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Vocabulary, phonological awareness and rapid naming: contributions for spelling and written production

Vocabulário, consciência fonológica e nomeação rápida: contribuições para a ortografia e elaboração escrita

ABSTRACT

Purpose: To investigate if the performance on linguistic tasks would be predictive of orthographic domain and quality of written productions. **Methods:** Participants were 82 fourth graders of Elementary Education, from public and private schools of São Paulo, with ages ranging from 9 years to 10 years and 2 months. The test battery was composed of an expressive vocabulary test, phonological awareness and rapid serial naming tasks, words and pseudowords spelling, and written text composition using a visual stimulus as a starting point. The statistical analysis included Spearman (r) correlations among all tasks. **Results:** The results indicated that the better the vocabulary skills, the smaller the number of spelling errors and the better the quality of the written text productions, considering all the analyzed categories. Also, the higher performance in both phonological awareness and rapid object naming tasks was correlated to fewer spelling errors and written text productions with greater grammatical structure. **Conclusion:** The linguistic abilities analyzed in this study were predictive of subjects' spelling performance. The vocabulary skills were predictive of the quality of written text productions. However, phonological awareness and rapid serial naming were only predictive of children's performance concerning the syntactic and grammatical structure of their written text productions.

RESUMO

Objetivo: Avaliar se o desempenho em provas de linguagem é preditivo do domínio ortográfico e da qualidade da produção escrita. **Métodos:** Participaram deste estudo 82 alunos do 4º ano do Ensino Fundamental de escolas públicas e privadas da região Oeste da Grande São Paulo, na faixa etária entre 9 anos e 10 anos e 2 meses de idade. A bateria de provas e testes deste estudo envolveu a avaliação de vocabulário expressivo, tarefas de consciência fonológica e nomeação seriada rápida de objetos, ditado de palavras e pseudopalavras, e elaboração de redação a partir de estímulo visual. Os dados foram submetidos a análise estatística para verificação da correlação entre todas as provas. **Resultados:** Os resultados indicaram que o melhor nível de vocabulário se correlacionou a um menor número de erros de ortografia e a uma melhor qualidade da redação, em todas as categorias analisadas. Assim como, o melhor desempenho em tarefas de consciência fonológica e de nomeação rápida de objetos se correlacionaram a menos erros de ortografia e melhor estrutura sintática e gramatical na produção do texto escrito. **Conclusão:** As habilidades linguísticas analisadas foram preditivas do desempenho ortográfico. A habilidade de vocabulário foi preditiva da qualidade de elaboração escrita. No entanto, a consciência fonológica e a nomeação seriada rápida predizem apenas o desempenho relacionado à estrutura sintática e gramatical da geração do texto escrito.

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INTRODUCTION

Although the oral language relevance to reading decoding is not unanimous in the literature, some authors have suggested that lexical acquisition has some influence on written language development in the initial phases of literacy acquisition, arguing that the writing of any word, even considering low frequency words and pseudowords, implies in lexical searching. Finding a lexical representation requires both phonological and orthographic processes, because this information is intrinsic to the word representation⁽¹⁾. Moreover, children's vocabulary level would be predictive of their later reading and writing performances⁽²⁾. Young children have a remarkable capacity for quickly acquiring new words. This is one of the most important and elementary aspects of language acquisition, which involves the ability to link the phonological form to its referent, due to general attentional mechanisms used to identify phonotactic, syntactic and semantic regularities of the linguistic environment⁽³⁾.

After the initial rapid vocabulary growth in the semantic level, vocabulary becomes more and more refined due to frequent exposures to words throughout weeks, months or years. This refining is a slower process that involves the development of a network of relationships among words, by means of semantic characterizations⁽³⁾. The hierarchical system of lexical organization involves a basic level of concepts and its superordinate concepts. The basic concepts are first learned by the child, that is, the child first learns "cat" (which is a basic concept) and then the concepts "animal" or "feline" (which are superordinate concepts), before "Siamese cat" (which is a subordinated concept).

