Panorama of the Non-Verbal Cognitive Abilities Among Children with SLI

Original Article

Reham Ahmed Fahiem, Hassnaa Othman Mohammed

Medical Studies Department for Children, Faculty of Postgraduate Childhood Studies, Ain Shams University, Egypt.

ABSTRACT

Background: SLI is a disorder with many questionable abilities and marked heterogeneity regarding many aspects. Many determinants could predict the drawback of the disorder on academic, social and vocational levels of the affected children. The full-blown picture of the disorder was and still is an area of interest. It seems urgent to make a revision of the disorder (regarding its definition, diagnostic criteria and classification). One of the questionable aspects of the disorder is the non-verbal cognitive abilities among the affected children.

Aim: The current work is aiming to explore the non- verbal cognitive abilities among different types of SLI children in order to draw an overview of the nature of cognitive affection among this population.

Patients and Methods: A cross sectional study carried on a random sample of 39 Egyptian children previously diagnosed as SLI (30 males and 9 females) their ages ranged from 2y 8 m to 8y. The participating children were subjected to an assessment protocol that included assessment of the language aptitude (by modified PLS-4 Arabic edition) and the non-verbal cognitive abilities (by Stanford Binet 5th edition).

Results: Showed that the syntactic phonological and the semantics pragmatics sub-types of SLI exhibited a varying degree of affection of the non-verbal cognitive abilities.

Conclusion: Different types of SLI showed a marked variability in their non-verbal cognitive profile. SLI could be classified into SLI-expressive type with unaffected cognitive abilities (both verbal and non-verbal) and SLI-receptive type which need deeper inspection of their non-vernal cognitive abilities.

Key Words: Non-verbal cognitive abilities, SLI, SLI-subtypes.

Received: 8 April 2020, **Accepted:** 5 June 2020

Corresponding Author: Hassnaa Othman Mohammed, MD, Medical Studies Department for Children, Faculty of Postgraduate Childhood Studies, Ain Shams University, Egypt, **Tel.:** +201066778915, **E-mail:** drmelwardany@yahoo.com

ISSN: 2090-0740, November 2020 Vol.21, No.3

INTRODUCTION

It seems very difficult to discuss an issue like Specific Language Impairment (SLI) which has a marked disagreement regarding terminology and the criteria used to identify and classify it[1]. The disagreement regarding this disorder is related to many factors. The most evident one was the multiplicity of the disciplines that deal with the problem (e.g. educators, medical staffs, psychologist, pediatricians and psychiatrists). Even in the same specialty there was a disagreement as regard many aspects of the disorder. Aspects of disagreement began at the terminology and extended to other areas (i.e. some terms describe the cause, other consider a more general profile of the communicative abilities of the child and others related to the outcome)[1]. Bellair *et al*.[2] stressed the need for a holistic profile of the child's communicative abilities among this population. Professors in different discipline -despite of their different conceptualization of the language difficulties among children with SLI- have a marked consensus regarding other aspects of SLI. The consensus was related to the rarity of the clinical cases with specific involvement of the language domain only[3]. They all agreed on the urgent need of dropping the exclusionary criteria from the diagnosis of SLI[4]. Regarding the field of phoniatrics in Egypt, SLI is used as a medical term to describe children with a failure in normal language development despite of having intact general cognitive abilities[5]. The disorder is diagnosed by the exclusionary and inclusionary criteria[6-8]. The term SLI reflects many fault concepts (e.g. a homogenous single disorder with exceptional selection of the verbal abilities and the term impairment reflects that it could resolve by its own with time)[3].

There are marked debates regarding the brain pathology of the affected population. Many evidences supported the presence of several neurodevelopmental deficits which block all compensatory ways of language development[7].

 DOI: 10.21608/ejentas.2020.27485.1194

Many developmental aspects of SLI were researched to make a deeper understanding with a panorama view regarding this disorder. Behavioral, social and academic performance all were different areas which received marked interest in the scientific research[3]. However, the cognitive aspect of SLI was an area which needs further evaluation especially with emerging new psychometric test that could measure an isolated island of the brain's functions[9]. The questions which were raised in the current work were: How children with SLI can perform on the non-verbal cognitive test. How could the non-verbal cognitive profile vary from one subtype of the disorder to another? Is there a need to make a revision of the diagnostic criteria of SLI? The current work tried to draw a broader view of the nature of this disorder and to give an answer regarding the extension of brain pathology in this population. Furthermore, it supports the view point of necessity of a new diagnostic criterion and a new classification system. The current work was aiming to develop a deeper understanding of the theoretical as well as practical aspects of such disorder.

OBJECTIVES OF THE STUDY:

The objectives of the study were to explore the non-verbal cognitive abilities among different types of SLI children in order to draw an overview of the nature of cognitive affection among this population.

PATIENTS AND METHODS:

The study was a cross-sectional study. Thirty-nine children (30 males and 9 females) were randomly collected from the phoniatrics clinic of Special Needs Centre of Ain-Shams University on Sunday and Tuesday in the period from January 2018 to June 2019. Their ages ranged from (2 years 8 months to 8 years) with a mean age of 5 years and 3 months. The participating children has been previously received the diagnosis of SLI (during the last three months). The objectives of the study were illustrated to the parents or one of them. A written consent was taken from the caregiver who accompanies the child during the assessment process. The present study received the approval of the Ethical Committee of Faculty of Medicine, Ain Shams University.

