Does the duration of silent pauses differ between words of open and closed class?

A duração da pausa silente difere entre palavras de classe aberta ou fechada?

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ABSTRACT

Purpose: The study aim was to determine whether the mean duration of silent pauses depends on the word class (open or closed) and to compare the duration for each type of word between children with typical language development and children with specific language impairment (SLI). **Methods:** The study included 40 children with typical language development and 20 children with SLI, aged between 7 and 10 years. Each subject produced 15 story narratives based on a separate sequence of four pictures for each narrative. After the transcription of the samples, the words were classified as open class (noun, adjective, verb, adverb, and numeral) or closed class (article, preposition, pronoun, conjunction, and interjection). In the second phase of the study, the samples were analyzed using software specific to the analysis of silent pauses and the duration (milliseconds) of the pauses that occurred immediately before each of these grammatical categories was recorded. **Results:** In both groups, silent pauses were longer when preceding closed class words and individuals in the SLI group produced longer silent pauses than their peers did. **Conclusion:** The duration of a silent pause varied according to the grammatical class of the preceded word and it was shorter when followed by an open class word. In addition, the fact that individuals with SLI produce longer silent pauses than their peers confirms that their language processing is slower.

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

RESUMO

Objetivo: Verificar se o tempo médio das pausas silentes difere para a classe das palavras (aberta ou fechada) e se há diferença entre esse tempo para crianças em desenvolvimento típico de linguagem e crianças com distúrbio específico de linguagem (DEL), em cada tipo de palavra. **Métodos:** Participaram da pesquisa 40 crianças em desenvolvimento típico de linguagem e 20 com DEL, com idade variando entre 7 e 10 anos. Cada sujeito elaborou 15 narrativas, baseadas em uma sequência de quatro cenas cada. Após a transcrição das amostras, as palavras foram classificadas como de classe aberta (substantivo, adjetivo, verbo, advérbio e numeral), ou fechada (artigo, preposição, pronome, conjunção e interjeição). Em um segundo momento, as amostras foram submetidas a um *software* para análise das pausas silentes, que permitiu o levantamento do tempo (milissegundos) das pausas imediatamente anteriores a cada uma dessas categorias gramaticais. **Resultados:** Em ambos os grupos, a pausa silente foi mais longa quando precedia as palavras de classe fechada, sendo que o grupo com DEL, em geral, apresentou pausas silentes mais longas que seus pares. **Conclusão:** A duração da pausa silente varia conforme a classe gramatical da palavra que será enunciada, sendo menor quando precede palavras de classe aberta. Além disso, o fato de os indivíduos com DEL apresentarem pausas silentes mais longas que seus pares, confirma a menor velocidade de seu processamento linguístico.

Descritores: Linguagem infantil; Transtornos do desenvolvimento da linguagem; Narração; Fonoaudiologia; Desenvolvimento da Linguagem

INTRODUCTION

Language acquisition is a complex and gradual process that builds on high cognitive requirements. When specific aspects of language (in particular, syntactic and lexical aspects) are being developed, there is a greater chance of speech disruptions[1,2].

Disfluency is expected during language development as it may reflect the child's uncertainties during sentence planning. It allows time for utterance elaboration and gradually decreases with maturation of the linguistic system[2]. Children with specific language impairment (SLI) do not usually exhibit this decrease; however, this pattern is observed because they have morphosyntactic difficulties that cause them to produce more disfluencies than the population with typical language development[3,4].

Among stuttering disruptions, silent pauses can be used as a strategy to gain time to plan utterance wording without adding words or sounds[2]. Moreover, pauses have been observed when there is an overload of information related to linguistic processing[5,6].

Because the occurrence of disruptions is associated with linguistic elements, recent studies have analyzed the relationships between the various word classes and disfluencies[7,8]. Studies have reported higher numbers of disruptions in closed class words (such as articles and prepositions) than in open class words, as a consequence of differences in acquisition and complexity. Closed class words are acquired later and are used as linking elements between words and sentences; they are thus more abstract[9-11]. Open class words (such as nouns and verbs) are acquired earlier and exhibit more concrete references; they are more easily related to the context and are thus less associated with disfluency[9,10]. Some authors have used electrophysiological tests to study brain behavior during the use of open and closed class words and concluded that there are differences in their processing, because of their distinct functions and linguistic relationships[12,13].

