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Impact of specific language impairment and type of school on different language subsystems

Impacto do distúrbio específico de linguagem e do tipo de escola nos diferentes subsistemas da linguagem

ABSTRACT

Purpose: This study aimed to explore quantitative and qualitative effects of type of school and specific language impairment (SLI) on different language abilities. **Methods**: 204 Brazilian children aged from 4 to 6 years old participated in the study. Children were selected to form three groups: 1) 63 typically developing children studying in private schools (TDPri); 2) 102 typically developing children studying in state schools (TDSta); and 39 children with SLI studying in state schools (SLISta). All individuals were assessed regarding expressive vocabulary, number morphology and morphosyntactic comprehension. **Results**: All language subsystems were vulnerable to both environmental (type of school) and biological (SLI) effects. The relationship between the three language measures was exactly the same to all groups: vocabulary growth correlated with age and with the development of morphological abilities and morphosyntactic comprehension. Children with SLI showed atypical errors in the comprehension test at the age of 4, but presented a pattern of errors that gradually resembled typical development. **Conclusion**: The effect of type of school was marked by quantitative differences, while the effect of SLI was characterised by both quantitative and qualitative differences.

RESUMO

Objetivo: Este estudo teve o objetivo de explorar os efeitos do tipo de escola e do distúrbio específico de linguagem (DEL) sobre diferentes habilidades de linguagem, tanto do ponto de vista quantitativo quanto qualitativo. **Método**: 204 crianças brasileiras de 4 a 6 anos participaram da pesquisa. As crianças foram recrutadas para formar três grupos: 1) 63 crianças em desenvolvimento típico de linguagem, estudantes de escola particular (DTPar); 2) 102 crianças em desenvolvimento típico de linguagem, estudantes de escola pública (DTPub); e 39 crianças com diagnóstico de DEL, estudantes de escola pública (DELPub). Todas as crianças foram avaliadas em provas de vocabulário expressivo, morfologia de número e compreensão morfossintática. **Resultados**: Todos os subsistemas da linguagem foram susceptíveis tanto a questões ambientais (efeito tipo de escola) quanto orgânicas (efeito DEL). As relações entre as medidas de linguagem foram exatamente as mesmas para todos os grupos, indicando que o aumento do vocabulário ocorreu em função da idade, e se mostrou associado ao desenvolvimento das habilidades morfológicas e de compreensão morfossintática. As crianças com DEL apresentaram erros atípicos na prova de compreensão aos 4 anos, mas passaram a apresentar um padrão de erros semelhante ao do desenvolvimento típico com o aumento da idade. **Conclusão**: O efeito tipo de escola foi marcado por diferenças quantitativas, enquanto o efeito DEL foi marcado por diferenças predominantemente quantitativas, mas também qualitativas.

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INTRODUCTION

Language development depends both on environmental and genetic factors[1]. Some of the language domains are largely influenced by the quantity and quality of stimuli children are exposed to[2], whilst others rely more on the genetic characteristics of the individuals[3,4]. Although environmental and genetic factors play different roles, language development is mainly influenced by the interaction between the two[5,6].

The influence of environmental factors such as socioeconomic status (SES) was first explored in a systematic basis on the 90's. Hart and Risley were the first to identify that the language used by parents coming from high SES was quantitatively and qualitatively more complex than the one used by low-SES parents. Those differences were directly related to the vocabulary used by children. At the age of 3, children from high SES used approximately 12 million words whereas low-SES children used only 3 million[7].

Since then – and mainly over the last decade – a lot of research evidence showed that the environment in which children are exposed to may influence his/her brain development, affecting different aspects of language and cognition[2]. The language aspects that are more influenced by SES seem to be those related to more general abilities, such as vocabulary acquisition[8-10] and comprehension[11,12]. These effects are often mediated by the school environment[13] (state or private schools), and it is well known that early attendance to preschool of good quality contributes to close the gap between groups[14]. In Brazil, particularly, low-SES is usually associated with a poor usage of the number morpheme (plural), probably due to sociolinguistic reasons. Studies with 3- to 6-year old children living in low-SES areas of the city of São Paulo have indicated that the number morpheme acquisition was the most difficult[15] and both its comprehension and use were only productive at the age of 5[16].

Besides socioeconomic studies, a number of research projects were conducted since the 1980's to investigate cases in which language does not develop as expected due to an atypical brain development, as in Specific Language Impairment (SLI). This functional (but not structural) brain impairment is influenced by genetic factors[17] and lead to important language impairment even when there are no comparable problems in other areas of development[18].

