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D E L T A

Articles

Use of secondary cues in prosodic focus marking in speech of children with phonological disorder

O uso de pistas secundárias na marcação de foco prosódico na fala de crianças com transtorno fonológico

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ABSTRACT

This paper presents an acoustic description of prosodic focus marking in speech of children with phonological disorder to identify which phonetic cues can be seen as markers of contrastive focus. The data was obtained in speech evaluation sessions through a task of repeating focus marking sentences. Duration, intensity and intonation on focused words were the phonetic cues under analysis. Results show that prosodic focus marking in speech of children with phonological disorder is characterized by increased duration and intensity, but is not characterized by the use of contrastive focus marking nuclear accent. These results are discussed

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considering, on one hand, the combination of phonetic cues relevant for characterizing the production of contrastive focus and, on the other hand, its clinical implications. We present contributions for both linguistic and clinical studies in language acquisition.

Keywords: *language acquisition; phonological disorder; speech production; prosodic focus.*

RESUMO

Este trabalho apresenta uma caracterização acústica do foco prosódico na fala de crianças com transtorno fonológico a fim de identificar quais pistas fonético-acústicas marcariam a produção do foco prosódico na fala desse grupo de sujeitos. Os dados analisados foram obtidos em sessões de avaliação fonoaudiológica a partir de tarefa de repetição de sentenças com elementos focalizados. Duração, intensidade e tipo de acento tonal no elemento focalizado foram as pistas submetidas à análise. Os resultados mostraram que a focalização prosódica na fala de crianças com transtorno fonológico é marcada por aumento da duração e por aumento da intensidade, mas não é marcada pelo acento tonal característico da marcação de foco prosódico. Esses resultados são discutidos à luz da combinação de pistas fonéticas responsáveis pela caracterização da produção do foco prosódico e de suas implicações clínicas. O estudo apresenta contribuições tanto para os estudos linguísticos quanto para os estudos clínicos com ênfase em aquisição de linguagem.

Palavras-chave: *aquisição de linguagem; transtorno fonológico; produção de fala; foco prosódico.*

1. Introduction

This paper qualifies as a prosodic analysis study carried out in the interface between Linguistics and Speech-Language Pathology studies. Within this scope, as a pilot study, we present an acoustic characterization of prosodic focus marking in speech of children with a so-called *phonological disorder* and discuss implications of this characterization for acquisition of prosodic focus as well as for clinical practices.

In the field of Speech-Language Pathology studies focusing on deviating processes of speech acquisition, there are considered to be so-called *Speech Sound Disorders.* Based on the structure set forth by the American Speech-Language-Hearing Association - ASHA (2021), *Speech Sound Disorders* is a term covering various deviating manifestations, which result from difficulties presented by their bearers and have an impact on speech production, hence affecting intelligibility. Such difficulties are of various kinds, but necessarily relate to aspects of perception, motor production and phonological representation both in regard to segmental aspects and to prosodic aspects.

In particular, we would like to highlight the deviating manifestations arising from aspects related to phonological representation, given that these are the difficulties underlying the *phonological disorder*, a disorder which affects the children whose speech samples are analyzed in this paper.

Considering ASHA's characterization, *phonological disorder* is viewed as the disorder whose manifestation in speech is expressed through errors defined by inconsistencies in representation of a linguistic system in acquisition. Thus, from the acquisitional point of view, according to Rvachew (2013), children with phonological disorder are children who display speech production errors inconsistent with their age and their development stage, i.e. errors which would not be expected in view of these two factors.

However, for the purpose of clinical diagnosis, given the variety of deviating manifestations falling under the category of *Speech Sound Disorders* and, consequently, the various kinds of disorders encompassed by this nomenclature, a classification system is required in order to identify the specificities of these disorders.

Dodd (2014) presents a classification of *Speech Sound Disorders* anchored in a linguistic perspective[4]. Based on that classification, the author suggests five categories which would be defined by differences in linguistic manifestations of the occurring speech errors. Considering

4. For the purpose of diagnosis, other classification systems depart from a medical perspective, as is the case of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) and/or the International Classification of Diseases (ICD-10), or from an etiological perspective, as proposed by Shriberg et al. (2010).

the classification by Dodd (2014), out of the five categories of speech errors, three of them would be characterized as phonological disorders, as follows: Phonological Development Delay, Consistent Atypical Phonological Disorder and Inconsistent Phonological Disorder. Additionally, there are categories of Articulation Disorder, of a motor kind, and Childhood Apraxia of Speech, which would involve inconsistencies in speech planning.

In these categories of Dodd's classification system (2014), prosodic aspects are mentioned as a target of alteration particularly in speech of children diagnosed with Childhood Apraxia of Speech. For cases of phonological disorder, no specifications are found in Dodd (2014) which would enable us to consider that children with this kind of disorder would show alterations at the prosodic level. However, in a previous study (Berti et al., in preparation) we observed that children who have the Phonological Development Delay subtype were divided into two groups. Although the groups were characterized as having the same linguistic error pattern, that is, presence of persistent phonological process, they differed in relation to prosodic performance. Particularly, among five tests applied, the groups differed in two of them, namely *Phrasal Accent Test* and *Multisyllabic Word Repetition*, both tasks involving prosodic aspects of speech production. This result led us to deepen the investigation regarding prosodic performance in children with phonological disorder. That is our purpose in this pilot study.

