance of patients with semantic dementia. In her seminal paper, Warrington [42] demonstrated that the comprehension of her three patients was affected by word frequency. In addition, one patient showed a reverse concreteness effect (better definition of abstract than concrete words). These two effects, frequency and reverse concreteness, have been reported since in two patients with semantic dementia [4, 6] and of frequency alone in two others [12, 25]. Breedin *et al.* [4] found that their patient exhibited a category effect in favour of tools over animals in a synonym judgement task.

The factors that affect picture naming performance in semantic dementia have been investigated in three papers which report significant effects of frequency for a total of four patients [25, 34]. Although Parkin's patient [34] showed relatively better naming of man-made objects than natural kinds, this effect was absent if the confounding factor of familiarity was partialled out.

Frequency effects have been reported in other non-progressive aphasics [9, 29], although the validity of this finding has been questioned [10, 22, 32] because the orig-

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inal reports did not consider the influence of other potentially confounding factors. For example, frequent words tend to be short, early acquired, imageable and conceptually familiar. When naming has been investigated more fully, few aphasic patients have been found to demonstrate a significant, independent effect of frequency on their accuracy [10, 22, 32].

Two studies have compared the factors that affect naming performance for each individual and for the group as a whole [10, 32]. The studies found a high degree of variation between individual aphasic subjects, and little consistency in the comparison between the group and individual subjects, even when the patients were split into fluent and non-fluent types. This led Nickels and Howard to conclude that “attempting to characterise aphasic naming generally by examining groups of aphasics is meaningless as there is no ‘average aphasic’” [32].

Category-specific disorders have been reported for non-progressive aphasic patients [e.g. 15, 44], although the validity of this finding has again been challenged [14]. Funnell and Sheridan [14] re-analysed the naming performance of their patient [44] and found that the animate kinds were less familiar than the man-made objects, and when this factor was partialled out no category effect remained. It would seem fair to say, however, that category-specific deficits can be observed even when confounding factors, such as familiarity, have been taken into account [e.g. 15]. Funnell, herself, on re-testing patient JBR with items drawn from matched sets, found that naming of animate kinds was worse than inanimate objects [13].

There are two papers in the literature which have attempted to investigate which factors affect naming in individual cases of semantic dementia. Barbarotto, Capitani, Spinnler and Trivelli [1] have recently reported data collected from patient MF. With a series of logistic regression analyses, Barbarotto *et al.* demonstrated that MF's naming and comprehension was significantly affected by frequency, familiarity and category (better performance for non-living than living categories). It should be noted that the dissociation between living and non-living was a classical one — MF's performance for artefacts was within the normal range. Unfortunately Barbarotto *et al.* did not include age-of-acquisition within their analyses.

Hirsh and Funnell reported data for patient EP [23]. There were significant simple correlations (measured across 76 items) between EP's naming and (log) word frequency, familiarity and rated age-of-acquisition (AoA). When these factors were included in a simultaneous linear regression only familiarity was found to be a significant independent predictor of naming accuracy, while word frequency approached significance ($P = 0.06$). Hirsh and Funnell [23] also reported a similar analysis for a patient with presumed Alzheimer's disease (“Mary”) whose comprehension was initially spared while her naming gradually deteriorated. They found that the same three variables correlated with Mary's naming

but only AoA reached significance in the regression analysis (which included 82 items). This apparent dissociation was interpreted as favouring a modular effect of each variable, with a familiarity effect occurring when an impairment occurs at the semantic level and an AoA effect when the damage is at a lexical-phonological level.

There are a number of reasons why this conclusion may be premature. Mary might have had a slight semantic impairment early in her deterioration (her comprehension was only assessed with one word-picture matching test) which could have contributed to her naming difficulties. If familiarity and AoA effects are located in the semantic system and lexical-phonological level, respectively, it is possible that, for example, AoA might influence the naming performance of a patient with a selective semantic impairment. If speech production is viewed as an interactive or cascading process [8, 37] then early acquired words may be easier to activate than late acquired words given an impoverished semantic input. Similarly, a post-semantic impairment may be more readily overcome by the extra “strength” or “boost” of semantic input given by highly familiar concepts. It is also possible that Hirsh and Funnell's analysis revealed only one significant factor for each patient because relatively few items were included.

We report below the results of an investigation into the factors affecting naming in nine patients with semantic dementia across the same set of 132 pictures. The analyses were designed to address the following questions:

- (1) What factors affect naming in semantic dementia?
- (2) Is performance consistent between individual patients?
- (3) Do the factors that affect performance depend on the severity of anomia or the laterality of atrophy (left vs right temporal lobe)?
- (4) Are the results found in a cross-sectional analysis repeated in a longitudinal assessment of one patient (JL)?

Method

Subjects

Nine patients with semantic dementia were included in this study. Some have been described in previous papers [16, 18, 20, 25–27, 35]. Structural imaging (3D volumetric MRI acquisition) showed focal temporal lobe atrophy in all nine patients. The degree and relative laterality of the temporal lobe atrophy was assessed with T1-weighted coronal images by an experienced behavioural neurologist (JRH), and the results are coded in Table 1. This table also shows the performance of the nine patients (and a group of 24 age-matched control subjects, see [25]) on a battery of tests of neuropsychological function. On tests of visuo-perceptual and non-verbal problem-solving abilities, the patients that were tested showed relatively preserved performance. DG showed a mild impairment when asked to copy the Rey Complex Figure [33] and GC was slightly outside the normal range on the Benton Face Recognition Test. On the two language tests shown, the patients, apart from GC, JH, MS

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