Children with SLI show, to a higher or less extent, difficulties related to all language subsystems: phonology, lexicon, grammar and pragmatics[18]. Despite the huge heterogeneity in the group, there is evidence showing that morphological deficits are one of the main clinical markers of SLI. These children tend to use non-finite forms – or the inflections that are more frequently in their native language – for a longer period than typically developing children[19]. The number of words and morphemes in their sentences (mean length of extension) are usually similar to the ones used by children who are two yeas younger[20]. Depending on the characteristics of their native language, these manifestations may be more common in verbal morphology[19,21], nominal morphology[22,23] or both[24]. Grammatical difficulties in SLI do not only refer to morphology, but may also be related to syntax. Many studies have demonstrated that SLI is characterised by difficulties in attributing thematic roles, especially when syntactic complexity increases[25,26].

A lot of studies have attempted to describe the linguistic profile of these groups of children. However, none have explored the influence of both effects (environmental and biological) simultaneously. This study aims to fill this gap by comparing the performance of typically developing children studying in different schools (state and private) to the performance of children with SLI.

In order to explore school effects, we compared the performance between typically developing children studying in state and private schools. To identify the effects of SLI, we compared the performance between children with and without SLI, both studying in state schools.

For each analysis, we aimed not only to explore quantitative differences but also the relation between different areas and the pattern of responses in each group.

METHOD

This research was approved by the Ethic Committee of the Institution under the number 226/05. All participants had their written consent form signed by parents or caregivers.

Participants

This sample was composed of 204 Brazilian children ranging from 4 to 6 years of age. Children were recruited to form three groups: 1) 63 typically developing children studying in private schools (TDPri); 2) 102 typically developing children studying in state schools (TDSta); and 39 children with SLI studying in state schools (SLISta). Children were paired by age.

Inclusion criteria for the typically developing group (DTPar e DTPub) were absence of previous speech-language, psychological or psychiatric treatment; no parents' or teachers' complaints about language development; and performance within reference levels in the Expressive Vocabulary test – ABFW[27]. Children in the TDPri group were studying in private schools of the south region of São Paulo, specifically in neighbourhoods in which most children (48% to 64%) receive more than ten minimum wages per capita[28]. Children in the TDSta group were selected in a state school of the west region of São Paulo. According to SEADE database[28], there is a huge variation of income distribution in this region, but most people (25%) earn from 1.5 to 3 minimum wages per capita. Therefore, the type of school (private or state) is strongly related to socioeconomic inequalities (respectively medium-high and medium-low SES).

The SLI group comprised children receiving speech-language therapy in the University of São Paulo. This service takes place in the same region of the city in which the TDSta group was recruited. All children from the SLISta group showed performance below expected in at least two out of the seven tasks of the language battery: expressive vocabulary, receptive vocabulary, phonology, verb production, adjective comprehension, production and comprehension of prepositions, and mean length of utterances. All children had adequate performance (M = 82.7) on the Primary Test of Nonverbal Intelligence (PTONI), a test for assessing nonverbal intelligence. No individuals from this

group were diagnosed with auditory, psychiatric and/or severe emotional disorders. For more information on the sample, see Puglisi[29].

Material

Children were assessed on three language measures taping the lexicon, the number morpheme and morphosyntactic comprehension. The lexicon was assessed by the expressive vocabulary test ABFW[27] (scores vary from 0 to 118). The remaining tasks were created for the purposes of this study. The number morpheme was assessed with a test that involved the recognition of singular and plural. The task consisted on pointing to the picture that correctly represented sentences such as: "where is the clown?"; "where are the ballerinas"? (scores vary from 0 to 20). Children who scored at least 70% on both singular and plural tasks were classified as mastering the number morpheme. The morphosyntactic comprehension was based on a test that requires the comprehension of both number morpheme and word order. The activity consisted on pointing to the picture that correctly represented sentences such as: "the ducks peck the black chicken"; "the boys that put their coat on hug the lady". All sentences were reversible and the task covered sentences with different syntactic complexities (scores vary from 0 to 40). The foils in each trial were designed to allow type of errors analysis. For each sentence, there was always one target and three foils that represented morphological errors (number morpheme), syntactic errors (word order) or morphosyntactic errors (number morpheme and word order). For more information on the material, see Puglisi[29].

