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Language and Mathematical skills in Greek children with SLI

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Abstract

Specific Language Impairment (SLI) is a disorder related with language difficulties. The last decades, there is an interest on how SLI can be related with Maths. The aim of this study was to investigate the language and mathematical skills, of Primary school children with SLI. The sample consisted of 60 children, seven to eight years old. Thirty children belonged to the SLI group, while 30 were typically developing children. Children were included in the SLI group according to their non-verbal and expressive vocabulary abilities. Other language and mathematical skills were also measured. According to the results, significant differences in language and mathematical skills were found between the 2 groups. Children with SLI performed worse across most of the language and mathematical tasks. Last, for the SLI group significant correlations were found between performance in language and mathematical tasks. The results highlighted that SLI is also related with difficulties in Maths.

Keywords: Specific Language Impairment, SLI, language development, mathematical skills, school age children

Introduction

Language development begins early in life and children between their 3rd -4th birthdays are quite proficient talkers of their native language. In school entry, most of the children have a rudimentary knowledge of language. However, in many cases language development is deficient, leading in language difficulties. The importance of children's oral language skills in school learning has been of concern to practitioners and researchers for some time. At the same time the influence of language on Maths is becoming more widely acknowledged (Donlan 2014). Children who continue to have language impairments when start Primary school may experience further learning problems. Investigating language and mathematical skills in children with Specific Language Impairment (SLI) could contribute in a better understanding of the language factors that can be associated with children's mathematical skills. Such knowledge could further expand the existent information for the professionals working with these children.

Specific Language Impairment (SLI) is a heterogeneous disorder characterized by deficient language development, without apparent evidence of cognitive impairment, hearing problems, physical handicaps, environmental deprivation or neurological damage (Bishop, 2006). Children with SLI, have difficulties in receptive and expressive language and sometimes even in tasks that do not require verbal answers (Bishop & Adams, 1992). According to van der Lely (1994) children with SLI confront difficulties in the implementation of grammatical and syntactical principles due to representational deficits. Most of the time, during the preschool years, children have deficits in the expressive language skills, specifically in phonology and vocabulary (Blackenbury, Pye, 2005; Bortolini & Leonard, 2000). During school years many children with SLI will face difficulties in attending the school curriculum (Bird, Bishop & Freeman, 1995; Dockrell & Connelly, 2009).

But what about Maths? How do children with SLI perform in Maths? This question has only started to be studied the last two decades (Arvedson, 2002; Cowan, Donlan, Newton, Lloyd, 2008, 2005; Donlan, Cowan, Newton, Lloyd, 2007; Durkin, Mok, Conti- Ramsden, 2013; Fazio, 1999, 1996, 1994). However, confounding evidence has come up.

Thus, there is a group of studies supporting a relationship between language difficulties and mathematical skills in children with SLI (Arvedson, 2002; Cowan et al., 2008, 2005; Donlan, et al., 2007; Fazio, 1999; Kleemans, Segers, Verhoever, 2012) while others haven't found similar results (Donlan, Bishop & Hitch, 1998; Donlan & Gourlay, 1999). Carey (2004) proposes that linguistic factors play a crucial bootstrapping role in the development of number concepts, through early experience of number-relevant language (Hodent, Bryant & Houde', 2005). It has also been found that children's vocabulary is related to their mathematical performance between 7-10 years of age (Durand, Hulme, Larkin, Snowling, 2005). Jordan, Hanich and Kaplan (2003) suggested that language comprehension deficits may inhibit problem-solving, and can affect performance on story problems and conceptual understanding of calculations. Children with SLI have also been reported in the literature as having difficulties in selective mathematical abilities. For example, although they may understand the counting principles, they perform mistakes in counting (Cowan et al., 2005). Furthermore, children with SLI appeared to face more difficulties in solving problems when they were asked to count verbally than when they did not use oral counting (Arvedson, 2002). These findings, suggest that it is at least possible that children with SLI can develop mathematical conceptual understanding, based on their strengths in non-verbal reasoning, in advance of procedural knowledge which is compromised by linguistic deficits (Donlan, 1998).

