

Effects of syntactic simplification on reading comprehension of Elementary School students

Efeito da simplificação sintática sobre a compreensão de leitura de crianças do ensino fundamental

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ABSTRACT

Purpose: To investigate the effects of Syntactic text simplification on the reading comprehension performance of Elementary School students. **Methods:** Cross-sectional, analytical, case-control study. Study participants were 112 students regularly enrolled in the 2nd-4th grades of public Elementary Schools. Participants were divided into two groups: Group OT – students exposed to the original expository text and Group ST – students exposed to the simplified expository text. The groups were matched for accuracy and did not differ with respect to reading comprehension capacity. The simplified text was obtained by submitting the original text to the following syntactic modifications: separation of complex sentences, simplification of discursive markers, suppression of active voice and anaphora, inversion of clause order with displacement of the main clause to the beginning of the sentence, and exclusive use of the subject-verb-object order. Text simplification was verified using the Coh-Metrix-Port computational tool. Comprehension analysis through retell of the texts read determined the total of ideas (central and detailed) and retold links. **Results:** Comparative analysis of the groups identified differences between the total of central, detailed and retold ideas, with the best performance observed in the Group ST. Students from 3rd and 4th grades benefitted the most from syntactic simplification. **Conclusion:** Text syntactic simplification, verified by the Coh-Metrix-Port parameters, facilitated the micro-structural text processing of 3rd and 4th grade students, promoting greater retention of ideas.

Keywords: Reading comprehension; Work simplification; Word processing, Language; Speech; Language and hearing sciences

RESUMO

Objetivo: Investigar o efeito da estratégia de simplificação sintática de textos sobre o desempenho em compreensão leitora de escolares de 2^o a 4^o ano do ensino fundamental. **Método:** Estudo transversal, analítico, caso controle. Participaram 112 escolares do ensino público, do 2^o ao 4^o ano escolar. Os participantes foram distribuídos em Grupo TO – expostos ao texto expositivo original e Grupo TS – expostos ao texto simplificado. Os grupos foram pareados segundo acurácia e não diferiram quanto à capacidade de compreensão leitora. O texto original foi submetido às seguintes modificações sintáticas: divisão de sentenças complexas, simplificação de marcadores discursivos, supressão de voz ativa e anáforas, inversão na ordem de cláusulas, com deslocamento da sentença principal para o início e utilização exclusiva da ordenação sujeito-verbo-objeto. Para atestar a simplificação, utilizou-se a ferramenta computadorizada CohMetrix-Port. A análise da compreensão por meio dos recontos dos textos lidos computou o total de ideias (centrais, detalhes) e de enlaces recontados. **Resultados:** A análise comparativa dos grupos identificou diferenças quanto ao total de ideias centrais ($U=1029,5$, $p=0,001$), de detalhe ($U=599,5$, $p=0,000$) e total de ideias recontadas ($U=1247,5$, $p=0,041$), com melhor desempenho para o Grupo TS. A análise da escolaridade mostrou que o 3^o e o 4^o ano mais se beneficiaram da simplificação sintática. **Conclusão:** A simplificação dos textos, atestada pelos parâmetros do CohMetrix-Port, produziu efeitos de facilitação sobre o processamento microestrutural do texto de escolares do 3^o e 4^o anos do ensino fundamental, promovendo maior retenção das ideias.

Palavras-chave: Compreensão leitora; Simplificação do trabalho; Processamento de texto; Linguagem; Fonoaudiologia

Study carried out at Núcleo de Estudos, Assistência e Pesquisa em Escrita e Leitura – NEAPEL, Departamento de Fonoaudiologia, Escola Paulista de Medicina, Universidade Federal de São Paulo – UNIFESP – São Paulo (SP), Brasil.

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Conflict of interests: No.

Authors' contribution: BMR: bibliographic search, collection, analysis and classification of data, preparation of the study discussion and results, and writing of the manuscript; GLS: bibliographic search and collection, analysis and classification of data; CRBA: study collaborator, analysis and interpretation of data, revision and approval of the manuscript; ASBK: study design, statistical analysis of data, preparation of the study discussion and results, revision and approval of the manuscript.

Funding: Programa Institucional de Bolsas de Iniciação Científica - PIBIC, Conselho Nacional de Desenvolvimento Científico e Tecnológico – CNPq. This study is part of the Projeto Universal, CNPq, no. 459953/2014-1.

