

Phonological Working Memory limitations and Agrammatism: Is there a causal relationship between the two?

Introduction

Syntactic processing in sentence comprehension requires some form of Working Memory (WM) resources. However, the nature of the relation between WM and sentence comprehension is controversial. One of the questions is whether WM for language is a single resource, or, alternatively, it consists of different components, each entrusted with a different linguistic function (Caplan & Waters, 1999). The aim of the study is to investigate the nature of the relation between WM and sentence comprehension by comparing sentence comprehension abilities with performance on WM tasks of four Greek-speaking patients with Broca's aphasia. The experimental hypothesis is that patients with different performance patterns in sentence comprehension will present with different verbal WM capacity.

Methods

Two Greek-speaking patients with agrammatic aphasia (with impaired comprehension of syntactically complex reversible sentences) and two Greek-speaking patients with non-agrammatic Broca's aphasia (with intact comprehension of syntactically complex sentences) participated in the study (for patients' language data see Varkanitsa et al. 2013). To assess patients' WM capacity, we adapted Friedmann and Gvion's (2003) battery. The battery included tests that assess phonological WM: (i) two word span tests, one with short words (two syllables) and one with longer words (four syllables), (ii) a nonword span test, (iii) a forward digit span test, (iv) a backward digit span test, which requires not only storage but also manipulation of stored information, and, finally (v) a digit-ordering task that has been claimed to share some key features with sentence processing (MacDonald et al. 2001). The performance of each individual patient in the WM tasks was compared to a control group of 10, age and education-matched non-brain-damaged adults, using Crawford and Howell's (1998) t-test.

Results

All patients with Broca's aphasia presented with some kind of WM limitations (see table 1). The agrammatic patients performed significantly worse than controls in both word span tests and in the nonword span tests. The non-agrammatic patients

performed significantly worse than controls in the 2-syllable word span test. All patients' performance in the forward digit span test was indistinguishable from controls. One agrammatic and one non-agrammatic patient performed significantly worse in the backward digit span test, In the digit-ordering task, both the agrammatic and the non-agrammatic patients presented with significantly worse performance compared to controls.

Discussion

These results are inconsistent with theories assuming a single WM capacity that deals with all types of linguistic information. Rather, this study provides evidence that syntactic parsing relies on different resources from what is typically measured in verbal WM tasks. The four patients with Broca's aphasia that participated in this study presented with similar phonological WM limitations with only quantitative differences in some tasks, despite the fact that only two of them also had sentence comprehension difficulties. The results also suggest that the agrammatic patients suffer from a specific WM deficit, linked to processing syntactic dependencies, which is not tapped by phonological WM tests.

References

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Table 1 Recall spans of individual patients with aphasia compared with the age and education-matched controls.

	Agrammatic patients		Non-agrammatic patients		Controls <i>mean (SD)</i>
	AV	AG	GP	MD	
2-syllable word span	2***	2***	3*	3*	4.5(0.47)
4-syllable word span	0.5**	2*	3	3	3.6(0.7)
2-syllable nonword span	0**	0**	2	2	2.8(0.59)
digit-ordering	4***	5*	4.5**	4***	5.9(0.32)
digit span – forward	4	5	4.5	4	6.1(1.29)
digit span – backward	2*	3	2.5*	4	4.7(1.16)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$