Hanich, Jordan, Kaplan, and Dick (2001) also compared 4 different groups of children (children with reading difficulties, with arithmetic difficulties, with dual deficits and typically developing children). Children with only reading difficulties performed worse in their understanding of place value, solution of story problems and performance of written computations in comparison to their typically developing peers. In these aspects, they resembled children with just arithmetic deficits. Children with both reading and arithmetic difficulties (dual deficit group) had the lowest performance across tasks, even when IQ was controlled.

In a longitudinal study, Fazio (1994, 1996, and 1999) demonstrated that children five, seven and nine years old with SLI had difficulties in producing series of numbers as well as in calculations with time limit. Durkin, Mok and Condi-Ramsden (2013), also found that not only the SLI group had fallen below peer norms on number tasks but that the gap became worse between the ages of 7 and 8 years old. In addition, Kleemans, Segers and Verhoeven (2012) in their longitudinal study, showed that children with SLI confronted difficulties in cognitive, linguistic and mathematical skills, working memory, phonological awareness, grammatical ability, naming speed and basic calculation skills (additions- subtractions) in comparison to the normal language achieving group of children. They also demonstrated that naming speed was a predicting factor for children with SLI who were likely to develop problems in basic calculation skills. The impact of language on Maths in children with SLI has been also explored by Cowan et al. (2008, 2005) and Donlan et al. (2007). Cowan et al. (2005) in their first study investigated the mathematical performance of children with SLI. The sample consisted of seven to nine years old children divided into 3 groups with typical non-verbal IQ ability (the SLI group, the age control group and the language control group which included children 2 years younger than the SLI group). The findings indicated that the SLI group performed worse in comparison to the age control group, but the differences were not significant between the SLI group and the language control group. More specifically, the SLI group presented deficits in counting and number knowledge but fewer difficulties in arithmetic principles. Also, the children with SLI used more strategies (e.g. counting with fingers or counting objects) in the calculations tasks, while the language control group didn't use such strategies.

On the other hand, there is another group of scholars proposing that numerical cognition is ontogenetically independent, and argue that conceptual understanding does not depend on number word knowledge (Gelman & Butterworth, 2005; Sarnecka & Gelman, 2004**)**. The researchers supported that children can develop normally their mathematical thinking (as assessed with specific tasks) without the language deficits being a barrier for them, and before the appearance of language difficulties (Arvedson, 2002). However, it is important to mention that in those studies, the researchers assessed children's mathematical skills using magnitude comparison tasks of single and double digits which did not require verbal responses.

Moreover, studies using non-verbal response formats have found that seven and eight-years-old children with SLI exceeded the performance levels of language-matched controls in magnitude comparison for single and double-digit numbers (Donlan, Bishop & Hitch, 1998; Donlan & Gourlay, 1999) as well as in matching cardinal values across identity and location change (Donlan, 2003).

The limited literature on mathematical skills of children with SLI is starting to expand, while at the same time the influence of language on mathematical development is becoming more widely acknowledged (Donlan, 2014).

According to the relevant literature the results about the relationship between Specific Language Impairment and mathematical skills are not consistent. So, there is still an open question regarding this issue. Furthermore, previous studies have some methodological limitations which need to be taken into account. Most of the previous studies have investigated possible links between SLI and difficulties in Maths, by identifying a group of children with SLI on which they only applied mathematical tasks without further assessing other aspects of their language profile. A limited number of studies have also investigated other language aspects such as reception of grammar and past tense production (Cowan et al., 2008; Donlan et al., 2007). Nevertheless, in order to study in more depth possible associations between SLI and Maths, different aspects of language and mathematical skills should be further investigated. Last, the majority of the studies in this field, comes mainly from other European languages such as English, French, German, Italian language (Bishop, 1979; Bortolini & Leonard, 1991; Clahsen, 1991; Leonard, 1998; Plaza & Le Normand, 1996; van der Lely, 1996). It would be worthwhile to study the impact of language skills in Maths, in diverse languages in order to be able to test generalizabilty of results across languages.