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Received: March 12, 2018; **Accepted:** August 22, 2018

INTRODUCTION

Syntactic text simplification is a practice of psycholinguistics supported by the evidence that certain grammatical features may impose greater or lesser difficulties in understanding a text. In this context, text simplification is based on different strategies designed to reduce the linguistic complexity of a text without changing its original information, that is, its meaning⁽¹⁾. Different objectives demand diverse forms of text simplification, considered possible, such as those aimed at reducing redundancy, increasing explicitness of information, simplifying syntactic structures, or facilitating cognitive processing in understanding information through the use of rhetorical markers capable of clarifying, explaining, or even motivating the reader. All of these resources are intended to facilitate connection of text information at the time of reading to ensure that less proficient or less competent readers can understand it. Among the different possible simplification strategies, the evidence that syntactic simplifications facilitate text comprehension is highlighted⁽²⁾.

Among the syntactic parameters that can affect text readability are length of sentences, number of sentences, and syntactic complexity, with adjective or adverbial subordinate clauses, syndetic coordinate clauses, and passive clauses as those that hinder understanding the most⁽³⁾. These syntactic characteristics increase text complexity and may hamper the understanding of beginning readers, especially of those who present difficulties or changes in language, or problems in learning to read^(4,5). Children at the initial stage of literacy are more sensitive to the syntactic-semantic organization of sentences. Facilitating this structure encourages reading comprehension and enables schoolchildren to use the verbal context more effectively for reading words whose spelling is unfamiliar to them⁽⁶⁾.

Although many studies have been conducted with the objective of assessing the impact of text simplification in favor of reading comprehension^(1,2,7), they simultaneously adopted different simplification strategies, such as syntactic, of vocabulary, and/or involving the introduction of rhetorical clues. This theoretical option precludes observation of the isolated influence that each of these strategies can have on the different levels of text processing. Consequently, this study adopted syntactic simplification as the only text modification strategy, aiming to understand its specific effects on the information processing of readers. The present study may contribute to the extent that it provides clues about the possibility of adopting this facilitation strategy for students in both the educational and clinical practice settings.

In the present study, it is also worth emphasizing the importance of adopting the analysis of retelling the text read as a methodological strategy, because this task usually provides information on how readers have constructed their understanding of what they have read. The retell task after reading provides access to direct expression of the mental representation constructed during reading. It also enables, through its different measures, identification of the nature of information that readers considered essential (total of central and detailed ideas retold), analysis of their way of integrating them (total of retold links), and their logical organization in a global scheme. Thus the analysis of retell provides access to the different levels of mental representation constructed by readers, free of possible interference or induction to response^(8,9). Therefore, the choice of retell after reading would enable learning about

the influence of syntax on the processing of text information at the micro- (total of retold ideas), macro- (total of central and detailed retold ideas, total of retold links), and super-structural (general retell score) levels. Knowledge about the effects of this facilitation on the levels of mental representation of a text may make the use of this strategy more specific in educational and clinical practice settings.

From these theoretical assumptions, this study aimed to investigate the effectiveness of text manipulation strategy, based on syntactic simplification, on the reading comprehension performance of 2nd-4th grade Elementary School students.

It is common knowledge that syntax is essential for establishing relations between the text components, favoring construction of the units of meaning (propositions) that promote local understanding, that is, the text microstructure^(10,11). The following hypothesis was considered: more efficient syntactic processing, favored by simplification strategies, would promote reading comprehension performance, which in turn would become a retell with a larger number of ideas.

Syntax, however, seems to influence even higher levels of text processing. Cohesion language devices enable the relationship between distinct text units and may be responsible for the proper understanding of the relationships between the main ideas of the text^(12,13). For this reason, another hypothesis was considered: there is a probable favoring effect of reading comprehension at its macro-structural level of text processing from the presentation of the simplified text^(11,14). Therefore, a larger number of retold links and better retell patterns are expected for the group exposed to the syntactically simplified expository text.

METHODS

This study was approved by the Research Ethics Committee of the Federal University of Sao Paulo - UNIFESP under protocol no. CAEE 57675616.8.3001.5406 and followed the guidelines of Resolution no. 196 of 1996 of the Brazilian Health Council (CNS), updated to no. 466 of 2012, which regulates research involving humans. All parents and/or legal guardians of the participants signed an Informed Consent Form (ICF) and all the participating schoolchildren signed an Assent Form prior to study commencement. This is a cross-sectional, analytical, case-control study.

In order to facilitate the understanding of the stages of this study, the following procedures are presented in this order: first, preparation of the simplified version of the adopted text; next, selection and final characterization of the study sample; finally, collection and analysis of the data.

Text simplification procedure

The expository text selected and submitted to text manipulation, through simplification of syntactic structure, was "The giraffe's long neck"⁽¹⁵⁾. The text was modified based on five rules for simplification of syntactic structures in Brazilian Portuguese⁽¹⁶⁾, namely, separation of complex sentences, simplification of discursive markers, suppression of active voice and anaphora, inversion of clause order with displacement of the main clause

to the beginning of the sentence, and exclusive use of the subject-verb-object order.

