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Assessment of Short-term Memory in Arabic Speaking Children with Specific Language Impairment

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Abstract: Children with Specific Language Impairment (SLI) may have some kind of memory disorder that could increase their linguistic impairment. This study assessed the short-term memory skills in Arabic speaking children with either Expressive Language Impairment (ELI) or Receptive/Expressive Language Impairment (R/ELI) in comparison to controls in order to estimate the nature and extent of any specific deficits in these children that could explain the different prognostic results of language intervention. Eighteen children were included in each group. Receptive, expressive and total language quotients were calculated using the Arabic language test. Assessment of auditory and visual short-term memory was done using the Arabic version of the Illinois Test of Psycholinguistic Abilities. Both groups of SLI performed significantly lower linguistic abilities and poorer auditory and visual short-term memory in comparison to normal children. The R/ELI group presented an inferior performance than the ELI group in all measured parameters. Strong association was found between most tasks of auditory and visual short term memory and linguistic abilities. The results of this study highlighted a specific degree of deficit of auditory and visual short-term memories in both groups of SLI. These deficits were more prominent in R/ELI group. Moreover, the strong association between the different auditory and visual short-term memories and language abilities in children with SLI must be taken into account when planning an intervention program for these children.

Key words: Memory, short-term, psycholinguistics, language disorders, developmental

INTRODUCTION

Specific Language Impairment (SLI) is used to refer to problems in the acquisition and use of language, typically in the context of normal development. It is characterized by marked delay of language development in the absence of any apparent handicapping limitations such as hearing disorders, behavioral or emotional disorders, neurological impairments, or mental retardation (Plante, 1998). Children with SLI may have some kind of memory disorder that could increase their linguistic impairment (Miller *et al*., 2001). Short Term Memory (STM) deficits in children with SLI are not confined to the auditory-verbal modality but constitute more general STM problems impacting auditory-verbal as well as visual STM (Nickisch and Kries, 2009).

It is estimated that 5 to 10% of school-age children with SLI had impairments in the areas of memory, learning and language processing (Miller *et al*., 2001; Benasich and Tallal, 2002; Montgomery, 2003). Failures in different functions of STM as well as the several aspects of language disorders could be present in children with SLI (Van der Lely and Howard, 1993). STM can be defined as the retention of small amounts of information over brief periods of time. It is a system for temporarily storing and managing information required to carry out complex cognitive tasks such as learning, reasoning and comprehension. It is involved in the selection, initiation and termination of information-processing functions such as encoding, storing and retrieving data (Baddeley, 2000).

SLI can be divided into expressive and receptive language disorders. In expressive SLI (ELI) only the expressive language abilities are below average, whereas the receptive skills are expected to be in the normal range. In contrast, children with receptive SLI almost always show deficits in receptive language skills as well as expressive language skills. Thus in receptive language disorder there is combined receptive-expressive language impairment (R/ELI) (WHO, 2005).

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Several authors reported that children with ELI show better therapy results compared to children who have R/ELI (Boyle *et al*., 2007; Law *et al*., 2004). Causes of these apparent differences in the success of treatment are poorly understood. Therefore, early identification, understanding the nature of the disorders and proper intervention is warranted. However, to our knowledge, there have been no studies were done to assess short term memory of Arabic speaking children with ELI and R/ELI. The objective of this study was to assess the short-term memory skills in Arabic speaking children with either expressive language impairment or mixed receptive and expressive language impairment in comparison to controls in order to estimate the nature and extent of any specific deficits in these children that could explain the different prognostic results of language intervention.

MATERIALS AND METHODS

Subjects: This study was conducted on children presented with language disorder to the Phoniatrics clinics, Ain Shams University Hospital and Sohag University Hospital during the period from June 2008 to December 2009. According to the Arabic language test (Kotby *et al*., 1995) and psychometric evaluation using Wechsler Intelligence Scale for Children (Wechsler, 1991), children were diagnosed as ELI if they had expressive language abilities one year less than their chronological age, while their receptive quotients were within normal range. R/ELI was diagnosed when both receptive and expressive language abilities were one year less than their chronological age. Eighteen cases were diagnosed as Expressive Language Impairment (ELI), who showed impaired expressive language abilities and fulfilled normal receptive language abilities. This group was matched by age, gender and non verbal Intelligence Quotient (IQ) to another 18 cases with Receptive and Expressive Language Impairment (R/ELI), where both receptive and expressive language abilities were impaired. All children demonstrated at least normal range of non-verbal IQ ($IQ \geq 90$).

