

Aspects of speech fluency in children with specific language impairment

Aspectos da fluência da fala em crianças com distúrbio específico de linguagem

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ABSTRACT

Purpose: The present study aimed to assess specific aspects of speech fluency in children with specific language impairment (SLI). This included examining the typology of speech disruption and rate (in words and syllables *per* minute), across different age groups. **Methods:** A total of 50 children, aged 3 to 7 years old, presenting with nonverbal IQ and hearing thresholds within normal limits (without the presence of stuttering) participated in the study. Children were divided into two groups: G1 (SLI) included 25 children (7 girls and 18 boys) and G2 (typical development) included 25 children matched on age and gender with G1. Each child was shown a figure and asked to discuss what s/he liked about the figure. Each speech sample included 200 fluent syllables or 100 fluent words. **Results:** Between-group analyses demonstrated that children aged 3 to 4 years old in G1 had lower speech rate than their age-matched peers from G2. Within-group analyses revealed no differences in disruption typologies between age groups in G1 participants. In contrast, hesitation was the most frequent typology for 4- to 5-year-old G2 children, whereas hesitation and word repetition typologies were observed in 6- to 7-year-old G2 children. **Conclusion:** Children with suspected SLI between the ages of 3 to 4 years old showed a reduction in word and syllable production. Hesitation-type speech disruptions were prominently used by typically developing children, regardless of age, and were not observed in SLI children.

Keywords: Child; Language development disorders; Child language; Speech, language and hearing sciences; Speech

RESUMO

Objetivo: Avaliar aspectos específicos da fluência da fala em crianças com DEL, quanto à tipologia de rupturas comuns e velocidade de fala (em palavras e sílabas por minuto), considerando as diferentes faixas etárias. **Métodos:** Participaram 50 crianças de ambos os gêneros, na faixa etária de 3 a 7 anos, com QI não verbal e limiares auditivos dentro da normalidade e ausência de gagueira. As crianças foram divididas em dois grupos: G1 (DEL), com 25 crianças (sete meninas e 18 meninos, com idades entre 3 e 7 anos) e G2 (desenvolvimento típico), com 25 crianças pareadas em idade e gênero ao G1. Foi apresentada uma figura à criança e solicitado que falasse o que quisesse sobre ela. Cada amostra de fala foi composta por 200 sílabas fluentes ou 100 palavras fluentes. **Resultados:** A análise intergrupos demonstrou que crianças de 3 e 4 anos do G1 apresentaram menor velocidade de fala que seus pares em desenvolvimento típico. Na análise intragrupos, no que se refere à tipologia de rupturas, o G1 não apresentou diferenças em nenhuma das faixas etárias. Já o G2, para as faixas etárias de 4 e 5 anos, a hesitação foi mais frequente e aos 6 e 7 anos, a hesitação e a repetição de palavras se diferenciaram das demais tipologias. **Conclusão:** Crianças com suspeita de DEL nas idades de 3 e 4 anos, aqui estudadas, apresentaram redução da produção de palavras e sílabas. As rupturas de fala, do tipo hesitação, foram recursos usados pelas crianças com desenvolvimento típico de todas as faixas etárias, o que não ocorreu nas crianças com DEL.

Descritores: Criança; Transtornos do desenvolvimento da linguagem; Linguagem infantil; Fonoaudiologia; Fala

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INTRODUCTION

Specific language impairment (SLI) is a diagnosed alteration whereby language development is disproportionately poor compared to a child's other cognitive abilities, for no apparent reason (e.g., the linguistic deficit is not the result of a more severe pathology)^(1,2). Thus, to diagnose SLI, the child must show two or more compromised areas of language without the presence of any neurological, psychiatric, sensory, or intellectual deficits⁽³⁾.

Linguistic manifestations of SLI are variable; however, it is common for children with SLI to show lexical acquisition deficits⁽⁴⁾, morphosyntactic difficulties⁽⁵⁾, and trouble with phonological short-term memory⁽⁶⁾. Impaired phonological short-term memory is a key factor that might compromise lexical acquisition, morphosyntactic performance, and sentence comprehension in this population^(6,7).

It is currently believed that an accurate SLI diagnosis also depends on tests based on speech production and/or non-word repetition. These tests evaluate articulatory abilities and phonological short-term memory, which are variables that are considered independent from the environment. This shift has led to evolved diagnostic criteria (i.e., strictly applying language tests should be sufficient to establish a diagnosis)⁽⁸⁻¹⁰⁾.

The specific language tests used are considered to be dependent on environmental factors (e.g., normality parameters established in other groups, family and school stimulation, quality of life, and socioeconomic conditions), which might cause, in the case of SLI, increased false positives, hindering the establishment of specific pathological attributes⁽¹¹⁾.

