Original Article

Correlation between time, error, speed and reading comprehension in students with learning disorders

Correlação entre tempo, erro, velocidade e compreensão de leitura em escolares com distúrbio de aprendizagem

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ABSTRACT

Purpose: To correlate the variables error, time, speed and reading comprehension of students with learning disorders and students without learning disorders. **Methods:** The participants of this study were 40 students, aged from 8 to 12 years old, of both genders, from 2nd to 4th grades of municipal elementary education, divided into GI: comprising 20 students without learning disorders, and GII: comprising 20 students with learning disorders. As procedure we used a selection of texts indicated by teachers of 2nd to 4th grades of municipal schools, for an oral reading task. Reading comprehension of the texts was assessed through four questions presented sequentially after reading, which students should answer orally. **Results:** Differences were found between GI and GII regarding the number of errors, reading speed and comprehension, and total reading time. There was a positive correlation between the variables total time of reading and errors during reading, and a negative correlation between the variables total time of reading and reading speed. GII obtained differences with negative correlation between the variables total time of reading and reading speed. **Conclusion:** For students with learning disorders, the performance in the variables correlated is altered, interfering in their reading development and, consequently, in their comprehension of the read text.

Keywords: Learning; Reading; Comprehension; Learning disorders; Educational status

INTRODUCTION

Learning disorders is a generic term that refers to a heterogeneous group of alterations and manifestations by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical skills, characterized by low performance in relation to the chronological age, measured intelligence and education which would be appropriate to age. It refers to a group of specific and determined alterations which are difficult to be identified. Although a learning disorder may occur concomitantly with other unfavorable conditions such as sensory alteration, mental retardation, emotional disturbance and/or social or environmental influences such as cultural differences, insufficient or inappropriate instruction and psychogenic factors, it is not a direct result of these conditions or influences[1].

Among the skills that are altered in students with learning disorders we can highlight those that involve decoding or word identification, reading comprehension, spelling activities and written expression. These changes are intrinsic to the individual, presumably due to dysfunction of the Central Nervous System[2-4].

Reading involves a variety of processes that begin in the visual identification of letters and goes to the understanding of content and context of the written word. For the reading process to occur it is necessary for the child to acquire some skills. These skills include language, attention to understand and interpret written language, auditory memory, visual memory, word identification, structural analysis and context of language, logic synthesis, expansion of vocabulary, comprehension and fluency in reading[5-8].

Because it is a complex activity, reading has been represented through models of information processing, among them is the dual-route model, which best describes the reading processing of the alphabetic writing, that is, reading by phonological route or through lexical route[9].

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Reading by phonological route depends on the use of knowledge of rules of grapheme-phoneme conversion for the construction of the pronunciation of the word to be made. It is created, then a phonological code, which is identified by the system of auditory recognition of words, releasing the meaning of the word. Reading by the lexical route depends on the recognition of a word previously acquired and memorized in the system of visual recognition of words, recovery of meaning and pronunciation of this word through direct addressing of the lexicon. In this case, pronunciation is obtained as a whole. Thus, words of different levels of alphabetical regularity can be read without problems[8-12].

The high frequency, regular and short words can be easily retrieved from the lexicon, allowing a faster and accurate reading. By reading new, infrequent, large, irregular words, or ones being learned, rules of grapheme-phoneme conversion are utilized and when this association occurs with a irregular phoneme the chances of errors during reading increases[8,10,13].

Like reading, reading comprehension will also depend on the interrelation between various cognitive and linguistic processes. Basic processes such as word recognition and extraction of the meaning of printed words are not sufficient for a successful reading comprehension. Thus, it is necessary that the reader realizes high-level cognitive processes such as the ability to make inferences, memory, vocabulary and fluent reading[8,14,15].

The process of comprehension begins when the reader comes to have contact with some new content, this way the working memory is activated in order to capture the information already stored in long-term memory. The reader then develops basic processes of reading, the recognition and extraction of the meaning of printed words, including the new information and its structure clearly and in an organized way, so now this will be archived, awaiting the opportunity to be accessed[12,16,17].

