

Working Memory Functioning in Children with Specific Language Impairment

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Abstract

Background: Children with an unexplained severe delay in the development of language are described as having Specific Language Impairment (SLI). Both etiology of SLI and neurobiological contributions are not yet clearly understood. Researchers currently regards deficit in working memory functioning as one major characteristic for language impairment.

Aim of Study: This study aims to assess working memory functions in children with specific language impairment to determine whether they exhibit associated working memory deficit or not.

Patients and Methods: This study is conducted on 60 Arabic speaking children, their age range from 5 to 8 years and divided into 2 equal groups; cases and controls. Receptive expressive Arabic language scale (REAL scale) subtests were used to assess the working memory functions in all children.

Results: Significant difference is seen between the study group and control group regarding the REAL scale subtests; understanding oral instructions and sentence repetition.

Conclusion: Deficits in working memory functions coexist with language impairment in children diagnosed with SLI.

Key Words: Working memory – Specific language impairment – Children.

Introduction

WORKING memory is a multicomponent, capacity-limited system that is responsible for temporarily holding information available for processing [1]. According to current models of working memory [2,3]; one of its components, which is the phonological loop, is responsible for storing verbal-acoustic information and it is claimed that deficits in the phonological loop component, which includes a phonological store and a sub-vocalic rehearsal process, are the main cause for language deficits in children with SLI [4]; a condition were the

language level observed is substantially below the nonverbal intellectual capacity that cannot be explained by any obvious factor [5].

Although, some studies show that children with SLI perform similar to their typically developing peers on visuo-spatial working memory tasks [6] other researchers have been identifying deficits in working memory and diverse aspects of phonological information processing in children with SLI [4,7,8]. Studying the association between working memory and SLI can in turn lead to early and tailored therapy for children with specific language impairment aimed not only at stimulating language development but also at strengthening working memory functions.

Patients and Methods

This study was conducted on 60 Arabic speaking children in the period between December 2015 and March 2018. Their age ranged from 5 to 8 years old. Children included in the study were selected from Kasr El-Aini Phoniatic outpatient clinic and mainstream nurseries or daycares and were divided equally into two groups; group A diagnosed with SLI and group B with normal language development.

Inclusion criteria:

Average intelligence (IQ 85-110) and delayed language development with at least one of the following; (A) The receptive language age score at least 6 months below the mental age or chronological age, whichever is lower; (B) A combined language score of at least 12 months below the mental age or chronological age; or (C) An expressive language age score that is at least 12 months below the mental age or chronological age.

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Exclusion criteria:

No present or past history of peripheral hearing impairment or otitis media (active or recurrent), psychological disorders or neurological disorders.

All children underwent the following protocol of assessment:

- 1- Parent and child interview; for history taking and general and neurological examination.
- 2- Psychometric evaluation; using Stanford Binet test (4th edition) [9]. It yields visual, verbal reasoning, quantitative and short-term memory.
- 3- Language assessment; using Modified PLS-4 (Preschool Language Scale) Arabic edition [10] to diagnose SLI and underlying language difficulties. The test is divided in 2 subtests.

A- Auditory comprehension subscale:

The auditory comprehension subscale includes test tasks that are important precursors for language development, test tasks that assess basic vocabulary, concepts, grammatical markers, understand complex sentences and inferences. It is used to assess a child's attention to people, sounds and objects in the environment, play behavior and comprehension of basic vocabulary, gestures, concepts (quantitative, qualitative, spatial and time/sequence concepts), morphology and syntactic structures, integration of language skills in tasks such as making inferences and categorizing objects and phonological awareness skills.

B- Expressive communication subscale:

Many of the tasks on the expressive communication subscale parallel to those on the auditory comprehension subscale. The expressive communication subscale is used to assess verbal development, preverbal communication, the child ability to produce speech sounds, communicate wants and needs, the child ability to use gestures, name objects, describe pictures and events, speak in grammatically correct sentences, integrate various aspects of language to categorize, complete analogies and provide word definitions, the child ability to demonstrate a few phonological awareness skills such as rhyming and segmenting word, use of specific prepositions, grammatical markers and telling short story.

- 4- Working memory assessment; using Receptive expressive Arabic language scale (REAL scale) [11]. Selected subtests were used; Understanding oral instructions and Sentence repetition to provide a more detailed picture of the underlying difficulties related to the children's working memory and auditory processing.