The participating children were subjected to the assessment protocol of children with Delayed Language Development (DLD) that was followed in the Phoniatrics Unit-Ain Shams University which included: full case history: personal history (name, gender, handedness, schooling, parental consanguinity and similar conditions in the family), perinatal history, developmental history, past history (head trauma, fits, ear disease & other diseases), history of present illness and communicative assessment. The communicative assessment was carried by a phoniatrics' consultant subjectively in order to determine the passive language skills (eye contact, comprehension of simple and complex commands) and the active language skills (the length of sentences, the syntax, the semantic, the phonology and the pragmatic). According to the consultant interaction with the child during a semi-structured setting that was equipped with material which could facilitate gathering information regarding child attention and comprehension of the simple as well as complex order, the diagnosis of SLI was reached. For children between 5-15 years, non-verbal intelligence quotient (NVIQ) was determined by performance intelligence quotient of Wechsler intelligence scale for children (PIQ)[10] in order to determine the cognitive performance of the participating children away from their verbal abilities. While those who were less than 5 years, they were assessed by the Adaptive behavior Scale for children[11]. Only those with intelligence quotient ≥ 89 were included in the current work. According to the results of the semi-structured setting with the phoniatrics' consultant and intelligence quotient (IQ), the final diagnosis of SLI was reached.

This group of children was further underwent another assessment protocol which included: language assessment via Modified Preschool Language Scale- four (Arabic edition (Modified PLS-4)[12] (in order to specify the sub-type of SLI) and cognitive assessment via Stanford Bienet-5th edition[9] to shed the light upon the detailed non-verbal cognitive abilities among these children.

Inclusion criteria included:

1- Children of both sexes in the age range between 2 years & 6 months and 8 years and received the diagnoses of SLI according to the exclusion and inclusion criteria.

2- Children without any risk factor in their perinatal period.

3- Children who did not previously received any phoniatrics rehabilitation.

4- Children with normal developmental milestones in areas like (parent recognition, behavioral aspect, gross and fine-motor and self-care) and received adequate environmental stimulation.

5- Absence of any past history of traumatic brain injury, convulsion or ear disease.

6- Arabic language was the mother tongue language and the only used language in the child's environment.

7- The socio-economic (SE) status of the families of the participating children was calculated and those only with the same SE status were included.

Exclusion criteria include:

1- If the parents reported any perinatal risk factor or developmental delay in other developmental areas.

2- Presence of past history of ear disease, traumatic brain injury, chronic illnesses, environmental deprivation and any medication intake.

3- Children who were enrolled in phoniatrics or cognitive rehabilitation sessions.

4- If the child was exposed to any foreign language in home or nursery.

5- The presence of any medical, psychological illness, or sensory impairment.

Procedure:

The assessment protocol included:

1- Modified pre-school language scale- four (Arabic edition)[12]: Modified Preschool Language Scale-four (Arabic edition) has two standardized subscales and two supplemental measures. The two standardized subscales are auditory comprehension subscale (Auditory comprehension subtest is composed of 62 items which are distributed at different age groups), and expressive communication subscale (expressive communication subtest is composed of 71 items which are also distributed at different age groups). The two supplemental measures are articulation screener and caregiver questionnaire. Modified PLS-4 (Arabic edition) is used to identify language abilities and disabilities in children and to establish whether or not remediation and language therapy is needed.

2- The Stanford-Binet Intelligence Scale 5th edition (SB-5th)[9]: it is an individually administered cognitive ability and intelligence test that is used to diagnose developmental or intellectual deficiencies in young children. It is referred to as an outstanding measurement instrument for the assessment of cognitive abilities of children, adolescents, and adults from age of 2 years to 85 years. The SB-5th is advantageous as it assesses both verbal and non-verbal abilities. The instrument is based on Cattell-Horn-Carroll theory (CHC) and factor analyses models of intelligence. The test measures five factors and consists of both verbal and non-verbal subtests. The five factors measured were: Fluid Reasoning, Knowledge, Quantitative Reasoning, Visual-Spatial Reasoning, and Working Memory, each with verbal and non-verbal components. Scores are classified as following: Very gifted or highly advanced (145–160), Gifted or very advanced (130–144), Superior (120–129), High average (110–119), Average (90–109), Low average (80–89), Borderline impaired or delayed (70–79), Mildly impaired or delayed (55–69), Moderately impaired or delayed (40–54).

The data were collected and tabulated. The statistical analysis of data was performed using the SPSS (Statistical Package for Social Sciences) program (V.17)[13]. Qualitative data were presented as frequencies and percentages. Chi square and Fisher's exact tests were used to compare the groups. Quantitative data were presented as the means and standard deviations (SDs). The two groups were compared using t-tests. Correlation coefficients were used to examine the correlations between parameters. *p values ≤ 0.05* indicate significance with a confidence interval of 95.