Children with ELI were 10 boys (55.6%) and 8 girls (44.4%). The mean age (±SD) was 6.3 years (±0.97) and age ranged from 5 to 8 years. Children with R/ELI were 12 boys (66.7%) and 6 girls (33.3%). The mean age (±SD) was 6.7 years (±1.39) and age ranged from 4 years and 6 months to 8 years. Children of both groups were compared to a control group composed of 18 normally developing children with age, sex and IQ matched. They were selected from children presented to Otorhinolaryngology clinics complaining of disorders not related to language or speech disorders. They were 11 boys (61.1%) and 7 girls (38.9%) with a mean age (±SD) of 6.2 years (±1.11) and age ranged from 4 years and 8 months to 8 years.

Procedures and clinical tools

Protocol of language assessment: All children included in this study were subjected to a comprehensive language assessment protocol (Kotby *et al*., 1995).

- **Parent's interview:** Taking a full personal, family, medical, developmental history (prenatal, natal and postnatal and milestones of development) and history of early childhood. No neurological dysfunctions were signaled in the clinical history of any of the children. None of the children had history of psychopathology and no bilingual children were included in this study
- **Patient's examination:** General, Neurological and Vocal tract examinations to exclude cases with any associated disorders
- **Audiological evaluation:** was performed using pure-tone audiometry and tympanometry as an exclusionary criterion for the diagnosis of SLI
- **Psychometric evaluation:** Non verbal IQ testing was done using Wechsler Intelligence Scale for Children-Third Edition (Wechsler, 1991). All children in this study were required to have a performance IQ score of greater value than 90
- **Objective language assessment:** All the children were diagnosed using the Arabic Language Test (ALT) (Kotby *et al.,* 1995). For each child, Receptive Language Quotient (RLQ), Expressive Language Quotient (ELQ) and Total Language Quotient (TLQ) were calculated. The diagnosis of SLI implies in the linguistic age being at least one year below the expected for the chronological age (Menezes *et al*., 2007). According to World Health Organization (WHO, 2005) expressive language abilities are below average in children with ELI while both receptive and expressive language abilities always show deficits in children with R/ELI. Lahey (1990) recommended that chronological age be used as the principal basis for judging language expectations in children with ELI and RLI

Assessment of short-term memory: Assessment of auditory and visual short-term memory tasks were done for all children, using the Arabic version of the Illinois Test of Psycholinguistic Abilities (El-Sady *et al*., 1996) that was formulated from the revised Illinois test of psycholinguistic abilities (Kirk *et al*., 1968). The raw scores for each subtest were used to derive scaled scores

for each task. The raw scores for each subtest were used to obtain the psycholinguistic age norms for each subtest used. Subsequently, the scaled scores for each subtest were derived from psycholinguistic age norms. The scaled scores are linear transformation of raw scores for each subtest according to the different age levels.

Assessment of auditory short-term memory included:

- **Auditory Sequential Memory (ASM):** Twenty eight different sequences of digits (from 1 to 9) were presented separately by the examiner at a presentation rate of two digits per second. Then, the child had to recall each digit sequence orally. The sequences were comprised of two to eight digits and each length of sequence was repeated three or four times in different combinations progressively
- **Sound blending:** This test included 32 combinations of ConsonantVowel (CV) syllables, each of which was presented orally by the examiner. The child had to repeat each syllable combination in the right order. Syllable combinations containing two to six syllables were used. First, all two-syllable combinations were used. Then, the length of the combinations increased stepwise. Each syllable was composed of one CV combination (e.g., me-ra, ka-pe-to, mo-na-lu-ra, ge-bi-da-fi-no, bi-ga-do- na-fe-ra). The presentation rate for this test was one syllable per second
- **Auditory closure:** This test consisted of a total of 30 words with unpronounced sounds. The examiner pronounced each word with one deleted sound or more, using the same stresses and tone for all the children irrespective of their ages. Then, the child had to pronounce the whole word correctly
- **Auditory association:** The test consisted of incomplete 42 phrases analogues. The child had to complete the missed parts of these phrases verbally. The correct answers were collected and scored according to the calculation rules of the test
- **Verbal expression:** The examiner gave an object out of a total of five objects to the child (namely ball, envelope, cube, nail and button) and then asked the child to give full description for each object alone. The description should include the name, the color and the shape of the object

