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# Phonemic discrimination and the relationship with other linguistic levels in children with typical phonological development and phonological disorder

## *Discriminação fonêmica e a relação com os demais níveis linguísticos em crianças com desenvolvimento fonológico típico e com desvio fonológico evolutivo*

### ABSTRACT

**Purpose:** To compare children with typical language development (TLD) and evolutional phonological disorder (EPD) regarding the phonemic discrimination and the linguistic performance of language levels (morphological, syntactic, semantic, and perceptual and productive vocabulary). **Methods:** The sample comprised 36 children, aged between 5 years and 7 years and 11 months, with TLD and EPD. Children with EPD were awaiting care in the speech units of two higher education institutions and children with TLD were screened in public schools. For inclusion in the study, the criteria were the following: being authorized by the informed consent and being within the required age group. After the inclusion of children, all subjects underwent the phonemic discrimination test with figures, to the average phrase value test, which assesses the morphosyntactic and semantic/lexical aspects, and the expressive vocabulary test. For statistical evaluation of the influence of variables, Spearman's nonparametric correlation coefficient was used, and for comparison between the groups regarding evaluation performance, Mann-Whitney test was used. **Results:** Only children with EPD showed influence of phonemic discrimination in other linguistic levels. In addition, a significant difference was observed between the performances of both groups in relation to the phonemic discrimination, vocabulary, and all levels assessed in the questions and description modality. **Conclusion:** The comparison between both groups showed a statistically significant difference in phonemic discrimination and morphosyntactic and lexical/semantic development, with better performance in the TLD group.

### RESUMO

**Objetivo:** Comparar crianças com desenvolvimento típico de linguagem (DTL) e com desvio fonológico evolutivo (DFE) quanto à discriminação fonêmica e ao desempenho linguístico dos níveis da linguagem (morfológico, sintático, semântico e vocabulários perceptivo e produtivo). **Métodos:** A amostra foi constituída por 36 crianças, com idades de 5a 7 anos e 11 meses e com DTL e com DFE. As crianças com DFE aguardavam atendimento nos setores de fala de duas Instituições de Ensino Superior (IES) e as crianças com DTL foram triadas em escolas públicas. Para a inclusão na pesquisa, os critérios foram: autorização pelo Termo de Consentimento Livre e Esclarecido (TCLE), ter a idade estipulada e ter DTL. Após a inclusão das crianças, todos os sujeitos foram submetidos ao teste de figuras para discriminação fonêmica (TFDF), ao teste média de valores de frases (MVF), que avalia os aspectos morfossintáticos e semânticos/lexicais, e ao teste de vocabulário expressivo (TVExp). Para avaliação estatística da influência das variáveis, foi realizado o

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coeficiente de correlação não paramétrico de Spearman, e para a comparação dos grupos em relação aos desempenhos das avaliações, o teste U de Mann-Whitney. **Resultados:** Somente as crianças com DFE apresentaram influência da discriminação fonêmica nos demais níveis linguísticos. Além disso, há uma diferença significativa entre os desempenhos dos grupos DTL e DFE em relação a discriminação fonêmica, vocabulário e todos os níveis avaliados na modalidade perguntas e descrição. **Conclusão:** A comparação entre os dois grupos mostrou que há diferença estatisticamente significativa em relação à discriminação fonêmica e ao desenvolvimento morfofossintático e semântico/lexical, com melhor desempenho no grupo com DTL.

## INTRODUCTION

Phonemic discrimination is a process of differentiation of acoustically similar sounds with different frequency, duration, and/or intensity when the information carried by the sound depends on these differences<sup>(1)</sup>. Therefore, it is the individual's ability to perceive minimum acoustic differences present in the discourse<sup>(2,3)</sup>, and it is considered as a key aspect for the correct production of speech sounds — the mental representation and storage of linguistic stimuli are established through reception, analysis, and organization of information by auditory processing<sup>(1-5)</sup>. Therefore, the ability to discriminate phonemes is critical to the beginning of this process and for phonological acquisition<sup>(3)</sup>.