Therefore, a higher amount of information is found in the basic level of categorization, which instances share an expressive amount of attributes concerning its form, representation gestures, and functionality to human beings. In the superordinate level, more instances are included but with less specificity. Conversely, in the subordinate level, there are fewer instances and more specificity⁽⁴⁾. The network of semantic connections continue to be developed during the scholar years and, around the age of nine years, there is a remarkable change concerning the conceptual domain of the taxonomic relationships that involves class relations. Thus, for most children at this age, a given word elicits another word of the same semantic class or paradigm, in word-association tasks (for example: car – truck). It suggests, therefore, that the taxonomic relations become amazingly noticeable throughout the time, although only around the age of 10 years children start to consistently include the labels of these categories⁽⁵⁾.

The cognitive operations involved in phonological processing work out automatically during the speech perception and production in real time. However, speakers gradually develop the capacity not only to think about the phonological information, but also to manipulate it. This metaphonological ability, the phonological awareness, is critical for written language learning, since the alphabetical system encodes lexical inputs at the phoneme level. In an alphabetic system, readers undergoing literacy rely basically on phonological decoding, converting a

letter or a letter set into sounds, in order to read the words⁽⁶⁾. There is wide evidence of a strong correlation between the phonological awareness before the onset of alphabetization and later reading and writing skills development^(7,8), and it is known that phonological awareness is the best indicator of spelling ability concerning both regular and irregular words^(9,10). Besides that, results from interventional studies⁽¹¹⁻¹³⁾ have proved that metaphonological abilities can be developed under stimulation, ensuring success in the learning of reading and writing.

Phonological decoding is also a self-teaching mechanism. Each time a child becomes able to successfully decode a non-familiar word, it allows the acquisition of specific orthographic information from that word. Consequently, the child develops knowledge about the words' orthography and the orthographic conventions of his or her idiom, which can be extended to other words. In that sense, writing provides a means for comprehension of the relationship between speech sounds and words' spelling, because it forces the child to think about the letter-sound correspondences, the relationship between spoken and written language, and the orthographic patterns and rules, leading him or her to develop better phonemic awareness abilities⁽¹⁴⁾.

The operational memory and the lexical access also perform a primordial role on the development of proficient reading and writing. When reading or writing a word, the child recovers some orthographic and phonological information from the lexicon and retains it in the operational memory, until he or she has made the phoneme-grapheme association⁽¹⁵⁾. Both the lexical access and the operational memory predict an additional variance in the written language learning, besides the variance predicted by both phonological awareness and the knowledge about phoneme-grapheme correspondence^(16,17). The information stored in the long-term memory is phonologically coded, allowing a faster and more effective recovering. The progressive lexical reorganization, as a response to the acquisition of a greater number of phonologically similar words, would explain how children develop the sensitivity required for deeper levels of phonological structures, faster and more accurate lexicon, and efficient use of the phonological sketchpad to encode information in the operational memory. Such fact justifies why children generally present better performances on phonological awareness tasks involving high frequency words⁽⁶⁾. Since the written language learning is tightly related to these three phonological processing operations, the rupture in any one of them could cause a deleterious impact on reading and writing learning⁽¹⁸⁾.

Until recently, the influence of rapid serial naming on reading and writing had been ignored or it was thought to be dependent to the general phonological processing. Differences between rapid serial naming and phonological awareness rely on the complex cognitive structure for naming, as well as on the importance of the time periods among and through each one of its multiple subprocesses. The rapid serial naming involves a series of attentional, perceptive, conceptual, mnemonic, and lexical processes. Then, the motor commands translate the recovered phonological information into a name which is then spoken into words. The entire process occurs in 500 ms. This

model exemplifies both the importance of the access to phonological encoding during naming and the fact that the phonological process represents only one of the multiple processes involved in the task. Moreover, an extra demand of speed and seriation is added to each one of these components, making the rapid naming a diverse and singular cognitive task⁽¹⁹⁾.

Even though many researchers have agreed that rapid serial naming is connected to the written language, the exact way it happens remains controversial. In the same way, the existence of a special relationship between rapid naming and the spelling ability, contrarily to phonological awareness, is not unanimously demonstrated. A study that have investigated the correlation among rapid serial naming, phonemic awareness, and several measures of reading and writing abilities highlights that phonological encoding skills are the basis for learning the words' correct spelling, even considering words with irregular letter-sound correspondences. The study also suggests that the subjacent mechanisms of rapid serial naming perform a relatively modest role on reading and writing acquisition in a written alphabetic system⁽²⁰⁾.

