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Speech rate and fluency in children with phonological disorder

Velocidade e fluência de fala em crianças com distúrbio fonológico

ABSTRACT

Purpose: To identify and describe the speech rate and fluency of children with phonological disorder (PD) with and without speech-language therapy. **Methods:** Thirty children, aged 5–8 years old, both genders, were divided into three groups: experimental group 1 (G1) — 10 children with PD in intervention; experimental group 2 (G2) — 10 children with PD without intervention; and control group (CG) — 10 children with typical development. Speech samples were collected and analyzed according to parameters of specific protocol. **Results:** The children in CG had higher number of words per minute compared to those in G1, which, in turn, performed better in this aspect compared to children in G2. Regarding the number of syllables per minute, the CG showed the best result. In this aspect, the children in G1 showed better results than those in G2. **Conclusion:** Comparing children's performance in the assessed groups regarding the tests, those with PD in intervention had higher time of speech sample and adequate speech rate, which may be indicative of greater auditory monitoring of their own speech as a result of the intervention.

RESUMO

Objetivo: Verificar e descrever a velocidade e fluência de fala de crianças com Distúrbio Fonológico (DF) com e sem intervenção fonoaudiológica. **Métodos:** 30 crianças, 5 a 8 anos de idade, ambos os gêneros, sendo: Grupo experimental 1 (G1) — dez crianças com DF em intervenção; Grupo experimental 2 (G2) — dez crianças com DF sem intervenção; e Grupo controle (GC) — dez crianças com desenvolvimento típico. As amostras de fala foram coletadas e analisadas segundo parâmetros de protocolo específico da área. **Resultados:** As crianças do GC apresentaram maior quantidade de palavras por minuto em comparação às crianças do G1, que, por sua vez, apresentaram melhor desempenho nesse aspecto em comparação às crianças do G2. Em relação à quantidade de sílabas por minuto, o GC foi o que apresentou melhor resultado. Nesse aspecto, as crianças do G1 apresentaram resultados melhores que os das crianças do G2. **Conclusão:** Comparando o desempenho das crianças dos grupos analisados nas provas aplicadas, as crianças com DF em intervenção apresentaram tempo maior de amostra de fala e velocidade de fala adequada, podendo ser indicativo de um maior monitoramento auditivo da própria fala como resultado da intervenção.

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INTRODUCTION

The ability to produce long sequences of syllables or words effortlessly, combining continuous issues, features a fluent speaker⁽¹⁾. The expression becomes a reflection of linguistic skill and maturity, with appropriate nuances of meaning associated with the, speed rate, intonation, and communicative intentions.

With regard to speed, calculated by some authors^(2,3) as the number of words issued per minute of plain text, this may be related to the rhythm of each individual's speech, adjusting to the context and situation he or she is in. Thus, two important parameters are united: individual aspects and the environment⁽²⁾.

To produce speech, the motor system has to control the speech rate (ratio of time for activation of the phoneme and for the orderly sequencing of movements)⁽³⁾. Therefore, to produce a fluent speech, the individual must move various parts of the vocal tract promptly and smoothly, allowing syllabic intelligibility to be continuously and quickly produced. The fluent speech flow is interrupted when the nervous system fails to generate an appropriate signal to guide the muscles involved in speech production⁽⁴⁾.

Information about the speech rate is relevant to the understanding of normal and abnormal communication processes, as the analysis of speech rate has been important for differential diagnosis of speech and language disorders, especially in cases of motor difficulties articulating speech sounds. The unintelligible speech may occur not only because of the difficulty in sound articulation but also when the organization of the phonological system is in reorganization, as in phonological disorders (PD). This disorder is characterized by a difficulty in organizing phonological rules of language in ages at which it would be expected to happen^(5,6). It is common to find children with language disorders concurrently with fluency disorders⁽⁷⁾. Studies show that speech rate is an important feature in differential diagnosis of PD subtypes, especially those related to motor difficulties, pointing differences in the values of speech production of children with and without PD^(5,8,9).