The study of equivalence between the texts was conducted using the Coh-Metrix-Port⁽¹⁷⁾ computation tool. The following parameters were analyzed: a) productivity: number of words and sentences and number of sentences per paragraph; b) grammatical complexity: number of words per sentence, incidence of functional words, and number of logical operators. Comparative analysis of the texts verified equivalence regarding the number of propositions (30) and readability (original text-OT = 54; simplified text-ST = 51), that is, the number of ideas conveyed and the level of decoding difficulty were maintained. In contrast, the simplified text presented, as desired, simpler syntax expressed by the Coh-Metrix-Port variables (Chart 1).

The larger number of sentences observed in the simplified text, coupled with reduction of the average index of words per sentence, revealed the effect of separation of complex sentences. In contrast, the reduced number of conjunctions caused significant decrease in the incidence rate of functional words and logical operators, demonstrating reduction in the use of more grammatically complex sentences, replaced with more frequent use of simple sentences.

Sample selection

Study participants were 112 students (70 girls) regularly enrolled in the 2nd-4th grades of public Elementary Schools. Selection as of the 2nd grade aimed to exclude schoolchildren who were still in the early stages of literacy. In addition, participants should meet the following inclusion criteria: absence of related complaints or indicators of hearing impairment; absence of related complaints or indicators of vision impairment; absence of related complaints or indicators of presence of neurological, behavioral, or cognitive disorders.

Composition of the study groups

As part of the procedures to compose the study groups, students were submitted to the tasks of oral reading of words^(18,19) and reading comprehension⁽²⁰⁾. These assessments were performed with the sole objective of ensuring matching of the study groups for decoding and comprehension skills, guaranteeing that the difference between groups was restricted to the experimental condition (exposure to the original and simplified texts).

The list of words used was composed of 48 real words, of low frequency, common to schoolchildren in 2nd-5th grades, selected according to vocabulary extracted from books used in Elementary School in Brazil⁽¹⁹⁾. All words were controlled regarding length (58.3% with 4-6 letters and 41.7% with

7-8 letters) and letter-sound correspondence (52.1% were regular and 47.9% were irregular)^(18,19).

To obtain the reading fluency values, the students were requested to read aloud 48 words printed on an A4 paper sheet. The words were written in uppercase, Arial font, size 14, distributed in two columns with 24 stimuli each. The oral readings were recorded for further transcription, calculation of correctness, and measuring of the time spent on the task. The following variables were obtained based on performance analysis: a) total reading time, calculated from listening to the recordings and measuring the total time (in seconds) spent to read the list of 48 words aloud; b) calculation of correctly read words, with reading of words without hesitation, segmentation, or self-correction considered as correct, disregarding variation from regional accents; c) calculation of reading rate, using the following formula: Rate = number of words read X 60 seconds / total reading time (in seconds); d) calculation of reading accuracy to obtain the rate, using the following formula: Accuracy = number of words read correctly X 60 seconds / total reading time (in seconds).

Participants were matched for the reading accuracy obtained in the task of oral reading of words⁽¹⁹⁾ and divided into the following experimental groups:

Group OT (original text) – composed of 56 schoolchildren (21 in 2nd grade, 11 in 3rd grade, and 24 in 4th grade; 21 boys) with mean age of 8.6 years exposed to reading of the original text.

Group ST (simplified text) – comprising 58 schoolchildren (21 in 2nd grade, 11 in 3rd grade, and 24 in 4th grade; 21 boys) with mean age of 8.5 years exposed to reading of the syntactically simplified text.

In the definition of pairs of schoolchildren according to reading accuracy, the members of each pair were randomly included in a given group by draw. In order to maintain the desired equity, the remaining member of the pair was immediately included in the other group.

A text comprehension assessment task using questions was applied so that the desired equivalence of the groups could be ascertained with respect to reading comprehension capacity⁽²⁰⁾. The participants were instructed to read the text in the habitual way (orally or silently), with no time limit, and then respond to fifteen questions orally. All the answers offered were recorded for further analysis. Correct responses were identified based on predetermined parameters by a panel of three referees, who created a correction screening⁽²⁰⁾. One point was assigned for each correct response and zero points were assigned for the incorrect answers. Therefore, participants were given one score per item (correct or incorrect) and a total score for the text (maximum of 15).

An analysis of equivalence was performed between the OT and ST groups to verify the equity of the groups according to their decoding and comprehension skills. As desired, it was observed that the study groups did not differ with respect to reading skills (Tables 1 and 2).

