

# Different variables predict anomia in different subjects: A longitudinal study of two Alzheimer's patients

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## Abstract

Two Alzheimer's patients participated in a longitudinal study of picture naming aimed at analysing the effect of lexical frequency, age of acquisition, stimulus familiarity, word length, name imageability, visual complexity and semantic category membership on naming success. The results were analysed with a new method [Capitani, E., & Laiacona, M. (2004). A method for studying the evolution of naming error types in the recovery of acute aphasia: A single-patient and single-stimulus approach. *Neuropsychologia*, 42, 613–623] that allows us to consider the consistency of responses to stimuli over repeated testing within clinical stages. The experiment was carried out as a longitudinal study of single cases, and the effect of each variable was estimated after removing the overlap with the other predictors. The semantic category of stimuli was not an influential factor for either patient. Other findings sharply distinguished between the two patients. In one case, disease-related decline consistently affected mainly late acquired names, whereas in the other case the decline affected names corresponding to low-familiarity items. To interpret this contrast, we further analysed the quality of the errors produced by each patient. This study shows that the psycholinguistic characteristics of a stimulus may exert varying influence in different patients, warranting further development of this line of inquiry.

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## 1. Introduction

The analysis of language deficits affords useful information throughout the course of Alzheimer's disease (AD), and allows us to collect finer-grain qualitative information about the status of the language system that go beyond a mere severity assessment. Qualitative information is available concerning what types of errors are produced over the whole set of stimuli. Moreover, beyond category membership, one may investigate whether the psycholinguistic and visual-perceptual characteristics of the stimulus, namely, lexical frequency, age of acquisition, stimulus familiarity, imageability, word length, and visual complexity influence the likelihood that the stimulus will elicit a correct response or a definite type of error.

From a theoretical perspective, the correspondence between error types and the impairment of single language processes is not unequivocal (Caramazza & Hillis, 1990), and a stringent definition of the locus of cognitive deficit can be attained only through considering a wider set of tasks. However, many authors have reasonably suggested that the prevalence of semantic category-related errors is compatible with a lexical/semantic deterioration (Hodges, Salmon, & Butters, 1991; Lambon Ralph, Patterson, & Hodges, 1997). In particular, it has been suggested that Alzheimer's patients undergo a hierarchical breakdown in performance. According to numerous studies, the majority of patients with semantic impairment showed a preservation of superordinate knowledge (name of the category—e.g. animal) compared to specific information (basic level name—e.g. tiger). By contrast, the scarce number of phonological errors generally observed at the early stages of the disease would indicate a relative preservation of phonological processing. Along this line of inquiry, some studies have surveyed the evolution of naming error types along AD progression. For instance, Barbarotto, Capitani, Jori, Laiacona, and

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Molinari (1998) studied the error type evolution of a group of AD patients. At early evaluation, errors consisted mainly of semantically related names or circumlocutions, but as the disease advanced missed responses and unrelated errors increased, indicating the likelihood of a progressive loss of conceptual information. Similar results were obtained by Cuetos, Gonzalez-Nosti, and Martinez (2005), who also reported an increase from 9.4% to 29.9% of the incidence of missed responses over 2 years.

The second point, more central to the present investigation, concerns the question of whether and how psycholinguistic variables influence naming. Although we do not yet have a received theory about the role played by different variables, most authors have focused investigation on which variables can be usefully adduced as predictors of naming performance in order to approach a characterization of the nature of the underlying deficit. In the following, we report some relevant empirical data.

Names with high *word frequency* are generally more resistant to brain damage than are names with low frequency (Hodges, Salmon, & Butters, 1992). With this hypothesis in mind, Garrard, Maloney, Hodges, and Patterson (2005) analysed the work of the English writer Iris Murdoch. The words used in Murdoch's last book "Jackson's Dilemma", written at a time when she was likely to have been suffering, undiagnosed, from early stage Alzheimer's disease, were of higher frequency than were the words used in her previous books (her first book "Under the Net" and her most famous book "The Sea, the Sea"). Word frequency measures estimate the degree of exposure to a given name, and are the most widely used predictors of naming success considered by language psychologists.