Studies combining the skills involved in reading, as reading speed, fluency, reading time, memory and comprehension, have become a focus of interest for works done with individuals with learning difficulties and disorders[4,8,11,15,16,18-20]. However, there are insufficient researches relating reading skills to comprehension, especially among students with learning disorders.

Given the above considerations, this study aimed to correlate the variables: errors, time, speed and reading comprehension in students with learning disorders in relation to students without learning disorders.

METHODS

This study was conducted after approval by the Research Ethics Committee of the Universidade Estadual Paulista "Júlio de Mesquita Filho", under protocol number 2596/2007.

The study included 40 Elementary School students from municipal schools, 35 (87,5%) males and five (12,5%) females, aged between 8 and 12 years old, paired by grade, divided into two groups:

Group I (GI): comprising 20 students without learning disorders, being six from 2nd grade, six from 3rd grade and eight from 4th grade, 16 (80%) males and four (20%) females.

The students without learning disorders were selected by teachers following the criterion of satisfactory performance in two consecutive bimesters in evaluation of reading and writing, and all students of this group were at the alphabetic level of writing development. From this indication, the students had previously been submitted to otorhinolaryngologic, hearing and eyesight evaluations with results within normal limits.

Group II (GII): comprising 20 students with interdisciplinary diagnosis of learning disorders, being six from 2nd grade, six from 3rd grade and eight from 4th grade, 19 (95%) male and one (5%) females.

The diagnosis of learning disorders was conducted prior to the start of this study, by an interdisciplinary team of the Center for Studies in Education and Health and Clinic of Child Neurology – Learning at the General Hospital of the Universidade Estadual Paulista "Júlio de Mesquita Filho", including speech and language evaluation, evolutionary neurological examination (ENE), educational, neuropsychological and neuroimaging studies (Single Photon Emission Computed Tomography – SPECT). All students of this group were at the syllabic or syllabic-alphabetic level of writing development. The students diagnosed with learning disorders who participated in this research were on the waiting list for speech language therapy, not having undergone any kind of intervention procedures prior to this study.

Exclusion criteria were considered the presence of sensory (visual or auditory), motor or cognitive impairment. Inclusion criteria were considered signature of the Free and Informed Consent Term, students with learning disorders diagnosed by neuropsychological, speech-language pathology, and neurological examination, and the absence of auditory or visual complaints described in the school records of the participants of this study.

Procedure was performed as oral reading and comprehension of texts through four questions where the students verbally answered the questions asked by the researcher. The selected texts were composed by an average of 215 to 265 words, and heir degree of complexity and length of words was increased according to grade level. The questions were developed considering the levels of mental activity necessary to comprehension[21,22], involving processes of local character, to verify that the student understood the parts that make up the text and is interconnecting the ideas of the text, and processes of global character, to check whether the student understood the text as a whole, or globally.

The analysis of the reading of the texts was realized by recording to count the number of errors in the words read (accuracy of reading), total time of reading and reading speed expressed in words per minute. The reading speed was calculated by multiplying the number of words in the text per 60 seconds (one minute) and this value was divided by the total reading time of the text in seconds, as described in the literature[23,24,25]. Responses were analyzed according to the following criteria: four correct answers = 100% accuracy (full understanding), three correct answers = 75% (partial understanding), two correct answers = 50% (partial understanding), a correct response = 25% (insufficiency understanding), and no correct answer (lack of reading comprehension).

Data collection was performed at the Center for Studies in Education and Health in an opposite period of students' class in an individual session with duration of 50 minutes.

The results were analyzed statistically with a significance level of 5% (0,050) for the application of statistical tests. The Mann-Whitney test was used in order to verify possible differences between the averages of the groups formed, and the Spearman Correlation Analysis test was used to verify the degree of relationship between variables.

RESULTS

The groups GI and GII were described by mean, standard deviation, minimum and maximum reference value and p-value of the variables: errors, speed, time of reading and comprehension of text (Table 1). When the Mann-Whitney test was applied, it was observed that there was no difference between GI and GII in all variables. In relation to the variable error, the GI had lower average errors in reading compared to GII. For the variable speed of reading, the students from GI showed higher average of speed compared to GII. In relation the variable reading comprehension, GI presented higher average score on the questions related to the texts compared to GII. For the variable total reading time, GI showed a lower average in reading time compared to GII.

