Systematic Review

Revisão Sistemática

The influence of morphological awareness on reading and writing: a systematic review

Influência da consciência morfológica na leitura e na escrita: uma revisão sistemática de literatura

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Keywords

Speech Therapy
Language
Children
Handwriting
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ABSTRACT

Purpose: this study aimed to perform a systematic review of national and international studies about the relationship between morphological awareness, reading/writing, reading comprehension, and spelling. **Research strategies:** a search for national and international literature was carried out using databases Medline (via PubMed) and Portal de Periódicos da Capes (Eric, PsycINFO, LILACS, SciELO) from August to September 2015. **Selection criteria**: the inclusion criteria were: studies that answered the guiding question and addressed the subject matter established by the descriptors and keywords. Studies with animals, laboratories, opinion/expert pieces, case series, case reports and review studies were excluded. **Data analysis**: the following markers were considered: type and objective of the study, the skills related to morphological awareness (reading, writing, reading comprehension and spelling), tests performed, and their main results. **Results**: the search carried out in the pre-established databases with descriptors and free terms resulted in 203 articles. The search in PubMed resulted in 81 studies, and in Portal de Periódicos Capes, 122. Of the total, 154 were excluded according to the title and abstract, whereas 39 were excluded upon reading the full text. This allowed for the analysis of 10 articles. **Conclusion**: children with better scores in the morphological awareness test show better results in reading and writing across all school grades.

Descritores

Fonoaudiologia
Linguagem
Crianças
Escrita Manual
Compreensão de Leitura

RESUMO

Objetivo: Realizar uma revisão sistemática de estudos nacionais e internacionais sobre a relação entre consciência morfológica e leitura e escrita de escolares. **Estratégia de pesquisa:** Foi realizado um levantamento na literatura nacional e internacional utilizando as bases de dados Medline (via PubMed) e Portal de Periódicos da Capes (Eric, PsycINFO, LILACS, SciELO) no período de agosto a setembro de 2015. **Critérios de seleção:** Os critérios de inclusão utilizados foram: artigos que respondiam à pergunta norteadora e que atendiam à temática estabelecida pelos descritores e palavras-chave. Excluíram-se os estudos com animais, laboratoriais, artigos de opinião/autoridade, série de caso, relato de caso e estudos de revisão. **Análise dos dados**: Foram considerados os seguintes marcadores: tipo de estudo, objetivo do estudo e habilidade relacionada à consciência morfológica (leitura, escrita), os testes realizados e principais resultados. **Resultados:** A partir da busca por meio de descritores e termos livres foram encontrados 203 artigos nas bases de dados pré-estabelecidas. Na Pubmed, a pesquisa resultou em 81 estudos e 122 no Portal de Periódicos da Capes. Do total, 154 foram excluídos pelo título e resumo e 39, pela leitura do texto completo. Isso possibilitou a análise de 10 artigos. **Conclusão:** Crianças com melhor desempenho em testes de consciência morfológica apresentam melhores resultados em provas de leitura e escrita, para todas as séries.

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INTRODUCTION

In recent years, studies about written language have focused on understanding the influence of metalinguistic skills on their development and performance[1]. However, metalinguistic skills *per se* rely on formal school learning, particularly reading and writing, in order to be explicitly manifested[2].

Several authors[1,3,4] postulate that three metalinguistic skills are more closely related to learning reading and writing: phonological, syntactic and morphological awareness. As studies on morphological awareness evolve, new methodological questions and theoretical viewpoints are raised, such as the real influence of morphological awareness on reading and writing skills.

The morphological awareness skill consists in the reflection about the smallest meaningful units of the language and their use for semantic and structural recognition of words[5]. Morphemes are divided into two classes: roots, constituted as the morphological nucleus, and affixes, which are categorized into prefixes and suffixes. For instance, the word "empowerment" has three morphemes: "em", "power", and "ment". Thus, the word "empowerment" is morphologically complex, as it is composed of more than one morpheme[6]. There are also morphologically simple words, composed of a single morpheme.