In a work of remarkable relevance, Peppé (2018), in turn, deals with prosody development in atypical populations. As stated by the author, an atypical prosodic development generally occurs in children with: other language disorders; auditory impairment; child disfluency; autistic spectrum disorder; Williams syndrome and Down syndrome. In this respect, we would like to stress that no specification is made concerning possible prosodic alterations in speech of children with atypical phonological development.

Beyond the classification systems enabling diagnoses, descriptive studies and analysis of linguistic aspects concerning the acquisition process are another important source of data which supports the assessment of deviating acquisition processes, given that, based on

what can be observed as a typical pattern, it is possible to recognize atypical processes.

Regarding prosody, internationally, we find a lack of studies, as well as challenges in the creation of assessment tools defining what are atypical acquisition processes (for this aspect, see Diehl & Paul, 2009; Gerken & McGregor, 1998; Peppé, 2009). Notwithstanding these difficulties, various studies published in the last years have shed light on developmental aspects related to prosody.

In particular, among these studies, we highlight those performed based on the tool *Profiling Elements of Prosodic Systems-Children* (PEPS-C) (Peppé & McCann, 2003), which assesses the production and perception of prosodic abilities based on tasks which evaluate different functions of prosody.

The studies carried out based on PEPS-C (De Ruiter, 2014, for German; Filipe, et al., 2012; Filipe et al., 2017, for European Portuguese; Kalathottukaren & Purdy, 2017, for New Zealand English; Wells et al., 2004, for British English), generally point to the fact that the main prosodic skills, such as display of emotions, differentiation between phrasal types and conversational turn markers, are acquired between age five and nine. In turn, skills involving a more grammatical usage of prosody, as is the case of prosodic focus and enunciation segmentations, tend to be established at a later time, after age 10.

Nevertheless, we point out that these studies aim to describe typical prosody acquisition processes, in other words, they are looking at how and in which age prosodic skills are typically acquired. Therefore, they do not deal with disorder and how the type of disorder could affect what is expected according to normative standards. In contrast, another group of works using PEPS-C pays attention to prosodic acquisition in populations affected by disorders such as autism, childhood fluency disorder and hearing impairment (Peng et al., 2008; Peppé et al., 2007; Pettinato & Verhoeven, 2009; Weber-Fox et al., 2013). However, none of the studies has aimed to understand prosodic skills in children with phonological disorder, as we have done.

Furthermore, concerning the characterization of prosody displayed by children in the acquisition process, we stress that few studies set out

to describe it acoustically, a fact which limits the precision regarding what children display in terms of speech production at the prosodic level. Arnhold et al. (2016) and De Ruiter (2014) provide exceptions, since they present an acoustic analysis for the characterization of prosody in speech of typical children in German and Finnish, respectively.

Concerning prosody of Brazilian Portuguese, we notice two major gaps: (i) lack of studies describing prosody displayed in speech of children during the language acquisition process, in particular those showing deviant processes; it is remarkable, for instance, that there is no version of PEPS-C with Brazilian Portuguese data; thus, a comparable test for prosodic ability is not available yet; (ii) lack of studies providing an acoustic characterization of prosodic aspects of children in phonological acquisition process, whether they are typical or atypical.

In sum, as the state of the art, we have found the following setting: on one hand, there is a lack of descriptions of how prosody of Brazilian Portuguese-speaking children who display deviant acquisition processes is characterized, especially by means of providing an acoustic description in order to precisely define which phonetic cues mark or do not mark the speech production of these children at the prosodic level; on the other hand, based on Dodd's (2014) and Peppé's (2018) propositions, we notice the absence of studies taking prosody as the analysis level to be observed in the characterization of phonological acquisition and, thence, providing material for discussion of whether children with phonological disorder could present prosodic alterations.

In view of the detected gaps, for this text, we aim to describe the prosodic focus marking in speech of children with phonological disorder. In particular, we examine which phonetic-acoustic cues would mark the prosodic focus production in speech of this group of subjects.

To develop such an analysis, we take into account considerations presented by Scobbie et al. (1996). The authors propose that a phonological contrast is signaled by a constellation of cues of varying interdependence and perceptual significance. So, during speech development, children can use acoustic cues differently to make a phonological contrast, characterizing the so-called *covert contrast*. Covert contrast refers to the phonemic distinction detected acoustically or articulatorily, but auditorily imperceptible. This inappropriate

use of the acoustic cues can be explained by different ways: a) the target values for a cue are not categorically distinguishable by the human perceptual apparatus; b) the values acquired for a cue are not categorically distinguishable by the speech community; c) the cues used for the contrast are appropriate, but are insufficient without the primary cue; d) the cues are inappropriate for the speech community; e) the cues are deviant; and f) too much variability of acoustic cues.