For the acquisition of speech sounds, it is essential that the ability to perceive minor differences between the distinctive features that occur by binary oppositions is established. These are described with values for the following combinations: [+sonorant] and [-sonorant], [+approx.] and [-approx.], [+cont.] and [-cont.], [+voice] and [-voice], and monovalent values for place of articulation: [labial] and [coronal], [coronal] and [dorsal], [labial] and [dorsal] [coronal+ant.] and [coronal-ant.]<sup>(5)</sup>. Therefore, conditions are necessary so that these sounds are discriminated<sup>(6)</sup>, such as the integrity of organic structures involved in the detection, reception, and conduction of sound, as well as interpretation processes, so that the sound is perceived<sup>(7)</sup>.

Children should learn to discriminate specific sounds so that their speech is adjusted to the adult target-pattern of their mother tongue<sup>(5)</sup>. For the child to learn the sounds of speech, there must be organic conditions for the discrimination of phonemes. In other words, it depends on neuromuscular integrity and maturation. Thus, the integrity and the development of sensory and motor aspects are involved in the learning process of a standard language<sup>(8)</sup>. It is through the association of auditory aspects for the motor articulatory gesture that language phonemes are memorized and become available for use in speech<sup>(3)</sup>. Thus, phonological acquisition depends on the child's perceptive capacity to hear sounds embedded in words and be able to analyze them according to their acoustic and articulatory characteristics.

The acquisition of the phonemes of a language also needs knowledge by the child of the contrast systems valid for that language community. Although each phoneme has no meaning in itself, its omission, insertion, translocation, or substitution in a word can cause changes in meaning.

In typical phonological acquisition, the domain of the phonological system of a target-language is reached spontaneously, in an age sequence that is common for the majority of children<sup>(9)</sup> (4- to 6-year-olds). It seems to obey a universal system of hierarchy and restrictions, responsible, ultimately, for predicting an order of acquisition of the phonemes of a particular language, but which may present individual variations<sup>(10)</sup>. Thus, the simpler characteristics and co-occurrences are learned before those more complex<sup>(11)</sup>. In turn, the disordered and/or delayed phonological acquisition happens when the adaptation of the phonological system is not achieved spontaneously and/or is not achieved in the same sequence and at the same time observed in most children<sup>(10)</sup>.

The phase of greater expansion of the phonological system occurs between 1 year and 6 months and 4 years, when there is an increase in children's phonetic/phonological inventory, enabling the production of polysyllabic words and more complex syllable structures. The age of 4 is considered an important milestone for the completion of the phonological inventory, and at this age, most children have acquired the phonemic contrasts of the adult phonemic system, and use language to communicate effectively<sup>(10)</sup>.

Therefore, deficiencies in auditory discrimination during the phonological development period may compromise the establishment and organization of speech sounds<sup>(3,7)</sup>. In addition, the difficulty in understanding speech sounds may be related to the occurrence of phonological changes during the period of childhood<sup>(12)</sup>. On the basis of this, it can be assumed that the disorder in the production of sounds is related to the difficulty in phonemic discrimination<sup>(1)</sup>.

Concurrently with the phonological acquisition, the acquisition of vocabulary begins approximately at the time the child learns how to relate properly sequences of sounds (signifiers) to sets of situations (referents) using corresponding mental representations (meanings) as intermediates. The construction of these mental representations is a job that the child must do to discover the regularities that dictate the use of lexemes by adults<sup>(13)</sup>.

From these first words, the vocabulary used by the child begins to enlarge, until, at around 24 months, there is a phenomenon known as vocabulary explosion. In fact, this phenomenon is related to the child's cognitive aspects, which, through the formation of concepts, name things that surround the child<sup>(14,15)</sup>. In this sense, the vocabulary is closely connected with the experiences of the subject because the child's curiosity and

experiences in new situations explain the acquisition of and the search for unknown words. Therefore, a considerable individual variation in the growth patterns of the initial vocabulary is expected<sup>(16)</sup>. This pattern of acquisition is because the vocabulary is an open system<sup>(17)</sup>, that is, constantly expanding throughout the subject's life<sup>(15)</sup>.