In turn, word morphology is divided into two types, inflectional and derivational morphology. These are opposed due to the role their affixes play, which have different functions. The first is essentially syntactic, once it allows to determine gender, number and verb tenses. Inflectional morphology, therefore, conforms to the variations of words according to their syntactic context. Derivational affixes, on the other hand, have a semantic role. The field of derivational morphology is related to word construction and the structural relationships they can have among one another (shoe - shoes - shoeless)[7].

In order to understand how morphemic manipulation supports writing, some authors[8] advocate that this skill requires combination of two overlapping principles: the phonographic and the semiographic. The phonographic principle concerns phonographic correspondences and acquisition of the alphabetic principle. In contrast, the semiographic concerns the relationships of graphic signs as units provided with semantic value. Morphological awareness is associated with the second system. In this vein, morphemes are the basic units of language provided with semantic value.

Nevertheless, the correspondence between phoneme and grapheme is not always reliable or univocal. Thus, the phonographic principle is not invariably enough for correct decision-making in spelling, as much as for reading comprehension. In Brazilian Portuguese, an alphabetic language, one graphic symbol may not represent a single sound, and oftentimes a single sound may be represented by several graphic signs. In this context, the semiographic principle presents a strong power for orthographic decision-making in writing[3].

On the other hand, in alphabetic languages it is unadvisedly believed that reading essentially requires decoding of graphic signs into sounds. Nonetheless, reading involves many other processes that are key for understanding the content read (graphophonic clues and visual, contextual, and phonological information previously presented in the text) that assist contextual reading and access to meaning, which occur parallel to conscious reflection of the word's morphological structure[1,9,10]. One may also identify variations as to the degree of correspondence between letters and the sounds of speech. Thus, the more regular, the more univocal the correspondence between letter and speech sound - and the more irregular, the less the written word resembles its pronunciation. In Brazilian Portuguese, a language considered not to be very opaque (deep), it is still possible to observe words whose morphology resembles its meaning, which makes reading and comprehension easier[9].

Some authors[11-13] have verified a strong correlation between performance in morphological awareness tests and reading and writing skills, particularly in English (a language less regular than Brazilian Portuguese). In turn, in Portuguese there is evidence of a relationship between morphological awareness and performance in writing and reading[14-16]. This fact is owed to the logistics that, although Portuguese is a regular language, in many occasions morphology can help decision-making for correct spelling of ambiguous words and of those whose spelling rules were arbitrarily established.

Taking the contributions of morphological awareness for written language processing in Brazilian Portuguese into consideration, as well as the need to better explore such content, this study concerns a systematic review of the literature focused on the studies that present relationships among morphological awareness, reading, and writing.

OBJECTIVES

This study aims to systematically analyze the scientific literature in the field of Speech Therapy, Psychology, and areas related to morphological awareness and its relationship with reading and writing.

RESEARCH STRATEGY

In order to reach the objective proposed, a systematic literature review was conducted, based on national and international literature, which sought to answer the following question: "What is the influence of morphological awareness on reading and writing?" This literature review was structured according to the following stages:

1. Identification of the theme and selection of the research question - (determination of Health Sciences Descriptors-DeCS); terminology found in the National Library of Medicine's Medical Subject Headings-MeSH, BVS-Psi, and free terms combined with the use of Boolean operators AND and OR);
2. Definition of the criteria for inclusion and exclusion of studies - definition of information to be extracted from the studies selected;
3. Categorization of studies - evaluation of studies included in the systematic review of literature; interpretation of results; presentation of knowledge review/synthesis.

SELECTION CRITERIA

The articles were selected from PubMed and Portal Capes databases using the following descriptors: ("*Consciência morfológica*" OR "morphological awareness" OR "morphological processing" OR "*consciência morfológica*") AND ("*leitura*" OR "*lectura*" OR "reading") OR ("writing" OR "*escrita*" OR "*escritura*") OR ("*ortografía*" OR "*ortografía*" OR "spelling") as well as free terms, respectively. Only articles in English, Portuguese and Spanish published between 2010 and 2015 were included.