Considering that the prosodic focus is marked by three different phonetic cues in typical adult speech (see description in the following section) and that one of these cues can be considered to be more robust in comparison to the others, i.e. being the main or primary cue, we hypothesized, based on Scoobie et al. (1996), that, in speech of children with phonological disorder, prosodic focus would be marked by secondary cues and would either not be marked or insufficiently marked by a main cue, according to Scobbie and colleagues's predictions (items b, c and d).

This hypothesis which we have just introduced here shall be explained in further detail at the end of the next section, in which we present descriptions of prosodic focus marking in Brazilian Portuguese.

2. Prosodic focus in typical adult speakers of Brazilian Portuguese

A linguistic entity is prosodically prominent when it stands out from its environment because of its prosodic characteristics (Terken & Hermes, 2000). Thus, it is generally understood that prominence is defined as a prosodic property of a linguistic entity that is in relation with another entity or a group of entities. As shown by different studies devoted to the theme (Beckman, 1986; Beckman & Edwards, 1994; Bolinger, 1958; Gussenhoven, 2011; Ladd, 1996; Lehiste, 1970; Terken, 1991; Terken & Hermes, 2000), different levels or categories of phonological prominence can be distinguished. Generally speaking, these works pointed out that while a type, at a lower level, could be identified by spectral and durational aspects as well as by intensity - the so-called *stress* -, the other type, at a higher level, is primarily identified by fundamental frequency (F0), which are the so-called *tonal accent*

or *pitch accent*. In this respect, Bolinger (1958) was one of the first authors to affirm that pitch and stress are phonemically independent.

Being classified as a prominence of a higher level, prosodic focus is one of the means by which prosody plays the role of marking prominence. Thereby it distinguishes important pieces of information from those which are less important in an utterance. This hierarchization in regard to prominence has semantic-pragmatic effects, given that, in a communicative situation, it guides how the utterance can be understood. For this reason, focus is closely related to Information Structure (Chafe, 1976; Chomsky, 1972; Gussenhoven, 2006; Halliday, 1967; Jackendoff, 1972; Lambrecht, 1994).

Considering such a structure, sentences with focused elements are called narrow focus sentences, since focus applies to one element of the clause. These types of sentences are opposed to broad focus sentences, in which focus may include more than one constituent or even all of the clause constituents, except for the topic (Lambrecht, 1994). Regarding narrow focus, two types can be identified: *informational (or non-contrastive focus)* and *contrastive focus* (Gonçalves, 1997; Gussenhoven, 2006; Kiss, 1998; Moraes, 2009; Zubizarreta, 1998).

Informational focus refers to the type of focus manifestation which carries new, and therefore not presumed information. In other words, it presents in a response the part which refers specifically to the information required by a previously asked question. Contrastive focus, in turn, accounts for the correction of a previous utterance and for establishing a semantic contrast to it[5]. As such, although it also focuses an element which carries new information, this type of focus is considered to play yet a further role, which is: the new focused information rectifies or refutes an implicit or explicit assumption of a previous utterance (Gussenhoven, 2006; Moraes, 2009; Zubizarreta, 1998;). In this paper, we analyze prosodic manifestations of contrastive focus. For a multimodal perspective of contrastive focus in Brazilian Portuguese and considering adult speakers from Rio de Janeiro, see Carnaval et al. (this volume).

5. That is the case of the utterance "MARIA aceitou participar da reunião" [MARIA agreed to participate in the meeting] contrasting with "Joana aceitou participar da reunião", produced in the same communicative situation. The prosodic focus on *Maria* aims to indicate that it was Maria, not Joana, who agreed to participate in the meeting.

Based on an analysis first done by Chomsky (1972) and Jackendoff (1972), it is consensual in different works that focus, as a category of prosodic prominence and closely related to information structure, is mainly marked by intonation, since the focus target word carries the prosodic prominence at a sentence level. As a result, F0 is pointed out to be the primary acoustic correlate of focus (Gussenhoven, 2011; Terken, 1991; Terken & Hermes, 2000). Duration and intensity, in turn, are secondary cues, although it is also known that "intensity is by its nature an unreliable phonetic parameter" (Gussenhoven, 2011, p. 2784).

In respect to prosodic characterization of contrastive focus in Brazilian Portuguese, a set of descriptive studies gave contributions to understand this phenomenon in that language. Fernandes (2007) shows, in regard to the prosodic structure (Nespor & Vogel, 1986, 2007), that the phonological phrase is the prosodic constituent in whose domain the prosodic focus occurs. Therefore, within an intonational phrase, one of the phonological phrases will receive the nuclear accent which marks the focus manifestation, thus reorganizing the tonal configuration of the intonational phrase domain.

