SPECIAL ISSUE: ORIGINAL ARTICLE

DEGRADED SEMANTIC KNOWLEDGE AND ACCURATE OBJECT USE

Gioia A. Negri[1], Alberta Lunardelli[1], Carlo Reverberi[1], Gian Luigi Gigli[2] and Raffaella I. Rumiati[1]

([1]Cognitive Neuroscience Sector, International School for Advanced Studies – SISSA, Trieste, Italy; [2]Neuroscience Department, Santa Maria della Misericordia Hospital, Udine, Italy)

ABSTRACT

In the present paper we report the performance on object use and on semantic tasks of two patients, D.L. with probable semantic dementia, and A.M. with an atypical onset of dementia of Alzheimer, assessed twice two years apart. In particular, we investigated whether the patients' ability to use objects degraded as a function of their semantic knowledge about those objects. Results from the two assessments in 2002 and in 2004 confirmed that both patients had a selective loss of the lexical-semantic knowledge, despite a relative preservation of the other cognitive abilities including object use. This pattern of results suggests that semantic knowledge is not necessarily involved in the correct use of objects.

Key words: apraxia, semantic dementia, object use, parietal cortex

INTRODUCTION

In 1975 Elizabeth Warrington described three patients with progressive anomia and impaired word comprehension. This syndrome has been successively considered as the temporal variant of the frontotemporal dementia, and as the fluent form of primary progressive aphasia (Luzzatti, 1999; Hodges et al., 1992; Snowden et al., 1989). Since it impacts primarily on the semantic memory of patients, the term "semantic dementia" (SD) has been proposed for it (Hodges et al., 1992; Snowden et al., 1989). Others called the same neuropsychological pattern *slowly progressive aphasia* as the conceptual loss is usually accompanied by a lexical deficit (see Poeck and Luzzatti, 1988). Whereas SD patients' naming and spontaneous speech are interspersed with anomias and semantic paraphasias, perceptual skills, non-verbal intelligence, syntactic skills, repetition and day-to-day memory may be relatively spared at least at an earlier stage of the disease (Bozeat et al., 2000; Lambon Ralph and Howard, 2000). SD is generally associated with circumscribed temporal lobe atrophy, affecting the temporal pole, the antero-medial and infero-lateral temporal lobe, bilaterally but asymmetrically. In addition, the ventromedial frontal cortex and the amygdaloid complex have been found affected too (Mummery et al., 1999, 2000). As shown in post-mortem examinations, in some instances the symptoms of progressive aphasia and semantic-lexical impairment may also reflect an atypical focal dementia of Alzheimer type (see Galton et al., 2000; Greene et al., 1996).

Based on the behaviour of patients with impaired semantics, conceptual knowledge has been suggested to be modality-specific, as it was found to be affected either in its verbal (Lauro-Grotto et al., 1997; McCarthy and Warrington, 1988; Coughlan and Warrington, 1981) or in its visual component (Warrington and McCarthy, 1994). These findings have been taken as evidence that the semantic system is indeed multimodal (Shallice, 1988). The fact, however, that patients with degraded knowledge for verbal and non-verbal stimuli have also been reported (Hodges et al., 1992; Snowden et al., 1989; Bozeat et al., 2000), supported the opposite view that the semantic system is amodal (Caramazza et al., 1990; Riddoch et al., 1988).

Interestingly, at least two SD patients have been reported with spared object use in the presence of semantic memory impairments. For instance, patients R.M. and D.M., described by Lauro-Grotto et al. (1997) and Buxbaum et al. (1997) respectively, were still able to use objects in everyday activities despite having a deficit in object naming and identification. Hodges et al. (2000) too described patients who, in some instances, were better at using objects than would have been predicted based on their semantic knowledge about those objects.

In sharp contrast with the behavioural pattern shown by patients with probable SD is that characterizing patients with ideational apraxia (IA), defined as a selective deficit of object use. It has been suggested that this deficit is often caused by lesions of the left hemisphere (e.g., De Renzi and Lucchelli, 1988), and in particular of the left inferior parietal lobe (Rumiati et al., 2004; see Johnson-Frey, 2004 for a review). IA patients have been described with a deficit in object use but with no semantic impairments (see Rosci et al., 2003).