Assessment of visual short term memory included:

- **Visual Sequential Memory (VSM):** The test estimated the visual short term memory capacity for sequences of abstract symbols. It contained 11 different symbols, which were neither generally familiar nor symbolic of anything familiar, to avoid verbal coding or recalling. All symbols were black on a white background to avoid verbal recoding using color matching. Two to eight different symbols were shown in one row simultaneously for 5 sec. Afterwards, the child had to place the plates with the symbols in the right order. The length of the series should increase progressively up to eight symbols
- **Visual reception:** The examiner allowed the child to see one picture out of a total of 34 pictures for three seconds. Then the child had to choose the one related to the former picture from other four pictures. The child could answer by pointing with no need for verbal output.
- **Visual closure:** This test consisted of four sheets of pictures in addition to one example sheet. First, the examiner named a picture of an object, while the child was looking at it. Then, the child had to look at the full sheet of pictures and point to the biggest number of pictures similar to the former object picture
- **Manual expression:** In this test the child looked at 15 pictures of tools, each presented lonely and then described the function of each of those tools manually. One point was scored for each correct act and the sum of total points was then calculated

Statistical analysis: Statistical package for social Sciences version 11 (SPSS, INC, Chicago, IL) under windows was used for data entry and analysis. Descriptive statistics were done for continuous variables by mean, standard deviation (±SD) and range; and for qualitative data by number and percent. Student t and ANOVA tests were used to compare continuous variables in various groups. Chi-square was used to compare qualitative data in various groups. Pearson's correlation was used to assess the association between the different parametric data. For all tests a probability (p) value less than 0.05 was considered significant.

RESULTS

There was no statistically significant difference ($p>0.05$) between the 3 groups regarding the age, gender distribution and IQ scores (Table 1).

Comparison of language abilities among the three groups: There were highly significant ($p>0.001$) differences between the 3 groups regarding the RLQ, ELQ and TLQ scores. Compared to the control

Table 1: Comparison between the expressive language impairment group (ELI), receptive/expressive language impairment group (R/ELI) and control group regarding the different demographic data

Variables	ELI group	R/ELI group	Control group	ANOVA p-value	ANOVA Sign.
	(Mean±SD)				
Chronological age (years)	6.3±1.0	6.7±1.4	6.2±1.1	>0.05	NS
Gender					
Boys	10 (55.6%)	12 (66.7%)	11 (61.1%)		
Girls	8 (44.4%)	6 (33.3 %))	7 (38.9 %))	>0.05	NS
IQ	94.3±4	94.5±5.2	95.9±4.5	>0.05	NS

ELI: Expressive language impairment, R/ELI: Receptive and expressive language impairment, IQ: Intelligence quotient

Table 2: Comparison between the expressive language impairment group (ELI), receptive/expressive language impairment group (R/ELI) and control group regarding language assessment

Variables	ELI group	R/ELI group	Control group	p-value ANOVA	p-value t-test
	(Mean±SD)				
Receptive language quotient	90±6.9	53.5±10.4	97.4±4.2	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)
Expressive language quotient	59.5±15	44.4±9.3	95.4±4	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)
Total language quotient	72.5±9	49.2±9	95.9±3.6	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)

ELI: Expressive language impairment, R/ELI: Receptive and expressive language impairment, IQ: Intelligence quotient. (a) = ELI. vs. R/ELI, (b) = ELI. vs. control group, (c) = R/ELI. vs. control group. **Highly significant

Table 3: Comparison between the expressive language impairment group (ELI), receptive/expressive language impairment group (R/ELI) and control group regarding the different auditory short-term memory subtests

Variables	ELI group	R/ELI group	Control group	p-value ANOVA	p-value t-test
	(Mean±SD)				
ASM	30.8±4.6	25.3±6.6	36.9±3.1	<0.001**	<0.05*(a) <0.001**(b) <0.001**(c)
Sound blending	24.3±3.3	20.9±4.6	35.6±2.3	<0.001**	<0.05*(a) <0.001**(b) <0.001**(c)
Auditory closure	23.2±3.3	21.2±2.5	44.1±8.6	<0.001**	>0.05(a) <0.001**(b) <0.001**(c)
Auditory association	20.1±3.3	18.6±3.8	40.3±3.7	<0.001**	>0.05(a) <0.001**(b) <0.001**(c)
Verbal expression	11.6±2.4	8.9±1.8	47.4±5.4	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)

ELI: Expressive language impairment, R/ELI: Receptive and expressive language impairment, ASM: Auditory sequential memory. (a) = ELI. vs. R/ELI, (b) = ELI. vs. control group, (c) = R/ELI. vs. control group. *Significant, **Highly significant

group, both ELI group and R/ELI group had highly significant ($p<0.001$) lower scores of RLQ, ELQ and TLQ. Moreover, in comparison to the ELI group, R/ELI group had highly significant ($p<0.001$) lower scores of all assessed language quotients (Table 2).