A- Understanding oral instructions:

This test is to evaluate the child's ability to follow orally presented instructions, 62 sheets involving pictures of many objects are introduced. For each sheet, an instruction is given by the assessor. The instructions are graded in difficulty; based on their length and degree of complexity. Understanding oral instructions involve the following:

- Sequential instructions involving different number of items and distracters.
- Spatial indicators.
- Temporal indicators.
- Specifies; adjectives/colors.
- Conditional indicators.
- Exceptional indicators.
- Quantitative terms.
- Complex instructions involving two or more of the above e.g. Temporal indicators, adjectives or spatial indicators all presented together at the same time.

B- Sentence repetition:

This test is to evaluate the child's ability to recall and reproduce sentences of varying length and syntactic complexity. The child was asked to repeat sentences that are orally presented by the examiner after clear instruction was given that each sentence will be presented once only and cannot be repeated. Sentences are graded in difficulty as regards both length and structure complexity. The sentences involved in this subtest include:

- Simple sentences.
- Question forms.
- Passive forms.
- Negative forms.
- Compound sentences.
- Complex sentences.
- Detailed sentences.
- Lengthy sentences.
- Sentences involving conditional indicators.
- Sentences involving contradictory phrases.
- Embedded phrases.
- Temporal clauses.
- Various verb tenses.
- Singular as well as plural forms.

Statistical analysis:

Numerical data were expressed as mean and standard deviation or median and range as appro-

appropriate. Qualitative data were expressed as frequency and percentage. Chi-square test or Fisher's exact test was used to examine the relation between independent qualitative variables. McNemar test was used to examine the relation between dependent qualitative variables. Agreement between different clinical tests was examined using kappa test. For quantitative variables, comparison between two groups was done using independent sample *t*-test or Mann-Whitney test as appropriate. Comparison of repeated measures was done using Wilcoxon signed-ranks test. All tests were two-tailed. A *p*-value <0.05 was considered significant.

Results

Both cases and controls in this study were age matched as there was no significant difference in the age of the children selected as seen in (Table 1). Regarding the Intelligence Quotient (IQ), results show that significant difference was found when comparing the IQ of the study group to the control group in (Table 2).

Table (1): Comparison between the study group and control group regarding the age of children included in the study.

Group	Study group		Control group		<i>p</i> -value
	Mean	SD	Mean	SD	
Age (years)	6.5	0.8	6.5	0.8	0.809

Table (2): Comparison between the study group and control group regarding the intelligent quotient.

Group	Study group		Control group		<i>p</i> -value
	Mean	SD	Mean	SD	
Intelligence Quotient	91	6	101	7	<0.001

There is significant difference seen between the two groups regarding the auditory comprehension standard score and language age, expressive communication standard score and language age and finally the total standard score and total language age.

Significant difference is observed between the study group and control group regarding the REAL scale subtests; understanding oral instructions and sentence repetition, were the scores are significantly lower in the study group compared to the control group.

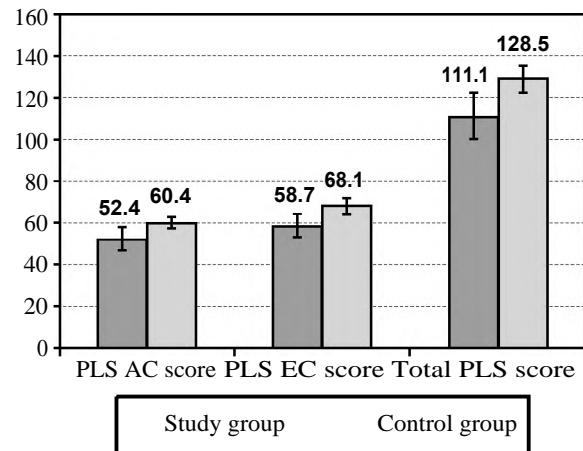


Fig. (1): Preschool Language Scale (PLS) scores and its subscales in the two studied groups.

PLS AC score: Auditory comprehension standard score.
 PLS EC score: Expressive communication standard score.