From a linguistic point of view, learning new words seems to be closely related to the acquisition of syntax, morphology, and phonology because without words, speakers cannot construct syntactic patterns, morphological structures, or even sound patterns of their language<sup>(16)</sup>.

The hypothesis of this study was that because the subsystems are closely related, changes in the phonological subsystem can influence changes in semantic, morphosyntactic, and lexical subsystems, and the conduction of studies on such relations is of great clinical and theoretical relevance.

Thus, it is hoped that these findings will contribute with adequate resources for the completion of the evaluation, diagnosis, and treatment of speech and language disorders, preventing or minimizing possible changes in other areas that may be involved.

Considering the above, this study aimed to compare children with typical language development (TLD) and evolutionary phonological disorders (EPD) regarding the phonemic discrimination and the linguistic performance of language levels (morphological, syntactic, semantic, and perceptive and productive vocabulary) of children aged 5 to 7 years and 11 months.

## METHODS

This was an experimental, descriptive, and prospective study, with quantitative analyses. It is linked to a research project filed by the research ethics committee of a federal educational institution, under protocol no. 360.535, and has a Certificate of Presentation for Ethical Assessment (CAAE), no. 17803713.9.0000.5346.

The study sample consisted of 37 children with TLD and EPD, 13 females and 24 males, with ages ranging from 5 years and 3 months to 7 years and 11 months at the time of initial evaluation. Children with EPD were awaiting care in the speech departments of Speech-Language Pathology and Audiology services linked to two higher education institutions, and children with TLD were screened in public schools that authorized this research.

The criteria for the inclusion of children with TLD were the following: authorization from legal guardians by signing the free and informed consent form, being within the age range stipulated and having TLD. For children with EPD, the main criterion was the diagnosis of EPD.

In addition, children had to be authorized by parents or legal guardians to participate in the study by signing the informed consent and be aged between 5 and 7 years and 11 months. These age limits were established to ensure the diagnosis because the majority of studies indicate that the age of 5 is when the stabilization of the phonological inventory can be expected. In turn, children as young as 8 who show these characteristics

raise suspicions about the possible causes for the symptoms, which can be classified as residual speech errors.

The exclusion criteria of children with TLD and EPD were as follows: subjects who had received or were receiving any kind of speech therapy; whose legal guardians have not authorized their participation through the FICF; whose auditory thresholds suggest alterations; and who present oral motor skills and structures that could compromise speech, as well as any evident neurological, emotional, or cognitive damage.

For the diagnosis of EPD, the following were assessed: speech and hearing screening, composed of the initial interview (anamnesis), and clinical observation, composed of phonological and oral and/or written language assessment, and audiological and orofacial motricity assessment.

After confirming the EPD, the children were submitted to data collection for assessment of phonological aspects: this aspect was assessed by spontaneous naming of figures that make up the Phonological Assessment Instrument: Children (*Avaliação Fonológica da Criança* — AFC)<sup>(18)</sup>. Then, the contrastive analysis was performed to establish the child's phonological system, and, finally, the Percentage of Consonants Correct-Revised<sup>(19)</sup> was calculated. For the classification of degrees of phonological disorder, the proposed rates were used, which classify the deviation in mild — MD (86–100%), mild-moderate — MMD (66–85%), moderately-severe — MSD (51–65%), and severe — SD (<50%).

For the evaluation of the productive vocabulary, the two groups (TLD and EPD) underwent further evaluation of morphosyntactic and semantic elements, through the average phrase value test<sup>(20)</sup>. For this analysis, the oral production of the first five sentences spoken by children was collected and recorded, under three different conditions of enunciation (describing a picture, telling a story, and answering questions).

According to this proposal, the scoring was as follows: nouns and verbs, because they are considered the first to emerge in language acquisition and give meaning to the phrase, were considered semantic elements, with two points given each time they were used; adverbs, adjectives, prepositions, conjunctions, pronouns, and articles were considered syntax elements, and four points were given for each one because the use of these words would show greater grammatical knowledge and linguistic evolution.