Comparison between the three groups regarding the auditory short-term memory tasks (ASTM): There were highly significant ($p<0.001$) differences between the 3 groups regarding the mean scores of all ASTM tasks. Compared to the control group, both ELI group and R/ELI group had highly significant ($p<0.001$) lower scores of all these tasks. Moreover, on comparing the 2 SLI groups, R/ELI group had significantly ($p<0.05$) lower scores of auditory sequential memory and sound blending and highly significant ($p<0.001$) lower score of verbal expression task than ELI group. Although, not reaching statistical significance, auditory closure tended to be higher in children with R/ELI than the ELI group ($p = 0.0502$). Meanwhile, auditory association subtest showed no significant difference ($p>0.05$) between the 2 SLI groups (Table 3).

Table 4: Comparison between the expressive language impairment group (ELI), receptive/expressive language impairment group (R/ELI) and control group regarding the different visual short-term memory subtests

Variables	ELI group	R/ELI group	Control group	p-value	
	(Mean±SD)			ANOVA	t-test
VSM	26.7±5.5	19.3±5.2	33.7±1.7	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)
Visual reception	27.2±3.6	23±2.4	43.7±8.7	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)
Visual closure	26.2±4.4	21.4±2.5	44.3±9.6	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)
Manual expression	35.1±2.2	28.1±3.6	44.6±10.1	<0.001**	<0.001**(a) <0.001**(b) <0.001**(c)

ELI: Expressive language impairment, R/ELI: Receptive and expressive language impairment, VSM: Visual sequential memory. (a) = ELI. vs. R/ELI, (b) = ELI. vs. control group, (c) = R/ELI. vs. control group. **Highly significant

Table 5: Correlation between the different auditory short-term memory subtests with IQ and different language quotients in all children with SLI (n = 36)

Variables	IQ		RLQ		ELQ		TLQ	
	r	p-value	r	p-value	r	p-value	r	p-value
ASM	0.10	>0.05	0.73	<0.001**	0.76	<0.001**	0.67	<0.001**
Sound blending	0.12	>0.05	0.66	<0.001**	0.89	<0.001**	0.55	<0.001**
Auditory closure	-0.13	>0.05	0.31	>0.05	0.55	<0.001**	0.43	<0.05*
Auditory association	0.21	>0.05	0.41	<0.05*	0.61	<0.001**	0.52	<0.05*
Verbal expression	-0.10	>0.05	0.55	<0.001**	0.34	<0.05*	0.49	<0.05*

IQ: Intelligence quotient, RLQ: Receptive language quotient, ELQ: Expressive language quotient, TLQ: Total language quotient, ASM: Auditory sequential memory. *Significant, **Highly significant

Comparison between the three groups regarding the visual short-term memory tasks (VSTM): There were highly significant (p<0.001) differences between the 3 groups regarding the scores of all VSTM tasks. Compared to the control group, both ELI group and R/ELI group had highly significant (p<0.001) lower scores of all VSTM tasks. Additionally, compared to the ELI group, R/ELI group had highly significantly (p<0.001) lower scores of all VSTM subtests (Table 4).

Correlation between auditory short-term memory tasks with IQ and different language quotients in all children with SLI (n = 36): No significant correlation (p>0.05) was detected between any task of auditory short term memory and IQ scores of all children with SLI. Auditory sequential memory showed highly significant correlation (p<0.001) with RLQ, ELQ and TLQ (r = 0.73, 0.76 and 0.67, respectively). Sound blending showed highly significant correlation (p<0.001) with RLQ, ELQ and TLQ (r = 0.66, 0.89 and 0.55, respectively). Auditory closure showed significant correlation (p<0.05) with TLQ (r = 0.43) and highly significant correlation (p<0.001) with ELQ (r = 0.55). Although, not reaching statistical significance, auditory closure tended to be correlated with RLQ (r = 0.31; p = 0.067). Auditory association showed significant correlation (p<0.05) with both RLQ and TLQ (r = 0.41 and 0.52, respectively) and highly significant correlation (0.0001) with ELQ (r = 0.61). Verbal expression showed highly significant correlation (p<0.001) with RLQ (r = 0.55) and significant correlation (p<0.05) with ELQ and TLQ (r = 0.34 and 0.49, respectively) (Table 5).