Procedures

Typically developing children were individually assessed in a quiet room in the school. Children with SLI were individually assessed in the same room they received speech-language therapy in the service. All children performed the vocabulary test followed by the morphosyntactic comprehension and then by the number morpheme task.

Data analysis

Data were analysed with SPSS Statistics 20.0 software.

To test for quantitative differences between groups for each language task, we ran univariate variance analyses (ANOVAs).

The dependent variables were the language tests, the independent variable was children's group and the controlling variable was age.

To explore the relationship between language abilities within each group, we employed different techniques that test for correlation or association between variables. Initially, we used bivariate and partial correlations with vocabulary, number morphology, morphosyntactic comprehension, and age. For the measures of interest after running the correlations, we employed the ROC curve followed by the Chi-Square test. Finally, in order to analyse the type of error in the sentence comprehension test, we correlated age with all types of answers in this task.

RESULTS

Descriptive results are shown in Table 1.

Initially, we present the results of quantitative analyses. Correlations and error analysis are described afterwards.

Quantitative differences between groups on the language tests

Table 2 shows a significant difference between groups for all language tests. Posthoc analysis (Bonferroni) indicated the pattern of responses was similar to all tests: children from the SLISta group performed worse than TDSta children (p<0.001), which in turn performed worse than TDPri children (p<0.001).

Correlations between lexical, morphological and morphosyntactic skills

There were positive moderate correlations between the three language tests (vocabulary, number morpheme and morphosyntactic comprehension), for all groups. Because the pattern of correlations was exactly the same to all groups, we decided to present correlations for the whole sample in order to increase statistical power and the robustness of the analysis (Table 3).

Considering all language measures moderately correlated with age, we aimed to explore whether the significant correlations were spurious, that is, represented indirect and not direct relations between variables. For this reason we ran partial correlations between the three language tests, controlling for the effect of age. All correlations remained significant (p < 0.001) and showed moderate effects (vocabulary and morphology: r = 0.478;

Table 1. Descriptive statistics. Children's performance in each language test split by group and age

Group	Age	Vocabulary		Number morphology		Comprehension	
		Mean	SD	Mean	SD	Mean	SD
TDPri	4 years	84.90	9.16	16.43	3.56	23.33	5.16
	5 years	90.43	6.08	17.05	3.65	25.90	5.08
	6 years	94.67	5.21	19.43	0.98	30.81	5.51
TDSta	4 years	70.44	10.04	11.82	3.12	16.18	3.97
	5 years	81.44	8.14	15.21	4.13	22.41	5.02
	6 years	89.56	5.56	17.71	3.29	24.32	5.46
SLISta	4 years	45.75	20.52	9.82	2.48	13.42	4.08
	5 years	61.42	20.40	10.75	2.09	16.25	6.27
	6 years	82.40	12.19	13.36	3.75	18.27	4.92

vocabulary and comprehension: r = 0.595; morphology and comprehension: r = 0.571). The opposite pattern (correlations between each language measure and age, controlling for the other language tasks) occurred only for the vocabulary. When correlations between age and vocabulary were controlled for the performance on the other language tasks, the results remained significant (p < 0.001; r = 0.275). But when the same

analysis was done to morphology and comprehension, the results were no longer or marginally significant (respectively, age and morphology: r = 0.168; age and comprehension: r = 0.079). Together, these results indicate that 1) there was a positive direct correlation between vocabulary, morphology and morphosyntactic comprehension, and 2) age was directly correlated only to vocabulary, showing that for morphology and morphosyntactic comprehension, there was a stronger correlation with vocabulary than with age.

Considering these results, we sought to explore if there was a minimum level of vocabulary that was necessary for the child to master the number morpheme, regardless of her/his age or group. For this purposes, we used ROC curve having expressive vocabulary as the continuous variable and the mastery of the number morpheme as the binary variable. ROC curve demonstrated good indexes (area = 0.839, standard error = 0.028, p < 0.001). We observed that, for this particular sample, the threshold of 83.5 on vocabulary represented sensitivity and specificity of 77.1% and 76.3%, respectively. We employed this threshold to classify children's vocabulary on "sufficient" and "insufficient" and used Chi-Square to test the association between vocabulary and morphology, using this criterion. As expected, there was a significant association between the vocabulary and the mastery of the number morpheme (χ^2=57.63, gl=1, p<0.001), what is shown in Figure 1.