Chart 1. Comparative analysis of the measures of syntactic complexity between the original and simplified texts

Parameters analyzed	Original text	Simplified text
Number of sentences	15	19
Number of words per sentence	14.4	12
Number of sentences per paragraph	3.75	3.8
Incidence of functional words	439.815	394.737
Number of logical operators	30.702	23.148

Reading comprehension assessment through retelling of the original and simplified texts

For the retell task after reading, the texts were presented on A4 paper sheet, in uppercase, Arial font, size 12. In both assessment conditions, the schoolchildren were instructed to read the texts in the habitual way (orally or silently), with no time limit. All participants retold the information read when they were ready, and could not refer back to the text. Their retells were recorded for further transcription and analysis.

The retells obtained in both assessment conditions (original text and simplified text) were transcribed and the evaluator identified each of the ideas and retold links, assigning one point for each piece of information. After that, the total number of retold ideas and links were calculated⁽¹⁵⁾. The data resulting from the analysis were classified by student and submitted to statistical analysis.

Statistical analysis

Data were initially submitted to analysis of normality using the Shapiro-Wilk test; next, to evaluate the effect of syntactic simplification, performance of the groups was compared regarding the micro- (total of ideas) and macro-structural (total of links) variables using the Mann-Whitney U test. Data were processed in IBM® SPSS Statistics 22.0 software.

RESULTS

Comparative performance analysis between groups showed that more global levels of processing were not directly influenced by text synthetic simplification, a premise indicated by the

similarity of performance of the groups in the analysis of the variable total number of retold links (Table 3). These results can be explained by the reduced number of connectives and logical operators. Global comprehension requires understanding the interrelationships between ideas, connections that can only be established through the use of these syntactic elements.

The results presented in Table 3 also showed significantly better performance of the ST group regarding the variables total of retold ideas, as well as total of central and detailed ideas, which indicates that Syntactic text simplification can favor the construction of mental representations from extraction of the meaning conveyed by the propositions, thus promoting the processing of the text microstructure by the reader.

Results showed that reading performance is favored, with regard to processing of the micro- and macro-structures of the text, in students in the final years of Elementary School (3rd and 4th grades) who read the simplified text. In contrast, 2nd grade students exposed to the simplified text had their gains restricted to the processing of detailed ideas. The difference in the favoring profile may be a consequence of reading experience. Less experienced readers, even if exposed to a simplified text, would have facilitated access to the meaning of propositions; however, this would not be sufficient to direct their attention to macro-structural processing, primarily favoring comprehension of ideas at the local level. The effect of Syntactic text simplification on macro-structural processing was only observed in the performance of 3rd and 4th grade students, who presented greater retell of ideas of major relevance in the text (central ideas) compared with that of students who read the original text. By favoring comprehension of the propositions at the local level, schoolchildren would be able to better process the relationships between the ideas conveyed, selecting information more accurately, and keeping the central ideas present in the text active (Table 4).

Table 1. Comparative performance analysis between the groups Original Text (OT) and Simplified Text (ST) according to reading decoding

Variables	OT		ST		t	Average difference	p value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)			
Rate	43.37 (19.9)	45.14 (20.1)			-0.469	-1.77	0.640
Accuracy	33.01 (22.2)	34.7 (22.2)			-0.403	4.17	0.687

Student's *t*-test for independent samples; significance level ($p=0.05$); Rate measured in words per minute; Accuracy measured in correct words per minute

Subtitle: SD = Standard deviation; OT = Original Text group; ST = Simplified Text group

Table 2. Comparative performance analysis between the groups Original Text (OT) and Simplified Text (ST) according to reading comprehension

Variables	OT		ST		U	p value	Result
	Mean (SD)	Mean ranks	Mean (SD)	Mean ranks			
Reading comprehension	3.86 (2.11)	54.94	4.12 (2.4)	61.28	1480.5	-0.673	OT=ST

Mann-Whitney U test; significance level ($p=0.05$); Reading comprehension measured by the total of correct responses to questions about the text

Subtitle: SD = Standard deviation; OT = Original Text group; ST = Simplified Text group

Table 3. Comparative performance analysis between the groups Original Text (OT) and Simplified Text (ST) according to retell after reading

Variables	OT		ST		U	p value	Result
	Mean (SD)	Mean ranks	Mean (SD)	Mean ranks			
Central ideas	0.91 (1.62)	47.06	1.4 (1.47)	67.12	1029.5	0.001	OT<ST
Detailed ideas	1.5 (1.64)	39.21	2.35 (1.67)	74.48	599.5	0.000	OT<ST
Total of ideas	2.91 (1.02)	50.77	3.26 (1.82)	63.12	1247.5	0.041	OT<ST
Total of retold links	0.64 (1.00)	58.77	0.56 (1.00)	54.64	1461.5	0.364	OT=ST

