ELSEVIER

Neuropsychologia 43 (2005) 1625–1632

NEUROPSYCHOLOGIA

www.elsevier.com/locate/neuropsychologia

The age of acquisition of words produced in a semantic fluency task can reliably differentiate normal from pathological age related cognitive decline

Katrina E. Forbes-McKay [a], Andrew W. Ellis [b], Michael F. Shanks [c], Annalena Venneri [c,*]

[a] *School of Applied Social Studies, The Robert Gordon University, Aberdeen, UK*
[b] *Department of Psychology, University of York, UK*
[c] *Clinical Neuroscience Centre, University of Hull, Cottingham Road, Hull HU6 7RX, UK*

Received 12 May 2004; received in revised form 11 January 2005; accepted 19 January 2005
Available online 25 February 2005

Abstract

This study examined differences in the characteristics of words produced by healthy elderly controls and by patients with Alzheimer's disease (AD) in a semantic fluency task (generating words from the categories of animals and fruit). Ninety-six AD patients (MMSE 13–29) and 40 controls matched for age and socio-cultural background completed a semantic fluency task. Length, frequency, typicality and age of acquisition (AoA) values were obtained for each word generated. In comparison with controls, AD patients generated fewer items, and their items were higher in frequency, shorter in length, more typical and earlier in AoA. Discriminant function analysis showed that AoA was the best predictor of group membership (patient/control). The mean AoA of words generated correctly classified 95% of controls and 88% of patients.

Keywords: Fluency; Age of acquisition; Production; Dementia; AD; Alzheimer

1. Introduction

At present there is no reliable clinical method to distinguish between normal age related cognitive decline and that due to degenerative dementia caused by Alzheimer's disease (AD). In contrast to other types of degenerative dementia (e.g. frontotemporal dementia), no distinctive clinical, cognitive or neuroimaging features are associated to AD, making differential diagnosis from normal ageing in the earliest stages of the disease very difficult. Neuropsychological studies that attempted the early detection of AD by assessing cognitive functions have for the most part concentrated on episodic memory tasks. No distinctive features specific to AD have been identified by these means, however. Impairment in episodic memory is a prominent symptom of AD, but there is a normal age decrement in this respect and not all individuals with episodic memory deficits ever develop AD (Celsis, 2000). Patients with mild cognitive impairment (MCI), for example, have an episodic memory impairment that exceeds established age limits, but can maintain otherwise normal cognitive functions with preservation of everyday skills (Peterson et al., 1999). MCI can be a phase of transition between healthy ageing and AD, and although MCI patients do not meet clinical diagnostic criteria for probable AD about 30–40%, convert to AD over 48 months (Devanand, Folz, Gorlyn, & Stern, 1997).

Investigators have, therefore, looked to the assessment of other cognitive domains in the search for reliable markers of incipient AD. One study found that patients could not be differentiated from healthy controls using tests that measured intelligence, orientation or memory, but there were significant differences on free word association and semantic fluency tasks (Capitani, Della Sala, & Spinnler, 1986). Verbal fluency declines with ageing, but the healthy elderly perform better on semantic fluency (generating words from specified seman-

* Corresponding author. Tel.: +44 1482 465558; fax: +44 1482 465599.
E-mail address: a.venneri@hull.ac.uk (A. Venneri).

0028-3932/$ – see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.neuropsychologia.2005.01.008

tic categories) than on letter fluency tasks (generating words beginning with specified letters) (Rosen, 1980). In contrast, the semantic fluency performance of AD patients declines faster than their letter fluency (Butters, Salmon, Heindel, & Granholm, 1988; Hart, Smith, & Swash, 1988; Martin & Fedio, 1983; Monsch et al., 1992; Zec, 1993). Not only do AD patients generate fewer exemplars within each category, they perseverate more and often demonstrate a loss of set (e.g. producing a vegetable when asked to generate names of fruit). Hodges and Patterson (1995) found category fluency to be the most sensitive measure of semantic memory in a sample of minimal, mild and moderate AD patients, and 70% of minimal AD patients showed impairment in category fluency. The literature suggests, therefore, that significant discriminating variables may emerge from the investigation of semantic abilities.

