

Occurrence of devoicing in phonological disorders: relationship with most affected phonemes, severity of the disorder and age

Ocorrência de dessonorização no desvio fonológico: relação com fonemas mais acometidos, gravidade do desvio e idade

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ABSTRACT

Purpose: To verify the occurrence of the phonological process of plosives and fricatives devoicing in children with phonological disorders. The following variables were involved: most affected phonemes, severity of phonological disorder, and age. **Methods:** Participants were 50 children, with an average age of 6 years and 5 months. Speech data were collected by means of the *Avaliação Fonológica da Criança* (Phonological Assessment of Children) and submitted to contrastive analysis. The severity of the phonological disorder was determined by the Percentage of Consonants Correct – Revised. Then, it was analyzed which plosive and fricative phonemes were affected by the devoicing strategy, with occurrence greater than 40%. Afterwards, statistical analysis was performed. **Results:** The simultaneous comparison the six phonemes showed no difference regarding the use of devoicing. Difference was found only for /g/ x /v/, and for /b/ x /v/. Regarding age, no significant difference was found. As for the severity of phonological disorder, difference was found only for the variable devoicing of /d/ and /z/. **Conclusion:** The phonological process of devoicing have high occurrence in children with phonological disorder, with higher prevalence for stops consonants. Age does not influence the occurrence of this process, and the severity of the phonological disorder is a relevant factor to its use, with higher prevalence in the most severe degrees.

Keywords: Speech, language and hearing sciences; Speech; Speech disorders; Child; Speech therapy

INTRODUCTION

The appearance of expressive language occurs during the first years of a child's life. Among other language skills, this period is marked by the acquisition of phonemes in the different positions they may occupy in the syllable and in the word⁽¹⁾.

Phonemes are sound units whose contrasts transmit differences in meaning, since by substituting only a sound one can obtain two distinct words, for example, in the minimal pairs,

/faka/ (Portuguese for “knife”) versus /vaka/ (“cow”).

The minimal pairs mentioned differ only by the [voice] feature, since the fricative /f/ is unvoiced and /v/ is voiced. For a sound to be voiced the vocal folds vibrate and in unvoiced sounds they must remain separate. The vocal fold vibration occurs due to a laryngeal adjustment and to an air flow control, an aerodynamic mechanism that approximates the vibrating vocal folds. Moreover, the unvoiced sounds are produced with greater vocal fold tension and in the voiced sounds they are less strained. Thus, the adjustments that occur in the vocal folds, responsible for the difference between voiced and unvoiced sounds, must be known so that the voicing contrast⁽²⁾ may be understood.

For the child to acquire such distinctions, the process of acquisition and development of phonological knowledge must occur gradually until there is an establishment of the phonological system, consistent with the adult target⁽³⁾.

However, some children present a deviant phonological system, and can undergo different paths in their phonological development, not reaching or reaching in a distinct way the target phonology of the language environment to which the child is exposed. This can occur with children who do not have

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Conflict of interests: None

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Received: 11/30/2010; **Accepted:** 3/19/2012

organic and/or emotional causes that justify these differences in development. Thus, this is what the literature identifies as phonological disorders^(4,5).

The acquisition period of the phonological system (both in normal or deviant development) is marked by the presence of phonological processes, which are defined as systematic changes that affect a class or sequence of sounds, and that are constituted of descriptions of patterns which occur regularly in the child's speech with the goal of simplifying the target sounds of adults⁽⁶⁾. It is noted that, in typical development, processes such as omissions and substitutions take place, which should disappear over time, with certain processes being expected for each age group⁽⁷⁾.

However, children with phonological disorders have their own characteristics regarding phonological development, such as: higher occurrence of phonological processes, which may continue for a longer period, whereas those processes from the beginning of the acquisition may occur concomitantly with those later processes or may even be suppressed later⁽⁸⁾.

Devoicing is a phonological process that can occur in children with typical phonological development and in very early age, usually under three. In typical development, the higher the age, the lower the occurrence of devoicing and this process seems to be eliminated previously in the plosive and later in the fricative phonemes⁽⁹⁾.

In the phonological processes there is the direct involvement of distinctive features. Among the functions of these features, one is to differentiate lexical items, that is, to determine the semantic difference between words. The main theme of this study, the difficulty in acquiring the distinctive [+voice] feature is common in many children. The [voice] feature is considered the strongest opposition feature of the Portuguese language⁽¹⁰⁾, and when there is no correct distinction of this trait, the phonological process of devoicing takes place, that is, the use of the unvoiced phoneme from the pair occurs, when the target should be the voiced phoneme⁽⁹⁾. This is also one of the most prevalent phonological processes that affect children with phonological disorders^(1,11,12).