Continuing the research on the relationship between grammatical classes and silent pauses, this study aimed to determine whether the mean duration of silent pauses depends on word class (open or closed) and to compare the duration of silent pauses for each type of word between children with typical language development and children with specific language impairment (SLI).

METHODS

The study was approved by the Research Project Approval Committee (CAPPesq) of the Hospital das Clínicas of the Faculty of Medicine, Universidade de São Paulo (USP), under number 1150/09. The adults responsible for the children who met the inclusion criteria for this study signed the informed consent document.

Sample

The study included 60 Portuguese-speaking subjects, aged 7 to 10 years. The groups were matched for age; for every subject with SLI, there were two subjects without language impairment. The group with SLI (SLIG) was composed of 20 children, of which 14 were boys. The group with typical language development (TLDG) was composed of 40 children, of which 18 were boys.

The criteria for inclusion in the SLIG were as follows: performance in non-verbal intelligence tasks within the normal range; intelligible speech production; diagnosis of SLI, confirmed by performance below expectations on at least two of the following standardized language tests: vocabulary, phonology, and pragmatics(as measured by the ABFW Language Test for Children[14]; and mean length of utterance[15]. The selection of TLD subjects was conducted in a state school on the west side of São Paulo. The inclusion criteria were the following: no productive phonological processes on phonological evaluation[16]; adequate performance in tasks involving phonological awareness, reading, and writing[17]; and academic performance compatible with age and school grade, confirmed by school records.

Procedures

All subjects produced 15 story narratives based on a separate sequence of four pictures for each narrative[18]. During data collection, the participants were informed that a sequence of four pictures made up a story. Children were asked to organize the pictures and narrate the corresponding story, which was recorded using a digital recorder. To eliminate any variables, such as short-term memory deficit, the children could see the pictures throughout the entire narrative.

The recording of each story was analyzed acoustically using the Audacity (1.3 Beta) software to register the duration of each word uttered by the children, as well as the pauses between them (sample transcription). All words were classified as open class (noun, adjective, verb, adverb, and numeral) or closed class (article, preposition, pronoun, conjunction, and interjection).

The recordings were then analyzed using software specifically developed to calculate the duration of the silent pauses (in milliseconds) that occurred immediately before each word. This software generated a report for all 15 narratives produced by each subject, resulting in the determination of the mean duration (in milliseconds) of the silent pauses that occurred before nouns, adjectives, verbs, adverbs, numerals, articles, prepositions, pronouns, conjunctions, and interjections. It is worth noting that, according to the adopted criteria, we considered as silent pauses all episodes of silence between words.

Data analysis

Descriptive and inferential statistical analysis was

performed to address the aims of this study. The Mann-Whitney test was used to compare the mean duration of the silent pauses between the groups and the Wilcoxon signed-rank test was used for the comparison between the word classes. This analysis was performed using SPSS software, version 18, and the significance level was set at 5%.

RESULTS

The comparison between word classes indicated that the longest silent pause occurred before closed class words, for both the TLDG (z=-5.471, p<0.001) and the SLIG (z=-3.435, p=0.001) (Figure 1).
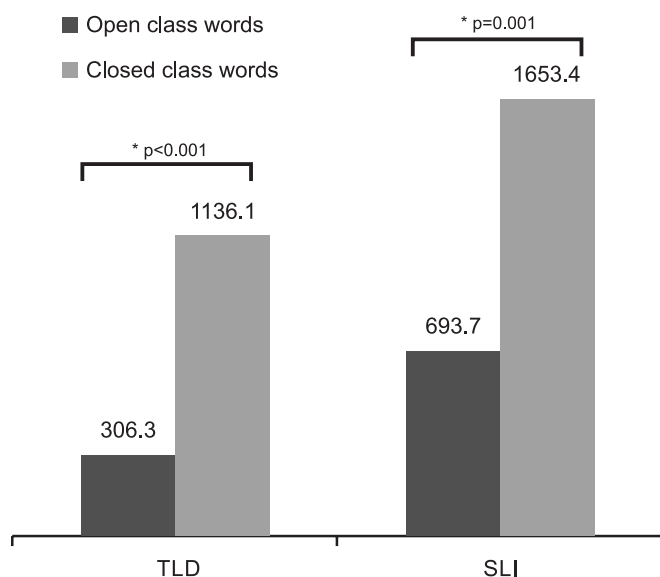