Correlation between visual short-term memory tasks with IQ and different language quotients in all children with SLI (n = 36): No significant correlation (p>0.05) was detected between any task of visual short term memory and IQ scores of all children with SLI. Visual sequential memory showed highly significant correlation (p<0.001) with RLQ, ELQ and TLQ (r = 0.81, 0.85 and 0.78, respectively). Visual closure showed highly significant correlation (p<0.001) with RLQ, ELQ and TLQ (r = 0.55, 0.65 and 0.63, respectively). Manual expression showed significant correlation (p<0.05) with ELQ (r = 0.53) and highly significant correlation (p<0.001) with both RLQ and TLQ (r = 0.61 and r = 0.63, respectively). Visual reception showed highly significant correlation (p<0.001) with RLQ and ELQ and TLQ (r = 0.56, 0.68 and 0.66, respectively) (Table 6).

Table 6: Correlation between the different visual short-term memory subtests with IQ and different language quotients in all children with SLI (n = 36)

	IQ		RLQ		ELQ		TLQ	
Variables	r	p-value	r	p-value	r	p-value	r	p-value
VSM	0.23	>0.05	0.81	<0.001**	0.85	<0.001**	0.78	<0.001**
Visual closure	0.2	>0.05	0.55	<0.001**	0.65	<0.001**	0.63	<0.001**
Manual expression	-0.13	>0.05	0.61	<0.001**	0.53	<0.05*	0.63	<0.001**
Visual reception	0.05	>0.05	0.56	<0.001**	0.68	<0.001**	0.66	<0.001**

IQ: Intelligence quotient, RLQ: Receptive language quotient, ELQ: Expressive language quotient, TLQ: Total language quotient, VSM: Visual sequential memory. *Significant, **Highly significant

DISCUSSION

Despite having normal nonverbal intelligence, children with SLI exhibit a range of linguistic and nonlinguistic deficits. They have poor performance on short term memory tasks (Archibald and Gathercole, 2006). Children with SLI display poorer coping strategies in socially demanding situations as compared to age-matched typically developing children (Marten *et al*., 2005) as well as educational difficulties (Catts, 1993). Therefore, early identification, understanding the nature of this disorder and proper intervention are warranted.

In this study attention was directed toward short-term memory, which was assumed to be related to cognitive processing tasks and linguistic acquisition. The purpose of this study was to assess both auditory and visual short-term memory skills in Arabic speaking children with ELI and R/ELI in comparison to normally developed children. Thus, all children of the three groups were selected to be free from any neurological, auditory deficits and within average IQ.

This study revealed that both SLI groups had highly significantly lower mean scores of the receptive, expressive and total language quotients of the Arabic Language Test in comparison to normal control children. Additionally, all of these quotients were highly significantly lower in R/ELI group in comparison to ELI group. This could be explained by the fact that children with SLI had marked delay in their linguistic abilities in comparison to normal children. In children with R/ELI both receptive and expressive language abilities were affected which may lower the score of total language in this group of children in comparison to children with ELI in which only the expressive abilities are affected. Our findings are comparable to the previous study done by Conti-Ramsden and Botting (1999) where the performance of the expressive-receptive group was reported to be clearly poorer than that of the expressive group in all linguistic tests.

Findings of auditory short-term memory in the study groups: In our study, the mean scores of the different auditory short term memory tasks were highly significantly lower in both R/ELI and ELI groups in comparison to normally developed children. Overall, these results are consistent with previous findings showing deficits in auditory-verbal STM in children with SLI compared to age-matched control groups (Hoffman and Gillam, 2004; Linassi *et al*., 2004; Keilmann *et al*., 2005; Archibald and Gathercole, 2006). Deficits in auditory STM skills have been consistently observed in children with SLI and are likely to be related to the deficits in language acquisition observed in these children (Nickisch and Kries, 2009).