Based on the above, the objective of this study was to determine the occurrence of the phonological process of devoicing of plosive and fricative phonemes in children with phonological disorders, involving the following variables: most affected phonemes, severity of phonological disorder and age.

METHODS

In this study, we analyzed 197 medical files from the database of two research projects, duly approved by the Ethics Committee of the Federal University of Santa Maria (46/02 and 108/05). This procedure of analysis and data collection from medical records was conducted during the months of August and September of 2009. In the mentioned database there are speech therapy evaluations and therapy data recorded from 2004 until the present. All records analyzed should contain the Free and Clarified Consent Term (TCLE) signed for participation in research.

For inclusion of subjects in the sample, the following

selection criteria were established: the subject should present diagnosis of phonological disorders; present the phonological process of devoicing of plosive and fricative phonemes in the general phonological system, with occurrence equal or greater than 40% for at least one phoneme; be aged between 4 and 8 years old; have hearing thresholds within normal limits for the speech frequencies; not to present speech-language disorders besides phonological disorders; not to have received any speech therapy prior to the first evaluation of the phonological system; and the absence of evident damage in neurological, cognitive, psychological and/or emotional aspects.

Only the unvoiced phonemes were used for analysis, where the percentage of devoicing could vary between 40% and 100%, considering that 40% of use of the process the minimum criterion used to include the subject in the sample. The percentage of 100% indicates the devoicing of the phoneme in all possible occurrences in the evaluation.

From the 197 charts reviewed, only 50 fulfilled the inclusion criteria adopted. Therefore, the sample of this study consisted of 50 children, aged between 4 and 8 years old, divided into four age groups, with the average age of 6 years and 5 months old. In the age group from 4 years and 1 month to 5 year olds, 13 children were included; ranging from 5 years and 1 month to 6 year olds, 17 children; aged from 6 years and 1 month to 7 years, 15 children; and aged from 7 year and 1 month to 8 years, five children were included. Regarding gender, the sample consisted of 17 female children (34%) and 33 male children (66%), with phonological disorders of different severity degrees: three children had mild deviation (MD) (PCC-R between 86 and 100%), 25 children with moderate-mild deviation (MMD) (PCC-R between 66 and 85%), 15 with moderate-severe deviation (MSD) (PCC-R between 51 and 65%) and seven with severe deviation (SD) (PCC-R less than 50%). The severity of the speech disorder was determined by the calculation of the Percentage of Consonants Correct – Revised (PCC-R)⁽¹³⁾, which uses the same calculation of the Percentage of Consonants Correct (PCC)⁽¹⁴⁾. The only difference is that the former does not consider the distortions to determine the percentage.

It should be noted that the calculation was performed in the conventional way, that is, all the consonants produced by children or not were taken into account. Thus, the most severe deviations were not necessarily determined by the higher occurrence of devoicing, since these children could present other associated phonological processes.

To determine the presence of phonological disorders, subjects underwent the following speech-language evaluations: anamnesis; assessment of the stomatognathic system; assessment of auditory discrimination; assessment of language and articulation examination. The phonological evaluation was performed by the *Avaliação Fonológica da Criança – AFC* (Phonological Assessment of Children)⁽⁷⁾, with phonetic transcription and contrastive analysis of speech data. It is noteworthy that all reviews mentioned were performed prior to initiating the speech therapy.

To describe the sample profile according to the variables in the study, frequency tables of the categorical variables (devoicing of phonemes, degree of deviation and age groups)

were made, with values of absolute frequency (n) and percentage (%).

In order to analyze the association between devoicing, severity of phonological disorder and age groups, we used the Fisher's exact test. To compare the devoicing among the six phonemes (/b/, /d/, /g/, /v/, /z/ e /ʒ/) the Cochran test (used for three or more categorical variables) and the McNemar test (used for two categories) were used. The significance level adopted for the statistical tests was 5% (p<0.05).

RESULTS

Table 1 shows the percentage of participants who presented or not the devoicing process, comparing the six phonemes (/b/, /d/, /g/, /v/, /z/ e /ʒ/) among themselves. There was no difference in the use of devoicing, when comparing the six phonemes simultaneously.

Table 1. Percentage of participants who presented devoicing or not

Phoneme	Subjects without devoicing (%)	Subjects with devoicing (%)	p-value
/b/	42	58	
/d/	50	50	
/g/	34	66	
/v/	60	40	0.108
/z/	46	54	
/ʒ/	48	52	

Cochran test (p<0.05)

Comparing the percentages of devoicing between pairs of phonemes (considering only the unvoiced phonemes) (Table 2), it was obtained difference in: /b/ x /v/ (with higher percentage of devoicing for /b/), and /g/ x /v/ (with higher percentage of devoicing for /g/).