The role of word frequency has, however, been put into question by the suggestion that the effects attributed so far to word frequency might be due to a related variable, the *age of acquisition* of a word. Several authors have reported that early learned words are more resistant to deterioration. Silverl, Cappa, Mariotti, and Puopolo (2002) asked a group of AD patients to name 80 pictures and found that significant predictors of the outcome included age of acquisition, name agreement, and the semantic category of pictured concepts, but not word frequency. Forbes-McKay, Ellis, Shanks, and Venneri (2005) found that the mean age of acquisition of the words generated by controls and by Alzheimer's patients during semantic fluency tasks was the best predictor of participant group membership. Cuetos et al. (2005) surveyed a group of AD patients for 2 years and found that the best predictor of naming accuracy – at the first evaluation as well as at the last – was the age of acquisition of the picture names. Furthermore, age of acquisition was the best predictor of response evolution observed to occur over time. The stimuli that were correct in both the first and the second session had the earliest age of acquisition, stimuli that were correct in the first session but which later yielded semantically related errors had an intermediate age of acquisition, while pictures names that were correct neither at the first nor at the second evaluation had the latest age of acquisition. As there are cases for whom age of acquisition is a significant predictor of performance while word frequency is not, we should argue that the cognitive counterparts of the effects of these variables are not fully coincident (see also Menenti & Burani, 2007).

*Object familiarity* quantifies the presence of the actual objects, or of a representation thereof, in the experience of each individual. Familiarity indices capture the degree of actual exposure to a given entity and are sensitive to the experience brought about by images, by sounds, odours, and possibly by other aspects of the entity. Recent studies (Albanese, Capitani, Barbarotto, & Laiacona, 2000) have shown that the overall evaluation of familiarity is equivalent to finer-grained indices sensitive to different facets of familiarity. The influence of familiarity on naming success has been reported among semantic dementia patients by Hirsch and Funnell (1995) and by Lambon Ralph, Graham, Ellis, and Hodges (1998).

Although word frequency, age of acquisition, and object familiarity are the most reported predictors of patient performance, other variables have also sometimes been reported to be useful in accounting for the naming skills of dementia patients. The *imageability* of a name quantifies how easily we can elicit the mental image of a noun, a step that could help to retrieve the target name, and its influence was reported by Astell and Harley (1998). In the present study, stimuli consisted of pictures so that it was unlikely that imageability would substantially influence naming performance. Anyway, we still decided to check the influence of this parameter.

*Visual complexity* was defined as the amount of detail or intricacy of line in a picture. We used ratings data to operationalize the visual complexity of the drawings in our stimulus set, using ratings made to a 5-point scale (1 means "drawing very simple" and 5 means "drawing very complex") collected by Sanfeliu and Fernandez (1996). It is reasonable that patients whose naming deficits depend on visual agnosia should be sensitive to this variable.

*Word length*, assessed by counting the number of phonemes or syllables in the pronunciation of the target name, has been reported as a significant predictor of naming skills by many studies of normal subjects (Alario et al., 2004; Cuetos, Ellis, & Alvarez, 1999; Santiago, MacKay, Palma, & Rho, 2000) and of aphasic patients (Cuetos, Aguado, Izura, & Ellis, 2002; Nickels & Howard, 1995) though we do have not data about the influence of this variable in picture naming in Alzheimer's disease.

Another predictor of naming success in AD patients has been found to be the *semantic category* of the stimulus. According to many studies, AD patients are less proficient with biological objects than with man-made objects. For instance, Laiacona, Barbarotto, and Capitani (1998), in a case series study of 26 DAT patients, found 8 patients more impaired with living than non-living categories, 15 patients without dissociations, and only 3 patients more impaired with man-made objects. Garrard et al. (2001) indicated that the representations of living concepts deteriorated at a consistently and significantly faster rate than those of non-living concepts. The literature on this topic has generally considered a quite broad categorical classification but most recent studies have definitely shown that biological categories should be further fractionated (Capitani, Laiacona, Mahon, & Caramazza, 2003). In relation to artefacts, recent theoretical work has provided principled reasons for disentangling the wide set of non-living categories. The basis for this latter fractionation is that some artefacts are endowed with their

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