RESULTS:

(a)- Descriptive statistics:

The current work was a cross-sectional study that included 39 -randomly selected- Egyptian children (30 (76.9%) males and 9 (23.1%) females) previously diagnosed (during the last three months) with SLI. The sample was recruited from the phoniatrics clinic of the Special Needs Center Ain-Shams University in the period between January 2018 and June 2019. Their ages ranged from 2 years and 8 months to 8 years. The mean age of children among the whole studied sample was 5 years and 3months (±1.2). The mean age of the male was (5 years and 3 months) and the mean age of females was (5 y 5 m). There were non-significant statistical differences between males and females mean ages. Sex distribution among different SLI-subtypes and their total non-verbal intelligence quotient values as measured by SB-5th were illustrated in (Table 1).

(b)-Comparative statistics:

Comparative statistics were carried on in order to compare the SLI-subtypes regarding their receptive language ages, expressive language ages and the total non-verbal intelligence quotient. One way ANOVA was used in order to determine the statistical significance of the difference between values; see (Table 2). The mean expressive language age of children with SLI was 3yr & 7 months (± 1year.1m) and the mean receptive language age of children with SLI was 3 years 5 months (±1 year 2 months). There was a highly significant statistical difference between the mean chronological age of the whole sample and their mean expressive language age at one hand and the mean receptive ages in the other hand (*p value was 0.001*).

Comparison between non-verbal items scores for the three different types of SLI was demonstrated in (Table 3). One way ANOVA was used in order to determine the significance of the statistical difference between values.

Graphic representation of the non-verbal items of SB-5th for the three SLI-subtypes was represented by a Bar chart; see (Figure 1).

Table (1): SLI subtypes and their total non-verbal IQ:

SLI-subtype	Sex distribution		Mean total non-verbal (±SD)	t	*P value*	significant
	type	No. (%)				
Phonological programming	Male	14 (35.89%)	98.6 (±16.1)	0.60	0.556	NS
	Female	3 (7.69%)	93.3 (±18.8)			
Syntactic phonological	Male	12 (30.7%)	75 (±18.2)	1.21	0.249	NS
	Female	3 (7.69%)	86 (±16.5)			
Semantic pragmatic	Male	4 (10.25%)	80.5 (±9.1)	2.59	0.049	S
	Female	3 (7.69%)	74.3 (±6.1)			
Total		39	84.9(±14.2)			

The table described the sex distribution of different types of SLI and the mean values (and their standard deviation) of the total non-verbal IQ assessment among different SLI-subtypes. The table showed the statistical significance of difference between males' & females' total non-verbal IQ values. The statistical significance only found between males and females' values in the SLI-semantic pragmatic subtype (i.e. female children with SLI-semantic pragmatic subtype were severely compromised than the affected males).

Table (2): showed the One way ANOVA test results of the comparison between the SLI types regarding their expressive age, receptive age and total non-verbal IQ

The compared factor	SLI sub-types		Mean (±SD)	Range	F	*P-value*	significant
	Type	No. (%)					
Expressive language age (years and months)	Phonological programming	17 (43.6%)	4 yrs and 1m (± 0.7)	2.5-5	2.98	0.064	NS
	Syntactic phonological	15 (38.46%)	3 yrs and 3m(± 1.2)	2-7			
	Semantic pragmatics	7 (17.94%)	3 yrs and 9 m (± 1.3)	3-3.6			
Receptive language age (years and months)	Phonological programming	17 (43.6%)	3 yrs and 8 m (± 1.0)	2.3-6	0.94	0.399	NS
	Syntactic phonological	15 (38.46%)	3 yrs and 4m (± 1.3)	2-6			
	Semantic pragmatics	7 (17.94%)	3yrs and 2m (± 1.3)	2-5			
Total non-verbal IQ	Phonological programming	17 (43.6%)	96.5 (± 16.2)	89-121	8.12	0.001	HS
	Syntactic phonological	15 (38.46%)	80.4 (± 18.3)	75-105			
	Semantic pragmatics	7 (17.94%)	78.38 (± 11.4)	72-87			
Total		39					

The table described the mean age of the expressive linguistic abilities of the three SLI-subtypes and the statistical significance of the differences between them. The mean receptive age of each type was compared to the two SLI-subtypes and the statistical difference between them was also measured. The table showed the mean total non-verbal cognitive abilities value of each SLI type and compared the values to measure the significance of their statistical differences.

Table (3): showed the results of the One way ANOVA test which compared between children with SLI-subtypes as regards their performances on the non-verbal-cognitive test items specifically: fluid reasoning, knowledge, visuo-spatial, quantitative reasoning and working memory

Non-verbal IQitems	SLI sub-types		Mean (±)	f	*p-value*	Significant
	Type	No. (%)				
Fluid reasoning	phonological programming	17 (43.6%)	103.4 (± 21.4)			
	syntactic phonological	15 (38.46%)	78.9 (± 18.5)	7.79	0.002	HS
	semantic pragmatic	7 (17.94%)	79.4 (± 13)			
Knowledge	phonological programming	17 (43.6%)	91.6(± 14.1)			
	syntactic phonological	15 (38.46%)	81.4(± 15.1)	5.12	0.011	S
	semantic pragmatic	7 (17.94%)	76.7(± 10.6)			
Visuo-spatial	phonological programming	17 (43.6%)	97.2(± 14.5)			
	syntactic phonological	15 (38.46%)	83.8(± 16.2)	4.88	0.013	S
	semantic pragmatic	7 (17.94%)	82.1(± 9.7)			
Quantitative reasoning	phonological programming	17 (43.6%)	97.1 (± 14)			
	syntactic phonological	15 (38.46%)	80.4(± 14.3)	8.22	0.001	HS
	semantic pragmatic	7 (17.94%)	77.3 (± 16.7)			
Working memory	phonological programming	17 (43.6%)	93.1(± 15.5)			
	syntactic phonological	15 (38.46%)	75.7(± 17.9)	5.67	0.007	HS
	semantic pragmatic	7 (17.94%)	76.4(± 9.9)			