Currently, some researchers have indicated that the orthographic domain depends on several linguistic knowledge sources that include: phonological awareness, phoneme-grapheme correspondence, rules for acceptable and non-acceptable sequences of letters, limitations of orthographic patterns according to the sound position in a word, that is, the orthotactic, semantics, and morphology, as well as clear and concise orthographic images⁽²¹⁾. The linguistic components that underlie orthography learning also underlie the reading learning⁽²²⁾. Therefore, the development of these two linguistic capacities follows a similar course of acquisition. Currently, the most accepted theory about orthography acquisition and development is the repertory theory, instead of the stages theory. The repertory theory proposes that since the onset of literacy acquisition, children use several strategies to write orthographically, based on the knowledge mentioned above, varying only the intensity of using these strategies throughout the school age until adulthood^(21,23).

There is also an effort to increase the scientific knowledge about the writing process concerning both the development and the comprehension of the aspects involved in this process. Generally, the models of written language development are conceptualized as problem-solving processes, by which writers attempt to produce a visible, legible, and understandable language that reflects their declarative knowledge⁽²⁴⁾.

Text production relies on the graphomotor and linguistic capacities, which are controlled by brain areas that are myelinated during early childhood, whereas planning and revision capacities are executive functions controlled by the frontal lobe, which will be completely myelinated only in adolescence. For most children, the cursive letter becomes automatic at the end of the initial scholar years, but the orthography does not. In the subsequent scholar years, both letter's tracing and spelling become more and more automatic, releasing the operational memory capacity for planning and self-regulation during the writing process. As a result, the operational memory starts to make connections to executive processes that are specific to

the writing system. However it happens in a limited way, since the revision process emerges before the planning process and it does not occur at all language levels. Thus, individual differences may be observed concerning the development of executive functions, which support the strategies for text adaptation to a possible reader. There is also an enhancement in the connections between reading and writing, since children are increasingly asked to write about what they read, or asked to read their own productions in order to revise them. Only in adolescence there will be an increase in the connectivity among operational memory and all the cognitive components of the writing system, as well as the emergence of the revision capacity in all language levels, making the teenager's written productions closer to the production of an adult proficient writer⁽²⁵⁾.

An important component of the writing system is the generation of ideas. Every written composition is a creative act because it generates what did not previously exist. Ideas are probably stored in the implicit memory until they are consciously experienced, as they get into our explicit memory. Although some individuals seem more creative than others, it is not known where and how the ideas are outlined in the brain. Moreover, they cannot be expressed or communicated to others without language⁽²⁵⁾.

The aim of this study was to investigate if the performance on vocabulary, phonological awareness and rapid naming tests would be predictive of orthographic domain and quality of a composition written by students from the fourth grade of Elementary School, so that more effective interventions can be developed concerning prevention, diagnosis, and treatment of reading and writing disorders.

METHODS

Participants

This research was approved by the Ethics Committee for the Analysis of Research Protocols (CAPPesq) of the School of Medicine of the Universidade de São Paulo (USP), under protocol number 410/04.

Participants were 82 fourth graders of Elementary Education, from public (41) and private (41) schools of São Paulo, with ages ranging from 9 years to 10 years and 2 months. Subjects were selected according to the following criteria: school teacher indication, assuring that the child did not present speech, language and/or learning complaints; absence of diagnosis of language disorder, phonological disorder and/or of previous phonological intervention according to a questionnaire completed by parents or legal tutors; normal results on the naming task of the ABFW Phonology Test⁽²⁶⁾, standardized for Brazilian Portuguese. All the participant's guardians signed the Consent Form.

