Sentence repetition as a function of episodic buffer: a pilot study in Croatian

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https://doi.org/10.36505/ExLing-2022/13/0018/000560

Abstract

In sentence repetition tasks, the function of the episodic buffer of working memory is to adjust semantic and syntactic information stored in long-term memory. To explain how working memory uses linguistic knowledge about words and constraints on their order in sentences, *the constrained sentence span task* was adapted and developed. The aim of the study was to determine how many words in sentences children could repeat under both conditions with and without articulatory suppression. Sixteen ten-year-old children participated in the study (M = 10;04). The results showed that success in repeating sentences under both conditions increased up to sentences with six words. This experimental task accounts for the function of the episodic buffer when controlling various linguistic aspects.

Keywords: sentence repetition, long-term linguistic knowledge, episodic buffer, working memory

Introduction

In Baddeley's model of working memory, the episodic buffer has the task of communicating with long-term memory while integrating and storing information from the other two components of working memory – the phonological loop and/or the visuospatial sketchpad, depending on the modality of the information (Baddeley, 2000).

In verbal tasks, the episodic buffer allows syntactic and semantic information from long-term memory to interact with that from working memory. In immediate sentence recall tasks, it is thought to act as a system that adapts to the contribution of long-term linguistic knowledge, explaining the ability to repeat a larger number of related units of meaning in a particular order. Other theories of immediate recall emphasise that linguistic knowledge is interwoven with memory for immediate sentence repetition (Acheson & McDonald, 2009).

Baddeley et al. (2009) have developed a sentence repetition task that reflects the functioning of, or measures the capacity of, the episodic buffer of working memory. This task can be used to examine the span of immediate sentence memory when demands on working memory are increased while controlling for linguistic knowledge of words and constraints on their order in sentences. The

aim of the present study is to test this adapted task with Croatian-speaking children.

Methods

Participants

Sixteen typically developing school-aged children participated in this pilot study (10;00 - 10;10 years old; M = 10;04 years, SD = 3.26 months). Children's non-verbal cognitive abilities were assessed using the Raven's Progressive Matrices (Raven et al., 2000). All children scored normal on the nonverbal IQ, confirming that they had no diminished intellectual abilities (SR mean = 104; SR range = 90 - 128.75; SD = 12.25) and had no language difficulties.

Experimental task

For this study, a specific experimental sentence repetition task – *the constrained sentence span task* – was designed to investigate sentence memory span and to determine how working memory uses linguistic knowledge about words and constraints on their order in sentences stored in long-term memory (Baddeley et al., 2009). In this task, sentences are constructed from a closed set of words (nouns, verbs and adjectives). Examples of 6-word sentences formed from a closed set of words are:

1) Susjed Matej prodaje dobar stari auto. [Neighbour Matthew sells (a) good old car].
2) Novi susjed otvara stari zeleni auto. [(The) new neighbour opens (the) old green car].

This task is similar to a standard memory span procedure in which a smaller number of words are used repeatedly in different places in sentences, taking into account the linguistic regularities and constraints of the Croatian language. Selecting a closed set of words and using a limited range of syntactic structures increases the demands on working memory during sentence repetition and forces subjects to focus on their current memory, minimising the variability that may arise from their individual language knowledge or the form and content of the sentences. Furthermore, this allows for proactive interference of similar linguistic material, reducing the contribution of gist-based long-term episodic memory. The proactive interference paradigm ensures that participants focus on temporary binding in working memory.

Design and procedure

A 6x2 repeated measures design was used in which sentence length was manipulated by gradually increasing noun phrases (so that sentences were 3-8

words long) and secondary tasks (performance without or with articulatory suppression to disrupt the phonological loop). Ten different sentences were designed for each sentence sequence, and each experimental condition was counterbalanced using a Latin square. As linguistic knowledge has previously been shown to influence immediate sentence repetition, word order, semantic plausibility, word length and word frequency were controlled. Therefore, all words were 2-3 syllables long, of medium to high frequency based on data from the Children's Frequency Dictionary of the Croatian Language (Kuvač Kraljević et al., 2021) and the Croatian Lexical Database (Kuvač Kraljević & Olujić, 2018), constructed in sentences in the canonical SVO order, and semantically plausible, as subsequently confirmed by children's rating on a Likert scale of 1-5 (M = 4.45). The experiment was conducted at school, in a quiet room. After listening to the audio recording of the sentences through headphones, the participants had to repeat each sentence as accurately as possible. Under conditions of articulatory suppression, they continuously repeated 1-2-3-4 while listening to the sentences.

Results and discussion

Since this study focused on the number of correct words that could be repeated in a sentence, each word that the children could recall was quantified. The repetition was correct if (1) the words were repeated in the correct order, i.e. there was no change of position between two adjacent words, (2) all inflexions were preserved and the number, gender and case of the content words matched the target word.

Inter-rater reliability was assessed using the intraclass correlation coefficient (ICC). Thirty percent of the samples (results from five children) were randomly selected and evaluated by the first author and an independent rater. Overall, the results showed excellent agreement between the two raters (ICC = .98).

The mean proportion of words correctly repeated by the children for each sentence sequence and in relation to performance in the conditions without and with articulatory suppression (AS) is shown in Table 1.

As expected, the results showed significant effects of sentence length, $F(1.76, 52.65) = 132.70$, $p < .01$, $\eta_p^2 = .82$, but no effects of secondary tasks, $F(1, 30) = 1.78$, $p = .192$, $\eta_p^2 = .06$, and no interaction between these two effects, $F(1.76, 52.65) = 1.24$, $p = .295$, $\eta_p^2 = .04$. Sentence recall performance increased up to sentences of six words, after which it began to decline. For example, the mean number of words in the retrieved 6-word sentences was 5.69 (SD = .34) and in the articulatory suppression condition was 5.54 (SD = .46) (Table 1).

	Secondary tasks	
	Without AS	With AS
3-word sentences	2,99 (.05)	2,93 (.09)
4-word sentences	3,98 (.06)	3,96 (.09)
5-word sentences	4,78 (.25)	4,78 (.25)
6-word sentences	5,69 (.34)	5,54 (.46)
7-word sentences	5,63 (.88)	5,24 (.99)
8-word sentences	5,45 (.97)	4,99 (1.04)

Table 1. Descriptive statistics data – mean proportion of words for each sentence sequence (with standard deviation) in relation to the two conditions

Articulatory suppression did not interfere with the binding of words to sentences during retrieval. These results support the fact that articulatory suppression, which limits the involvement of the phonological loop that supports repetition, is not cognitively demanding enough to significantly impair sentence memorisation and repetition. This study contributes to the assumptions that the constrained sentence span task accounts for the function of the episodic buffer when controlling for different linguistic aspects from the word to the sentence level. Furthermore, the type of errors the children made could provide additional information about underlying language processing problems.

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