The table showed the mean values of the performances of children with different SLI sub-types on non-verbal items of SB-5. The significance of the statistical difference between the mean values of different items of SB-5 among the three SLI subtypes was measured.
N=number, SD=Standard deviation, NS= non-significant, HS= highly significant.

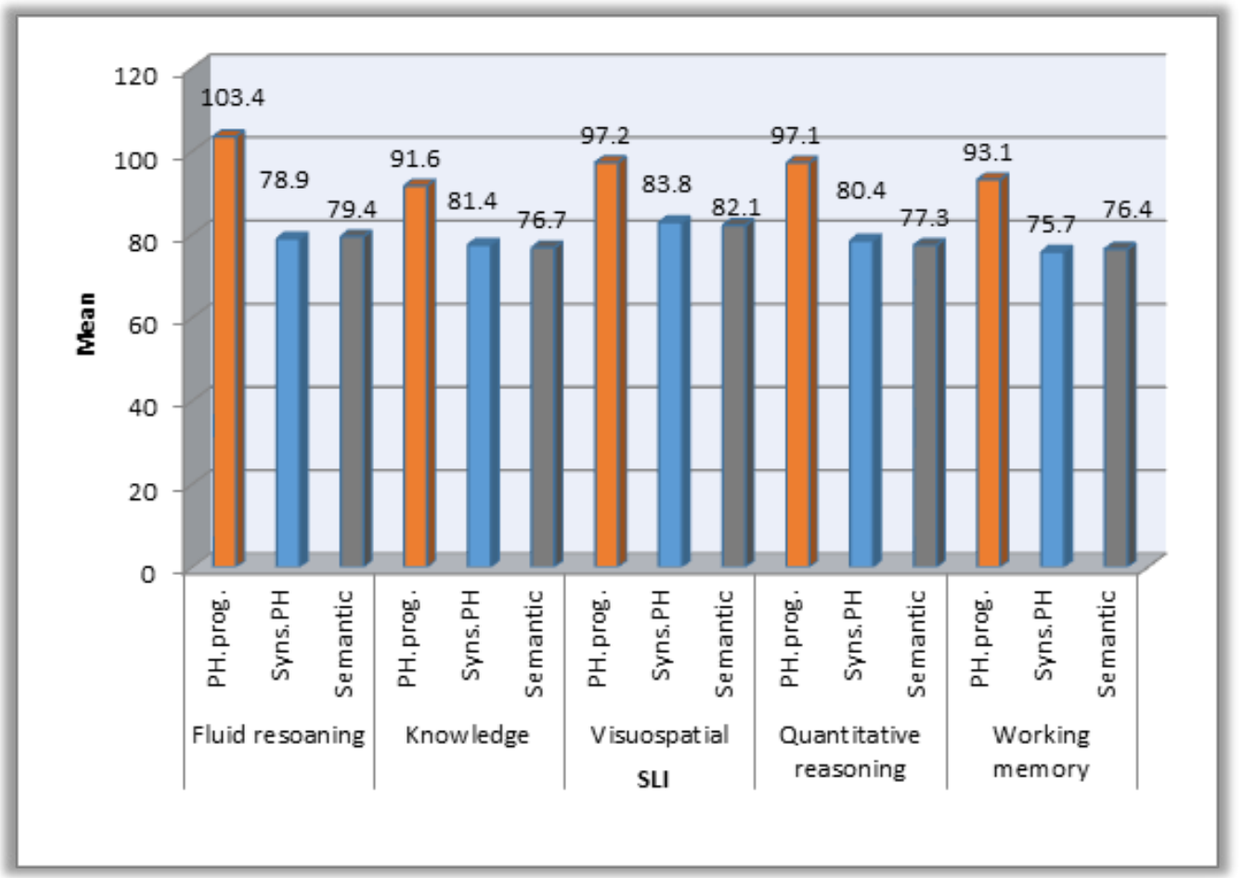

Fig. (1): Bar chart representing a comparison between children with different SLI sub-types regarding their performances in the non-verbal items of SB-5. The compared items of non-verbal domain of SB-5 were: fluid reasoning, knowledge, visuo-spatial, quantitative reasoning and working memory.
PH.prog.= SLI-phonological programming sub-type
Syns. PH=SLI-syntactic phonological sub-type
Semantic= SLI-semantic pragmatic sub-type
SLI= specific language Impairment

DISCUSSION

The exploration of the non-verbal cognitive abilities among children with SLI among the current work was used as an objective tool to assess how different brain areas are working among the affected children. The scientific argument regarding the relationship between language development and cognitive development was the theoretical background of the current work. Several questions were raised about the direction of this relation.