Mann-Whitney U test; significance level ($p=0.05$)

Subtitle: SD = Standard deviation; OT = Original Text group; ST = Simplified Text group

Table 4. Comparative performance analysis between the groups Original Text (OT) and Simplified Text (ST) according to retell after reading as a function of education level

Grade	Variables	OT	ST	U	p value	Result
		Mean ranks	Mean ranks			
2 nd	Central ideas	22.48	21.55	221.00	0.767	OT=ST
	Detailed ideas	17.29	26.5	132.00	0.130	OT<ST
	Total of ideas	18.8	24.98	165.5	0.100	OT=ST
	Total of retold links	21.26	22.70	215.5	0.549	OT=ST
3 rd	Central ideas	22.3	21.55	19.500	0.003	OT<ST
	Detailed ideas	17.29	26.5	17.500	0.002	OT<ST
	Total of ideas	16.88	24.98	58.000	0.040	OT<ST
	Total of retold links	21.26	22.70	52.500	0.413	OT=ST
4 th	Central ideas	29.27	18.50	149.500	0.006	OT<ST
	Detailed ideas	15.71	32.65	77.000	0.000	OT<ST
	Total of ideas	21.21	26.91	209.000	0.004	OT<ST
	Total of retold links	25.85	22.07	281.500	0.261	OT=ST

Mann-Whitney U test; significance level ($p=0.05$)

Subtitle: SD = Standard deviation; OT = Original Text group; ST = Simplified Text group

DISCUSSION

Syntactic text simplification required the choice of previously studied syntactic modification criteria⁽¹⁶⁾ and adoption of methodological care to ensure, through assessment of the texts according to psycholinguistic parameters, the necessary conditions to conduct the proposed experiment. For this reason, we used the Coh-Metrix-Port⁽¹⁷⁾ computational tool, which offers different parameters of linguistic productivity that were used in the comparison of the texts: number of sentences, number of words per sentence, number of sentences per paragraph, incidence of functional words, and number of logical operators.

The syntactic simplification process preserved the original content of the text, considering that the purpose was to simplify the syntax and not reduce the text length, which could risk omitting some of its ideas. Thus, analysis of the texts using the Coh-Metrix-Port⁽¹⁷⁾ computational tool showed the following results: the simplified text presents a larger number of sentences because of the desirable breaking of complex sentences of the original text into simple sentences; reduction in the average number of words per sentence, showing a slight decrease in the total number of words per sentence, making the information more direct; maintenance of the average number of sentences per paragraph, which indicates that, although phrase modifications were made, information was not lost in the simplification process. In turn, with the simplification of complex sentences, functional words (prepositions, pronouns, conjunctions) and logical operators (incidence of AND, OR, IF, and number of negations) were the main reductions present in the simplified text. In contrast, maintenance of the number of propositions and equivalence of readability, according to the Flesch-Kincaid Index (both at reasonably difficult level of decoding), demonstrated that the syntactically simplified text can be understood in this way, because the comparative data of the psycholinguistic variables of the texts ensure greater simplicity to their linguistic structure, without loss of content or changes in its level of difficulty of decoding.

Also regarding methodological care, we highlight the comparative results of the performance variables in reading decoding and comprehension (Tables 1 and 2) - skills adopted as

control between the groups. It was possible to observe that the Original Text (OT) and Simplified Text (ST) groups presented similar level of reading, which enabled the assumption that the results observed in the performance comparison in the retell task were exclusively due to the effect of the type of text presented (original or simplified).

Results indicate that syntactic simplification influenced reading comprehension, because reading of the simplified text provided better performance in the retell of text ideas. These findings suggest that the text simplification employed, based especially on reducing sentence complexity and length, seems to have been determining for the students in the ST group to be able to process a larger number of propositions of the text, consequently presenting a larger number of retold ideas compared with those in the OT group. The simplified text, as previously discussed, was characterized by suppression of complex sentences and reduction of sentence length. These changes make the sentences closer to the structure of the text propositions, considered as the smallest units capable of expressing a complete meaning, composed of a predicate and its argument^(8,9). Therefore, simplification of the structure would facilitate the access to the sense of each unit, favoring its maintenance in memory^(3-5,11) and, consequently, increasing the probability of being retold later.

According to Kintsch⁽¹⁰⁾ and Kintsch and Vipond⁽¹¹⁾, processing of the text base is the structure for reading comprehension and its construction is directly associated with the processing of sentences, and this processing measures the decoding stage and the mental construction of the discourse conveyed by the text. It can thus be inferred that syntactic facilitation could favor access to meaning at its local level and create conditions for the more refined stages of reading comprehension to emerge.

