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Effects of working memory capacity on inference generation during story comprehension in adults with Parkinson's disease

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Abstract

A group of non-demented adults with Parkinson's disease (PD) were studied to investigate how PD affects pragmatic-language processing, and, specifically, to test the hypothesis that the ability to draw inferences from discourse in PD is critically tied to the underlying working memory (WM) capacity of individual patients [Monetta, L., & Pell, M. D. (2007). Effects of verbal working memory deficits on metaphor comprehension in patients with Parkinson's disease. *Brain and Language*, *101*, 80–89]. Thirteen PD patients and a matched group of 16 healthy control (HC) participants performed the Discourse Comprehension Test [Brookshire, R. H., & Nicholas, L. E. (1993). *Discourse comprehension test*. Tucson, AZ: Communication Skill Builders], a standardized test which evaluates the ability to generate inferences based on explicit or implied information relating to main ideas or details presented in short stories. Initial analyses revealed that the PD group as a whole was significantly less accurate than the HC group when comprehension questions pertained to implied as opposed to explicit information in the stories, consistent with previous findings [Murray, L. L., & Stout, J. C. (1999). Discourse comprehension in Huntington's and Parkinson's diseases. *American Journal of Speech–Language Pathology*, *8*, 137–148]. However, subsequent analyses showed that only a subgroup of PD patients with WM deficits, and not PD patients with WM capacity within the control group range, were significantly impaired for drawing inferences (especially *predictive* inferences about implied details in the stories) when compared to the control group. These results build on a growing body of literature, which demonstrates that compromise of frontal–striatal

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systems and subsequent reductions in processing/WM capacity in PD are a major source of pragmatic-language deficits in many PD patients.

Keywords: Language processing; Discourse comprehension; Pragmatics; Resource allocation; Frontal–striatal disorders; Parkinson's disease

1. Introduction

Parkinson's disease (PD) is a chronic neurodegenerative illness linked to decreased dopamine production in the basal ganglia and is recognized primarily by its motor symptoms. However, from early stages of the disease and in the absence of dementia, many PD patients display cognitive impairments that include difficulties with planning, selective attention, and working memory (WM) (Brown & Marsden, 1991; Cooper, Sagar, & Sullivan, 1993; Lewis et al., 2003; Owen et al., 1993, 1992; Taylor, St-Cyr, & Lang, 1986). Many of these limitations in "executive" control and associated resources can be traced to progressive changes in the frontal lobes and connecting pathways (the frontal–striatal–thalamic system), which functionally decline over the course of PD. Of key interest here, WM deficits are present in many PD patients and have been linked to altered dopaminergic innervations to the dorsolateral prefrontal cortex (DLPFC) and progressive interruptions in the frontal–striatal pathways (Gilbert, Belleville, Bherer, & Chouinard, 2005; Lewis et al., 2003; Monetta & Pell, 2007).

WM, which can be subdivided into verbal and visuospatial components, refers to a dynamic cognitive system required to maintain information "on-line" and to manipulate it (Baddeley, 1986; Just & Carpenter, 1992; Petrides, 1995). Neuroimaging studies highlight an important link between different prefrontal sites and processes for manipulating information in WM (DLPFC) and processes for information encoding and retrieval (ventral prefrontal regions; for reviews see D'Esposito et al., 1995; Owen, 2000; Petrides, 1995). In addition, dopaminergic projections to the DLPFC (Williams & Goldman-Rakic, 1995) and possibly also to the caudate nucleus (Collins, Wilkinson, Everitt, Robbins, & Roberts, 2000) seem to play an important modulating role in the function of the WM network. Given that many of the functional brain regions implicated by WM systems overlap considerably with those which systematically decline in PD, some researchers have investigated a possible link between changes in individual WM capacity in PD and specific language processing abilities (Breitenstein, Van Lancker, Daum, & Waters, 2001; Grossman et al., 2003; Hochstadt, Nakano, Lieberman, & Friedman, 2006; Monetta & Pell, 2007).

In fact, there is growing evidence that PD is associated with selective difficulties in processing language and that some of these deficits may be explained by limitations in WM or other measures of individual processing resource capacity. Many PD patients fail to perform normally when language processing is "complex" or depends on high resource capacity, such as when the patients are required to interpret the intended or pragmatically appropriate meaning of metaphorical language, paralinguistic behaviors, or discourse as defined by its social context (see Berg, Bjornram, Hartelius, Laakso, & Johnels, 2003; McNamara & Durso, 2003; Natsopoulos et al., 1993, 1997; Natsopoulos, Katsarou et al., 1991; Natsopoulos, Mentenopoulos et al., 1991). In one study, Natsopoulos et al. (1997)