Journal of Neurolinguistics 26 (2013) 737–744

Contents lists available at ScienceDirect

Journal of Neurolinguistics

journal homepage: www.elsevier.com/locate/jneuroling

Semantic disturbance for verbs in Parkinson's disease patients off medication

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ARTICLE INFO

Article history:
Received 6 July 2012
Received in revised form 17 January 2013
Accepted 20 January 2013

Keywords:
Parkinson's disease
Semantic system
Verb processing
Dopamine

ABSTRACT

Word-association tasks are considered useful tools to assess the normal functioning of the lexico-semantic system in healthy people and patients suffering from neurological disorders. Parkinson's Disease (PD) patients usually present some language dysfunction related to the functioning of the semantic system as a consequence of dopamine depletion. The aim of this study was to check if there were differences in the strength of association of the words generated by a group of non-demented PD patients on and off dopamine medication using a word-association task. In the study, 20 PD patients and 20 healthy-matched controls performed a word association task consisting of 10 nouns and 10 verbs matched by psycholinguistic variables. The participants were asked to generate the first word that came to mind given a specific single target. The results revealed that PD patients off medication said words less associated with the target compared with when they were on medication. Interestingly, comparisons between PD off patients and healthy controls revealed statistical differences only in response to verbs, while differences between PD on and controls were not found. Regarding nouns, we did not find any difference between PD off or PD on and healthy controls. This experiment adds more evidence to the assumption that the lexico-semantic system is disrupted in the absence of dopamine, resulting in poor spreading activation among associative words.

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http://dx.doi.org/10.1016/j.jneuroling.2013.01.002

1. Introduction

When a person is asked to produce the first word that comes to mind when a single word is provided, people usually say a word semantically associated with the given word. For example, given "cat" people will be more likely to say "dog" than "can" or "bat" (Postman & Keppel, 1970). As result of this finding, Collins and Loftus (1975) proposed the spreading-activation theory of semantic processing. This theory assumed that semantic memories are represented as nodes (e.g. dogs, cats) and organized into a larger network of concepts (e.g. animals). In addition, these specific semantic memories are interconnected through associative and bidirectional links. According to this theory, the normal functioning of the semantic system requires that the activation of any semantic node will spread along the associative links to other related nodes located into the conceptual network. It is assumed that the links between two nodes are determined by their common properties; this means that the more common properties between concepts, the more closely related they are within the semantic network (Collins & Loftus, 1975). To prove this assumption, psycholinguistics have been using word-association tasks based on the notion that word stimuli drive responses related to meaning.

The word-association task is widely used to assess the normal function of the semantic network in different kinds of people. Thus, experiments with bilingual participants have found that word association performance was comparable between the first and the second language (Sheng, McGregor, & Marian, 2006). For example, participants will say "dog" in the presence of "cat" in the same manner in both English and Mandarin, supporting the notion that words are stored by meanings.

Numerous studies have also used this task with patients with brain damage, such as Alzheimer's disease (AD), a neurodegenerative disorder typically involved in semantic memory deterioration (Hodges, 2006), to test the hypothesis of gradual semantic memory loss (Chertkow & Bub, 1990). Gollan, Salmon, and Paxton (2006) used a spoken word-association test with weakly and strongly associated pairs of words. They found that AD patients produced less common responses than normal controls for those pairs with a high strength of association. For the pairs of words with weak associations, the performance of AD patients was similar to that of the healthy controls. These results suggested that AD patients could have a disruption in the links of the semantic system, modulated by meanings. The normal connections within the semantic store of AD patients seem to be partially damaged, resulting in unusual responses when a word is given. In fact, weak association words are less dependent on meaning than strong associations, supporting the semantic degradation hypothesis in AD patients.

Furthermore, previous findings have demonstrated the role of dopamine as a neuromodulator within the semantic system. Kischka et al. (1996) measured the performance of healthy volunteers who ingested levodopa or a placebo in a lexical decision task with a long and a short SOA and direct (prime and target are closely related e.g. "dog – cat") and indirect priming (the connection is made by a mediating associated word e.g. "cat – bone" with the mediating word "dog"). They found that hyperdopamine causes a more focussed activation, consisting of a decrease of indirect semantic priming effects. That is, while direct semantic priming effects were present in both groups and SOAs conditions, they found priming effects in the indirect semantic condition at the long SOA in the placebo group but not in participants under L-Dopa. These results suggest that the access to directly related words is not disrupted by dopamine. However, the spread of activation to words indirectly related within the semantic system is disrupted by dopamine intake in healthy volunteers. Similar results were found by Roesch-Ely et al. (2006) with dopamine agonists probably mediated by D1 receptors (Pederzolli et al., 2008). These results suggested that increased levels of dopamine are capable of focussing semantic associations. In this line, an interesting study was conducted by Copland, McMahon, Silburn, and de Zubicaray (2009) to examine the neuromodulation of semantic processing by dopamine. They assessed a group of healthy volunteers who ingested L-Dopa using a priming task while undergoing brain imaging acquisition with fMRI. The results provided further evidence in favour of focussing semantic activation (or restricted spreading of activation) in participants who ingested L-Dopa. Moreover, the imaging data showed that the automatic priming could be modulated by the influence of dopamine in the anterior cingulate which enables increases in attentional mechanisms during the task.

Therefore, if dopamine decreased the spreading of activation in the semantic system, what could be occurring under dopamine depletion? The answer could be reached by measuring patients with loss of dopamine diseases such as Parkinson's.