Aims of the study

Taking into account the confounding research evidence, the methodological limitations and the lack of studies in other languages except English, the present study aims to extend previous studies in two ways. Firstly, it will further explore the confounding evidence about the relationship between SLI and Maths in other languages than English such as Greek that has not been explored till now. Secondly it will assess a range of language and mathematical dimensions in order to reveal in more depth possible associations between different aspects of language impairments and a variety of mathematical skills. A further possible advantage of this study, concerns the multiple measurements for language, and the possibility that these might give some new light on the math/language relationship. A novel 'story problem' task, testing quantifier comprehension as well as calculation, will be also included. Thus, we move away from simplistic models of discrepancy between nonverbal and verbal skills for children with Specific Language Impairment in a greater attempt to profile performance on different tasks across different situations.

Method

Participants

Sixty Greek school age children seven to eight years old participated in the study. The age range is well targeted to capture the children's response to formal mathematical teaching in terms of their number knowledge and basic calculation skills. This also allows direct comparison with existing studies (which are predominantly based on English speakers). The children were assigned in two groups, the SLI group (n = 30) and the typically developing children (n = 30). The SLI group included 14 (46.7%) boys and 16 (53.3%) girls. The typically developing children group included 12 (40%) boys and 18 (60%) girls. In order for the children to be included in the SLI group, they had to meet certain criteria (see screening measures in the next section). All the children attended general schools in the east region of Attica in Athens and had Greek as their native language. Parents and teachers affirmed that the children had no neurological, brain damage or hearing and visual problems. Children with other special education needs were excluded from the sample. Parents consent was assured in order for the children to participate in the study. All the tasks were administered individually in a quiet room without noise or other objects that could detract children's attention. Each child was assessed in a period of 3-4 sessions.

Screening Measures for the identification of children with SLI

Children were first administered the Raven's Colored Progressive Matrices (Raven, 1998) and then the Expressive vocabulary language test (Vogindroukas, Protopapas, Sideridis, 2009), which is the Greek, standardized edition of the Word Finding Vocabulary Test (Renfrew, 1997).

Raven' s Colored Progressive Matrices (Raven, 1998)

The Raven's IQ test is a non verbal IQ test, widely used in the identification of SLI groups used in order to examine their non-verbal abilities. Raven's Colored Progressive Matrices test consists of 36 diagrams and designs with a missing part. Every child has to choose, the piece that completes the picture among 6-8 choices. Once the assessment is completed, a final score (intelligence quotient) is given for each child. In order for a child to be included in the SLI group, he/she had to have typical non-verbal abilities (IQ>85, SD =1).

The Expressive language test (Vogindroukas, Protopapas, Sideridis, 2009)

The expressive language test which is the Greek standardized edition of the Word Finding Vocabulary Test (Renfrew, 1997), with a high reliability score (R = .937) evaluates the expressive language skills (naming vocabulary) of children. According to Renfrew (1997) the low performance in the expressive vocabulary could be a good predictor for Specific Language Impairment. The Word Finding Test consists of 50 images. These images were selected and placed in a developmental series for children aged 4 to 8 years old. The concepts illustrated a range from everyday objects and known categories of objects to concepts from childhood, fairy tales and children's television programs. The researcher showed a card with an object to the child and the child had to name it. The maximum score was 50. In order for a child to be included in the SLI group, he/she had to have a performance below the 20th percentile, which was equivalent to <1 SD below the Mean score.

Further Language tasks

A range of language tasks (sentence structure, sentence production, semantic relationships), focusing on syntax and semantics were also designed for the present study and applied in order to have a more complete view of the language profile of children with SLI. The design of the tasks was based on other relevant assessments such as the Clinical Evaluation of Language Fundamentals (CELF-4 Semel, Wiig, Secord, 1987).