This premise seems to find support in the data of the present study and in experiments conducted to test the interference of syntactic complexity with word recognition and reading comprehension⁽²¹⁾. Results of the survey revealed that simpler sentences favored the comprehension of expository texts and reduced the reading time of 2nd-9th grade Elementary School students, attesting to the positive effect of Syntactic text simplification.

As for the data of the present study, it is worth emphasizing that the significant reduction of linguistic elements, such as functional words (prepositions), and suppression of anaphora can also foster reading comprehension according to the literature.

Evidence indicates that logical connectives, called conjunctions or discursive markers, e.g., also, as a result, moreover, etc., play a strategic role in establishing text coherence, but usually cause an increase in reading time when present in long sentences, that is, they demand more time for their proper understanding. Other research findings point to the fact that presence of anaphoric references tends to undermine comprehension at their higher levels, because many of them are essential for the establishment of linear relationships between arguments at the local or global levels^(12,13). Therefore, the following hypotheses should be considered: inaccuracies in the comprehension of these elements can cause ruptures at the local level, which may interfere with the overall understanding of the text or, in the case of less proficient readers, the slower processing can compete for the necessary attention and monitoring of information fundamental to the overall comprehension of the text. In this context, its suppression would favor local understanding of the ideas - information compatible with the results obtained in the present research.

This study did not find any effects of syntactic simplification on the overall processing of the text, as evidenced by the similarity of the groups' performance, when the total number of retold links is studied - results that contradict the first hypotheses considered. Therefore, it is believed that mere syntactic simplification is not capable of producing effects on overall processing, as the effect of release of attention and operational memory resources implied the processing to other high-order functions involved in global processing.

Similar results were found by Graesser et al.⁽²²⁾. These authors justified that simplification of syntactic complexity facilitates only the access to the individual ideas of the text, to the detriment of global processing⁽²²⁾.

The explanation for these findings is compatible with the results of studies addressing text simplification that used suppression of anaphora in informative texts, which tend to be more demanding cognitively. Suppression of these constituents can favor access to the idea units, but they cause ruptures in comprehension at text macro-structural level⁽¹²⁾, preventing readers from establishing a relationship between the ideas and achieving the appropriate construction of the base text. Moreover, anaphoric relationships seem to use greater memory demand, making it difficult for readers to understand, which slows their reading in order to facilitate the processing of information⁽¹⁷⁾.

Studies that addressed the analysis of participants' ocular movements during reading indicated that readers readily retrieved information with respect to finding the pronoun only when it was a near syntactic antecedent, or when the sentences were syntactically simpler⁽¹⁴⁾. In other circumstances, the times of ocular regression trajectory to posterior regions of the text were increased, proving the greater cognitive demand of the text to resolve anaphora^(13,14), competing with the demand for overall text processing.

In summary, the results discussed so far suggest that syntax is determining in understanding the relationship of the text propositions, influencing the retell as the reader shows better conditions to perform syntactic parsing, which is the ability to identify the syntactic structures of sentences and use them to establish relationships between constituents. Therefore, its

simplification favors the construction of sense units that promote local comprehension, that is, the microstructure^(10,11), and the local establishment of the relationship between the pieces of information (macrostructure) because of improvement in semantic processing. However, suppression of anaphora and connectives (conjunctions) prevent these gains from being sensed at more global levels of text processing^(13,14,17).

For a more comprehensive understanding of the influence of simplification on reading comprehension, however, the present study investigated the effect of increased schooling and, therefore, of reading experience. It worth highlighting that both comprehension and memorization of central and detailed ideas were favored by text simplification when considering the entire sample. These data suggest that favoring of text processing occurred specifically on the access to units of text ideas (propositions), regardless of their importance to the overall structure of the text. However, study of the effect of text simplification as a function of education level (Table 4) enabled us to deepen the understanding of the results based on the aspects associated with the reader's learning.

Effects of text simplification on the microstructure were more efficient for students in the 3rd and 4th grades of Elementary School than for those in the 2nd grade. It is possible to assume that students in the final grades are more experienced readers, and that they have improved their reading decoding skills⁽²³⁾ and developed reading strategies capable of favoring the identification, selection and memorization of text ideas. Thus, when these students are exposed to a simplified text, these skills and the use of their linguistic and cognitive resources, for the sake of comprehension⁽²⁴⁻²⁶⁾, become unrestricted to process the text macrostructure, which makes them perform better in retelling the total of central and detailed ideas.

