Does phonological working memory limitation cause comprehension deficits in agrammatic and conduction aphasia?

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Introduction

We explored the relation between verbal working memory limitation and sentence comprehension in agrammatic and conduction aphasia, focusing on the following questions:

- Does verbal WM limitation cause a deficit in sentence comprehension?
- If so – does it impair all types of sentences?
- Is there a difference between sentences that require syntactic-semantic processing and sentences that require phonological processing?
- Does the severe phonological WM limitation in conduction aphasia cause deficit in sentence comprehension and if so, in which sentence types?
- Should the agrammatic deficit in relative clause comprehension be attributed to WM limitation, specifically to the antecedent-gap distance, which is longer in object relatives?

The study

The study explored the comprehension of two types of sentences.
Experiment 1 tested relative clauses, in which a semantic reactivation is required.
Experiment 2 tested sentences with ambiguous words that get disambiguated to the less preferred meaning in a process that requires word-form reactivation.
In both experiments we compared long and short distances to the reactivation point, and tested the relation between the distance and comprehension in the two aphasia groups.

Participants

5 Hebrew-speaking conduction aphasics, 3 agrammatic aphasics and 8 matched controls.

Experiment 1: gap-antecedent distance in relative clauses

160 Hebrew relative clauses were included in binary sentence-picture matching task, in which the participant heard a sentence and chose between the matching picture and a reversed-role foil. Number of words between the antecedent and the gap (2,5,7 or 9 words), and relative clause type (subject vs. object) were manipulated.

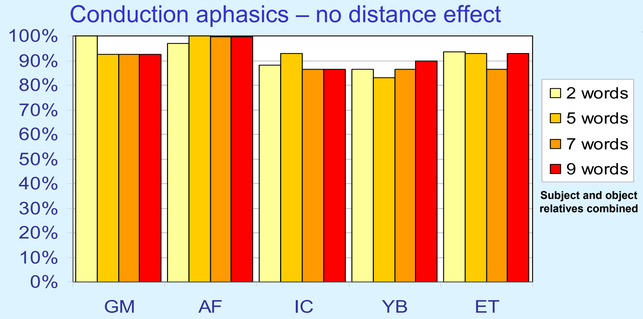
Examples (translated from Hebrew):
9 word distance object relative:
This is the **king** with the long gown, the golden crown and the nice moustache that the boy combs ___

2 word distance object relative:
This is the **king** that the boy combs ___

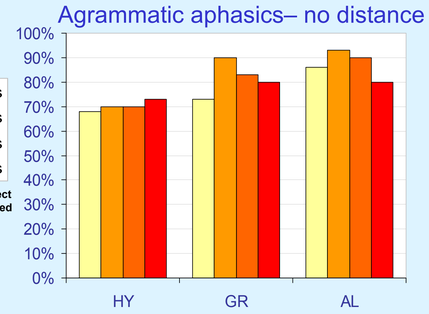
Results

Increasing antecedent-gap distance had no effect despite the limitation in WM.
Conduction aphasics succeeded on all types of relative clauses.
Agrammatic aphasics showed the "classical" dissociation, and performed better on subject relatives than on object relatives.

Conduction aphasics – no distance effect



Agrammatic aphasics– no distance effect



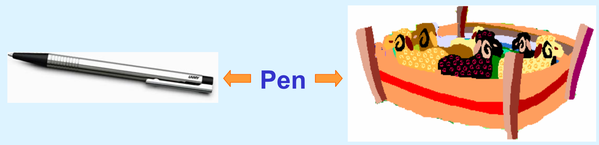
conclusion When the processing that is required is syntactic-semantic, distance does not impair comprehension, even when WM is limited.

Experiment 2: disambiguation distance

80 Hebrew sentences with ambiguous words that get disambiguated either after 2-3 words or after 7-9 words were included in a plausibility judgment and paraphrasing task (auditory presentation). 100 additional semantically implausible or plausible sentences matched for length served as fillers.

Examples (translated from Hebrew):
7-9 word disambiguation distance: the **pen** that the student received from his grandma when he graduated was **packed** with wooly sheep.

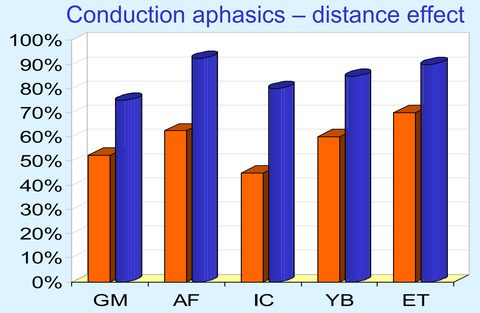
2-3 word disambiguation distance: the **pen** is always **packed** with wooly sheep.



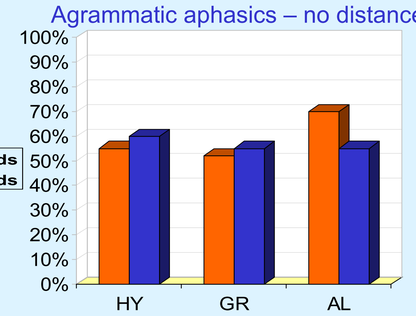
Results

Conduction aphasics showed a severe deficit in comprehension of long distance disambiguation, rejecting more than half of the sentences as "implausible". They showed much better comprehension when the same ambiguity was resolved after 2-3 words. Agrammatic aphasics showed no significant difference between short and long distance.

Conduction aphasics – distance effect



Agrammatic aphasics – no distance effect



conclusion When the processing that is required is phonological, larger distance does impair comprehension when WM is limited.

Working memory tests:

Digit-span
Word span: phonologically similar/dissimilar
Word span: long/short words
non-word span
Listening span
Recognition word-span
2-back: 3 versions of 100 words, 2 SOAs

	Agrammatic aphasia			Conduction aphasia				
	HY	GR	AL	GM	AF	IC	YB	ET
Digit span	2	3	3	2.5	2.5	2.5	3	4.5
Word span	2.5	2.1	3	2	3	2.6	3	3.7
Non-word span	1.5	0	2	1.5	0	1.5	1.5	
Listening span	4	6	6	3	6	6	6	5
recognition span	5.5	6	6	2.5	3	2.5	4.5	5.5

Results

Conduction aphasics: very limited digit-,word-,non-word spans in recall and recognition. Listening spans reached normal values in 3 patients probably due to semantic reliance on the sentence that preceded the word. Agrammatic aphasics: limited digit,-word-and non-word spans, possibly due to articulatory agility difficulties as the recognition span tasks approached normal values. Above 90% in both groups in the 2-back test.

Conclusion

1. Phonological working memory limitation can cause a comprehension deficit in conduction aphasia only in very specific structures that require phonological, rather than syntactic-semantic reactivation, and that include phonological load.

2. The comprehension deficit in agrammatism is not related to phonological WM limitation.

We therefore suggest that given a phonological load, the type of processing (phonological or syntactic-semantic) is the crucial factor that determines whether a phonological WM limitation would cause a failure in comprehension.

The poster can be downloaded at
http://www.tau.ac.il/~naamafr