Sentence Structure task

The *sentence structure task* was used for the evaluation of receptive language. It consisted of 26 sentences and 4 pictures for each sentence. Each child had to point out one of four pictures that illustrated the given sentence. The sentences contained basic grammatical and syntactic items such as adverbs, adjectives, main and subordinate clauses, direct and indirect objectives, interrogative clauses, passive voice. The 4 pictures looked similar but they differed in a specific characteristic. For instance, the child, listened to the sentence in the Example (1), and was asked to choose the correct picture that depicted completely the meaning of the sentence. The sentences were allocated from the simple to the complex grammatically sentences. The maximum score for this task was 26.

(Example 1) O andras exei ena kainourio gialistero aspro autokinito The man-nom has a brand new-adj shining-adj white-adj car. 'The man has a brand new shining white car'

Sentence production task

The sentence production task was used for the assessment of expressive language. It consisted of 20 sentence items. Each child was asked to produce a sentence using a specific word or phrase and visual stimuli. The words were comprised of nouns, adjectives, verbs, prepositions and conjunctions. The visual stimuli defined were familiar objects from everyday life. For example (Example 2) each child was given the word:

(Example 2) Psilos *'tall'* and a picture of a basketball player. Then the participant was asked to produce a sentence using the word that was related to the picture. A range of criteria were used for scoring each sentence such as the use of the given word, the knowledge of the meaning of the word, its syntactical function and the rational coherence of the sentences. The maximum score for the task was 60.

Semantic Relationships task

The semantic relationships task evaluated children's semantic skills. The task consisted of 28 sentences and 4 choices for each sentence. The task was divided into 4 units (contrasting relationships, place value awareness, passive voice and time awareness). Each child listened to a sentence and (Example 3) then was asked to select two associates that were related to the target sentence. For instance, the child listened to the sentence:

(Example 3) Ta domatia einai mikrotera apo

The rooms-nom are smaller-comp than 'the rooms are smaller than' and then he/she had to complete it with two out of four choices (3a, 3b, 3c, 3d)

(3a) ta louloudia	(3b) ta ktiria	(3c) ta trapezia	(3d) ta spitia
The flowers	The buildings	The tables	The houses

The maximum score for this task was 28.

Mathematical measures

For the purposes of this study an informal mathematical assessment was designed in order to evaluate children's mathematical skills. The content of the mathematical assessment was based on tasks of previous studies (Cowan et al., 2008, 2005; Donlan et al., 2007) as well as on the Greek national curriculum (2005) and on Primary school teachers' views. Moreover, a novel story problem task was specifically designed for the purposes of the study. The final mathematical assessment included 7 tasks (verbal and non-verbal) which were the *completion of number lines task*, the *calculation task*, *the place-value principle task*, the *transcription from numbers to words task*, the *matching objects - images task*, the *transcription from words to numbers task* and the *story problems task*. Each task had a separate total score (see below) while a composite score was also calculated for all the mathematical tasks which led to a total maximum score of 100 for each child.

Completion of number lines task

The *completion of number lines task* required from the child to complete 2 number lines with two-digit numbers in an ascending (from 64 to 74) and a descending scale (from 41 to 31). The maximum score for each correct scale was 10 and the total score for both number lines was 20.

Calculations task

The *calculations task* included 10 additions and 10 subtractions. There was a gradual level of difficulty from one-digit numbers (e.g. 2+6= ?) to two-digit numbers (e.g. 75-51 = ?). The results from each calculation did not exceed 100. The maximum score for the calculations task was 20.

Place value principle task

The *place value principle task* required from the children to compare 10 pairs of numbers including one and two digits. The children had to choose the greatest two-digit number in each pair of numbers. The numbers differentiated in one digit (e.g. 22-32), in the order of the digits (e.g. 72-27) and in the number of the digits (e.g. 96-6). The maximum score for the place value principle task was 10.

Transcription from numbers to words task

In the *transcription from numbers to words* task, each child had to transcribe 10 single digit numbers in letter words. The maximum score for this task was 10.

Matching objects - images task

In the *matching objects - images* task each child had to correspond 10 pictures with 10 numbers. The pictures presented a number of different items such as stars, fishes, dogs and each child had to count the number of the items in each picture and then to match it with the correct digit and the maximum total score was 10.