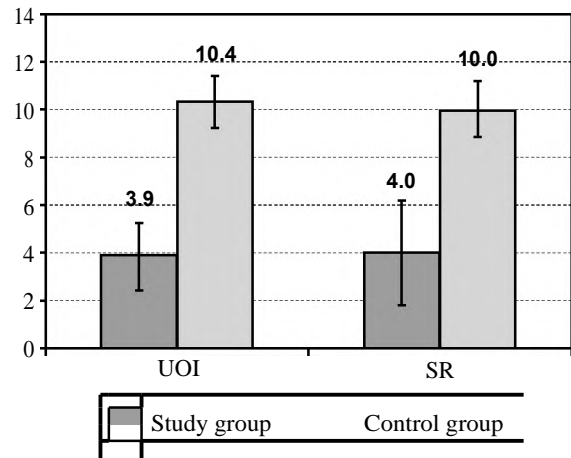


Fig. (2): Understanding oral instructions and sentence repetition scores in the two studied groups.

Discussion

In the SLI literature, some studies have reported problems with working memory functioning and others have not found a working memory deficit [12].

Currently, in this study, in understanding Oral Instructions test, both groups of children, SLI and typically developed, showed comparable performance in the single-load condition where instructions involved a single direct command, suggesting that the children with SLI had some ability to coordinate both storage and processing functions, but only when the processing demands were not too taxing. It was the dual-load condition where more than one instruction were given at a time in form of a hierarchical demand, that the children with SLI demonstrated reduced working memory capacity relative to age control children.

That is, children with SLI perhaps not only have greater difficulty retaining/processing the entire input sentence but also completing, in a timely fashion, and a number of other information processing demands of such tasks, including scanning and visually processing each of the stimulus pictures, generating a linguistic representation of each of the stimulus pictures, and deciding which picture best matches the input sentence.

These results are consistent with a study done earlier [13], for the working memory load prompts, the majority of errors for the language impaired group, were hierarchical errors. A hierarchical error suggests that the subject's memory did not connect the subject of the sentence, ablated by the preposition, with the description at the end of the prompt. This suggests that this type of statement overloads the working memory, and thus verbal input was incorrectly processed in the order it was received.

On the other hand, in Sentence Repetition task scores of the SLI children were significantly lower when compared to the typically developing group scores. However, children with SLI once more showed comparable repetition of the short sentences to the typically developing children but showed significantly poorer repetition of long sentences compared to the control group. As the sentences become longer it shows more compound words and the task appears to draw heavily on lexical knowledge to assist word recognition and recall. Unlike other the memory assessment tasks, the sentence repetition testing entails two skills, language and memory. It depends on adequate language level and familiarity with the syntactic features together along with auditory memory and processing.

In accordance, it was stated [1] that poorer repetition of long sentences by the children with SLI is related in part to their phonological working memory deficit in that they are less able to store as much speech material at any given moment, thereby hindering their ability to generate a complete sentence representation. This is interpreted to suggest that the difficulty children with SLI have managing the dual functions of information storage and repetition may in part be responsible for their trouble with lexical and morphological learning. That is, children with SLI have difficulty maintaining the novel phonological information in short-term memory long enough to process its meaning.

Collectively, results are interpreted to suggest that children with SLI have greater difficulty man-

aging the dual (or more) functions of storage and processing i.e., when they had to complete two mental operations in a timely fashion. Thus, children with SLI showed what is described as a classic storage/processing trade-off; storage suffered when the processing demands required a greater allocation of working memory resources [1].

Conclusion:

The current study shows a consistent finding that is; verbal working memory deficit for children with SLI as compared to their typically developing peers.

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Nil.

Conflicts of interest:

There are no conflicts of interest.

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وظائف الذاكرة العاملة فى الأطفال الذين يعانون من اضطراب ضعف اللغوى النوعى

يتم وصف الأطفال الذين يعانون من تأخير شديد غير مفسر فى تطور اللغة على أنهم يعانون من ضعف لغوى نوعى. المسببات والمساهمات العصبية البيولوجية ليست مفهومة بشكل واضح حتى الآن. يعتبر الباحثون حالياً أن العجز فى الذاكرة العاملة يعمل كأحد الخصائص الرئيسية لضعف اللغة. تهدف هذه الدراسة إلى تقييم وظائف الذاكرة العاملة لدى الأطفال ذوى الضعف اللغوى النوعى لتحديد ما إذا كانوا يعانون من عجز فى الذاكرة العاملة المرتبطة أم لا.

أجريت هذه الدراسة على ستون طفلاً يتحدثون العربية، تتراوح أعمارهم ما بين خمس إلى ثمانية سنوات وينقسمون إلى مجموعتين لتقييم وظائف الذاكرة العاملة. أثبتت نتائج البحث أن العجز فى وظائف الذاكرة العاملة يصاحب الأطفال الذين يعانون من ضعف اللغوى النوعى.