The current work estimated the non-verbal cognitive abilities among children with SLI twice. First, it was by Wechsler intelligence scale for children and Adaptive Behavior Scale for children (ABS) then for the second time by SB-5th. These tests were designed to assess the non-verbal cognitive abilities among children. The current work reported significant difference between the mean scores obtained by Wechsler and ABS in one hand and the SB-5th on the other hand. The significant difference between Wechsler and SB-5th was reported in previous studies among different population[14-15]. Higher scoring was reported for Wechsler over SB-5th in Baum *et al*.[15] and the reverse was reported in Gilmore *et al*.[14]. The authors concluded that despite of being widely used as intelligence tests, they could not be used interchangeably[15].

The current work determined that the mean value of the total non-verbal IQ as measured by SB-5th obtained by the participants was 84.9. Such value is found in the below average intelligence range. This finding was supported by plenty of research work which supported the rarity of specification of language impairment in SLI children[1,3]. Saar *et al*.[16] and Conti-Ramsden

et al.[17] reported a significant decline in the non-verbal cognitive abilities among children with SLI which contributes to later emerging comorbidities among the behavioral and academic aspects in this population. Researchers supposed that language impairment is not specific and there is a blockage of all compensatory mechanisms that could facilitate language development[18]. The nature of NVIQ affection was illustrated by Saar *et al*. and[16] Bishop[18]. They proposed that it could be such a comorbidity or secondary to language impairment.

The current work found that although children with different types of SLI scored variably among different SB 5th subtests with a significant statistical difference, they obtained an approximating language ages (receptively and expressively) with a non-significant statistical difference on PLS-4 (Arabic edition). In agreement with this result Norbury *et al*.[19] examined the severity of language impairment among children with language disorders of unknown etiology with average and low average non-verbal intelligence quotient (NVIQ) scores. They found that they did not differ significantly from each other. Therefore, they concluded that relaxing the boundaries of the non-verbal intelligence to include children with borderline intelligence raised the prevalence of primary language impairment to more than seven times. The authors recommended that further research work should be carried on in order to determine the need for best practice guidelines for each category of children with primary language impairment.

The current work classified children with SLI according to the results of PLS-4 (Arabic Edition) into syntactic-phonological, semantic pragmatic and phonological programming sub-types. PLS-4 (Arabic edition) seems to be a language test with excellent discrimination abilities that could differentiate between different SLI-subtypes[12]. Saar *et al*.[16] reported that not all language tests could differentiate between different forms of SLI.

According to PLS-4 (Arabic edition) results in the current work, both the receptive and expressive language ages were significantly below the chronological ages. This finding could be attributed to the late presentation of the children (i.e. their mean chronological ages were 5 years 3 months). Such data was in accordance with Norbury *et al*.[19].

The current work classified children with SLI into three sub-types according to their linguistic strength and difficulties. The sub-types included were SLI-phonological programming, SLI-syntactic phonological and SLI- semantic pragmatics. It was found that, at the time that different SLI subtypes scored variably among SB 5th, phonological programming scored the highest and semantic pragmatic type and the syntactic phonological types showed approximating values (Table 3). In accordance to this, Saar *et al*.[16] preferred to classify children with SLI into SLI-receptive (SLI-R) and SLI-expressive (SLI-E). This classification was based on clinical manifestation and a set of neuropsychological test (WPPSI-III subtests)[20] and varying subtest combinations of NEPSY-II[21]. They based their classification on the significant statistical difference between the two groups on VIQ (verbal intelligence quotients) and PIQ (performance intelligence quotient). The SLI-R was significantly lower on verbal comprehension tests, PIQ and all sub-tests of NEPSY except for phonological processing which seems to be within the range of typically developing children. They concluded that there is a matter of direct proportional relation between receptive language abilities and performance on non-verbal intelligence testing. Botting *et al*.[22] Hoffman[23] and Dionne *et al*.[24] pointed out that semantic abilities interact with cognitive level and strong vocabulary storage seems to be related to better non-verbal abilities.

From another perspective Krassowski and Plante[25] viewed that the non-verbal score of intelligence test significantly varied from one time to another among children with SLI according to their total language age due to verbal contamination of non-verbal tests.

The current work examined the prevalence of different SLI sub-types. It was found that 43.58% was SLI-phonological programming type. The second common presentation of SLI is syntactic phonological type 38.46% while the third was semantic pragmatics 17.94%. Sallam[6] supported this finding.

In the present work 76.92% were male children. The gender distribution in the current work reflects what has been already known about male predominance in communicative disorders. The explanation could be attributed to the cultural background, testosterone effect that hinder myelination which result in functional delayed maturation among male gender[26]. The gender distribution in semantic pragmatic type was nearly equal male and female affection.

The data of current work determined the mean score of each item of the non-verbal abilities of SB-5th among the studied sample. Data showed that fluid reasoning got the best score among children with SLI-phonological programming and the worst was among children with SLI-syntactic phonological type and semantic pragmatic types. The task examined the ability to solve novel problems visually. Saar

et al.[16] supported that SLI-E showed adequate response on sub-test which examine the visual concepts and matrices. This SLI-E sub-type may show marked decline in their abilities if time factor is added (i.e. fast processing of visual information is compromised).