Figure 1. Mean duration (in milliseconds) of silent pauses that precede open and closed class words for both language groups

For open class words, the silent pauses produced by the SLIG were longer than those produced by the TLDG, with the exception of numerals (Table 1).

For closed class words, the silent pauses produced by the SLIG were longer than those produced by the TLDG, with the exception of interjections (Table 2).

DISCUSSION

We observed that silent pauses were shorter when they were preceded by open class words in both language groups. Because they occur frequently in maternal and previously acquired speech, open class words are more common and are used more often in children's daily activities[2]. This early and continuous contact allows for the consolidation of concepts, semantics, and phonology associated with these words and leads to more rapid and accurate lexical acquisition[19,20].

As their vocabulary builds, the extension of children's discourse tends to increase. The introduction of closed class words in utterances is required for words to be linked in a sentence and for sentences themselves to be linked. Therefore, the fact that closed class words do not have a concrete reference and are acquired later explains the longer mean duration of silent pauses preceding these type of word[21].

Moreover, the duration of silent pauses was longer in children with SLI for both classes of words. Symbolic difficulties negatively affect the categorization of the semantic traits of both classes of words. Disruption in the phonological system negatively affects the phonological representation of such words. SLI children usually exhibit impaired memory and slower lexical acquisition, which is probably associated with such symbolic difficulties and disruption. As a result,

Table 1. Comparison of the mean duration (in milliseconds) of silent pauses that precede open class words

Class words	Group	Mean	Standard deviation	Median	Confidence interval		U	Z	p-value
					Lower bound	Upper bound			
Noun	TLD	25.70	19.25	21.69	19.54	31.85	71.0	-5.159	<0.001*
	SLI	67.22	37.22	55.91	49.80	84.64			
Adjective	TLD	52.76	85.44	20.84	25.44	80.09	255.5	-2.267	0.023*
	SLI	190.74	301.31	112.61	49.72	331.76			
Verb	TLD	89.05	45.91	76.06	74.36	103.73	144.0	-4.014	<0.001*
	SLI	185.71	94.90	172.96	141.30	230.12			
Adverb	TLD	99.48	100.80	70.59	67.24	131.72	215.0	-2.901	0.004*
	SLI	182.52	142.70	136.79	115.73	249.30			
Numeral	TLD	39.33	134.43	0.00	-3.66	82.32	328.0	-1.393	0.164
	SLI	67.55	133.77	0.00	4.95	130.16			
Open class words	TLD	306.32	210.38	230.52	239.03	373.60	146.0	-3.983	<0.001*
	SLI	693.73	464.34	586.83	476.41	911.05			

* Significant values (p≤0.05) – Mann-Whitney Test

Note: TLD = children with typical language development (n=40); SLI = children with specific language impairment (n=20); U = Mann-Whitney test; Z = z score

Table 2. Comparison of the mean duration (in milliseconds) of silent pauses that precede closed class words