Transcription from words to numbers task

The *transcription from words to numbers task*, was the reverse of the fourth task (Transcription from numbers to words task). Each child had to read numbers (written in words) and then to write down the corresponding number. The maximum score for this task was 10.

Story problems task

In the *story problems task* each child had to solve 5 story problems. Each story problem required 2 calculations which were only additions and subtractions. The story problems examined the understanding of the concepts *"more", "less", "double", "half"* and the monetary value in everyday life situations. For example a problem that was chosen for the understanding of the concept *"more"* was the following :

(Example 4) H Maria eixe 23 markadorous. O Giannis eixe 12 markadorous perissoterous apo tin Maria. Posous markadorous eixan kai ta duo paidia mazi?

'Mary had 23 pencils. John had 12 pencils more than Mary. How many pencils had both the children together?'

Each story problem was assessed according to 3 criteria (a) understanding of the problem, (b) correct calculations and (c) correct written answer. The maximum score for each story problem was 4 resulted from the 3 above criteria (1 point for the understanding of the problem, 2 points for the two correct calculations and 1 point for the written answer). Nevertheless, a half point could be given in the case of not completing either the calculations or the correct written answer. The maximum score for each story problem was 4, and the maximum score for the whole story problems task was 20 (5 problems X 4 points each one).

Results

Firstly, the cognitive and language profile according to the screening criteria, of both groups of children will be presented. Children's performance in language and mathematical tasks will follow in the next subsection. In the last section, the correlations between the language and the mathematical measures for children with SLI and their typically developing peers will be presented.

The cognitive (non-verbal) and language profile of the children with S L I according to the Screening criteria

As we can see in Table 1, the group of typically developing children had a better performance in the expressive vocabulary task in comparison to the SLI group of children. At the same time, both the SLI group and the typically developing children demonstrated normal non-verbal ability.

Table 1: Non-verbal ability (intelligence quotient) and expressive vocabulary (raw scores) for children with SLI and typically developing children (screening criteria).

	TD				SLI			
	M	S.D	Min.	Max.	M	S.D	Min.	Max.
Non verbal ability	114.77	14.44	94	151	105.33	10.32	88	123
Expressive vocabulary	37.20	3.56	30	42	25.67	2.44	19	29

The language profile of children with SLI and their typically developing peers

Children's performance across the three language tasks is presented in Table 2. Children with SLI had the worst performance across all language measures in comparison to their typically developing peers. The t-test analysis for independent samples revealed significant differences between the two groups across all tasks (*sentence structure, sentence production, semantic relationships*).

Table 2: The language skills of children with SLI and typically developing children

	TD		SLI				
	M	S.D	M	S.D	T	df	p-value
Sentence Structure	22.17	1.55	17.60	3.21	7.00	41	0.00
Semantic Relationships	18.30	2.33	9.20	3.07	12.89	54	0.00
Sentence production	41.67	6.18	26.23	7.18	8.91	58	0.00

The mathematical skills of children with SLI in comparison to their typically developing peers

Children with SLI performed worse almost across all the mathematical tasks in comparison to their typically developing peers (Table 3). Specifically, significant differences between the two groups were found in the *completion of number lines task, calculations task, transcription from numbers to words, and story problems task*. Furthermore, children's overall mathematical performance was calculated and a composite mathematical score was given for each child in the certain task. Again, children with SLI, performed significantly worse in comparison to their typically developing peers. Size effect (d) for children's performance in each separate task as well as for the total score varied between 0.14 and 1.90.

Table 3: The mathematical skills of children with SLI and typically developing children