A study was conducted to compare the performance of children with and without PD in different speech rate tests. A sample of 20 children was diagnosed with PD (GPD) and 20 with typical speech and language development (CG), aging 4 to 10 years and 11 months, both genders. Speech rate measures were analyzed (total elapsed time, syllables per second, and phonemes per second), and results showed that the CG had better performance compared to the GPD in all standard imitation test measurements, as well as in total duration of long sentences in the self-imitation test, with the size and type of sentences influencing the performance of both groups. The authors concluded that lower speech rate values were from children with PD, due to possible language or motor deficits, although there is evidence of control of speech production rate depending on the length of the sentence⁽⁹⁾.

The literature shows a relationship between PD and changes in speech rate and fluency. On the basis of the studies found and the clinical experience of the authors, questions regarding the degree of influence that a variable has on another in children with disorders were raised, or even whether it is possible that PDs predispose or interfere with speech parameters such as rate and fluency. Finally, questions about the impact of speech-language therapy to prevent changes in these features were also raised.

Thus, this study aimed to verify and describe the speech rate of children with PD and to compare the performance of children with this diagnosis who are already in speech-language therapy process and children with the same diagnosis who are not included in an intervention process yet.

METHODS

This study was approved by the research ethics committee (protocol number 055/2010) and all children involved had voluntary participation in the study and consent by their parents (or guardians), who signed the informed consent after receiving information about all study procedures.

The study sample comprised 30 children aged 5-8 years, of both genders, who were divided into three groups:

1. Experimental group 1 (G1), ten children diagnosed with PD who were in speech-language therapy at the Clinical-School of Speech-Language Pathology and Audiology, Bauru School of Dentistry, Universidade de São Paulo (USP);
2. Experimental group 2 (G2), ten children diagnosed with PD, on a waiting list for speech-language therapy at the earlier-mentioned institution; and
3. Control group (CG), ten children without speech and/or language deficits, selected at a conventional school after being submitted to speech screening to confirm the absence of complaints related to speech and/or language. Children in CG were paired with children from G1 and G2 following the criterion of chronological age.

Children from G1 and G2 had one and only speech diagnosis of PD, no other language or speech changes associated; diagnosis was performed in the Clinical-School of Speech Pathology, Bauru Dental School, USP.

To collect data, recordings were made in digital media, each child in interaction with an adult (party) in a playful situation, for 30 minutes. The recordings were afterward transcribed literally, based on a specific protocol transcription. This protocol provided the child and the observer's identification, the date, number and duration of recording, transcription number, and results observed. Preference was given to the analysis of speech representing spontaneous conversation in 30 minutes so that the 5 initial and final minutes of the recording could be disregarded, to eliminate variables such as the difficulty to string a speech or to conclude it (which may interfere in speech rate and fluency). Spontaneous conversation was the situation chosen for

analysis because it most approximates the actual situation of use of speech for communication. The first 200 fluent syllables, after the initial 5 minutes of recording, were considered as analysis *corpus*.

The speech rate and fluency was analyzed according to criteria adopted by a specific fluency assessment protocol proposed by Andrade et al.⁽¹⁰⁾ and Andrade⁽³⁾. Therefore, word and syllable flows per minute were analyzed. To do so, we analyzed 200 fluent syllables collected from a spontaneous conversation in their interaction with an adult, as previously mentioned. In case of difficulty to initiate or maintain the dialogue (due to the situation of recording/assessment itself), a visual stimulus of action figure was used to elicit speech.

To obtain speech rate in syllables per minute, the total number of fluent syllables (200) of each subject was divided by the total time of speech, including breaks. A stopwatch was used to determine the time. The speech rate in words per minute was obtained by calculating the total number of words issued, divided by the total talking time, including breaks. These are common clinical evaluation features used in fluency analyses to assess speech rate and fluency, although not specifically for PD.

Each group was analyzed quantitatively and qualitatively. After the assessment of the entire sample data, the three groups were comparatively analyzed using parametric and nonparametric statistical tests. The analyses were made using Tukey and Kruskal–Wallis and Dunn tests. The Tukey test allows testing of any contrast, always between two treatment means, that is, it does not compare groups with each other. The test is based on the least significant difference (LSD). The Kruskal–Wallis and Dunn tests are a nonparametric statistical tools used to compare three or more independent groups, where the variable must be of orderly and continuous measurement. The first test was used to compare the sample of speech variables, total words, flow of words, flow of syllables, and percentage of speech discontinuity and disfluency, for these had normal distribution; the latter was used to compare other variables because these were not normally distributed.