In contrast, younger schoolchildren who are still finishing the learning process of reading and developing in terms of reading efficiency and automaticity, seem to show that gains from text simplification only provide access to the meaning of propositional units, without being able to direct attention, language and cognitive resources to the selection of the central ideas necessary for the comprehension of the text⁽²⁷⁾. In the present study, only the retell of detailed ideas was favored by text simplification offered to 2nd grade students.

Similar studies⁽²⁸⁾, but conducted with learners of a second language, have indicated that simplification of sentences leads to a greater comprehension of propositions; however, readers tend to generate fewer inferences, especially those associated with anaphoric information. In addition, more proficient readers remembered a larger number of text propositions, especially those of greater relevance to the textual chain⁽²⁹⁾.

This study contributes to the adoption of Syntactic text simplification by Speech-language Pathology (SLP), considering that research on this theme has been confined to the field of psycholinguistics so far. Investigations in the field of SLP have become relevant, because in this area the clinical branch minds with the communicative aspects of reading and writing, seeking evidence on which simplification actions are capable of ensuring good levels of reading comprehension for good and bad readers, on understanding how they interfere throughout schooling and with learning to read, as well as on identifying at what point in the processing of text information they are able to act. The results obtained so far indicate benefits of syntactic simplification to the reading comprehension of Elementary School students in terms of micro-structural processing of texts.

Nevertheless, further investigations conducted with clinical groups may indicate important ways to attest to the efficiency of this simplification as a strategy to facilitate reading for bad readers in the academic and therapeutic contexts.

CONCLUSION

Syntactic text simplification favors the reading comprehension of 3rd and 4th grade Elementary School students. Reducing sentence length and grammatical complexity by replacing complex sentences with simple sentences promotes comprehension of the propositions, that is, of the units of information conveyed by the text.

However, favoring effects are different considering the schooling factor. More experienced readers (3rd and 4th grade students), when faced with text simplifications, are able not only to understand the propositions more easily, but also to direct their attention to better process the most relevant information in the text. The same does not occur with younger schoolchildren, for whom simplification only favors local processing of the text.

ACKNOWLEDGEMENTS

The authors are grateful to *Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq, Projeto Universal* no. 459953/2014-1, and *Programa de Bolsas de Iniciação Científica - PIBIC/CNPq* for supporting this study.