In addition, the total score was counted for each sentence, to obtain the total complexity (construction), and the number of words in the sentence was also counted, to obtain its total extension.

The productive vocabulary was assessed in its expressive form<sup>(21)</sup>, using the expressive vocabulary test. This test has been validated and standardized for the 18 months to 7-year-old age group, originally with 100 items for oral appointment, and the total number of correct answers was counted (for this, exchanges, omissions, and substitutions were disregarded).

To evaluate the perceptual aspects, we used the Phoneme Discrimination Test with Figures (PDTWF)<sup>(5)</sup>. This tool evaluates the phonemic discrimination of children aged 4 to 8 years old. The test consists of 30 minimal pairs (60 words) and 4 demonstration items. These minimal pairs were organized in

40 presentations; of which, 30 are presentations with two different words and 10 are presentations with two equal words. Presentations with two equal words were included in the test to make the participating children pay more attention.

Of the 30 presentations with two different words, 3 differed for the opposition [+/-sonorant], 1 for the opposition [+/-approx.], 3 for [+/-cont.], 5 for [+/-voice], 3 for the opposition [coronal+/-ant.], 2 for [labial] x [coronal], 2 for [dorsal] x [coronal], 4 for [dorsal] x [labial], and 7 for the opposition of syllabic structures, of which 2 differ for V x CV, 2 for CV x CVC, and 3 for CV x CCV. The order of presentations follows the same sequence. The test score is obtained by adding one point for each correct answer and zero point for each incorrect answer, or obtained through repetition, totaling 40 points.

For statistical analysis, the methods used were the non-parametric Spearman correlation coefficient, for analyzing the influence of phonological aspects in relation to perceptual and productive vocabularies in both groups, and the Mann-Whitney test to compare the scores between the two groups. In addition, the Spearman correlation coefficient varies between -1 and 1, and the closer it is to these extremes, the greater the association between variables. For these analyses, the statistical program Statistic 9.1 and the significance level of 5% were used.

## RESULTS

Table 1 shows the correlation of the performances of TLD and EPD groups, between the perceptual aspect of phonology (phonemic discrimination) and each linguistic variable (syntax, semantics, total construction, and total extension) in the enunciation patterns of language, as well as vocabulary. For this, the Spearman's correlation coefficient was used, in which p-values lower than 0.05 were considered significant, which are highlighted with an asterisk in the table.

Spearman's correlation coefficient indicated that there are differences regarding the influence of phonemic discrimination in other linguistic levels between both groups studied, as only the group with EPD presented significant correlations in these aspects.

As can be seen, there were statistically significant, positive correlations only in the group of children with EPD. These occurred between semantics and syntax in the description modality; in semantics, between the total construction and total extension category of the story modality, which is to say that the greater the capacity of discrimination, the greater the semantic and syntactic development.

Also in the group with EPD, there was a significant negative correlation between discrimination and vocabulary. However, it was negative, indicating that the higher the discrimination, the lower the vocabulary.

However, the TLD group had negative correlation, which indicates that the findings of the correlation are inversely proportional to the growth of the variable (in this case, phonemic discrimination), but without statistical significance.

The analysis of the results between groups highlights the fact that, in the deviations (EPD group), language levels seem

to correlate significantly, unlike what occurs in typical development (TLD group), as there was no alterations in discrimination or in any of the subsystems assessed in this population.