	TD				SLI							
	M	S.D	Min.	Max.	M	S. D	Min.	Max.	t	df	P value	Cohen's d
	19.97	0.18	19	20	15.10	6.45	0	20	4.12	29.04	0.000	1.06
Ascending number line (max=10)	9.97	0.18	9	10	8.50	3.51	0	10	2.28	29.15	0.03	0.59
Descending number line (max=10)	10	0	10	10	6.60	4.76	0	10	3.91	29	0.001	1.01
Calculations (total max=20)	18.13	2.03	13	20	13.40	5.34	1	20	4.53	37.18	0.000	1.17
Additions (max=10)	9.33	0.95	7	10	7.37	2.58	1	10	3.91	36.86	0.000	1
Subtractions (max=10)	8.80	1.42	5	10	6.03	3.06	0	10	4.48	40.94	0.000	1.16
Place value principle (max=10)	9.93	0.25	9	10	9.60	1.19	5	10	1.49	31.62	0.14	0.38
Transcription from numbers to words (max=10)	8.40	1.38	5	10	7.20	1.54	4	9	3.17	58	0.002	0.82
Matching objects-images (max=10)	9.63	0.55	8	10	9.50	1.13	4	10	0.57	58	0.56	0.14
Transcription from words to numbers (max=10)	10	0	10	10	10	0	10	10	0	0	-	-
Story problems (max=20)	12.75	2.95	8.5	20	6.98	3.11	1.5	12	7.35	58	0.000	1.90
Total score (max=100)*	88.5	5.54	74.5	98	71.78	11.96	43	85	6.95	40.88	0.000	1.79

The composite mathematical scores for each problem and each group are presented in Table 4. Statistical significant differences were found in the first problem [$t(53.11) = 1.88$, $p = 0.065$], in the second [$t(52.35) = 4.40$, $p = 0.001$] and in the last one [$t(51.43) = 5.72$, $p = 0.001$]. The effect sizes measured by Cohen's d ranged from 0.49 to 1.43.

Taking into account the complexity of the task, a further analysis was carried out. The responses to each story problem task were coded according to three criteria (a) understanding of the problem, (b) correct calculations and (c) correct written answer (see Methods section above). Table 5 presents the total performance (means) of both groups of children according to the previous criteria. As it can be seen in Table 5, performance of the SLI group of children was statistically significantly lower in comparison to their typically developing peers, across all criteria {understanding of the problem [$t(58) = 6.46$, $p = 0.001$], correct calculations [$t(58) = 7.49$, $p = 0.001$], correct written answer [$t(58) = 5.16$, $p = 0.001$].

Table 4: Children's composite mathematical scores (Means and Sds) in the story problems by group of children

	TD				SLI				
	M	S.D	Min.	Max.	M	S.D	Min.	Max.	Cohen's d
Story problem 1	2.05	1.13	0.5	4	1.56	0.82	0	4	0.49
Story problem 2	2.01	1.43	0	4	0.60	1.02	0	3.5	1.13
Story problem 3	3.11	1.17	0.5	4	2.13	1.47	0	4	0.73
Story problem 4	2.63	1.33	0	4	1.66	1.48	0	4	0.68
Story problem 5	3.06	1.11	0	4	1.07	1.61	0	4	1.43

Table 5: Children's total performance (Means and Sds) in the criteria of the story problems tasks by group of children

	TD				SLI				
	M	S. D	Min.	Max.	M	S. D	Min.	Max.	Cohen's d
Understanding of the problems	3.76	0.70	2.5	5	2.36	0.95	0.50	4.50	1.67
Calculations	6.96	1.37	5	10	3.90	1.76	1	8	1.94
Written answers	2.15	1.21	0	5	0.75	0.85	0	2.50	1.33

The relationship of language and Mathematical skills in children with SLI

In order to further investigate possible relationships between language and mathematical skills bivariate correlations were carried out. According to Table 6, significant correlations were found between the sentence structure and the place value principle. Significant correlations, were also identified between the semantic relationships and the total score for the criterion 'understanding of the story problems'. Last significant correlations were found between the sentence production and the total score for the criterion 'correct written answer'.