In addition, our results revealed that the R/ELI group had significant lower mean scores of auditory sequential memory and sound blending and highly significant lower mean score of verbal expression than the ELI group. Our findings might be supported by the previously reported results of the poor responses to treatment in children with R/ELI which could be potentially related to more severely impaired auditory-verbal STM abilities compared to children with ELI (Nickisch and Kries, 2009). Meanwhile, both auditory closure and auditory association tasks were more impaired in R/ELI group than the ELI group, yet they showed no significant different between the two SLI groups. These findings may be explained as these two tasks might be more related to expressive abilities which were disturbed in the two SLI groups with the R/ELI group having more impaired expressive abilities than the ELI group.

Findings of visual short term memory in the study groups: In addition to reduced auditory-verbal STM in children with SLI compared to normal language groups, children with SLI were found to exhibit significantly lower mean scores of visual short memory tasks. All the tasks of visual short term memory were highly significantly affected in both SLI groups in comparison to normal control group. Moreover, all these tasks were highly significantly lower in children with R/ELI than in children with ELI. Our findings could be favorably comparable to the results described by Hick *et al*. (2005) and Menezes *et al*. (2007), where significant deficits in children with SLI in tasks involving visual STM were detected in comparison to normally developed children. Visual short-term memory seems to influence learning and retrieving long term memory and complex cognitive tasks (Marton and Schwartz, 2003).

Moreover, our findings are supported by the reported deficits in visual short term memory that might affect the different therapeutic outcomes of ELI and R/ELI (Baddeley, 2003). They added that visual STM could be fundamental for acquiring semantic knowledge of concrete objects and their usage as well as for learning to combine visual imagery with the corresponding semantic-lexical component. Also, Nickisch and Kries (2009) in their study mentioned that the existing differences between ELI and R/ELI in auditory and/or visual STM abilities would potentially explain the discrepant outcomes in expressive and receptive language impairments after treatment.

Conclusively, our findings regarding significant impairment of STM in our two groups with SLI in comparison to the normal control group, despite the subtype of SLI, could be supported by the assumption of a more general disturbance in STM functions in children with SLI that was reported by Bavin *et al.* (2005).

Association between auditory short-term memory tasks and language abilities in children with SLI: This study revealed strong association between all subtests of auditory STM and linguistic abilities in all children with SLI that ranged from significant to highly significant association. This might support the connection between auditory working memory ability and normal language development, while there was no association between any subtest of auditory STM and IQ. The present study gave similar results to Jarrold *et al.* (2004). They reported that differences in auditory short-term memory have been found to be related to and predictive of, vocabulary skills depending on the age of the subjects. Additionally, short-term memory for speech sounds has been shown to correlate highly with vocabulary acquisition and speech production (Jarrold *et al.*, 2004).This has led to the hypothesis that a primary function of this memory is to facilitate language learning Nickisch and Kries (2009)

Our findings are agreed by several authors, who supported the significant associations between receptive language skills and auditory-verbal STM (Gathercole *et al.*, 1992, 1994, 1997; Just and Carpenter, 1992) as well as between the expressive language scores and auditory-verbal STM (Edwards and Lahey, 1998; Nickisch and Kries, 2009).

Association between visual short-term memory tasks and language abilities in children with SLI: Our study revealed strong association between all visual STM subtests and linguistic abilities in all children with SLI that ranged from significant to highly significant correlation while no association was found between any subtest of visual STM and IQ. These findings might point to the importance of visual short term memory ability and normal language development. Menezes *et al.* (2007) mentioned that despite children with SLI frequently present good non-verbal abilities, the deficits observed in visual short-term memory must be taken into account for the intervention as these children do not benefit from visual clues in verbal development as normal children do.

Conclusively, our findings revealed deficits in different functions of auditory and visual STM, as well as disorders of several aspects of language parameters present in children of both groups of SLI in comparison to normally developed children. Theses functions were significantly lower and poorer in children with R/ELI than ELI group. These deficits may provide a possible explanation for the differences between children with ELI and R/ELI in the outcome of therapy after treatment. These findings were in agreement with Van der Lely and Howard (1993) and Nickisch and Kries (2009) where limitations of short-term memory could be expected to affect the therapeutic outcome.

CONCLUSION

The results of this study highlighted a specific degree of deficit in both auditory and visual short-term memories in children with R/ELI and ELI. Their performance was worse than their normal peers of the same age. In addition to, these deficits were more prominent in R/ELI group. Moreover, there was strong association between the different auditory and visual short-term memories and the various language disorders assessed in children with SLI in general. Therefore, deficits in auditory and visual short-term memories must be taken into account when planning an intervention program for children with ELI and R/ELI.

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