Table 2. Inferential statistics. Quantitative differences between groups in each language test

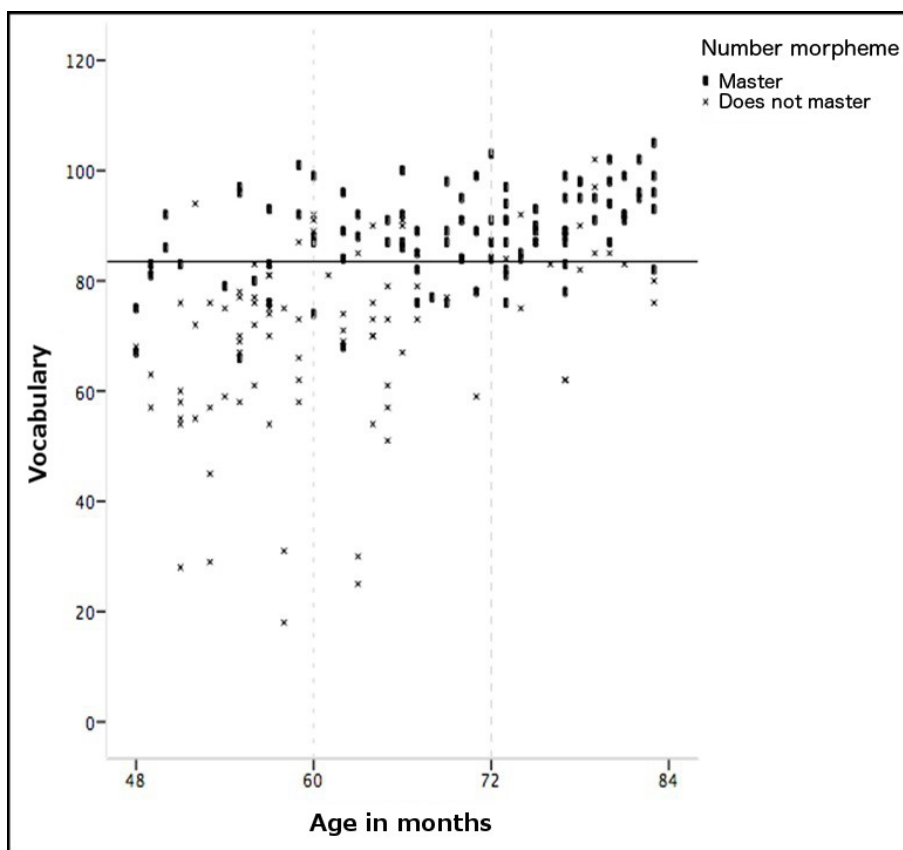| Language test	df	F	Sig.	η^2	Power
Vocabulary	2	75.731	0.000	0.440	1.000
Number morphology	2	43.552	0.000	0.311	1.000
Comprehension	2	54.725	0.000	0.362	1.000

Caption: Statistic tests: univariate ANOVAs

Table 3. Correlations between language tests and age, for the whole sample

Pearson Correlations	Vocabulary	Number morphology	Comprehension
Number morphology	0.575**		
Comprehension	0.671**	0.647**	
Age	0.504**	0.407**	0.430**

Caption: We present correlations for the whole sample because the pattern for each group was exactly the same
**Significant correlations at p<0.001

Caption: The horizontal line represents the threshold obtained through the ROC curve. The figure shows that the majority of the children above the threshold line masters the number morpheme, while the majority of children below the threshold does not
Figure 1. Mastery of the number morpheme in function of vocabulary and age, according to ROC curve's criterion

Table 4. Correlations between errors in the comprehension test and age, for each group

Pearson Correlations	Age		
	DTPar	DTPub	DELPub
Morphological errors	-0.494**	-00.184	0.576**
Syntactic errors	-0.376*	-0.454**	-0.694**
Morphosyntactic errors	-0.500**	-0.528**	-0.458*

*Significant correlations at p<0.01; **Significant correlations at p<0.001

Correlations between type of errors in the comprehension test and age, for each group

Differently from previous analyses, that was the first analysis in which we found different patterns of correlations for each group, and for that reason we present the results separately (Table 4). The only common pattern of correlations refers to age: the older the child, the fewer the syntactic and morphosyntactic errors (negative moderate correlations). However, for morphological errors – that demonstrate problems identifying singular and plural information in the sentence – there was a different trend for each group. There was no correlation between this error and age for children in the TDSta group, and an opposite pattern for children in the SLISta group (more morphological errors with age).