The non-verbal aspect of knowledge score was the highest among children with SLI-phonological programming and the lowest among children with SLI-syntactic phonological type and semantic pragmatic types. Non-verbal knowledge examines the fund of general information through Procedural Knowledge Subtest and Picture Absurdities Subtest. Such abilities are chiefly the function of cognition and development of pragmatics. Cummings[27] demonstrated that the relationship between cognition and pragmatics is bidirectional in the aspect that the multidiscipline root of pragmatics should firstly include cognitive root as a basic and most important root (beside philosophy, sociology, linguistic and neurology). On the other hand cognitive examination should incorporate utterance explanation and beliefs of fixation.

Assessment of non-verbal quantitative reasoning included the ability to solve numerical problems -non-verbally- was one of the non-verbal assessed items. The current work showed that children with SLI demonstrated significantly diminished non-verbal quantitative numerical skills. More specifically, the most compromised sub-group was SLI-syntactic phonological type and semantics pragmatic type. This finding was matched with what has been published by Koponen *et al*.[28]. They claimed language deficit (especially in grammatical rules acquisition, semantics knowledge and pragmatic domain) is associated with a compromise of the mathematical skills even if non-verbally administered. Furthermore, they illustrated that children with SLI are not a homogenous group specifically in their performance on the verbal and non-verbal mathematical skills. They proposed that some language factors are associated with development of number skills. In contrary to the current work findings was the conclusion drawn by Cross *et al*.[29]. They reviewed literature on mathematics and developmental language disorder. They found that children with developmental language disorder performed significantly lower than their peers on mathematical tasks that demanding high verbal processing while performance was similar to their peers with typical development on number line, magnitude comparison, and conceptual mathematical skills.

Assessment of visual working memory (WM) included the ability to hold visual information in the short-term memory and transform it (ex. Delayed Response Subtest and Block Span Subtest). The current work demonstrated that the worst score was obtained by semantic pragmatics and syntactic phonological sub-types. Such results went in accordance with what has been reported by Weismer *et al*.[30]. They conducted a comparative study between a group of SLI, ASD and typically developed children. The three groups were comparable for age, non-verbal IQ and socio-economic status. They concluded that verbal working memory deficit was strongly linked to the syntactic and phonological errors among SLI children. Leonard *et al*.[31] examined memory abilities (verbal and spatial/short-term and WM) and processing speed relative to language abilities in a large sample of adolescents with and without SLI. Their findings indicated that language scores were highly correlated to the processing speed and memory abilities, with verbal WM making the largest contribution. Among their series, the nonverbal (spatial) WM was not a significant predictor of language abilities in SLI children group. However, Karasinski and Weismer[32] and Vugs *et al*.[33] found that the spatial WM was a significant predictor of distant inference comprehension for adolescents with SLI in a spoken narrative comprehension task. Weismer *et al*.[30] were in disagreement. They reported that SLI children were significantly lower than typically developed children in detecting the position of morpho-syntactic error as indexed by grammatical judgment task. However, they did not differ significantly from typically developing children on non-verbal working memory test.

Assessment of visuo-spatial abilities included the ability to see relationships among figural objects, describe or recognize spatial orientation, identify the whole among a diverse set of parts, and generally see patterns in visual material (ex. Form Board and Form Patterns Subtest). The current work found that semantic pragmatic type and the syntactic phonological type of SLI showed a significant deficit among these skills. This issue was studied in literature and results regarding this aspect were inconsistent. Hick *et al*.[34] concluded from their work that SLI children demonstrated slower development of the short term memory. Tomalski[35] reported that human speech is a multisensory experience and the most important modalities for language comprehension and production are visual spatial modalities. They reported that integrity of the social pragmatics aspects resulted from adequacy of audiovisual processing of the speech. This fact could explain the deficit of visuo-spatial skills among SLI-semantic pragmatic type. Cooper and Aslin[36] magnified the role played by the visual information from speakers' mouth and the direction of movement of the articulator in the space in addition to the motherese in increasing the number of vocabulary before the age of 12 months. Lewkowicz and Hansen-Tift[37] reported that infants as young as few months are able to match speech sounds

and lip movement. Meronen *et al*.[38] proposed that SLI children experienced a weak McGurk effect and when signals to noise ratio decreased, SLI children could not rely on visual speech as typically developing children of the same chronological age. Heikkilä *et al*.[39] showed that word level-lip reading is impaired in 7 years old children with SLI. Moradi *et al*.[40] have suggested that audio-visual training reinforces the rout to phonological and lexical representation in a way that facilitates their further access. The visuo-spatial skills were presumed by some research work to be responsible for morpheme errors among children with SLI. But they were unable to confirm their suggestion in their sample of SLI children[38].