Table 3 shows the comparisons of the occurrence of devoicing to each phoneme among the age groups of subjects. In this analysis, they were regrouped according to age. It was verified that there was no difference among the age groups for any of the variables studied.

Table 4 shows the comparison of the occurrence of devoicing to each phoneme between the degrees of phonological

Table 2. Comparative analysis of the occurrence of devoicing between pairs of phonemes

Pairs of phonemes	p-value
/b/ x /d/	0.317
/b/ x /g/	0.394
/b/ x /v/	0.013*
/b/ x /z/	0.617
/b/ x /ʒ/	0.531
/d/ x /g/	0.074
/d/ x /v/	0.197
/d/ x /z/	0.683
/d/ x /ʒ/	0.853
/g/ x /v/	0.005*
/g/ x /z/	0.221
/g/ x /ʒ/	0.194
/v/ x /z/	0.052
/v/ x /ʒ/	0.221
/z/ x /ʒ/	0.827

* Significant values (p<0.05) – McNemar test

disorder of the subjects. There was significant difference between the degrees of deviation for the following variables: devoicing of /d/ (higher frequency in MSD and SD degrees), and devoicing of /ʒ/ (most often in MD and MMD degrees).

DISCUSSION

Data analysis showed that the phoneme /g/ was the one in which the devoicing process occurred most frequently, in 66% of subjects. Related to this result, in a study about the speech of children between 2 years and 9 months and 5 years and 5 months old, it was observed a higher occurrence of phonological processes of devoicing in the class of plosive phonemes⁽¹⁵⁾. Another study also reports that one of the most common processes for plosive phonemes was devoicing, preferably at the dorsal point⁽¹⁶⁾, confirming the present study.

The plosive phoneme /g/ also showed to be more affected in the comparison between pairs of phonemes, as it was significantly more devoiced than /v/. This result is in agreement with another study, in which there was a higher incidence of devoicing in velar and palatal phonemes than in labial phonemes⁽¹⁷⁾. This fact may be explained as follows: the lips, the

Table 3. Comparison of occurrence of devoicing to each phoneme among the age groups surveyed

Devoiced phoneme	Occurrence (%)				p-value
	4y1m – 5y0m	5y1m – 6y0m	6y1m – 7y0m	7y1m – 8y0m	
/b/	46.15	64.71	53.33	80.00	0.599
/d/	61.54	47.06	40.00	60.00	0.670
/g/	61.54	64.71	73.33	60.00	0.880
/v/	38.46	29.41	53.33	40.00	0.578
/z/	46.15	47.06	60.00	80.00	0.561
/ʒ/	38.46	58.82	53.33	60.00	0.730

Fisher's test (p <0.05)

Note: y = years, m = months

Table 4. Comparison of occurrence of devoicing to each phoneme among degrees of phonological disorder

Devoicing	Occurrence (%)				p-value
	MD	MMD	MSD	SD	
/b/	0.00	56.00	66.67	71.43	0.208
/d/	0.00	36.00	66.67	85.71	0.016*
/g/	0.00	72.00	66.67	71.43	0.121
/v/	0.00	32.00	53.33	57.14	0.228
/z/	0.00	64.00	60.00	28.57	0.105
/ʒ/	100	64.00	33.33	28.57	0.048*

* Significant values (p<0.05) - Fisher Test

Note: MD = mild deviation; MMD = moderate-mild deviation; MSD = moderate-severe deviation; SD = severe deviation

tongue tip and hard palate contain a greater number of afferent nerve endings (sensations) than the tongue back and soft palate. This way, children receive a greater sensory feedback from frontal articulatory movements than from the rear part movements⁽¹⁸⁾.

However, when comparing the pairs /b/ x /v/, the first was more devoiced, with statistical significance, even though both are labial, disagreeing partially from the research mentioned above. This could be explained because /v/ presents the [+continuant] feature, which makes the [+voice] feature become more synaesthetically noticeable or due to other motor issues that might be involved⁽¹⁹⁾. However, the production of the [+continuant] feature does not seem to be so simple. A survey, which suggests a classification to the phonological deviation based on distinctive features, shows that only when children present deviation classified as moderate and present medium-high level of contrasts, the [+continuant] feature will appear in their phonological systems⁽²⁰⁾.