Concerning the acoustic cues which define prosodic focus marking, Barbosa and Madureira (2015), Leite (2009) and Moraes (2009) identify the *fundamental frequency* and *duration* as being decisive to describe prosodic focus in Brazilian Portuguese, since they observe a high fundamental frequency value and increased duration as acoustic characteristics of the focused element. For similar results on the role of fundamental frequency and duration in the realization of Brazilian Portuguese contrastive focus, see Carnaval, et al. (this volume). Barbosa (2012), in turn, adds *intensity* to the phonetic parameters which characterize focus manifestations. Additionally, according to Yano and Fernandes-Svartman (2020), a pause could be produced before or after the focused word within the sentence; however, the authors highlight that a pause insertion is not a frequently used cue.

On the other hand, studies which adhere to an integrated view of Prosodic Phonology (Nespor & Vogel, 1986; 2007) and Intonational Phonology (Ladd, 1996) understand the fundamental frequency curve to be the acoustic correlate of intonation, and thus, based on the model of Autosegmental-Metrical Model of Intonation Phonology (Arvaniti

& Fletcher, 2020; Beckman & Pierrehumbert, 1986; Pierrehumbert, 1980), identify and describe regularities in the tonal configuration of sentences in a given language, taking into account the functions identified in each of them (see Fernandes, 2007; Frota et al., 2015; Truckenbrodt et al., 2009).

Inside this model of intonation analysis, according to Fernandes (2007), Frota et al. (2015), Yano and Fernandes-Svartman (2020), L*+H is the most representative pitch accent for contrastive focus marking in the typical adult population in the Southeastern varieties of Brazil. As a nuclear accent in contrastive focus sentences, L* + H is characterized by a low tone associated with the tonic syllable of the focused element, followed by a high tone. Although these works also emphasize the role of edge tones in the focused element marking in the Southeastern Brazilian Portuguese varieties, the type of tonal configuration of the nuclear pitch accent seems to us to be more robust, thus being considered the main cue.

To summarize, in accordance with the set of international studies on prominence and descriptions of Brazilian Portuguese, we assume that intonation can be considered to be the main cue for contrastive focus marking in typical adult speech, whereas duration and intensity are considered secondary cues. Having made this assertion, we detail our hypothesis, formulated from predictions done by Scoobie et al. (1996), as it follows: prosodic focus in speech of children with phonological disorder would be marked by secondary cues, such as duration and intensity, but would either not be marked or insufficiently marked by the main cue: intonation, with regard to the nuclear pitch accent.

3. Method

Ethical Aspects

This study has been approved by the Research Ethics Committee under number 45522721.6.0000.5406. The guardians of the participants have voluntarily signed the Informed Consent Form and have been informed about the procedures followed in the research work.

Characterization of the study and the sample

The analyzed data is part of the child speech production database belonging to the Laboratory of Articulatory and Acoustic Analysis (LAAc). Within this database, the sample analyzed in this pilot study comprised data of children diagnosed with phonological disorder and persistent phonological disorder (Shriberg et al., 2010).

Speech productions of 10 children from age 4.2 to 14 have been analyzed. The children were recruited in Speech-Language assessment sessions, in the course of services provided in the Supervised Internship in Speech-Language Pathology Therapy with emphasis in Clinical Phonology at the Health Rehabilitation Center (CERII)/ Center of Education and Health Studies (CEES) at São Paulo State University - Campus of Marília city, São Paulo, Brazil.

The data has been collected in the above-mentioned sessions through a set of Motor Speech Assessment tests, recorded and afterwards submitted to acoustic analysis. All subjects included in the sample previously underwent an audiological screening and have been approved.

Procedure

During the Speech-Language assessment sessions with emphasis on clinical Phonology, five Motor Speech Assessment Tests were applied, as proposed by Preston et al. (2016) and adapted for Brazilian Portuguese. The data analyzed in this paper were obtained by applying one of the five tests, namely *Phrasal Accent Test*.

Featuring the repetition of sentences, the test required the child to repeat sentences presented by an assessor, replicating in their speech the way the assessor produced the sentence, with due prominence in one of the terms of the clause[6]. The instruction given to the participants was as

6. Despite the limitations of a 'listen and repeat' task, such a test was part of a protocol for Motor Analysis of Speech, applied for children with phonological disorder in order to produce differential diagnosis (results of this analysis are presented in Berti et al., in preparation). Therefore, no changes in procedure could be done at all. However, the analysis presented in this pilot study is being replicated in new data, collected in a method specially designed for contrastive focus production in a more spontaneous way.

follows: “Agora você ouvirá algumas frases. Você deverá repeti-las de modo idêntico ao que ouviu. Preste bastante atenção.” ‘Now you will listen to some sentences. You must repeat them identically to what you heard. Pay attention.’. In his/her production, the assessor performed contrastive focus using cues that were conformed to the Brazilian Portuguese standard. That standard was observed in an acoustic analysis of assessor’s production, which showed that the focused word was marked by increased duration, higher mean intensity and by the nuclear accent L* + H. No pause was produced after the focused word in the assessor’s production.

The sentences were formed by four words and syntactically qualified as simple clauses with subject, verb and object. The test was composed of twelve sentences. In this study, four of these sentences have been analyzed acoustically. Table 1 presents the analyzed sentences and identifies in uppercase the elements which received the prosodic focus as presented by the assessor.