The significance of meticulous examination of the non-verbal cognitive abilities among children with delayed language development was examined by Mc kean *et al*.[41]. They claimed that the diversity in the diagnosis that labeled different types of language disability did not address a proper understanding of the individual differences in children's language inventory. Their work determined the characteristics of language trajectories between the age of 4 and 7 years through examination of 22 factors. Thirteen of them showed a significant correlation with language out come at age of 4 years. They classified these factors according to their potentiality of being changeable by intervention. They found that low score in non-verbal IQ was one of the least changeable risk factors and can negatively influence the language out-come at age of 4 years. The authors found that speech sound disorder was of the proximal risk factor (changeable) that could be changed by intervention. Accordingly we recommended the necessity of a longitudinal study that investigate and remediate children with SLI regarding many aspects including the non-verbal cognitive abilities. The efficacy of this comprehensive management protocol in diminishing the unfavorable outcome of SLI on many life aspects should be thoroughly examined.

CONCLUSION

The current work concluded that sub-types of SLI showed marked variability of the non-verbal cognitive abilities in addition to their primary linguistic impairment. The current work supported the use of a general cognitive test that rule-out cognitive impairment. However, the clinician should address a battery of assessment tool that determine the weakness and strength area in cognitive abilities among children with SLI. The linguistic parameters that seemed to be related to non-verbal cognitive affection in children with SLI were lexical-syntactic linguistic aspect and semantic pragmatic linguistic aspects. We could conclude that according to the results of non-verbal cognitive test SLI could be classified into SLI-expressive type with unaffected cognitive abilities (both verbal and non-verbal) and SLI-receptive type which need deeper inspection of their non-vernal cognitive abilities (its assessment and rehabilitation).

ETHICAL

The current work was conducted in accordance to the guidelines of ethical committee of Faculty of Medicine Ain-Shams University after receiving the committee's approval.

CONFLICT OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Bishop DVM, Snowling MJ, Thompson PA, Greenhalgh T. CATALISE: A Multinational and Multidisciplinary Delphi Consensus Study. Identifying Language Impairments in Children. PLOS ONE. 2016; 11(7).

2. Bellair J, Clark S, Lynham S. Can any label work for both intervention and research purposes? Commentary on Bishop DVM. Ten questions about terminology for children with unexplained language problems, International Journal of Language and Communication Disorders. 2014; 49: 381- 415.

3. Bishop DVM, Snowling MJ, Thompson PA, Greenhalgh T. and the CATALISE-2 consortium, Phase 2 of CATALISE: a multinational and multidisciplinary Delphi consensus study of problems with language development: Terminology, Journal of Child Psychology and Psychiatry. 2017; 58(10): 1068–1080.

4. Dockrell J, Lindsay G. The view from the chalk face. Commentary on Reilly, S., Tomblin, B., Law,J. ,McKean,C., Mensah, F. K., Morgan, A., Goldfeld, S., Nicholson, J. M. and Wake,M.,2014, Specific language impairment: a convenient label for whom? International Journal of Language and Communication Disorders. 2014; 49: 416–451.

5. Archibald LM, Gathercole SE. Short-term and working memory in specific language impairment. Int. J Lang Commun Disord. 2006 Nov-Dec; 41(6): 675-693.

6. Sallam YA. Prevalence of subtypes of specific language impairment. Unpublished doctoral dissertation, Faculty of Medicine. Ain Shams university, Cairo, Egypt; 2011.

7. Leonard L. Is expressive language disorder an accurate diagnostic category? American Journal of Speech-Language Pathology. 2010; 18: 115–123.

8. Novogrodsky R. Specific Language impairment (SLI) is not specific. Subtypes of SLI and their implication for the theory of the disorder. In Specific Lnguage Imparment. Current trends in research S. Stavrakaki (ed.). USA: John Benjamins published Company.2015.

9. Abou El-Neel M, Taha M, Ismaeel A. Instruction notebook Stanford–Binet Intelligence Scale, fifth edition. The Arab foundation for legalization and preparation of psychological tests. Cairo; 2009.

10. Ismaeel M, Melaka LK. Wechsler intelligence scale for children, Cairo (el-Nahda liberary); 1999.

11. Farag S, Ramzy N. Translated and standardized Adaptive Behavior scale, Cairo: Anglo library; (1974).

12. Abu-Hasseba A. Standardization, Translation and Modification of the Preschool Language Scale-4. Unpublished Ph. D. Dissertation. Ain Shams University. Cairo; 2011.

13. Field A. Discovering statistics using SPSS. 3rd ed. London: SAGE Publications Ltd; 2009.

14. Baum KT, Shera PK, Howe SR, Bishop SL. A comparison of WISC-IV and SB-5 intelligence scores in adolescents with ASD. Autism. 2015; 19 (6): 736-745.

15. Gilmore, Linda, Garred, Melinda, Wilson, Kimberley, Can difference measures of intelligence be used interchangeably? A comparison of Wechsler and Stanford –Binet Scales. In the 11th European conference on psychological assessment, 31 August-3September (2011) Riga-Latvia.

16. Saar V, Levänen S, Komulainen E. Cognitive Profiles of Finnish Preschool Children with Expressive and Receptive Language Impairment. Journal of Speech, Language, and Hearing Research. 2017: 1-12.

17. Conti-Ramsden G, St Clair MC, Pickles A, Durkin K. Developmental trajectories of verbal and nonverbal skills in individuals with a history of specific language impairment: From childhood to adolescence. Journal of Speech, Language, and Hearing Research. 2012; 55: 1716-1735.