The search for texts in the database was carried out independently by two researchers, aiming to minimize possible loss of references. All references retrieved from the database were analyzed by both researchers with the aim of examining its relevance for selection and inclusion in the study. References published in languages other than English, Portuguese and Spanish, or that didn't allow access to the full text, and references repeated due to crossing of keywords, as well as studies with animals, laboratory, opinion/expert pieces, case series, case reports and review studies were excluded from this study.

Out of the full texts found, the ones which were not directly related to the subject matter were excluded. All stages of the study were conducted independently by the researchers. In case of disagreement between the researchers, only texts whose final decision was consensual were included. All articles related to the subject matter were included in the survey, regardless of their study design.

DATA ANALYSIS

The following markers were considered for analysis of the 203 studies selected: study location, type, and design; sample characteristics; tests carried out taking into account the skills related to morphological awareness; reading and/or writing; and main results. Then, the observational studies were analyzed according to the propositions of STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) initiative[17], composed of ten items related to information contained in the title, abstract, introduction, methodology, results and discussion of the articles. The articles were assessed by two independent researchers who, by the end of the analysis, crossed-referenced the results and discussed them in order to settle disputes by consensus.

The STROBE initiative (whose main objective is to divulge the guiding principles for description of observational studies, prepared by researchers, epidemiologists, statisticians and scientific magazine editors) was used in this study to assist analysis of the observational studies selected and reduce the effects of subjectivities, common in bibliographic review studies.

RESULTS

From the search using descriptors and free terms, 203 articles were found in the pre-established databases. In PubMed, the search resulted in 81 studies, and in Portal de Periódicos da Capes, 122 studies were found. Of the total, 154 were excluded by the title and abstract, and 39 by reading the full text. This allowed for the analysis of ten articles (Figure 1).

The information regarding analysis of observational studies in this review are described in Table 1.

With regard to analysis based on the STROBE strategy, the articles were evaluated according to the checklist proposed by the authors[17] and classified as to meeting, to a greater or lesser extent, the criteria proposed. The predominance of classification of items as "partially meets" (the criteria), followed by "meets" was observed. There were no items classified as "does not meet" (Figure 2).

Of the articles selected, three publications were recorded in 2014, two in 2013 and 2015, and one in 2010, 2011, 2012, respectively, which demonstrates a progression in the number of publications on the subject in the last five years.

The USA and Brazil were the countries with the highest number of selected studies related to the question of this review. Of these, 50% were in English language. These findings reflect the state-of-the-art and point to a predominance of studies addressing this subject in the American continent. The other publications looked into the influence of morphological awareness in Brazilian Portuguese and Spanish, less opaque languages which, however, present over the last five years a growing number of studies on the relationship between morphological awareness and reading and writing skills.

The fact that English is the most recurrent language is directly related to this language's structure. The grammatical structure of the English language presents a high level of irregularity (words that do not abide to the rule of correspondence between letter and sound), which highlights the potential of morphological