Deficits in semantic processing also influence the spontaneous speech of early AD patients so that their expressive language is characterised by an impoverished vocabulary, paraphasias, word finding difficulties, circumlocutions and irrelevant terms (Croisile et al., 1996; McNamara, Obler, Au, Durso, & Albert, 1992; Vuorinen, Laine, & Rinne, 2000). Impairments of spontaneous speech can distinguish patients at the minimal stage of AD (MMSE >24) from healthy controls. The discriminating measures include frequency of semantic paraphasias, word finding delays and information content (Forbes, Venneri, & Shanks, 2002). Additional support for the discriminating potential of semantic measures comes from a study using the Pyramid and Palm Trees test, a task which assesses the patient's ability to make semantic judgements (Howard & Patterson, 1992). Forty one percent of minimal AD patients were impaired on this task compared to healthy controls (Hodges & Patterson, 1995).

Given that semantic tasks may be of discriminating value, development of research in this area should consider those stimulus attributes of tests assessing semantic abilities which most influence the subject's responses. Age of acquisition and word frequency are two attributes implicated in the successful retrieval of object names in healthy individuals. Objects with an earlier age of acquisition and higher frequency are named more rapidly (Ellis & Morrison, 1998) by healthy young adults and more accurately by normal elderly people (Hodgson & Ellis, 1998) than objects with later acquired and lower frequency names. The influence of these attributes is also evident in the naming impairment shown by patients with degenerative diseases and those with aphasia. Names of objects learned later in life are more vulnerable to cognitive dysfunction (Cuetos, Aguado, Izura, & Ellis, 2002; Lambon Ralph, Graham, Ellis, & Hodges, 1998). There is an increased error rate in the naming performance of AD and MCI patients and a decreased naming success in the performance of minimal-mild AD patients (mean MMSE 19.2) for items which have later age of acquisition (Frol et al., 2001; Kremin, Hamerel, Dordain, De Wilde, & Perrier, 2000; Silveri, Cappa, Mariotti, & Puopolo, 2002).

All of these studies have relied on preselection of word items with specific attributes which were then presented to patients and controls or on spontaneous language assessment requiring complex linguistic analyses. A more practical approach to group discrimination in a clinical setting might be to assess the attributes of words spontaneously uttered and measure their classificatory potential. A suitable and reliable task for this purpose might be the semantic fluency task. This task is broadly sensitive to early cognitive changes in AD, and has the advantages of simplicity, brevity and extensive usage in clinical settings (Cerhan et al., 2002; Robert et al., 2003). Generating words from pre-defined semantic categories is necessarily dependent on the semantic system and requires access to and retrieval of semantic knowledge. Semantic fluency also depends on lexical retrieval so that the names of items can be produced. There is, in addition, a component of executive control: participants must remember the category in operation, must organise strategies for searching semantic memory (seen, for example, when participants generating animal names produce a sequence of farm animals followed, perhaps, by a sequence of wild animals) and must remember which items have been generated in order to avoid repetitions. Lexical retrieval and executive processes, however, are also required in the letter fluency task in which AD patients show less impairment (Pestell, Venneri & Shanks, 2000). This evidence suggests that impaired semantic processing may be mainly responsible for the deficits in semantic fluency observed in AD patients. Previous studies of semantic fluency in AD have simply focused on the number of relevant items produced in verbal fluency tasks.

The aim of the present study was to investigate whether attention to the more detailed characteristics and properties of the words generated in a semantic fluency task would be useful in discriminating patients with early AD from healthy elderly controls. The characteristics examined were the AoA, frequency, typicality and length of generated words.

2. Methods

2.1. Participants

Ninety-six probable AD patients were recruited from an outpatient diagnostic and management clinic in Aberdeen, UK. All patients underwent cerebral structural and blood flow imaging, clinical assessment and neuropsychological testing. All met the NINCDS–ADRDA clinical criteria for a diagnosis of probable dementia of the Alzheimer type (McKahnn et al., 1984) and all had clinical diagnosis confirmed after at least six months follow up. Local ethical committee approval was obtained and all patients and/or their carers gave informed consent/assent.

The AD group was aged between 63 and 87 years with a mean of 76.65 (S.D. 6.99). Education ranged between 9 and 17 years with a mean of 10.55 (2.35). The patients achieved a mean score of 21.84 (S.D. 3.80) on the Mini Mental State