18. Bishop DVM, What causes specific language impairment in children? Current Directions in Psychological Science. 2005; 15(5): 217–221.

19. Norbury CF, Gooch D, Wray C, Baird G, Charman T, Simonoff E, Pickles A. The impact of nonverbal ability on prevalence and clinical presentation of language disorder: Evidence from a population study. Journal of Child Psychology and Psychiatry. 2016; 57(11): 1247-1257.

20. Wechsler D, Kaplan E, Fein D, Kramer J, Morris R, Delis D, *et al*. Wechsler intelligence scale for children. Fourth Edition. San Antonio: Pearson, Inc.; 2003.

21. Korkman M, Lahti-Nuuttila P, Laasonen M, Kemp SL, Holdnack J. Neurocognitive development in 5- to 16-year-old North American children: A cross-sectional study. Child Neuropsychology: A Journal on Normal and Abnormal Development in Childhood and Adolescence. 2013; 19 (5): 516–539.

22. Botting N, Adams C. Semantic and inferencing abilities in children with communication disorders, International Journal of Language & Communication Disorder. 2005; 40(1): 49-66.

23. Rice ML, Hoffman L. Predicting vocabulary growth in children with and without specific language impairment: A longitudinal study from 2;6 to 21 years of age. Journal of Speech, Language, and Hearing Research. 2015; 58(2): 345–359.

24. Dionne G, Dale PS, Boivin M, Plomin R. Genetic evaluation for Bidirectional effects of early lexical and grammatical development. 2003; 74: 394-412.

25. Krassowski E, Plante E. IQ variability in children with SLI implications for use of cognitive referencing in determining SLI. j. commun. Disord. 1997; 30: 1-9.

26. Molini-Avejonas DR, Ferreira LV, De La Higuera Amato CA. Risk Factors for Speech-Language Pathologies in Children. 2017.

27. Cummings L. Cognitive aspects of pragmatic disorders. In: L. Cummings (Ed.), Research in Clinical Pragmatics, Series: Perspectives in Pragmatics, Philosophy & Psychology. Cham, Switzerland: Springer International Publishing AG, 2017; 11: 587-616.

28. Koponen T, Mononen R, Räsänen P, Ahonen T. Basic numeracy in children with specific language impairment: heterogeneity and connections to language. Journal of Speech, Language, and Hearing Research: JSLHR. 2009; 49(1): 58-73.

29. Cross AM, Archibald MD, Lisa J, Marc F. Mathematical Abilities in Children with Developmental Language Disorder. Health and Rehabilitation Sciences Publications. Western University: Scholarship@ Western.2018; 14.

30. Weismer SE, Davidson MM, Gangopadhyay IA, Sindberg H, Roebuck H, Kaushanskaya M. The role of nonverbal working memory in morphosyntactic processing by children with specific language impairment and autism spectrum disorders. Journal of Neurodevelopmental Disorders. 2017; 9: 28.

31. Leonard L, Weismer SE, Miller C, Francis D, Tomblin J, Kail R. Speed of processing, working memory, and language impairment in children. J Speech Lang Hear Res. 2007; 50:408–428.

32. Karasinski C, Weismer SE. Comprehension of inferences in discourse processing by adolescents with and without language impairment. J Speech Lang Hear Res.2010; 53:1268–1279.

33. Vugs B, Cuperus J, Hendriks M, Verhoeven L. Visuospatial working memory in specific language impairment: a meta-analysis. Res Dev Disabil. 2013; 34: 2586-2597.

34. Hick R, Botting N, Conti-Ramsden G. Cognitive abilities in children with specific language impairment: Consideration of visuo-spatial skills. International Journal of Language & Communication Disorders. 2005; 40(2): 137-149.

35. Tomalski P. Developmental Trajectory of Audiovisual Speech Integration in Early Infancy. A Review of Studies Using the McGurk Paradigm. Psychology of Language and Communication. 2015.

36. Cooper RP, Aslin RN. Preference for infant-directed speech in the first month after birth. Child Development, 1990; 561 (5): 1584-1595.

37. Lewkowicz DJ, Hansen-Tift AM. Infants deploy selective attention to the mouth of a talking face when learning speech. Proceedings of the National -Academy of Sciences of the United States of America. 2012; 109 (5): 1431- 1436.

38. Meronen A, Tiippana K, Westerholm J, Ahonen T. Audiovisual speech perception in children with developmental language disorder in degraded listening conditions. Journal of Speech, Language, and Hearing Research. 2013; 56 (1): 211-221.

39. Heikkilä J, Lonka EE, Meronen A, Tuovinen S, Eronen R, Leppänen PHT, et al. The effect of audiovisual speech training on the phonological skills of children with specific language impairment (SLI). Child Language Teaching and Therap. 2018;September: 1- 19.

40. Moradi S, Wahlin A, Hällgren M, Rönnberg J, Lidestam B.The efficacy of short-term gated audiovisual speech training for improving auditory sentence identification in noise in elderly hearing aid users. Frontiers in Psychology. 2017; 8: 368.

41. Mckean C, Mensah FK, Eadi P, Bavin EL, Brwtherton L, Cini E, Reilly S. Levers for language Growth: Characteristics and predictors of Language Trajectories between 4 &7 years, PLOS ONE. 2015.