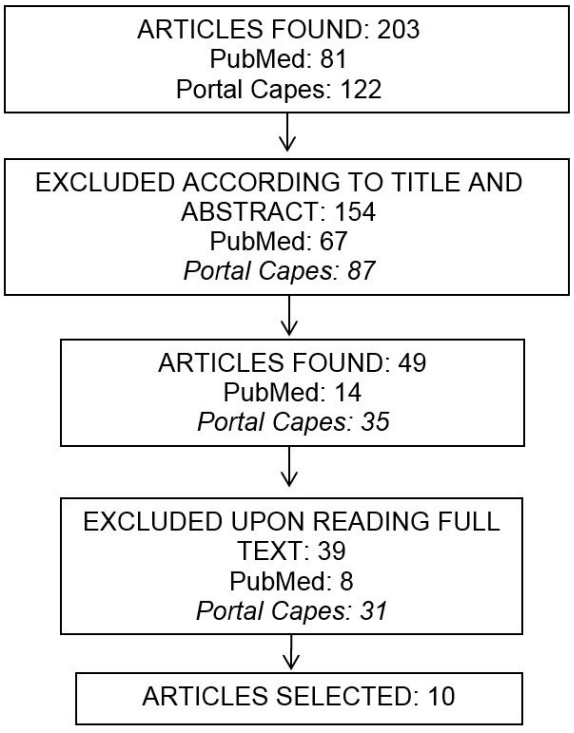


Figure 1. Flowchart of the process of selecting studies

Table 1. Simplified description of selected studies

Author	Year	Location	Design	Sample	Instruments	Results
Guimaraes SRK, Paula FV, Mota MMPE, Barbosa VR[18].	2014	Brazil	Analytical observational, cross-sectional	72 children in the 3rd, 4th and 5th grades of a public school.	Assessment of morphological awareness - Grammatical categorization task (Sá, 1999, 2006), Writing assignment (reproduction of storybook "O pote vazio") Inflectional and derivational grapho-morphological task (paula, 2007) and reading comprehension, measured by the Close procedure.	Morphological awareness influenced reading and spelling in general. In the three groups assessed, students with better performance in morphological awareness presented better results in spelling and reading.
Kirby JR, Deacon SH, Bowers PN, Izenberg L, Wade-Woolley L, Parrila R[19]	2012	Canada	Analytical observational, Cohort	102 children, between 5 and 8 years old, from public schools. Assessed in kindergarten, 1st, 2nd grades and, lastly, in 3rd grade.	Assessment of vocabulary with pictures (Peabody Test-III), Morphological Processing Test (analogy of words), Phonological Processing (CTOPP), Reading of words, phrases (Woodcock, 1998), Speed of reading and identification of words (Test of Word Reading Efficiency (Torgesen, Wagner, & Rashotte, 1999), Reading of texts (GORT 4; Wiederholt & Bryant, 2001).	There was a significant correlation between morphological awareness and reading of words, accuracy in reading and comprehension, particularly for the 3rd grade. The study also stresses the importance of morphological awareness tests in the battery of reading and writing tests.
Apel K, Diehm E[20]	2014	USA	Analytical observational, Case-control	151 students in kindergarten, 1st and 2nd grades of a public school, randomly divided into case and control groups.	Test of silent reading comprehension (Test of Silent Reading Efficiency and Comprehension -TOSREC; Wagner, Torgesen, Rashotte, & Pearson, 2010), grammatical analogy, creation of neologisms, identification of affixes (Apel, Brimo, et al. 2013), Identification of derivations and inflections (Carlisle, 2000), writing of words and pseudowords.	Students in the case group from the three grades assessed presented significantly better results post-intervention, compared to their peers.
Mota MMPE[21]	2011	Brazil	Analytical observational, cross-sectional	52 elementary school children in 2nd and 3rd grade of a federal public school.	Grammatical analogy tests (adapted from Nunes and peers, 1997), morphological decision, test of academic performance-TDE, digit span test WISC III.	Morphological awareness was poor, but there was a significant correlation with reading. The relationship between morphological processing and reading is maintained, after controlling the other variables, phonological processing significantly contributes to reading.
McCutchen D, Stull S, Herrera BL, Lotas S, Evans SP[22]	2014	USA	Analytical observational, Case-control	170 elementary school students in 5th grade from public schools, 95 composed the case group and underwent a morphological intervention, while 75 composed the control group.	Reading of words (Woodcock Reading Mastery Tests-Revised -WRMT-R), oral vocabulary test (Woodcock Johnson III Tests of Achievement), Assessment of morphological awareness by means of writing combined sentences.	Results show statistically significant positive effects for the intervention group after morphological training in all of the skills tested.

Table 1. Continued...