In table 2, it is possible to verify the correlation between the variables of reading of the GI. When the Spearman Correlation Analysis was applied, it was observed negative correlation coefficient between the variables speed and total reading time in GI; that is, the higher the speed of reading, the higher the number of words read per minute and the lower the time taken to perform this task.

From the data we found that students of the group GII, in correlation analysis of variables also showed negative correlation, indicating that the higher the reading speed, lower was the time need to perform the same (Table 3).

When the Spearman Correlation Analysis was applied in the variables of reading of GII it was observed a positive correlation between the variables total time of reading and errors in reading, indicating that with increasing number of errors committed in reading there was an increase in the total time of reading among students of GII.

Table 1. Comparison between the groups GI and GII for the variables of reading skills and text comprehension

Variables	Group	Mean	SD	Minimum	Maximum	p-value
Errors	I	6.75	3.96	0.00	16.00	<0.001*
	II	31.55	13.08	8.00	58.00	
SR	I	94.31	35.30	34.40	177.30	<0.001*
	II	38.58	12.42	22.20	69.50	
COMP	I	0.78	0.24	0.25	1.00	<0.001*
	II	0.18	0.20	0.00	0.75	
TT	I	177.15	56.14	88.00	318.00	<0.001*
	II	426.55	136.45	225.00	756.00	

* Significant values (p≤0.050) – Mann-Whitney test

Note: TT = total time; SR = speed of reading; COMP = text comprehension; SD = standard deviation

Table 2. Correlation between the studied variables regarding the performance of the students in group GI

Variables	Statistical	Errors	SR	COMP
SR	Correlation coefficient (r)	-0.127	—	—
	p-value	0.594	—	—
COMP	Correlation coefficient (r)	-0.194	0.204	—
	p-value	0.413	0.387	—
TT	Correlation coefficient (r)	0.092	-0.948	-0.206
	p-value	0.698	<0.001*	0.385

* Significant values (p≤0.050) – Spearman Correlation Analysis test

Note: TT = total time; SR = speed of reading; COMP = text comprehension

Table 3. Correlation between the studied variables regarding the performance of students in the group GII

Variables	Statistical	Errors	SR	COMP
SR	Correlation coefficient (r)	-0.342	—	—
	p-value	0.140	—	—
COMP	Correlation coefficient (r)	-0.359	0.354	—
	p-value	0.120	0.126	—
TT	Correlation coefficient (r)	0.495	-0.910	-0.352
	p-value	0.027*	< 0.001*	0.128

* Significant values (p≤0.050) – Spearman Correlation Analysis test

Note: TT = total time; SR = speed of reading; COMP = text comprehension

The results of correlation analysis of variables speed and reading time for the students of the group GII showed negative correlation between them, indicating a decrease in reading speed and increase in total time required for reading the text, that is, for students with learning disorders, reading words is less automated.

DISCUSSION

Our results revealed that, in comparing the groups GI and GII, the students of the group GI had the highest score average in speed and comprehension of reading. Our data corroborate the literature[12,20,26], considering that the more rapid the identification of a word in a text, the greater the availability of resources of working memory to perform operations of syntactic analysis, semantic integration of the constituents of the sentence and integration of sentences in textual organization. These processes are of great importance to performance in reading comprehension and speed as well as for decoding words.

Thus, it becomes difficult for students with learning disorders to present regulatory performance in tests that require speed of reading and accuracy in word identification, due to the impairment in phonological skills (phonological awareness, syntax and semantic) and the change in access to lexicon and previously stored in memory[4,12,25,26].

With regard to errors made during the reading and the total time required for reading, the students of the group GI had a lower average of errors when compared with the group GII, suggesting a change in recognition skills and association of the generative mechanism, grapheme/phoneme and word identification for students with learning disorders. The increase in the number of errors in reading leads to a decrease of the number of words read per minute, that is, it causes an increase of the total time required to perform the reading, also affecting the full comprehension of the text[4,18].