Material and procedures

All participants were assessed using the following tests:

- ABFW Vocabulary Test⁽²⁷⁾, standardized for Brazilian Portuguese, consisting of 118 pictures from nine conceptual

fields: clothing, animals, food, means of transportation, furniture and accessories, professions, places, shapes and colors, and toys and musical instruments. The number of usual word designations (UWD), incorrect designations or substitutions processes (SP), and the number of no designations (ND) were analyzed. Even though this test was standardized for children up to 6 years of age, a lower age range than the mean age of the subjects, we chose to use it as part of the test battery anyway, due to the lack of another available vocabulary test standardized for Brazilian Portuguese. The same analysis type was used, comprising usual word designations and substitution processes.

- Lindamood Auditory Conceptualization Test (LAC), adapted for Brazilian Portuguese⁽²⁸⁾, for phonological awareness assessment. The converted scores (CS) were calculated for the following categories: I-A (identification and discrimination of three isolated phonemes), I-B (identification and discrimination of three isolated phonemes, having one repeated phoneme), II (metaphonological skills: phoneme exclusion, segmentation, addition, and phoneme inversion in pseudowords), and Total (sum of all the CS).
- Rapid Object Naming (RON) subtest from the Comprehensive Test of Phonological Processing (CTOPP), adapted for Brazilian Portuguese⁽²⁸⁾. The naming time of 36 stimuli of two picture boards was measured and the number of errors was calculated.
- Spelling of ten high-frequency words (HFW), ten low-frequency words (LFW), and ten pseudowords (PW)⁽²⁹⁾. The number of errors was computed.
- Written composition using a visual stimulus as a starting point. This task was analyzed using a protocol developed exclusively to this study, based on the Test of Written Language 3rd Edition⁽³⁰⁾, which defines three categories of written narrative assessment: Contextual Conventions (use of capital letters in the beginning of the phrases, number of paragraphs, use of commas, and number of spelling errors); Contextual Language (written text development concerning the use of periods, use of punctuation, connectives, subject-verb, gender and numeral agreement, utterances length, the amount of correct words, cohesion, and vocabulary choices); and Story Construction (development of the theme suggested by the picture stimulus, ideas expression in an organized and understandable way, relationship between the story and the picture stimulus, written composition's level of energy, creativity, presence of characters with emotional or affective characteristics, some moral expression, and ending the story).

The test battery was administered at the school, during the period of students' attendance. The tests' administration was carried out in two individual sessions and one group session. In the first session, the Phonology tasks from the ABFW Child Language Test were administered. If the child presented no phonological disorders, the ABFW Vocabulary Test was then administered. In the second individual session, the LAC and RON tests were administered, in a randomly determined order, in the way that half of the subjects have first performed the LAC test, and the other half have first performed the RON test.

The third session was a group session, when the spelling and written composition tests were administered.

Statistical analysis

The Spearman correlation coefficients (r) were calculated for determining correlations between the Vocabulary, LAC, RON, spelling, and written composition tests. The significance level adopted for all analyses was $p=0.05$.

RESULTS

Table 1 shows the p -values and the Spearman correlation coefficients (r) among the Vocabulary, LAC, RON, spelling, and written composition tests.

The results point out the existence of correlations between the number of errors in the RON test and the number of errors in the spelling of HFW, total errors in the spelling, and the Contextual Language category of the written composition test; besides correlations among the LAC scores and the number of errors in the spelling of words and pseudowords, and the Contextual Conventions and Contextual Language categories of the written composition test. Moreover, there was correlation among the number of UWD and SP of the Vocabulary test and the errors in the spelling of words and pseudowords, and all the analysis categories of the written composition test (see Table 1).

DISCUSSION

Results suggest that the RON seems to influence the orthographic domain, with special highlight to the correlation found between naming time and number of errors in the HFW spelling, confirming, therefore, the findings of previous research, which have reinforced the importance of this ability to the acquisition of orthographic encoding patterns^(16,17). As it can be seen, the greater correlation between time of RON and word spelling occurred for the HFW, for which lexical access is supposed to be faster and more effective, due to a more segmented storage of these words, as a consequence of the lexical reorganization⁽⁶⁾. This result may indicate that the lexical access involved in the rapid naming task would influence the writing of high-frequency words, which are expected to be written from a memory strategy, being therefore strongly dependent of the quality of this lexical access. It is also possible to speculate that the subprocesses of visual integration involved in the RON task would be related to the establishment of orthographic mental pictures of the HFW⁽²¹⁾.