Genetic SLI studies have demonstrated that compromised memory and/or articulation associated with language deficits are always present, and are therefore distinctive attributes of SLI. The improvement in the understanding of his condition allows the evaluation of specific aspects of the speech that might also contribute to higher diagnostic accuracy of SLI cases⁽¹²⁻¹⁵⁾.

To produce speech, the motor system has to control articulatory speed (i.e., the relationship between the time necessary to activate a phoneme and to organize movement sequences). For fluent speech production, the individual has to move various parts of the vocal tract in an agile and soft way, allowing syllabic intelligibility to be continuous and quickly produced. The quicker the speech movements, the greater the muscular activity⁽¹⁶⁻¹⁸⁾.

The motor processes responsible for syllable formation should be ready and stored in memory, forming a group of speech gesture markers. Each gestural group has five elements, which correspond to five independent control subsystems: glottal, velar, tongue body, tongue tip, and lips. The motor group specifies the task to be performed by each subsystem, but does not specify how performance of these tasks should proceed. This is because, depending on the configuration constancy of changes in the peripheral speech mechanisms

(i.e., during connected, and therefore fluent, speech), the task may be performed via different paths, some of which may be more efficient than others^(16,19-23).

Due to immaturities in the linguistic system among children with SLI, speech sounds are usually shorter than those of typically developing children during discursive tasks⁽²⁴⁾, whereas silent pauses between words are longer⁽²⁵⁾.

Based on the aforementioned evidence, the goal of the current study was to evaluate specific aspects of speech fluency in children with SLI, specifically with regard to speech disruption and rate (in words and syllables *per minute*) typologies.

METHODS

Participant selection and evaluation procedures were initiated after adequate ethical procedures were followed. This study was approval by the Ethics Committee for the Analysis of Research Projects of the Clinical Directorate of the Hospital das Clínicas, School of Medicine, Universidade de São Paulo (USP) (266/05), and informed consent was obtained from children's guardians. The research did not involve invasive or experimental techniques absent of proper approval, which classified our study as having "minimal risk."

Fifty children between 3-7 years old, presenting nonverbal IQ and hearing thresholds within normal limits and the absence of stuttering, participated in the study. Nonverbal intelligence was evaluated by the Primary Test of Nonverbal Intelligence (PTONI), which measures visual perception, analogical thinking, spatial relations perception, semantic seriation, and classification. Its application is appropriate for children older than 3 years⁽²⁶⁾.

All children lived in the São Paulo metropolitan area, used the Unified Health System (SUS), and frequently attended a Public Education Institution.

Children were divided into two groups: G1 (SLI) included 25 children (7 girls and 18 boys, 3-7 years old) and G2 (typical development) included 25 children matched on age and gender to the children in G1. Group composition in terms of age is shown in Table 1.

Table 1. Distribution of participants by age in each group

| | 3 years | 4 years | 5 years | 6 years | 7 years | Total |
|---------|---------|---------|---------|---------|---------|-------|
| Group 1 | 3 | 7 | 5 | 7 | 3 | 25 |
| Group 2 | 3 | 7 | 5 | 7 | 3 | 25 |

Note: Group 1 = specific language impairment; Group 2 = typical language development

A child was included in G1 (SLI) if s/he fulfilled the following criteria:

- Presented normal hearing;
- Presented language performance below what would be expected for his/her chronological age in terms of vocabulary, phonological, and pragmatic features based on the ABFW⁽²⁷⁾

- battery, with average sound length (morphemes and words)⁽²⁸⁾ and symbolic entertaining tasks;
- c. Did not present speech disruptions typical of stuttering according to the parameter type⁽²⁹⁾.
A child was included in G2 (typical development) based on the following criteria:
 - a. Presented normal hearing;
 - b. Did not present a history of speech, language, and/or learning problems;
 - c. Presented language performance typical of a child at his/her chronological age in terms of vocabulary, phonological, and pragmatic features based on the ABFW⁽²⁷⁾ battery, with average sound length (morphemes and words)⁽²⁸⁾ and symbolic entertaining tasks;
 - d. Did not present speech disruptions typical of stuttering according to the parameter type⁽²⁹⁾.

Speech samples were recorded over approximately 10 minutes. Task procedures followed the methodology proposed by Andrade. Children were shown a figure and asked to discuss what they liked about it. Each speech sample included 200 fluent syllables or 100 fluent words. Speech sample (200 fluent syllables) analysis followed a validated pattern and typology variables related to speech disruptions and rate were tabulated in words and syllables *per minute*⁽³⁰⁾.