Table 6: Correlations between language and mathematical tasks for the children with SLI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Expressive lexical vocabulary	-	0.20	0.03	0.28	0.02	0.00	0.07	0.12	0.19	-	0.07	0.11	0.16	0.12
Sentence structure		-	0.34	0.23	0.00	-0.00	0.44*	0.05	0.03	-	0.11	0.10	0.11	0.11
Semantic Relationships			-	-0.12	0.15	0.11	0.29	0.18	0.15	-	0.48**	0.35	0.04	0.35
Sentence production				-	-0.12	0.11	-0.23	0.13	0.12	-	0.03	0.09	0.44*	0.17
Number lines					-	0.35	-0.03	-0.10	0.12	-	0.23	0.26	0.09	0.24
Calculations						-	0.00	0.12	0.24	-	0.16	0.45*	0.42*	0.42*
Place value principle							-	0.00	-0.05	-	0.20	-0.08	-0.23	-0.17
Transcription from numbers to words								-	0.15	-	0.34	0.38*	0.31	0.41*
Matching objects-images									-	-	0.31	0.31	0.25	0.34
Transcription from words to numbers										-	-	-	-	-
Understanding of the problems (Total)											-	0.79*	0.45*	0.86**
Calculations (Total)												-	0.57**	0.96**
Written Answers (Total)													-	0.72**
Story problems (Composite score)														-

P < 0.05 *, P < 0.01 **, P < 0.001***

Discussion

The aim of the present study was to investigate the language and mathematical skills, of Primary school children with SLI. The multiple measurements administered shed some light on the language/math relationship. Children with SLI had both expressive and receptive language difficulties in comparison to the typically developing children. They also faced difficulties with syntactic and semantic skills. An extensive literature review by Stavrakaki, Koutsandreas, Clahsen (2012) mentions that children with SLI confront difficulties in different aspects of grammar, such as complex syntax or inflectional morphology (inflectional morphemes such as number person, gender, tense). Also in the present study children with SLI had semantic difficulties. According to Tomblin, Mainela-Arnold, Zhang (2007) the comprehension of reality confuses children with SLI as a result of representational deficits and secondly of lexical classification of the world.

Turning to the mathematical performance, children with SLI performed worse across almost all the mathematical tasks in comparison to their typically developing peers. The findings agree with other studies, which have reported that language disabilities can have several implications in mathematical performance (Cowan et al., 2008, 2005; Donlan et al., 2007; Fazio, 1999).

More specifically, children with SLI performed significantly worse in the *completion of number lines task* than the typically developing children. The ability to count is generated from the capacity of the memory that leads to the acquisition of knowledge of the first 10 number- items, from processing abilities for the formulation of the up-to-ten numbers and finally from the insight for the principles of the sequence of numbers. Children with SLI may confront difficulties in some of these essential skills (Cowan et al., 2005; Weismer, Evans, Hesketh, 1999).

Calculations was another area of difficulty for the SLI group in comparison to the typically developing children. Particularly, performance in the calculations with greater numbers was lower for the SLI group as a more demanding task. These findings confirm previous studies which identified corresponding difficulties in calculations additions and subtractions (Donlan et al., 2007).

Significant differences between the two groups were also found in the *transcription from numbers to words task*. Although children with SLI exhibited some knowledge of numbers as digits, they faced difficulties into transcribing them to words. Same results were also found in the study carried out by Cowan et al. (2008). Last, children with SLI demonstrated a quite low performance in the *story problems task.* Children, confronted difficulties with all the examined mathematical concepts (more, less, half, double and the monetary value in everyday situations).The task was quite demanding and was based on a variety of cognitive skills (e.g. reading ability, understanding of the appropriate process, correct calculations and the production of a correct written answer). It is known from previous research that reading difficulties may hinder the solution of story problems (Cowan et al., 2008, 2005). Alternative explanations could be related with those studies which have found relationships between low mathematical performance and working memory (Gathercole & Alloway 2004)**,** processing speed (Leonard, Weismer, Miller, Francis, Tomblin, Kail, 2007) and oral language abilities (Durand et al, 2005). The above findings could be also attributed to the pragmatic difficulties that children with SLI confront (Bishop & Adams, 1992) as well as to the complexity of the task.

On the other hand, no significant differences were found in the *transcription from words to numbers task.* The translation of number words to digits was an easy task for all the children since it only required the use of one symbol-digit, in comparison to the reverse task which required a word. Additionally, no significant differences were found in the *place value principle task* between the two groups. The above findings do not coincide with previous research (Donlan et al., 2007) in which significant differences were found. The contradictory results could be probably explained by the smaller number of digits used in the present study (2 digits) in comparison to the other study (2-5 digits).