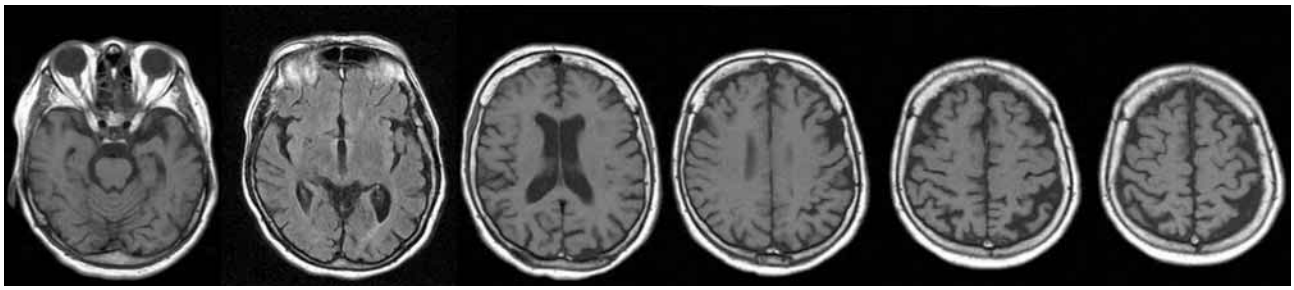

Fig. 1 – *Selected images from the MR scan performed on patient A.M. in March 2005. The diffused amplitude of liquoral spaces is evident in the ventricular and subaracnoidal spaces and in the fronto-temporo-parietal regions bilaterally, more pronounced in the left hemisphere. This neuroradiological finding fits well with a diagnosis of a dementia of Alzeheimer's type.*

Moreover, a few patients have been reported with a completely preserved performance on tests tapping semantic knowledge about the same objects they failed to use (patients D.R. and F.G. in Rumiati et al., 2001; but see also patient H.B. in Buxbaum et al., 1997). In general, several patients with spared semantic knowledge in the presence of object use impairment have been described in literature (Ochipa et al., 1989; case 3 in Hodges et al., 1999; Buxbaum et al., 2000) Double dissociations between the ability to perform tasks tapping semantic information about objects and the movements necessary to use them appropriately indicate that these two abilities might be independent and have different cerebral correlates (see Rumiati et al., 2004).

According to some authors (Coccia et al., 2004; Bozeat et al., 2002a, 2002b; Hodges et al., 2000), as SD progresses, patients become also apraxic. Hodges et al. (2000), and Bozeat et al. (2000) reported SD patients who were still able to use highly familiar but not less common items, and therefore concluded that the object familiarity is the best predictor of proper use. Because of the strong correlation between the performance on object use and the preservation of the semantic knowledge about objects, Hodges et al. (2000) argued that in SD patients the spared praxic skills seem to rely strictly upon object-specific conceptual knowledge, in addition to the mechanical problem solving abilities and visual affordances. Furthermore, object use performance seems to be strongly influenced by the context in which the objects are presented. Indeed Bozeat et al. (2002b) observed that patients' performance improved significantly when they were assessed at home, using objects that belonged to them, as opposed to when they were tested in the laboratory using objects perceptually dissimilar to those of their own.

The theoretical inferences cannot be conclusive for the patients who showed a dissociation were tested using different stimuli in the tasks assessing object knowledge and object use (e.g., Buxbaum et al., 1997; Lauro-Grotto et al., 1997). Therefore the dissociations reported could have been due to items presenting different degrees of difficulty in either one or the other task.

Here we report a two-year longitudinal study in which we assessed the ability to use objects of two patients, D.L. with probable semantic dementia and A.M. with an atypical onset of a dementia of Alzheimer type, as well as their lexical-semantic knowledge concerning the same objects. The aim of the study was to verify whether semantic information is necessary to correctly use objects. Evidence that the integrity of the semantic knowledge is not sufficient to support tool use comes from the observation of patients with IA (Rumiati et al., 2001; Buxbaum et al., 2000; Hodges et al., 1999; Ochipa et al., 1989).

Method

Participants

Patients

A.M. is a right-handed woman born in 1928, with five years of education, who, before retirement, worked as a farm labourer. On March 2002 she underwent a neuropsychological assessment because of word finding impairment and memory problems. Two months earlier, a single photon emission computed tomography (SPECT) was performed revealing a concentration deficit of the tracer in the left temporal lobe. A more recent nuclear magnetic resonance (NMR) (March 2005) scan revealed a diffused cerebral atrophy (see Figure 1), although she was described by her family as still able to carry out a relatively normal life, and to perform everyday activities such as cooking and keeping her flat clean, without obvious difficulties.

D.L. is a right-handed man born in 1933, with five years of education, who, before retirement, worked as a baker and lorry-driver. In October 2000 he was referred for a neuropsychological evaluation for a name retrieval problem, affecting proper names (people and streets) as well as names of animals and objects of common use. A NMR scan in September 2000 revealed bilateral temporal lobe atrophy, greater in the left temporal pole and Sylvian areas (see Figures 2 and 3). Notwithstanding his severe semantic memory