Table 2 shows the comparison of the performance of children with TLD and EPD in relation to the perceptual aspect of phonology and other linguistic levels. For this, Mann-Whitney

**Table 1.** Correlation of the performances of perceptual aspects of phonology in relation to other linguistic levels in the groups with typical language development and evolutionary phonological disorder

Language levels	PDTWF			
	TLD		EPD	
	Coefficient	p-value	Coefficient	p-value
Vocabulary	-0.001	0.995	-0.524	0.030*
Description				
Semantics	-0.434	0.063	0.554	0.020*
Syntax	-0.009	0.969	0.520	0.032*
Total construction	-0.120	0.622	0.460	0.063
Total extension	-0.157	0.512	0.282	0.271
Story				
Semantics	-0.005	0.173	0.602	0.010*
Syntax	-0.005	0.982	0.391	0.120
Total construction	-0.266	0.270	0.645	0.005*
Total extension	-0.301	0.209	0.645	0.005*
Question				
Semantics	0.297	0.215	0.642	0.105
Syntax	0.324	0.175	0.179	0.493
Total construction	0.330	0.166	0.248	0.337
Total extension	0.374	0.114	0.418	0.09

\*Significant values (p<0.05); Spearman's correlation coefficient

**Caption:** TLD = typical language development; PDTWF = phoneme development test with figures; EPD = evolutionary phonological disorder

**Table 2.** Comparison of linguistic performances between groups

Language levels	Values	Values	p-value
	obtained in TLD	obtained in EPD	
PDTWF	499.5	166.5	0.000*
Vocabulary	506.5	165.5	0.000*
Description			
Semantics	417.5	248.5	0.035*
Syntax	413.0	253.0	0.050*
Total construction	417.5	248.5	0.036*
Total extension	433.0	233.0	0.009*
Story			
Semantics	369.0	297.0	0.577
Syntax	381.0	285.0	0.348
Total construction	412.5	253.5	0.052
Total extension	439.5	226.5	0.005*
Question			
Semantics	414.5	251.5	0.044*
Syntax	459.5	206.5	0.000*
Total construction	432.5	233.5	0.010*
Total extension	440.5	225.5	0.004*

\*Significant values (p<0.05)

**Caption:** TLD = typical language development; EPD = evolutionary phonological disorder; PDTWF = phoneme development test with figures

*U*-test was used, in which *p*-values lower than 0.05 were considered significant, which are highlighted with an asterisk in the table.

Mann-Whitney *U*-test indicated that there is a significant difference between the performance of children with and without phonological deviations regarding phonemic discrimination, vocabulary, and all levels assessed in the questions and description modalities. There was also no significant difference in the total length of the story modality. In all cases, higher performance scores can be observed in the group with TLD.

## DISCUSSION

This study aimed to analyze the influence of phonological aspects in the linguistic performance and correlate phonological perceptive performances with other language levels in children with EPD and TLD, by comparing the scores between the two groups.

From the data analysis, differences were observed in the performance of other linguistic levels in relation to phonemic discrimination between the groups studied. However, only the group with EPD was presented significant correlations in these aspects.

Related to this result, a study on phonemic discrimination in children aged 4 to 7 years and 11 months found that phonemic discrimination disability can be an aggravating factor in cases with EPD, and errors involving the phonological processes may highlight the difficulty of children with speech disorders in discriminating sonority and articulation point<sup>(22)</sup>. In addition, the percentage of errors found in the auditory discrimination test may be indicative of the association between this ability, phonemic discrimination, and the alterations in speech<sup>(23)</sup>.

In addition, it is clear that phonemic discrimination is important for the development of language skills, semantic/lexical morphosyntactic, and aspects of children with EPD. This may indicate that the difficulty in auditory discrimination is associated with linguistic alterations, more specifically in speech, such as the linguistic levels<sup>(24)</sup>. Therefore, this fact undermines stabilization in the phonological system. Another factor that can explain this result is that the difficulty in auditory discrimination may be a causal factor or just an aggravating factor in EPD, a situation improves with increasing age<sup>(5,7,23)</sup>.

As can be seen in the results explained earlier, phonemic discrimination showed a statistically significant relationship in the population with EPD. This fact corroborates the literature, which states that the auditory discrimination is a relevant factor in the process of typical language acquisition<sup>(5)</sup>, because, with the perceptive ability to differentiate sounds in words and, consequently, to analyze them according to their acoustic and articulatory characteristics, the process of phonological acquisition takes place concurrently, and often children with alterations in phonology, EPD, present difficulties with this perceptual ability<sup>(3,22,25)</sup>.