No significant differences were demonstrated in the *matching objects- images task* between the two groups of children. It is possible that the specific task was a quite easy task, since the children had to match numbers with objects up to 10 and probably this skill was already in children's repertoire from their preschool years. Significant relationships between children's language ability and their mathematical skills were also demonstrated by the correlational analysis. Firstly significant correlations were found between the sentence structure task and the place value principle task. In the sentence structure task, children had to listen to a sentence and choose among 4 pictures the most appropriate one that was related to the sentence. On the other hand, in the place value principle task, the children had to compare a pair of two numbers each time, and to choose the greater one. The identified relationship between these tasks could be explained by a common cognitive mechanism which might be employed in both tasks which could be named as a comparison mechanism.

Significant correlations were also found between the semantic relationship task and the first criterion of the story problems task (understanding of the problem). It seems that those children who had impaired semantic skills faced also difficulties in understanding the text (such as story problem) which was mainly based on semantic relationships. In summary, the results demonstrated that children with SLI faced difficulties not only in expressive and receptive language skills, but also in Maths in comparison to their age counterparts. A relationship between language and mathematical skills in children with SLI was also evident in the present study. The findings support and extend previous studies (Cowan et al., 2008, 2005; Donlan et al., 2007). Although, there is a limit on how much explanation can be justified on the basis of correlations, these identified relationships could be explained with two main hypotheses. According to the first hypothesis, the way of thinking in language and math, maybe is underpinned by common cognitive systems.

In fact, neuroimaging techniques have revealed that central cognitive systems recruit language and mathematical cognitive systems (Dehaene, Molko, Cohen & Wilson, 2004). For example Dehaene Piazza, Pinel, Cohen (2003) suggested that a model of three representational systems is responsible for calculation: the quantity system, the verbal system and the visual system. The verbal system is responsible for the connection with the mathematical skills through a phonological, lexical and syntactic representation of numbers. Therefore, a dysfunction in a cognitive mechanism affects both the acquisition of linguistic and mathematical knowledge. Other evidence focusing on common underlying mechanisms between the above skills comes from Gathercole and Alloway (2004). They suggested that mathematical ability and reading share similar cognitive mechanisms such as working memory, processing speed and oral language ability (Leonard et al., 2007). Especially Kail and Hall (1999) found that the children in order to solve a word problem need to combine many skills such as processing ability (memory, reading) and mathematical knowledge (additions and subtractions). Consequently a dysfunction in one or more of these mechanisms probably affects linguistic and mathematical performance.

A second explanatory hypothesis about the relationship between language and mathematical skills could be that mathematical performance involves linguistic aspects which may inhibit the understanding and the acquisition of mathematical knowledge. It is also plausible that language, the core medium of teaching, should affect mathematical concepts, since mathematical concepts and procedures can be differentially be constrained by language.

Cowan et al. (2008, 2005) as well as Donlan et al. (2007) demonstrated that the involvement of linguistic factors in mathematical procedure retards the acquisition of mathematical knowledge. According to Kleemans, Segers and Verhoeven (2012), basic calculation skills are related to linguistic ability (i.e. phonological awareness and grammatical ability) in children with SLI. The impediments that language induces in maths performance, has also been mentioned by Durkin, Mok & Conti-Ramsden (2013) concluding that language underpins the number understanding.

Turning to the limitations of this piece of research, the present study had a moderate sized sample, and a lack of a language-age matched group. Nevertheless, a language-age matched group might not be possible to be included in the certain research design, since if it had been included, it wouldn't be possible for the researchers to study the same mathematical skills as those studied in the other two groups (SLI and typically developing children) since they would belong at a different educational level having being taught different curricula.

Further studies, using longitudinal designs, larger samples, as well as other language and mathematical skills (such as geometry) need to be conducted to explore in more depth the above hypotheses. Another broader issue of great interest would be the examination of the cognitive mechanisms as an explanatory factor for the correlation between language and Maths in SLI children.

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