Table 1 – Contrastive focus sentences presented to the participants

Sentence	Contrastive focus sentences	Syntactic position on which the focus is applied
1	BIA comeu duas bananas [BIA ate two bananas]	Focus on subject
2	Bia COMEU duas bananas [Bia ATE two bananas]	Focus on verb
3	Bia comeu DUAS bananas [Bia ate TWO bananas]	Focus on object’s determinant
4	Bia comeu duas BANANAS [Bia ate two BANANAS]	Focus on object’s nucleus

Data analysis

The sentences produced by the participants were stored in individual files and accordingly labeled taking into account the target focus position in the assessor’s production: focus on subject, focus on verb, focus on object’s determinant and focus on the object’s nucleus (see Chart 1). In total, forty sentences (4 sentences x 10 subjects) were submitted to acoustic analysis through the *Praat* software (Boersma & Weenink, 2022).

In the acoustic analysis, the three relevant phonetic-acoustic cues for contrastive focus marking in Brazilian Portuguese were taken into account: duration, intensity and intonation. Pause after the focused word, despite being possible in the productions of Brazilian Portuguese speakers, was not considered for analysis due to two reasons: firstly, the assessor did not produce pause as a model of target production during the task; secondly, children did not produce it either.

For analysis of duration, we measured the relative duration of the contrastive focus target word as well as the relative duration of the same word in a non-focus context in order to assess whether there would be any difference in the relative duration of the word in question when comparing its production in both contexts. Therefore, the relative duration of the same word was compared in two different prosodic contexts – with contrastive focus and without contrastive focus. For instance, as we see in Chart 1, the duration of "Bia" was measured in sentence 1 and sentence 4. In order to extract the relative duration of each word in both contexts under consideration, we extracted the duration of the word and the duration of the sentence in which the word was produced, both in milliseconds; afterwards, we obtained the ratio between the duration of the word and the duration of the sentence.

For analysis of intensity, we measured in decibels the mean intensity of the contrastive focus target word and the mean intensity of the same word in a non-focus context, so as to compare both contexts, as in the case of duration.

For analysis of intonation, in turn, based on the principles of Autosegmental-Metrical Model of Intonation Phonology, the tonal interpretation was performed based on the fundamental frequency curve, in order to verify whether the type of pitch accent performed by the participants in the contrastive focus target word would match the nuclear accent L* + H. Such an accent is the most representative for contrastive focus marking in the typical adult population in the Southeastern varieties of Brazil - the same varieties which participant children belong to[7]. After performing the intonational analysis to identify which accents were associated with the focused word, we

7. We have taken into account the tonal description for Southeastern varieties since participants came from the region of Marília, countryside of São Paulo State, thus belonging to these linguistic varieties.

counted the number of pitch accents performed according to the standard, i.e. L*+H, as well as the number of pitch accents which were not performed according to the standard for focus marking. Then, we obtained percent values for these two performed possibilities: standard nuclear accent and non-standard nuclear accents.

Statistical Analysis

The data of the three phonetic cues was subject to descriptive and inferential statistical treatment. Regarding descriptive statistics, we obtained the mean value and the standard deviation of the relative duration and the mean intensity for each of the analyzed sentences, taking into consideration the syntactic positions which were targets of contrastive focus. For intonation, we obtained the mean value and the standard deviation of types of pitch accents produced at the contrastive focus target word.

Concerning inferential treatment, the Paired T-Test was applied to run analysis for each acoustic cue investigated. In regard to duration and intensity, the T-Test was applied for each of the four produced sentences, differed by syntactic positions which were targets of contrastive focus; the values of relative duration and mean intensity were the dependent variables, and the type of production context (with or without contrastive focus) was the independent variable taken into account. Regarding intonation, the T-Test was applied for the whole set of sentences, the type of pitch accent being the independent variable (standard-compliant and non-compliant with the standard), while the percent values related to the production amount of these accents was the dependent variable. For all cases, we set a significance level α of 0.05.

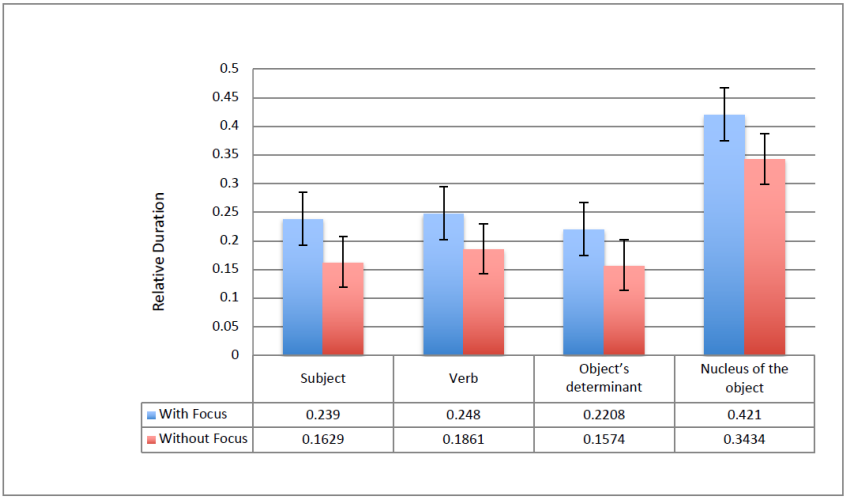
4. Results

Our research aim was to describe the prosodic focus marking in speech of children with phonological disorder. Therefore, an acoustic analysis was carried out taking into account the three relevant cues for marking contrastive focus in Brazilian Portuguese, according to

the description of typical adult speech. The results for the parameters taken into consideration are presented below.