In the analysis of correlation between the variables of the group GII, there was a positive correlation between the variables of total time of reading and errors made in reading, indicating that with the increase in the number of errors made during the reading there was an increase of the total time of reading.

In the literature[2,4,27] there are reports that students with learning disorders have an impairment in cognitive mechanisms required to analyse, decode, manipulate, store and recall the linguistic information. Thus, the number of errors made during the reading becomes more frequent, which consequently, increases the total time required to perform the reading due the difficulty in decoding, change in information storage and deficit in automatically and fluently recognizing the word.

The results of correlation analysis of the variables speed and reading time for the students of the group GII, showed a decrease in reading speed and increase the total time required for reading the text, suggesting that for students with learning disorders reading words is less automated[4,8,10]. This data points to the relationship between automaticity in word reading, speed reading of texts and working memory, because the accurate and fast (automatic) access to the mental lexicon influences positively on the time spent in the reading of a text, as we see in the results of this study[12,28,29].

The students of the group GI, in the correlation analysis of variables speed and time of reading, show negative correlation, indicating that the higher the reading speed, the lower the time needed to perform the task, suggesting that for these students the mechanisms for identifying and decoding words are presented automated[4,10].

This can be explained by the close relationship between the development of reading and letter/sound decoding skill, that is, the knowledge of letters with their respective sounds and reading speed. Thus, it becomes possible to suggest that, when the students have changes in reading and in skills which depend on its performance, these students may not be making substantial gains in knowledge of letters and certainly present difficulties in reading acquisition, as well as involved in other skills such as word identification, fluency, reading speed, among others; which interferes negatively in the academic performance of students with learning disorders[4,20,29,30].

Although our data come from students with learning disorders, the results point to the need to include in the initial evaluation, the variables in this study, in order to establish a profile of reading in students who have some type of reading problem. Thus, it would be possible to contribute to the diagnosis of speech language therapy in the field of reading and writing and establish intervention programs. The inclusion of mechanisms of fluency and accuracy of reading, could provide, in addition to speed in access to the mechanism of grapheme-phoneme conversion, speed, accuracy and comprehension of material read.

CONCLUSION

Data from this study have highlighted that there was a positive correlation between the variables total time of reading and errors committed during the reading for students of the group GII, and a negative correlation between the variables total time of reading and speed to the students of GI and GII. These findings contributed to identify the factors that affect the acquisition and reading comprehension of students with learning disorders.

RESUMO

Objetivo: Correlacionar as variáveis: erros, tempo, velocidade e compreensão de leitura de escolares com distúrbios de aprendizagem e escolares sem dificuldade de aprendizagem. **Métodos:** Participaram deste estudo 40 escolares de 8 a 12 anos de idade, de ambos os gêneros, de 2ª a 4ª série do Ensino Fundamental Municipal, divididos em GI: composto por 20 escolares sem dificuldade de aprendizagem e GII: composto por 20 escolares com distúrbio de aprendizagem. Foram utilizados textos selecionados a partir da indicação de professores da 2ª à 4ª série da Rede Municipal de Ensino, para a realização de leitura oral. A compreensão foi realizada por meio de quatro perguntas apresentadas após a leitura do texto, às quais os escolares deveriam responder oralmente. **Resultados:** Houve diferença entre GI e GII no número de erros, velocidade e compreensão de leitura e tempo total de leitura. A correlação entre tempo total de leitura e erros cometidos durante a leitura foi positiva, e entre as variáveis tempo total de leitura e velocidade de leitura foi negativa. Para o grupo GII, houve diferença com correlação negativa entre as variáveis tempo total de leitura e velocidade de leitura. **Conclusão:** Para os escolares com distúrbio de aprendizagem, o desempenho nas variáveis que foram correlacionadas encontra-se alterado interferindo no desenvolvimento em leitura e, consequentemente, na compreensão do texto lido.

Descritores: Aprendizagem; Leitura; Compreensão; Transtornos de aprendizagem; Escolaridade

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