REFERENCES

- Siddharthan A. A survey of research on text simplification. *ITL-International Journal of Applied Linguistics*. 2014;165(2):259-98.
- Young DJ. Linguistic simplification of SL reading material: effective instructional practice? *Mod Lang J*. 1999;83(3):350-66. <http://dx.doi.org/10.1111/0026-7902.00027>.
- Siddharthan A. Resolving attachment and clause boundary ambiguities for simplifying relative clause constructs. In: *Proceedings of the 40th Meeting on Association for Computational Linguistics (ACL'02)*; 2002 July 6-12; Philadelphia. Stroudsburg: Association for Computational Linguistics; 2002. 60-5.
- Keblanov BB, Knight K, Marcu D. On the move to meaningful internet systems: OTM 2016 conferences. Rhodes: Springer; 2004. 977 p.
- Devlin S, Unthank G. Helping aphasic people process online information. In: *Proceedings of the 8th International ACM SIGACCESS Conference on Computers and Accessibility*; 2006 Oct 23-25, Portland. Portland: ACM; 2006. 225-6. <http://dx.doi.org/10.1145/1168987.1169027>.
- Tunmer W, Nesdale A, Wright D. Syntactic awareness and reading acquisition. *Br J Dev Psychol*. 1987;5(5):25-34. <http://dx.doi.org/10.1111/j.2044-835X.1987.tb01038.x>.
- Keshavarz MH, Atai MR, Ahmadi H. Content schemata, linguistic simplification, and EFL readers' comprehension and recall. *Read Foreign Lang*. 2007;19(1):19-33.
- Reed DK, Vaughn S. Retell as an indicator of reading comprehension. *Sci Stud Read*. 2012;16(3):187-217. <http://dx.doi.org/10.1080/10888438.2010.538780>. PMID:23125521.
- Kida ASB, Bueno GJ, Lima VLCC, Rossi SG, Nepomuceno PF, Martin MM, Ávila CRB. Influência da modalidade de reconto na avaliação do desempenho de escolares em compreensão leitora. *Estudos de Psicologia (Campinas)*. 2015;32(4):605-15. <http://dx.doi.org/10.1590/0103-166X2015000400004>.
- Kintsch W. *Comprehension: a paradigm for cognition*. New York: Cambridge University Press; 1998.
- Kintsch W, Vipond D. Reading comprehension and readability in educational practice and psychological theory. In: Nilsson L, organizador. *Perspectives on memory research: essays in honor of Uppsala University's 500th Anniversary*. Uppsala: Psychology Press; 1979. p. 329-65.
- Britton BK, Gulgoz S. Using Kintsch's computational model to improve instructional text: effect of repairing inferences calls on recall and cognitive structures. *J Educ Psychol*. 1991;83(3):329-45. <http://dx.doi.org/10.1037/0022-0663.83.3.329>.
- Murphy GL. Processes of understanding anaphora. *J Mem Lang*. 1985;24(3):290-303. [http://dx.doi.org/10.1016/0749-596X\(85\)90029-4](http://dx.doi.org/10.1016/0749-596X(85)90029-4).
- Cummings I, Patterson C, Felser C. Structural constraints on pronoun binding and coreference: evidence from eye movements during reading. *Front Psychol*. 2015;23(23):840. PMID:26157400.
- Kida ASB, Ávila CRB, Capellini SA. Marcadores sintáticos no reconto oral de escolares disléxicos. *CoDAS*. 2015;27(6):557-64. <http://dx.doi.org/10.1590/2317-1782/20152015106>. PMID:26691620.
- Watanabe WM, Candido A Jr, Uzêda VR, Fortes RPD, Pardo TAS, Aluísio SM. Facilita: reading assistance for low-literacy readers. In: *Proceedings of the 27th ACM International Conference on Design of Communication*; 2009 Oct 5-7; Bloomington. Bloomington: ACM Press; 2009. p. 29-36.
- Scarton CE, Aluísio SM. Análise da Inteligibilidade de textos via ferramentas de Processamento de Língua Natural: adaptando as métricas do *Coh-Matrix* para o Português. *Revista Linguística*. 2010;2(1):45-61.
- Pinheiro AMV. Transparência ortográfica e o efeito de retroalimentação fonológico grafêmica: implicações para a construção de provas de reconhecimento de palavras. In: Alves LM, Mousinho R, Capellini AS, editores. *Dislexia: novos temas, novas perspectivas*. Rio de Janeiro: Editora Wak; 2011.
- Pinheiro AMV. Frequency of occurrence of words in textbooks exposed to brazilian children in the early years of elementary school. *Childes - Child Language Data Exchange System*. 2015. Retrieved from <http://childes.talkbank.org/derived>
- Lucio PS, Kida ADSB, Carvalho CAFD, Cogo-Moreira H, Ávila CRBD. Construção de uma prova para avaliação da compreensão leitora no ensino fundamental: estudo piloto. *Temas em Psicologia*. 2015;23(4):1035-50.
- Ecalle J, Bouchafá H, Potocki A, Magnan A. Comprehension of written sentences as a core component of children's reading comprehension. *J Res Read*. 2013;36(2):117-31. <http://dx.doi.org/10.1111/j.1467-9817.2011.01491.x>.
- Graesser A, McNamara DS, Louwse M, Cai Z. Coh-Matrix: analysis of text on cohesion and language. *Behav Res Methods Instrum Comput*. 2004;36(2):193-202. <http://dx.doi.org/10.3758/BF03195564>. PMID:15354684.
- Seigneuric A, Ehrlich M. Contribution of working memory capacity to children's reading comprehension: a longitudinal investigation. *Reading Andwriting*. 2005;18:617-56.
- Bowey JA. Recent developments in language acquisition and reading research: the phonological basis of children's reading difficulties. *Australian Educational and Developmental Psychologist*. 2000;17(1):5-31. <http://dx.doi.org/10.1017/S0816512200028017>.

25. Kendeou P, Muis KR, Fulton S. Reader and text factors in reading comprehension processes. *J Res Read.* 2010;34(4):365-83. <http://dx.doi.org/10.1111/j.1467-9817.2010.01436.x>.
26. Kim YSG. Why the simple view of reading is not simplistic: unpacking component skills of reading using a Direct and Indirect Effect Model of Reading (DIER). *Scientific Studies of Reading.* 2017;21(4):1-24. <https://doi.org/10.1080/10888438.2017.1291643>.
27. Amendum SJ, Conradi K, Hiebert E. Does text complexity matter in the elementary grades? A research synthesis of text difficulty and elementary students' reading fluency and comprehension. *Educ Psychol Rev.* 2018;30(1):121-51.
28. Clapham C. The effect of language proficiency and background knowledge on EAP students' reading comprehension. In: Clapham C. *Validation in language assessment.* London: Routledge; 2013. p. 155-182.
29. Crossley SA, Kyle K, McNamara DS. The tool for the automatic analysis of text cohesion (TAACO): automatic assessment of local, global, and text cohesion. *Behav Res Methods.* 2016;48(4):1227-37. <http://dx.doi.org/10.3758/s13428-015-0651-7>. PMID:26416138.