A digital video camera, tripod, microphone, and digital chronometer were used for recording, and a standardized figure was used to elicit expressive speech. A t-test and analysis of variance (ANOVA) were used for between- and within-group analyses, respectively, with a significance level of 5% ($p \leq 0.05$).

RESULTS

The means (standard deviations) and between-group comparisons (1 and 2) for “typical disfluencies”, “words *per minute*,” and “syllables *per minute*” are presented in Table 2.

The following were observed in the between-group analyses for each age group:

- 3-year-old group: Groups did not differ in terms of the number of typical disruptions ($p=0.659$). Speech rate was significantly different between groups for both words ($p=0.007$) and syllables *per minute* ($p=0.001$). Speech rate was lower in 3-year-old G1 compared to G2 children.
- 4-year-old group: The number of common disruptions did not differ between groups ($p=0.061$). Speech rate was significantly different between groups for both words ($p=0.043$) and syllables *per minute* ($p=0.031$). Speech rate was lower in 4-year-old G1 children.
- 5-year-old group: Groups did not differ on any speech variables (number of common disruptions: $p=0.091$; speech rate: $p=0.075$ for word/min and $p=0.971$ for syllables/min). The G1 and G2 children did not differ in this age group.
- 6-year-old group: Groups did not differ on any speech variables (number of common disruptions: $p=0.434$; speech

- rate: $p=0.836$ for word/min and $p=0.843$ for syllables/min). As with the 5 year olds, 6-year-old children with SLI (G1) did not differ from their typically developing peers (G2).
- 7-year-old group: Groups did not differ on any speech variables (number of common disruptions: $p=0.885$; speech rate: $p=0.846$ for word/min and $p=0.518$ for syllables/min). As with the 5- and 6-year-old children, there were no differences between G1 and G2.

To identify possible differences between the speech disruption types, within-group analyses were performed (Table 3).

The within-group analyses revealed the following:

- 3-year-old group: In G1, there were no significant differences in typologies ($F=0.52$; $p=0.758$), but there was a trend toward word repetition. In G2, there were no significant differences in typologies ($F=2.89$; $p=0.061$), but there was a trend toward hesitation.
- 4-year-old group: In G1, there were no significant differences in typologies ($F=0.99$; $p=0.447$). In G2, there was significantly more hesitation ($F=7.97$; $p<0.001$).
- 5-year-old group: In G1, there were no significant differences in typologies ($F=0.44$; $p=0.814$). In G2, there was significantly more hesitation ($F=6.33$; $p<0.001$).
- 6-year-old group: In G1, there were no significant differences in typologies ($F=2.61$; $p=0.441$). In G2, there was significantly more hesitation and word repetition ($F=6.93$; $p<0.001$).
- 7-year-old group: In G1, there were no significant differences in typologies ($F=0.90$; $p=0.450$). In G2, there was significantly more hesitation and word repetition ($F=5.60$; $p=0.012$).

DISCUSSION

Results from the present study indicate that evaluating speech fluency might improve SLI diagnostic accuracy. The measurement of words *per minute* indicates the ability to produce and convey a message. The measurement of syllables *per minute* indicates the ability to perform articulatory transitions and coarticulation. In the between-group analyses, children with suspected SLI at 3 and 4 years old presented reduced speech rate in terms of both words and syllables *per minute*; however, this difference was not observed for children aged 5 and older. Therefore, the current results justify the evaluation of speech rate in children with suspected SLI between the ages of 3 and 4^(16,30).

The results of the within-group analyses indicated disrupted speech typologies in children with suspected SLI, particularly 4-year-olds. Typically developing children over the age of 4 already use hesitation automatically to increase the time necessary for speech processing. In mere milliseconds, hesitation allows motor processes to receive data stored in phonological short-term memory and transform this information into articulatory movements^(16,23).

Table 2. Average (standard deviation) and intergroup comparison (1 and 2) for typical disfluency variables, words per minute, and syllables per minute