Regarding the comparison between the phonemic discrimination and the relationship with language, there are a limited number of studies. But when compared with the other language levels studied in this article (morphology, syntax, and lexicon), there are no studies that analyze this relationship.

It was found that the higher the auditory discrimination of phonemes in EPD, the better the development of language levels would be. Similarly, another study suggested that phonemic discrimination may be related to the severity of the deviation<sup>(1)</sup>, which agrees with the findings of this study.

By observing the results, it can be seen that the group with TLD does not seem to be influenced by the performance of other linguistic levels. A fact that may explain the lack of correlation with this population is that the tasks of PDTWF are seemingly simple, but require attention, discrimination of stimuli, lexical access, and audiovisual association; another fact is that children with normal phonological development reached the maximum values allowed in the test without noticeable difficulty<sup>(3)</sup>.

Regarding the result that shows statistically significant differences between the vocabulary of children with TLD and EPD, these findings corroborate the literature, which suggests that performance in the vocabulary of children with phonological disorders is lower than that of children with typical phonological development<sup>(22,26)</sup>. A fact that can explain this is that the relationship between phonological development and early lexical development is so close, it is not possible to separate these two aspects in the early stages of language acquisition<sup>(9)</sup>. However, these results disagree with the findings of other studies<sup>(5,19)</sup>, which showed that children with phonological disorders showed similar vocabulary to that of children with typical phonological development.

Regarding the other linguistic subsystems, results showed statistically significant differences between phonology and all modalities (semantics, syntax, total construction, and total extension) of the description and story categories. This fact agrees with the literature, which indicates that these subsystems work together throughout the development of language skills and may undergo mutual influences<sup>(15)</sup>. These language skills work together, providing effective communication. Other searches related to certain semantic factors influence the phonetic-phonological accuracy<sup>(13,17)</sup>. Regarding syntax, the phonological subsystem shows direct influence<sup>(13)</sup>.

Regarding the morphosyntactic and semantic aspects, it can be observed that there is a statistically significant difference regarding the performance of the two groups, EPD and TLD. This fact agrees with the literature, which indicates that the phonological subsystem directly influences the syntax<sup>(13)</sup>. Another study reported that the meaning of a sentence depends on its syntactic organization, the proper use of morphemes, the acquisition of their meaning, and that the access to the name of an object depends on phonological skills. Other authors also reported that all people have a mental lexicon, which is accessed when you want to represent, through words, an object, an action, an attribute, or an event<sup>(15)</sup>.

In addition, a phonological acquisition deficit may cause difficulties at various levels of language, such as errors that are unexpected for the age and alterations in lexicon<sup>(27)</sup>. According to another study<sup>(27)</sup>, pragmatic, semantic, morphosyntactic, and phonological aspects cannot be separated because they act together in the development of language skills.

According to the literature, there is a strong synchronization between the development of the semantic aspect and the phonological aspect. On the one hand, there are children with a small phonetic/phonological repertoire, who tend to have few words stored in their lexicon; on the other hand, there are children with a broad vocabulary and phonetic/phonological repertoire<sup>(9)</sup>.

In general, it can be observed that phoneme discrimination, or perceptual aspects, is closely related to both the phonology and other language levels.

Regarding the lexicon, studies suggested that the limited phonological repertoire with restrictions in syllabic classes and positions can interfere with good linguistic understanding of communication, as the child ends up using homonyms, producing the same word to refer to different objects<sup>(28)</sup>.

## CONCLUSION

This study met the proposed objective and, through its findings, it could be observed that phonemic discrimination plays an important role in the development of the other linguistic levels studied. Children with phonological disorders presented alterations in phonemic discrimination as in other linguistic levels, being possible to analyze the interrelationship between perception levels and language production. However, no alterations were observed in the population with typical development, for they had no alterations in phonemic discrimination skills as well as in the language levels analyzed.

*\*CRF was responsible for the drafting of the project, data collection, and analysis; CLM was responsible for the drafting of the project, data analysis, and literature reviews; DCGMV was responsible the drafting of the project, data analysis, and general review.*

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