Regarding the acoustic parameter of "duration", the Paired T-Test indicated a difference in duration in the contexts compared for all syntactic positions which receive prosodic focus (Focus on subject, $t(9)=4.280$, $p=.002$; focus on verb, $t(9)=3.941$, $p=.003$; focus on object's determinant, $t(9)=3.446$, $p=.007$; focus on the object's nucleus, $t(9)=2.871$, $p=.018$). On average, the duration of the word was greater in the context of contrastive focus production. Chart 1 displays the mean relative duration of the words measured in the four different syntactic positions in a context of contrastive focus and in a non-focus context.

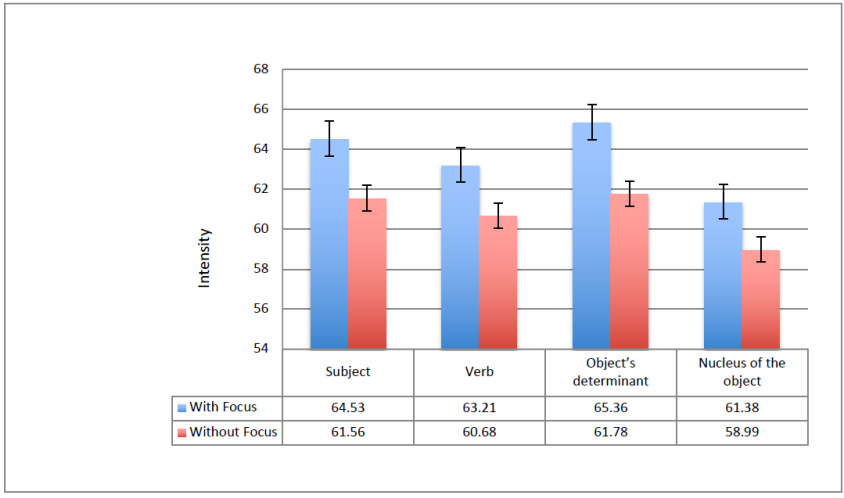
Chart 1 – Relative duration of words in different syntactic positions in contexts with and without focus



Regarding the acoustic parameter of "intensity", the Paired T-Test indicated a difference in the average intensity in the contexts compared for three out of four controlled syntactic positions (Focus on subject, $t(9)=2.521$, $p=.033$; focus on verb, $t(9)=3.568$, $p=.006$; focus on object's determinant, $t(9)=3.142$, $p=.012$). On average, the intensity of the words was greater when they were produced in the context of contrastive focus. In turn, no statistical difference was detected

between the compared contexts when the object's nucleus was target of contrastive focus (Focus on the nucleus of the object $t(9)=2.150$, $p=.060$). Chart 2 displays the mean intensity of the words in both contexts under comparison, considering the four different syntactic positions.

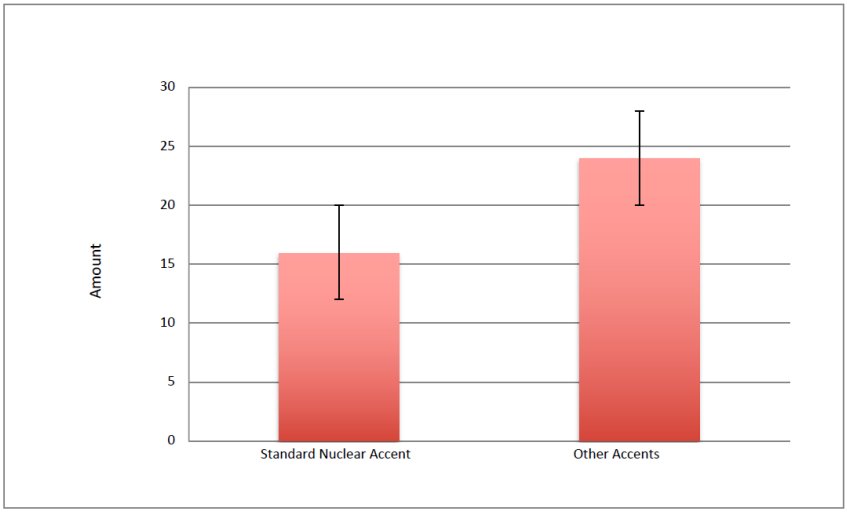
Chart 2 – Relative intensity of words in different syntactic positions in contexts with and without focus



	Subject	Verb	Object's determinant	Nucleus of the object
With Focus	64.53	63.21	65.36	61.38
Without Focus	61.56	60.68	61.78	58.99

In regard to intonation, the Paired T-Test did not indicate any statistical difference in the performance of the standard nuclear accent for contrastive focus marking in the analyzed data ($t(9)=-0.937$, $p=.373$). On average, non-standard pitch accents were more recurrent in the production of focused words ($M=2.40$; $SD=1.350$) than the standard nuclear accent L*+H ($M=1.60$; $SD=1.350$). Chart 3 shows the frequency in which the identified pitch accent categories were performed in the analysis of words in the context of contrastive focus.