DISCUSSION

This study aimed to explore the effects of type of school and SLI on different language abilities, both from the quantitative and qualitative points of view.

The first finding of this study showed that children from state schools performed worse than children studying in private schools for all analysis, and children with SLI scored poorly than both typically developing groups. This finding reinforces the effects of type of school[13] and of the SLI[18] for all language subsystems.

This is an interesting result because it shows that all language subsystems were vulnerable to both environment (type of school effect) and biological effects (SLI effect). It is important to highlight however that we only analysed in this study the number nominal morpheme and not other nominal and verbal morphemes. In Brazil, there is a huge linguistic variation particularly related to the use of plural in different socioeconomic and cultural contexts[15,16]. If we had used other morphological markers that are less influenced by sociolinguistic aspects, we could have found smaller effects of type of school (TDSta < TDPri) for the morphology. We believe so because the morphological deficits are considered to be a clinical marker of SLI[19,20] and shall not be vulnerable to the school environment. The lexical and comprehension difficulties, on the other hand, are vastly found in both children with SLI[25,26] and children from low-SES[11,12]. It is necessary that future studies investigate this issue in depth and address whether children studying in state schools present difficulties to identify other nominal and verbal morphemes, besides the number morpheme.

Regarding the relationship between the language abilities for each group, we found that all groups showed the same pattern. There was a positive moderate correlation between the three language measures (vocabulary, number morphology and morphosyntactic comprehension), even after accounting for age variance. Age was significantly correlated to vocabulary only, after controlling for the other language variables. Together, these findings suggest twofold conclusions: first, the older the child, the bigger her/his vocabulary. This is in line with many studies on language development, despite potential differences in speed of lexical acquisition of each group[1,5,7,10]. Second, morphological and morphosyntactic abilities depend more on vocabulary growth than on age. More than that, we identified it was necessary a minimum vocabulary of 83 on the ABFW test for children to be able to master the number morpheme. These findings are consistent with the view that morphological development depends on a minimal vocabulary that enables the child to start analysing words subcomponents[18]. These relations were the same to both typically developing children (studying in state and private schools) and children with SLI.

On the contrary, the analysis of type of errors in the morphosyntactic comprehension task showed a distinct pattern of responses among groups, more specifically for the morphological errors. We expected that the quantity of all errors in the comprehension test would reduce with age. This was true for syntactic morphosyntactic errors, but there was an increase of morphological errors with age in the SLISta group. This finding is at first glance contradictory, considering older children showed better morphological abilities than younger children. However, subsequent analyses showed that the increase in morphological errors in the SLISta group reflected better qualitative responses. At the age of 4, children from SLISta group showed a similar proportion of all errors, while typically developing children already demonstrated more morphological errors than others. The typically developing groups show a quantitative improvement with age: the pattern of errors remains mainly morphological, but reduces in magnitude. The SLISta group, on the other hand, shows a qualitative improvement with age: they shift from providing random responses at the age of 4 to answering in a more systematic and typical way two years later (more morphological errors).

The deviant pattern of response is compatible with the notion that language development in SLI is not only delayed, but usually idiosyncratic, reflecting atypical patterns of brain specialization[18,30]. The deviant patterns found in SLI usually occur in tasks with high demands of linguistic processing[18], as in the morphosyntactic comprehension task. As children grew older and improved their language abilities, the linguistic demands were probably minimised and children started to present a pattern of response that is similar to the one found in typical development – although quantitatively worse.

The findings of this study contribute to understanding the effects of type of school on different language subsystems, and help understand the extent to which these effects differ from SLI. More studies are needed to cover a wider age range (including the early years) and explore these effects over other language measures.

CONCLUSION

This study demonstrated that all language subsystems were susceptible to both environmental (type of school effect) and biological (SLI effect) aspects, but the difficulties experienced by children with SLI were always bigger than in the other groups. The relationship between the three language measures was exactly the same to all groups: vocabulary growth correlated with age and with the development of morphological abilities and morphosyntactic comprehension. Children with SLI showed atypical errors in the comprehension task at the age of 4, but started to present a pattern of response that was similar to their peers as they grew older.

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Author contributions

MLP participated at the phases of research design, data collection and analyses, discussion of the results and paper writing; DMBL participated at the phases of research design, discussion of the results and paper writing.