Class words	Group	Mean	Standard deviation	Median	Confidence interval		U	Z	p-value
					Lower bound	Upper bound			
Article	TLD	97.86	70.85	76.52	75.20	120.52	81.0	-5.002	<0.001*
	SLI	244.79	118.99	212.56	189.10	300.48			
Preposition	TLD	75.76	72.26	56.96	52.65	98.87	124.0	-4.328	<0.001*
	SLI	169.40	100.38	136.74	122.42	216.38			
Pronoun	TLD	179.49	245.50	94.88	100.98	258.01	271.0	-2.023	0.043*
	SLI	283.29	271.01	214.76	156.46	410.13			
Conjunction	TLD	309.45	213.52	261.41	241.16	377.73	232.0	-2.634	0.008*
	SLI	478.09	269.55	425.85	351.94	604.24			
Interjection	TLD	473.49	578.62	351.68	288.44	658.54	369.5	-.479	0.632
	SLI	477.80	379.28	366.30	300.29	655.31			
Closed class words	TLD	1136.05	797.03	928.95	881.15	1390.96	221.0	-2.807	0.005*
	SLI	1653.37	808.90	1435.62	1274.80	2031.94			

* Significant values (p≤0.05) – Mann-Whitney Test

Note: TLD = children with typical language development (n=40); SLI = children with specific language impairment (n=20); U = Mann-Whitney test; Z = z score

their lexical acquisition is less accurate. Despite this pattern, open class words remain the grammatical category most easily acquired and used by these children because they are more content-bearing[15,22].

In addition to exhibiting deficits in some stages of language processing, children with SLI have difficulties understanding the need for, and when to use, closed class words. Thus, they exhibit difficulties applying the grammatical rules of language and tend to produce short sentences without syntactic refinement; in addition, they need more time to process these linking words, which explains the longer pauses that precede these type of words[21].

The fact that the population with SLI used longer silent pauses than children with typical language development for all grammatical classes studied, with the exception of numerals and interjections, clearly reflects the lexical acquisition difficulties and uncertainties these children experience in linguistic formulation during discourse production[2,21]. The absence of a statistically significant difference for numerals and interjections may be explained by the fact that the stimulus pictures did not favor the production of these words in either group, which interfered with data analysis of these two categories of words.

The data showed a close relationship between acquisition and use of the grammatical classes and their impact on speech fluency in schoolchildren. Moreover, we observed that the two groups under study exhibited different levels of linguistic fluency. The results contribute to diagnostic evaluation as they suggest that a discourse with long pauses between words is indicative of a compromised discourse production ability. Therefore, the process of therapeutic intervention in children with impaired language development should consider the need to improve their discourse, in order to provide them with the

ability to convey their message with more clarity and in a more elaborate manner.

CONCLUSION

The duration of silent pauses varies according to the grammatical class of the word that follows the pause; it is shorter when it precedes open class words. In addition, the fact that individuals with SLI produce longer silent pauses than their peers confirms their slower language processing.

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REFERENCES

1. Rispoli M. Changes in the nature of sentence production during the period of grammatical development. J Speech Lang Hear Res. 2003;46(4):818-30. http://dx.doi.org/10.1044/1092-4388(2003/064)

2. Guo LY, Tomblin JB, Samelson V. Speech disruptions in the narratives of English-speaking children with specific language impairment. J Speech Lang Hear Res. 2008;51(3):722-38. http://dx.doi.org/10.1044/1092-4388(2008/051)

3. Rodrigues A, Befi-Lopes DM. Memória operacional fonológica e suas relações com o desenvolvimento da linguagem infantil. Pró-fono Rev Atual Cient. 2009;21(1):63-8. http://dx.doi.org/10.1590/S0104-56872009000100011

4. Befi-Lopes DM, Bacchin LB, Pedott PR, Cáceres-Assenço AM. Complexidade da história e pausas silentes em crianças com e sem

distúrbio específico de linguagem. CoDAS. 2013;25(4):325-9. http://dx.doi.org/10.1590/S2317-17822013000400005

5. Krivokapi J. Prosodic planning: effects of phrasal length and complexity on pause duration. J Phon. 2007;35(2):162-79. http://dx.doi.org/10.1016/j.wocn.2006.04.001

6. MacGregor LJ, Corley M, Donaldson DI. Listening to the sound of silence: disfluent silent pauses in speech have consequences for listeners. Neuropsychologia. 2010;48(14):3982-92. http://dx.doi.org/10.1016/j.neuropsychologia.2010.09.024