Chart 3 – Type of Pitch Accent Performed in Contrastive Focus Target Words



The results presented above shall be discussed in the following section. On one hand, our aim is to characterize the prosodic focus marking in speech of children with phonological disorder, and, on the other hand, to point out clinical implications of this characterization.

5. Discussion

The aim of this pilot study was to acoustically describe the prosodic focus production in speech of children with phonological disorder. Based on Scobbie et al. (1996) and their discussion about the so-called covert contrasts during the phonological acquisition process, we hypothesized that prosodic focus would be marked by secondary cues and, conversely, it would not be marked - or would be insufficiently marked - by a main cue.

According to the results, we have detected that prosodic focus in speech of children with phonological disorder is marked by increased duration and increased intensity on the element receiving contrastive focus, but is not defined by the standard nuclear accent of contrastive focus marking. Particularly in regard to intonation, we would like to highlight that, in the data set, the production of the nuclear accent L*+H in the focused element was performed, however less frequently

than the other tonal configurations, which displayed different types of accents, none of them being predominant[8].

Based on these results, firstly, concerning the combination of phonetic cues, we can evaluate how the production of prosodic focus is defined in the speech of children with phonological disorder. Secondly, we evaluate in which way the results provide clinical implications.

In respect to phonetic-acoustic cues, among the three relevant cues for marking prosodic focus in Brazilian Portuguese, intonation can be considered the main cue, while duration and intensity are secondary cues, i.e. cues which, despite having their own specificity, reinforce the function of the main cue. Thus, the results obtained based on the statistical analysis allow us to confirm our hypothesis: the prosodic focus in speech of children with phonological disorder is characterized by secondary cues, and is either not marked or insufficiently marked by the main cue, considering the nuclear pitch accent carried by the focused element. Confirming such a hypothesis means that we also can assume that, in speech of children with phonological disorder, covert contrast could be found not only in the segmental level of phonological compound in a language (involving phonological contrast) as proposed Scobbie et al. (1996), but the covert contrast could also be seen at the prosodic level.

The contrastive focus in the analyzed sample is marked by secondary cues, given that duration and intensity were the cues which marked the focused element through increased values of these parameters. This result is observed when the T-Test indicated a difference in the comparison of duration and intensity values in contexts *with contrastive focus* and *without focus.*

However, the prosodic focus in the analyzed sample is not defined by the nuclear pitch accent as the main cue, as is the case with typical adult speech, especially in view of the characteristic intonational pattern for prosodic focus marking. This result owes to the fact that we did not have statistical support from the T-Test which would enable us to state that the nuclear pitch accent on the focused element in speech

8. Other types of pitch accents performed were: H+L* (similar to nuclear accent for declarative sentences), H*+L, L*, H*.

of children with phonological disorder is produced according to the standard of the considered linguistic variety of Brazilian Portuguese. In our data, a variability in the tonal configuration of the focused word was observed. The standard nuclear accent taken as a target production model of contrastive focus - which was presented by the assessor - was merely one of the possible production configurations observed. This result reinforces our hypothesis, given that, as a main cue, intonation, with regard to the nuclear pitch accent, did not occur to the extent, or in other words, according to the standard required. This observation does not allow to consider nuclear pitch accents preferentially performed by children as typical manifestations of contrastive focus since the adult pattern is taken as a model.

This unprecedented result enables us to, on a first level, recognize that children with phonological disorder marked (or signaled) differently contrastive focus in their speech production, and, on a second level, in which of the phonetic cues this difficulty/alteration occurred, namely, the nuclear pitch accent.

We could interpret the different tonal configurations observed in the focused element as indicators both of prosodic alteration and of difficulty in the production of prosodic focus, which, from the acquisitional point of view, would signal a process which is on the way of stabilizing, intrinsic to the acquisition process. Nevertheless, the choice of one interpretation over the other requires a comparison with a control group formed by children without phonological disorder, in order to detect similarities or differences between these groups. Particularly, it is important to assess whether the alterations observed in children with phonological disorder could be considered unexpected errors for their age and development stage as compared to typical children, thereby reinforcing the atypical condition in which these children find themselves according to Rvachew's proposition (2013).

We highlight that in addition to recognizing which pitch accents were performed at the focused word, it is worth investigating other parameters such as scaling, pitch excursion, edge tones and alignment of tones in order to better understand the difficulty observed in children with phonological disorder regarding intonation. Thus, taking into account the results obtained in this pilot study, we will present in future

works not only a comparative analysis of performance using a control group, but also a detailed intonational description of prosodic focus marking by these groups of children, since intonation is an available prosodic resource to be acquired in language acquisition in view of its functional effects for communication purposes.