| Age group | Group | Variable | Average (SD) | T | p-value |
|-----------|-------|----------|----------------|-------|---------|
| 3 years | 1 | TD | 10.67 (9.61) | 0.51 | 0.659 |
| | 2 | | 13.67 (3.21) | | |
| | 1 | WPM | 41.83 (14.47) | 6.67 | 0.007* |
| | 2 | | 131.50 (18.3) | | |
| | 1 | SPM | 65.42 (14.84) | 13.09 | 0.001* |
| | 2 | | 201.40 (10.18) | | |
| 4 years | 1 | TD | 7.29 (3.04) | 2.22 | 0.061 |
| | 2 | | 15.71 (9.55) | | |
| | 1 | WPM | 40.40 (28.10) | 2.35 | 0.043* |
| | 2 | | 69.09 (16.01) | | |
| | 1 | SPM | 67.70 (52.00) | 2.55 | 0.031* |
| | 2 | | 124.5 (27.80) | | |
| 5 years | 1 | TD | 11.80 (6.83) | 1.96 | 0.091 |
| | 2 | | 22.40 (9.96) | | |
| | 1 | WPM | 61.20 (29.20) | 0.44 | 0.675 |
| | 2 | | 67.82 (16.24) | | |
| | 1 | SPM | 113.40 (44.50) | 0.04 | 0.971 |
| | 2 | | 114.24 (20.93) | | |
| 6 years | 1 | TD | 9.57 (2.30) | 0.82 | 0.434 |
| | 2 | | 11.00 (4.00) | | |
| | 1 | WPM | 90.50 (43.80) | 0.21 | 0.836 |
| | 2 | | 94.40 (20.31) | | |
| | 1 | SPM | 159.70 (73.80) | 0.20 | 0.843 |
| | 2 | | 165.90 (31.70) | | |
| 7 years | 1 | TD | 10.00 (10.39) | -0.16 | 0.885 |
| | 2 | | 9.00 (2.00) | | |
| | 1 | WPM | 55.17 (8.81) | 0.21 | 0.846 |
| | 2 | | 56.87 (10.79) | | |
| | 1 | SPM | 95.90 (12.40) | 0.78 | 0.518 |
| | 2 | | 108.00 (24.00) | | |

* Significant values ($p \leq 0.05$) – t-test

Note: Group 1 = specific language impairment; Group 2 = typical language development; TD = typical disfluencies; WPM = words per minute; SPM = syllables per minute; SD = standard deviation

Although useful data were obtained, the current study has a few limitations. For example, it is necessary to assess these paradigms with a larger sample to better generalize the results. It would also be useful to extend this method to other Brazilian states and to other languages to determine the influence of variables such as regionality and native language on speech fluency in SLI. Overall, the current results suggest that speech rate in children between the ages of 3 and 4 years deserves careful attention when an SLI diagnosis is not yet conclusive.

CONCLUSION

The current study contributes to the improvement of early

diagnoses for children with suspected SLI. This might be accomplished by assessing speech rate in children aged 3 to 4 years who show a reduction in word and syllable production. In addition, the current study indicates that speech disruptions, specifically hesitation, are used by typically developing children to allow for elaboration of complex speech (without losses in speed), and do not occur in children with SLI.

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Table 3. Average (standard deviation) disruption typologies according to group (1 and 2) across age

| Disruption typology | 3 years | | 4 years | | 5 years | | 6 years | | 7 years | |
|-----------------------|----------------|----------------|----------------|----------------|----------------|-----------------|----------------|----------------|----------------|----------------|
| | G1 | G2 | G1 | G2 | G1 | G2 | G1 | G2 | G1 | G2 |
| Hesitation | 3.00 (4.36) | 4.67 (1.16) | 1.57 (1.72) | 8.29 (6.29) | 2.20 (3.35) | 13.20 (9.58) | 3.00 (2.00) | 4.57 (1.99) | 5.67 (6.43) | 4.00 (1.00) |
| Interjection | 2.33 (4.04) | 3.67 (2.52) | 1.86 (2.85) | 0.43 (0.79) | 2.80 (5.22) | 1.40 (1.67) | 1.00 (1.16) | 1.43 (1.90) | 1.00 (1.00) | 0.67 (0.58) |
| Revision | 0.67 (0.58) | 0.67 (1.16) | 1.29 (1.38) | 2.71 (0.76) | 2.60 (2.41) | 1.40 (1.52) | 2.87 (1.89) | 1.57 (0.98) | 3.33 (3.51) | 1.67 (0.58) |
| Unfinished word | 0.33 (0.58) | 1.00 (1.00) | 0.14 (0.38) | 0.29 (0.49) | 0.80 (1.30) | 1.00 (0.71) | 0.86 (1.07) | 0.86 (0.69) | - | - |
| Repetition of word | 4.00 (6.93) | 1.67 (1.53) | 1.14 (1.68) | 2.86 (3.08) | 2.40 (1.52) | 4.80 (3.90) | 1.14 (1.07) | 2.43 (2.15) | - | 2.00 (1.73) |
| Repetition of segment | - | 2.00 (1.73) | 0.29 (0.49) | 1.14 (0.69) | 1.00 (1.00) | 0.60 (0.55) | 1.29 (0.76) | 0.29 (0.49) | - | 0.67 (0.58) |
| Repetition of phrase | 0.33 (0.58) | - | 1.00 (1.92) | 0.14 (0.38) | - | - | - | - | - | - |

Note: G1 = specific language impairment; G2 = typical language development

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