RESULTS

G1 comprised two females and eight males aged 6–7 years and 9 months diagnosed with PD, with speech-language therapy time ranging from 18 to 32 months. In G2, the age of children ranged from 5 years and 1 month to 7 years and 3 months, featuring three females and seven males. It is noteworthy that the children in this group were diagnosed with PD and were in a waiting list to start speech-language therapy process in the institution. Finally, CG was composed of eight females and two males aged between 6 years and 2 months and 7 years and 11 months.

Concerning speech duration in the sample collected from G1, the time varied 64–500 seconds (mean 126.7 seconds), with total of words issued ranging 93–126 (mean 114.2);

in G2, time ranged 64–215 seconds (mean 124.6 seconds), with total of words issued ranging 109–175 (mean 127.9). In CG, the time was between 53 and 190 seconds (mean 98.4 seconds) with words issued ranging from 104 to 124 (mean 113.6).

Regarding sample size, as shown in Table 1, when the means of the three groups were compared, we found difference between CG and G2, unlike the mean total words of the samples, without differences.

As to speech rate, the performances in G1 and G2 are shown in Table 2. In comparison between groups, difference was not found as to any of variables (Table 3). In the analysis of the speech, although this was not the purpose of this study, word repetition was the most common kind of disfluency in G1, G2, and CG, these last two also presenting word reviews. Regarding stuttering disfluencies, the most frequent type was extension in G1 and CG, as well as in G2, which also featured syllable repetition.

DISCUSSION

The results varied according to group. It is clear that, although some of the variables analyzed and compared did not present statistically significant results, numerically they differed, and these are the guides of this discussion.

As to speech duration, although comparison between groups showed no difference, children with PD in speech-language therapy needed more time to issue the number of syllables necessary for analysis related to children with PD without intervention, as well as in relation to the group of children without speech and/or language disorders. It is noteworthy that the methodology proposed was to analyze 200 syllables issued and, as children have different speech rates, the time required for speech conclusion is different for each of them after all, as well as the total words issued until the mark of 200 syllables collected for analysis.

In the standardization of ABFW test for fluency, prepared by Andrade⁽³⁾, the mean speech time values for the age group 5–8 years were as follows: 5-year-old children, mean 80.9–113.5; 6-year-old children, mean 82.2–109.2; and 7-year-old children, mean 90.4–127.2. When comparing data from standardization to the study findings, these were proven above the average for most children in all

Table 1. Duration of speech and total words issued by groups compared by mean values

Groups	Time of the sample (seconds)	Total words
G1	126.7	114.2
G2	124.6	127.9
CG	98.4	113.6
p-value	0.513	0.025*

*Statistically significant

Caption: G1 = Experimental Group 1; G2 = Experimental Group 2; CG = Control Group

Table 2. Speech rate (number, mean, median, and standard deviation) of Experimental Group 1 (children with phonological disorder in speech-language therapy) and Experimental Group 2 (children with phonological disorder without speech-language therapy)

Group	Child typology	1	2	3	4	5	6	7	8	9	10	Mean	Median	Standard deviation
G1	FWM	88.46	55	29.39	20.28	46.5	70.32	97.18	108.75	91.53	78.75	68.62	74.54	29.82
G1	FSM	153.84	100	48.58	34.38	100	129.03	169.01	187.5	153.84	125	120.12	127.02	50.10
G2	FWM	49.66	32.93	41.67	93.75	83.87	84.48	68.72	96.98	46.79	102.18	70.10	76.30	25.52
G2	FSM	79.47	55.81	71.85	107.14	129	122.44	109.09	164.38	75.47	187.50	110.22	108.12	42.17

Caption: G1 = Experimental Group 1; G2 = Experimental Group 2; FWM = flow of words per minute; FSM = flow of syllables per minute

Table 3. Speech rates compared by mean values

Group	FWM	FSM
G1	68.616	120.118
G2	69.803	110.215
GC	82.049	146.592
p-value	0.535	0.281

Caption: G1 = Experimental Group 1; G2 = Experimental Group 2; GC = Control Group; FWM = flow of words per minute; FSM = flow of syllables per minute

groups analyzed, except for two individuals (20%) in the group of children with PD in speech-language therapy and four individuals (40%) in the group of children without speech-language therapy, whose values were below the standardization mean.