Thus, it can be inferred that the combination between the features [labial] and [+continuant] favors the production of the [+voice] feature, and there may be factors of a motor order determining such production pattern. Alterations of a motor order were mentioned, since devoicing corresponds to a difficulty in coordinating glottic and supraglottic events, showing impairment in spatial-temporal organization of phonoarticulatory movements. Then, it may be assumed more difficulty in suppressing this process when compared to others⁽²¹⁻²³⁾.

Another study, which used acoustic analysis, shows that the fricative phonemes are less devoiced than plosive phonemes, confirming the present study⁽¹⁹⁾. Furthermore, in the mentioned study, the [+voice] feature was more perceived in fricative phonemes than in plosives, in both the auditory-perceptual evaluation and the acoustic analysis.

As to age, there was no difference between the percentage of use of the devoicing process and the investigated ages. This way, there was no evidence of the influence of age on the use of the analyzed process. This finding disagrees with other studies⁽²³⁻²⁵⁾, which mention the presence of a more stabilized production of the [voice] feature in older children, and it is probably associated to a greater maturity of the phonoarticulatory organs. That is, these authors, using data from typical speech, suggest a complex relation between the motor variability of speech and the language development in children with respect to time.

Considering this, it could be expected in the present study a decrease in the use of the devoicing process in older age groups. It is inferred that a possible explanation to the absence of a relation between the dominance of production of phonemes and the age may be related to the speech of children with phonological disorder, since it is already mentioned in another study⁽²⁶⁾ the presence of a high variability in the production of the [+voice] feature in the speech of these children.

It was possible to verify significant differences only between the degrees of deviation for the following variables: devoicing of /d/ (higher occurrence in moderate-severe and severe deviations), and devoicing of /ʒ/ (higher occurrence in mild and moderate-mild deviations). These results can be explained by the fact that the phoneme /d/ is acquired around age 1 year and 6 months and the phoneme /ʒ/ is of a later acquisition, around 2 years and 6 months, being the last of fricatives to be acquired⁽⁸⁾. Thus, it can be inferred that the /d/, being a phoneme of initial acquisition, when devoiced characterizes severe cases of deviation, whereas the /ʒ/, being of later acquisition, could be found replaced both in more severe deviations, as in the mildest ones, as well as in cases of phonological delay.

Regarding fricative phonemes, a study that aimed to verify the occurrence and types of phonological processes employed in this class showed that, just as it occurred in the present study, the phoneme /z/ suffers more devoicing in moderate-mild and moderate-severe deviation degrees⁽²⁷⁾. As for the phoneme /ʒ/, the results differ, since in the mentioned study the authors found predominance of devoicing in the moderate-severe degree, while in this study, this process predominated in milder degrees. Finally, the phoneme /v/ was the least devoiced in this research, as well as in the one mentioned, with no difference between the degrees of deviation⁽²⁷⁾.

CONCLUSION

The phonological process of devoicing has high occurrence in cases of phonological disorders, being more prevalent for plosive phonemes in relation to fricatives.

The severity of phonological disorders is a relevant factor for the occurrence of devoicing in the phonemes /d/ and /ʒ/, and the occurrence of this process was not influenced by age in the studied group.

RESUMO

Objetivo: Verificar a ocorrência do processo fonológico de dessonorização de fonemas plosivos e fricativos em crianças com desvio fonológico, envolvendo as seguintes variáveis: fonemas mais acometidos, gravidade de desvio fonológico e idade. **Métodos:** A amostra constituiu-se de 50 crianças, com média de idade de 6 anos e 5 meses. Os dados de fala foram coletados por meio da Avaliação Fonológica da Criança e submetidos à análise contrastiva, sendo a gravidade do desvio fonológico determinada conforme o Percentual de Consoantes Corretas-Revisado. Então, analisou-se quais fonemas plosivos e fricativos sonoros eram acometidos pelo processo de dessonorização, com percentual de ocorrência maior que 40%. Posteriormente, realizou-se análise estatística. **Resultados:** Verificou-se que ao comparar os seis fonemas, simultaneamente, não houve diferença quanto ao emprego da dessonorização. Obteve-se diferença somente para /g/ x /v/, e /b/ x /v/. Quanto à faixa etária, não houve diferença. Quanto à gravidade do desvio, foi possível constatar que houve diferença apenas para a variável dessonorização de /d/ e /z/. **Conclusão:** O processo fonológico de dessonorização possui alta ocorrência em crianças com desvio fonológico, sendo mais prevalente para consoantes plosivas. A idade não influencia a ocorrência deste processo e a gravidade do desvio é um fator relevante para seu emprego, sendo mais prevalente nos graus mais graves.

Descritores: Fonoaudiologia; Fala; Distúrbios da fala; Criança; Fonoaterapia

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