On the other hand, the observation of an existing correlation between time of RON and number of errors in the pseudowords spelling was unexpected. To write such words, the child is expected to use phonological encoding. In that sense, we did not suppose that some possible correlation with rapid naming would be found. Nevertheless, we observed that some of the participants used analogy strategies to write some words from their lexicon. Thus, the lexical access in the rapid naming task could be the common component between pseudowords writing and time of rapid naming, since some children did not write

Table 1. Correlations among the Vocabulary, LAC, RON, spelling, and written composition tests

Test		HFW	LFW	PW	Total errors	Contextual convention	Contextual language	Story construction
Naming errors	r	0.240*	0.277*	0.144	0.278*	-0.106	-0.257*	-0.089
	p	0.030	0.012	0.197	0.012	0.341	0.020	0.426
Naming time	r	0.412*	0.351*	0.229*	0.362*	-0.304*	-0.408*	-0.184
	p	0.000	0.001	0.039	0.001	0.005	0.000	0.098
LAC Category IA	r	-0.054	-0.207	-0.264*	-0.197	-0.043	0.083	0.012
	p	0.633	0.062	0.016	0.077	0.704	0.460	0.917
LAC Category IB	r	-0.061	-0.073	-0.186	-0.127	0.015	0.115	0.073
	p	0.584	0.515	0.093	0.255	0.891	0.303	0.514
LAC Category II	r	-0.199	-0.374*	-0.188	-0.308*	0.194	0.238*	0.050
	p	0.073	0.001	0.092	0.005	0.080	0.032	0.657
LAC Total	r	-0.251*	-0.406*	-0.242*	-0.367*	0.236*	0.338*	0.212
	p	0.023	0.000	0.028	0.001	0.033	0.002	0.056
UWD	r	-0.413*	-0.331*	-0.293*	-0.410*	0.318*	0.440*	0.321*
	p	0.000	0.002	0.008	0.000	0.004	0.000	0.003
ND	r	0.041	0.046	0.060	0.057	0.092	-0.183	-0.271*
	p	0.717	0.679	0.595	0.610	0.409	0.101	0.014
SP	r	0.434*	0.339*	0.297*	0.422*	-0.345*	-0.439*	-0.312*
	p	0.000	0.002	0.007	0.000	0.002	0.000	0.004

* Significant values (p<0.05) – Spearman Correlation Test

Note: Naming errors = number of errors in the Rapid Object Naming test; Naming time = execution time in the Rapid Object Naming test; LAC Category IA = Lindamood Auditory Conceptualization Test Category I A; LAC Category IB = Lindamood Auditory Conceptualization Test Category IB; LAC Category II = Lindamood Auditory Conceptualization Test Category II; LAC Total = LAC total converted score; UWD = designation of the usual word; ND = no designation; SP = substitution process; HFW = high frequency word; LFW = low frequency word; PW = pseudowords; Errors total = total number of errors in the spelling test

them exclusively by phonological encoding, recovering segments of words from their long-term memory that were similar to the presented pseudowords^(16,19). These findings reinforce the idea that lexical access and operational memory are predictive of an additional variance in written language learning, besides the variance already predicted by phonological awareness and by the knowledge of grapheme-phoneme correspondence⁽¹⁷⁾.

Results have also showed that the better the children's performance in the identification, discrimination and phonemic manipulation tasks, the fewer the number of errors presented by them in the spelling task, reinforcing the importance of phonological awareness to the spelling apprehension of any kind of word^(9-10,20). Moreover, phonological decoding makes possible the self-teaching mechanisms, which allow the student to acquire orthographic representations that are needed to a rapid and accurate visual recognition of a word, as well as to achieve a proficient spelling⁽¹⁴⁾.