In turn, in regard to clinical implications, the results of this work enable us to certify the relevance of considering prosody as one of the elements to be observed in the process of phonological acquisition, whether in a typical or an atypical context, and sheds light on the fact that children with phonological disorder could present prosodic alterations. In particular, the result presented by us is new in comparison to what has been described in literature to date, due to the fact that, within Speech Sound Disorders, alterations in prosody are primarily identified as pertaining to cases of Apraxia of Speech, when taking into account Dodd's proposition (2014). Nevertheless, these alterations are not necessarily limited to this subgroup, which is described as difficulty in motor planning of speech. We have formulated and found evidence, such as the one presented in this paper, that prosody, as part of phonological representation, could also occur in subgroups characterized by an atypical phonological acquisition.

We point out that Peppé (2018), in her organization of groups of subjects who are liable to present an atypical prosodic development, likewise does not specify children with phonological disorder among these groups. In this author's organization, that group could be included in the group called in her research as "children with other language disorders". In this case, our pilot study would suggest a specification to be made for a group of children where an atypical prosodic development could occur.

In addition to that, it is important to highlight that children with phonological disorder signaled the prosodic focus by secondary cues (increased duration and increased intensity) and inappropriate use of primary cues regarding tonal configurations, characterizing the covert contrast at a prosodic level. As highlighted by Gibbon and Lee (2017), the presence of covert contrasts in children's speech leads to important clinical implications. The first clinical implication is that speech acquisition is a gradual process and that children can be

making significant steps in phonetic mastery of the sound system. The second one, for children with speech disorders, the presence of covert contrasts has been interpreted as indicating that children have some phonological knowledge of the sound system, given that they don't use the acoustic cues randomly, although differently. Finally, the third clinical implication refers to which phonetic cues should be emphasized during the therapeutic process.

6. Conclusion

This pilot study intended to characterize the prosodic focus in speech of children with phonological disorder. Duration, intensity and intonation were the phonetic-acoustic cues taken into consideration in the analysis of contrastive focus sentences, obtained by means of the task of sentence repetition applied during a session of speech-language assessment.

The obtained results have shown that prosodic focus in speech of children with phonological disorder is marked by increased duration and increased intensity, but is not defined by the standard nuclear accent of prosodic focus marking in the linguistic variety of Brazilian Portuguese which the children belong to. In other words, the results indicate that, from the perspective of standard adult speech, intonation, considering the nuclear pitch accent, is the cue whose required standard for marking the focused element has not been achieved.

Assuming that the tonal configuration of the nuclear pitch accent is the cue considered to be primary in prosodic focus marking, our results show that, in speech of children with phonological disorder, the secondary cues are the ones which mark the focused element, whereas we notice instabilities in the usage of the tonal configuration as main cue for the production of prosodic focus.

Besides indicating in which phonetic cue resides the difficulty/alteration observed in speech of children with phonological disorder in marking prosodic focus, as a contribution, this paper presents the need of considering prosody as one of the elements to be observed in the process of phonological acquisition, whether in a typical or in an atypical context.

As a main contribution in the field of speech-language pathology, our study states the importance of accounting for prosodic aspects, whereof prosodic focus is merely one, in order to characterize and assess speech alterations in children in the period of language development. The paper also suggests that children with problems in phonological representation, as cases of phonological disorder are defined, might present instabilities in regard to prosody, beyond the groups for whom such alterations are already expected within the Speech Sound Disorders. Accordingly, our study suggests that alterations in prosody could be considered a possible symptom of deviating processes of phonological acquisition.

Undoubtedly, our study has three main limitations: reduced sample size, absence of a control group and the use of a "listen and repeat" task. Therefore, the conclusions which we have presented shall be revisited in studies to be published in the future[9]. These studies will take into consideration a larger sample of subjects and a control group in order to compare prosodic focus marking in speech of children with and without phonological disorder. This kind of comparison could serve the purpose of discussing differences and similarities in the processes of typical and atypical phonological acquisition. Additionally, it is important to say that data will be collected by means of a task that favors focus marking for communicative purposes, i.e. we will adopt a kind of elicitation methodology. Furthermore, we wonder if it is important to consider different ages and the severity of disorder to precise the results and to deepen the discussion. We believe that such issues, nevertheless, surpass what has been presented as the main objective in this paper, without invalidating the contributions presented here for a pilot study.

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9. Some of these studies are already under development at the Laboratory of Articulatory and Acoustic Analysis in São Paulo State University, Brazil.

Conflict of interests (multiple authors)

The authors declare they have no conflict of interest.

Credit Author Statement

We, Geovana Soncin, Luiza Polli and Larissa Cristina Berti, hereby declare that we do not have any potential conflict of interest in this study. The first and third authors have participated in the conceptualization of the study, methodology, data analysis and project management. The second author has participated in data collection and organization, as well as in the execution of the analysis. All authors approve the final version of the manuscript and are accountable for all aspects, including the assurance of its veracity and integrity.

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