7. Au-Yeung J, Gomez IV, Howell P. Exchange of disfluency with age from function words to content words in Spanish speakers who stutter. J Speech Lang Hear Res. 2003;46(3):754-65. http://dx.doi.org/10.1044/1092-4388(2003/060)

8. Juste FS, Sassi FC, Andrade CR. Exchange of disfluency with age from function to content words in Brazilian Portuguese speakers who do and do not stutter. Clin Linguist Phon. 2012;26(11-12):946-61. http://dx.doi.org/10.3109/02699206.2012.728278

9. Juste FS, Andrade CRF. Speech disfluency types of fluent and stuttering individuals: age effects. Folia Phoniatr Logop. 2011;63(2):57-64. http://dx.doi.org/10.1159/000319913

10. Savage C, Howell P. Lexical priming of function words and content words with children who do, and do not, stutter. J Commun Disord. 2008;41(6-5):459-84. http://dx.doi.org/10.1016/j.jcomdis.2008.01.004

11. Befi-Lopes DM, Pedott PR, Bacchin LB, Cáceres AM. Relação entre pausas silentes e classe gramatical em narrativas de crianças com distúrbio específico de linguagem. CoDAS. 2013;25(1):64-9. http://dx.doi.org/10.1590/S2317-17822013000100012

12. Liu B, Jin Z, Wang Z, Wu G. Chinese function words grammaticalized from content words: evidence from ERPs. J Neurolinguist. 2010;23(6):663-75. http://dx.doi.org/10.1016/j.jneuroling.2010.07.002

13. Maxfield ND, Lyon JM, Silliman ER. Disfluencies along the garden path: brain electrophysiological evidence of disrupted sentence processing. Brain Lang. 2009;111(2):86-100. http://dx.doi.org/10.1016/j.bandl.2009.08.003

14. Andrade CRF, Befi-Lopes DM, Fernandes FDM, Wertzner HF. ABFW: teste de linguagem infantil nas áreas de fonologia, vocabulário, fluência e pragmática. 2a ed. Barueri: Pró-Fono; 2004.

15. Araujo K. Desempenho gramatical de criança em desenvolvimento normal e com Distúrbio Específico de Linguagem [tese de doutorado]. São Paulo: Universidade de São Paulo; 2007.

16. Wertzner HF. Fonologia. In: Andrade CRF, Befi-Lopes DM, Fernandes FDM, Wertzner HF. ABFW: teste de linguagem infantil nas áreas de fonologia, vocabulário, fluência e pragmática. 2a ed. Barueri: Pró-Fono; 2004. Capítulo 1, p. 5-32.

17. Andrade C, Befi-Lopes D, Fernandes F, Wertzner H. Manual de avaliação de linguagem do serviço de fonoaudiologia do Centro de Saúde Escola Samuel B. Pessoa. São Paulo: Centro de Saúde Escola Samuel B. Pessoa; 1997. p. 127.

18. Perissinoto J, editor. Conhecimentos essenciais para atender bem a criança com autismo. São José dos Campos: Pulso; 2003. Capítulo 5, Avaliação fonoaudiológica da criança com autismo; p. 45-55.

19. Richtsmeier PT, Gerken L, Goffman L, Hogan T. Statistical frequency in perception affects children's lexical production. Cognition. 2009;111(3):372-7. http://dx.doi.org/10.1016/j.cognition.2009.02.009

20. Clark E. Adult offer, word-class, and child uptake in early lexical acquisition. First Lang. 2010;30(3-4):250-69. http://dx.doi.org/10.1177/0142723710370537

21. Castilho A. Fundamentos teóricos da gramática do português culto falado no Brasil: sobre o segundo volume, classes de palavras e as construções gramaticais. Alfa. 2007;51(1);99-135.

22. Gândara JP, Befi-Lopes DM. Tendências da aquisição lexical em crianças em desenvolvimento normal e crianças com alterações específicas no desenvolvimento da linguagem. Rev Soc Bras Fonoaudiol. 2010;15(2):297-304. http://dx.doi.org/10.1590/S1516-80342010000200024