Although we have found correlations between children's performance in the phonological awareness and rapid naming tasks and the number of errors in the spelling of words and pseudowords, these correlations were modest. This finding may indicate that, after the first years of literacy acquisition, with the increasing fluency on reading decoding, cursive letter, and orthographic domain, there would be, in the subsequent grades, a gradual decreasing of its influence on the writing process. Nevertheless, our results seem to indicate that, even in

the fourth grade of Elementary School, children's performance in phonemic manipulation and rapid naming tasks may be a warning of possible difficulties in the orthographic domain. In that sense, these tasks should be part of the test battery for spelling assessment, in the diagnostic process of reading and writing disorders, or in preventive interventions.

The results also showed correlations between subjects' performance in the phonological awareness and rapid naming tasks and the categories Contextual Conventions and Contextual Language of the written composition test. Although most subjects had already acquired the domain of cursive letter, they were still dealing with spelling apprehension and starting to construct longer length texts, a process that involves the integration of several levels of knowledge and cognitive-linguistic processing, many of them common to phonological awareness and rapid naming tasks. Thus, the influence of the metaphonological capacity and rapid naming skills could be observed not only in spelling, but also in the generation of a written text. However, these linguistic processing abilities were not found to be correlated to the category Story Construction of the written composition test, which depends on other linguistic knowledge related to the narrative gender, executive and self-regulatory functions, and world knowledge⁽²⁴⁾.

Considering that the ABFW Vocabulary test⁽²⁷⁾ is standardized for children up to six years of age, we could not establish direct comparisons between this reference and the

studied subjects, once the lexical acquisition is a continuous process. Nevertheless, the characteristics of the SP observed in this study can be an indicator of greater lexical domain by the subjects, as they presented processes of superordination and subordination, showing the existence of a lexical analysis that involves more or less specificity⁽⁴⁾, in which more complex, deeper, and richer characteristics are predominant, besides a greater conceptual domain of the taxonomic relationships, including the categories' labels⁽⁵⁾.

It seems, therefore, considering the children's word choices characteristics, that the subjects presented an adequate lexical development, using linguistic skills for naming pictures when they do not remember or do not know their exact name, presenting substitution processes that were in general very pertinent, and almost not presenting no designations.

An important point to mention is the lack of lexical formal assessment tools standardized for Brazilian Portuguese that comprise the age range considered in this study.

Results indicated that the better the performance in the Vocabulary test, the smaller the number of errors in spelling of both words and pseudowords. Thus, the writing of any word, even considering low frequency words and pseudowords, would involve lexical searching, in the way that the vocabulary level seems to influence not only the comprehension and writing construction, but also the orthographic domain⁽¹⁾. This finding suggests that both oral and written language are dependent of the same basic subjacent cognitive capacities and, thus, the children who present worse oral language skills will probably have more difficulties in writing⁽²⁾. These results point out to the importance of specific vocabulary stimulation since the first scholar years, in order to enhance both word recognition and spelling.

Results also showed that all the analysis levels of the vocabulary test were correlated to the three categories of the written composition test. Children presenting greater vocabulary were found to write better stories, considering all the categories of writing composition analysis. On the other hand, no designations in the vocabulary test were found to be correlated to story construction. Although it was not a strong correlation, it might suggest that this level of vocabulary analysis would be related to the generation of ideas⁽²⁵⁾. However, it is just a supposition and more specific researches are needed to confirm this hypothesis. Nevertheless, the occurrence of no designations in the vocabulary test could be considered as an indicator of difficulties in story construction from something that does not previously exist⁽²⁵⁾, what may be relevant to the diagnosis of reading and writing disorders.

The results regarding subjects' performance in the vocabulary test and in the categories of analysis comprised in the written composition test reinforce the relevance of lexical acquisition to the subsequent linguistic processing necessary to written language development, which involves orthographic, morphosyntactic and semantic domains, besides operational memory and lexical access. We could not forget to highlight the importance of language as the mediator of self-regulatory processes and executive functions, which perform a primordial role in the construction of a proficient writing.

CONCLUSION

The linguistic abilities related to vocabulary, phonological awareness and rapid naming were predictive of the spelling performance of students attending the fourth grade of Elementary School. Besides that, students' performance in the vocabulary test was shown to be predictive of the capacity of developing a written narrative. In this age range, the phonological awareness and rapid naming abilities may predict syntactic and grammatical performances during the generation of a text, but not the quality of the story construction.

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