Regarding total words used in the speech samples, children with PD without speech-language therapy issued more words than children of the group intervention, as well as the group without speech and/or language disorders. In the comparison between groups, we found differences as to total number of words issued. The fact that the time and the number of words issued were both lower in children in speech-language therapy can be explained by the fact that children with PD are more aware of the difficulties and phonological processes involved in their speech activity, so they constantly focus on the ability to develop the auditory monitoring in the intervention process, as well as control of their speech rate in spontaneous conversations, factors that probably caused this group to regulate more the flow of words.

As for speech rate, children without speech disorders issued more words per minute ($n=82.05$) compared to children with PD without speech-language therapy ($n=70.10$); these, in turn, also had greater flow of words per minute than the group of children with PD intervention ($n=68.62$). When comparing these data to the standardization of ABFW test for fluency, developed by Andrade⁽³⁾, 24 children (80%) were not put within the margin established by the author for the variable words by minute, 67.7–89.8 words for 5-year-old children, 68.0–88.4 for 6-year-old children, and 58.1–81.8 for 7-year-old children. Therefore, groups had mostly lower flow of words per minute than the test standardization, with 14 children (46.6%) and 10 children (33.3%) with greater flow of words per minute related to the test.

However, as to syllables per minute, the group of children with PD in intervention ($n=120.12$) showed better results than children with PD without intervention ($n=110.22$), but the group of children without speech and/or language disorders showed even better results ($n=146.59$). Comparing these data to the standardization of ABFW test for fluency⁽³⁾, 23 children (76.6%) were not placed within the margin established by the author for the variable syllables per minute, 118.8–154.0 for 5-year-old children, 119.3–154.5 for 6-year-old children, and 105.0–142.8 for 7-year-old children; groups had mostly lower flow of words per minute, with 14 children (46.6%) and 10 children (30%) presenting higher flow of syllables per minute than in the aforementioned standardization.

Therefore, the group with the highest number of participants with speech rate within the standards set by Andrade⁽³⁾ was the group of children with PD in speech-language therapy, and it can be explained by the time of stimuli children receive weekly, focusing on phonology, but addressing language input and parameters of speech as a whole. One can also say that such differences in speech rate between groups are the result of individual and environmental aspects, consistently with results indicated in another study that cites the change speed of expressing emotions, speech being used at a lower rate to express tenderness, and at a greater rate to express anger⁽²⁾.

In a study that compared the speech rate of children with PD and children with typical language development, the authors concluded that lower speech rate values were those of children with PD, resulting, thus, from possible language or motor deficits⁽¹¹⁾. Another study reported that during diadochokinetic rate test, children with PD had a lower rate of sequences repeated per second compared to children without language disorders⁽¹²⁾.

CONCLUSION

On the basis of our findings, children with PD in speech-language therapy presented greater flow of syllables per minute and lower flow of words per minute compared to children with PD who were not under speech-language therapy. Data showed that among children with PD who were in speech-language therapy or not, the most notable differences were that children not in speech-language therapy had samples with shorter time, with more total words, that is, greater flow of words and lower flow of syllables per minute. Children

with PD in intervention had longer speech samples, as well as lower rate of common speech disruptions, which may be an indication that they perform auditory monitoring of their own speech.

However, as this study had a small sample, the results reported cannot be extended to the whole population, and further studies with larger samples should be conducted, so that the information found can be confirmed.

**PMN was responsible for data collection and analysis, data tabulation, and writing of the paper; APNC helped in data collection and analysis, as well as in discussion and writing of the paper; SALH was responsible for the study design and general orientations in all phases of the study and writing.*

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