Working memory and syntactic comprehension

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To understand sentences with syntactic dependencies, some kind of memory is no doubt required. In fact, linguists and psycholinguists often refer to a "short-term memory" whose role is to hold partial parses of a sentence (Ackema & Neeleman, 2002; Kimball, 1973; Pritchett, 1992) until the parsing of the sentence is complete.

The question is what is the nature of this working memory, and whether this is the same working memory that psychologists measure using span tasks and other tasks that examine the ability to hold phonological information for a limited time.

In the line of studies that I will present in my talk, we examined the relation between phonological working memory and syntactic processing using the examination of relative clause comprehension in individuals who have extremely limited phonological working memory: individuals after brain damage who have conduction aphasia and cannot retain more than two words in memory, and children with developmental disorder of phonological-WM with similar difficulties. I compare these individuals' comprehension of sentences that require semantic-syntactic reactivation and sentences that require phonological reactivation (including various types of garden path sentences). I then examine phonological working memory in large groups of individuals with acquired and developmental deficit in Wh-movement.

The results unequivocally show that even severe deficit to phonological working memory does not affect the comprehension of Wh-movement-derived sentences (although it does affect the comprehension when the sentences require phonological reactivation). Moreover, individuals with severely impaired comprehension and production of sentences derived by Wh-movement do not necessarily have phonological working memory impairment. These findings indicate that phonological working memory is not involved in Wh-movement parsing, and that one may consider the existence of a syntactic WM that is used in syntactic processing and which is sensitive to intervention.

Method

The participants were 14 individuals with conduction aphasia and 214 control participants without language or memory impairments. All participants had pre-morbidly full control of Hebrew, and at least 12 years of education. Ten recall and recognition span tasks were used to measure their pWM capacity. To assess phonological output buffer we used a full transcription of spontaneous speech, repetition of words and nonwords, picture naming, and various phonological manipulation tasks such as spoonerism and sound deletions. To exclude a deficit in the early auditory processing stage, we also included auditory rhyme judgment tasks and auditory discrimination tasks .

Experiments 1 and 2 tested the comprehension of relative-clauses, which require semantic-syntactic reactivation, using sentence-picture matching of 168 relative-clauses, and plausibility-judgment of 80 relative-clauses. Experiments 3 and 4 tested phonological reactivation, using a paraphrasing task for sentences with lexical ambiguity in which the disambiguation requires re-access to the word-form (148 sentences), and rhyme judgment (184 sentences). The distance between a word and its reactivation site was manipulated in terms of number of words/syllables, number of intervening arguments, and the number of intervening embeddings .

Results

All the participants with conduction aphasia showed very limited recall spans compared to the control group. Two participants performed similarly to the controls in recognition spans, suggesting a selective output buffer deficit, further supported by their error pattern in naming, repetition, spontaneous speech, and phonological manipulation tasks. Of the remaining 12 participants, 7 showed phonological errors in the output tasks in addition to limited recall and recognition spans, suggesting a mixed (input and output) conduction aphasia, and 5 participants had pure input conduction aphasia, with limited recall and recognition spans but without phonological errors in the output tasks .

Although their pWM was very impaired, the twelve individuals with input-buffer deficit comprehended relative-clauses well and without distance effect. They did, however, have difficulties understanding and judging sentences that required phonological reactivation, but only when the phonological distance was long (Figure 1). The participants with output conduction aphasia comprehended both types of sentences well and not different from the healthy controls.

Conclusions

The results suggest that pWM is not involved in sentence comprehension when only semantic-syntactic reactivation is required. It does support comprehension in very specific conditions: when phonological reactivation is required after a long phonological distance. The results also show that a pWM deficit only in the output-buffer does not affect the comprehension of sentences of any type.