Author	Year	Location	Design	Sample	Instruments	Results
Miranda LC, Mota MMPE[23]	2013	Brazil	Analytical observational, cross-sectional	57 elementary school children in 2nd and 3rd grade of a federal public school.	Testing of knowledge of correspondence between letter and sound; subtraction of phoneme and Spoonerism (Sternberg, 2000), Intelligence test, (subtest digits- WISC), Academic performance test – TDE (Stein, 1994) and morphological awareness test - grammatical analogy task.	The grammatical analogy task was significantly correlated with reading of words, upon controlling the other variables. However, it must be more closely studied since upon removal of the variance attributed to knowledge of correspondence between letters and sounds measured by the spoonerism task, the morphological awareness scores are no longer significant.
Gutiérrez CS[24]	2013	Spain	Analytical observational, cross-sectional	66 (Hispanic) students in 3rd, 5th and 6th grades of two private schools.	Writing by dictation (paradigmatic writing with variation of verb tenses).	At least in the fifth grade, students showed to rely on morphological awareness to write verb tense paradigms in Spanish language. There was a progressing improvement in the amount of errors of the grades tested. The study found limitations in the statistical analysis and generalizations, since morphological awareness tests were not applied for comparison of data, in addition to other tests for vocabulary and phonological awareness control.
Gilbert JK, Goodwin AP, Compton DL, Kearns DM[25]	2014	USA	Analytical observational, cross-sectional	169 students in 5th grade of elementary school.	General academic knowledge (Woodcock-Johnson III), morphological awareness (morphological decision, creation of neologisms and grammatical analogy), reading of multi-syllable words, reading comprehension (Qualitative Reading Inventory QRI-3; Leslie & Caldwell, 2001), receptive vocabulary test with pictures (Peabody Picture Vocabulary Test, Dunn & Dunn, 2007).	There was a significant correlation between morphological awareness and reading of multi-syllable words only for children with reading difficulty, but not for children with higher performance in reading, proving to be a compensation strategy for "low-level readers".
Deacon SH, Benere J, Pasquarella A[26]	2013	USA	Analytical observational, cross-sectional	100 children, tested in 2nd and 3rd grades.	Test of vocabulary with pictures (Peabody Picture Vocabulary Test– Third Edition PPVT-III; Dunn & Dunn, 1997), phonological awareness, (based on the proposed by Rosner and Simons, 1971), reading (Woodcock Reading Mastery Test–Revised) morphological awareness (analogy of sentences, analogy of words (based on Nunes et al., 1997).	Morphological awareness and reading accuracy presented a statistically significant correlation, regardless of phonological awareness and vocabulary variables controlled.

Table 1. Continued...

Author	Year	Location	Design	Sample	Instruments	Results
Foorman BR, Petscher Y, Bishop MD[27]	2012	USA	Analytical observational, cross-sectional	4780 children from the 3rd to 10th grades of public schools.	Derivational and inflectional morphological knowledge by sentence completion (Foorman & Petscher, 2010), spelling by dictation, reading (Comprehensive Assessment Test -FCAT; Florida Department of Education, 2001, 2005).	Strong relationship between morphological knowledge and reading comprehension across all grades, except for the 10th.

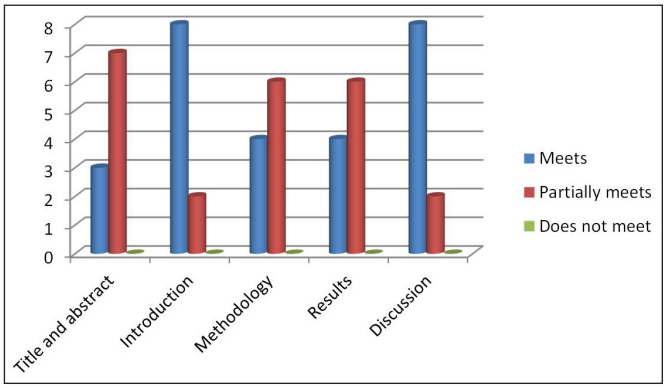


Figure 2. Global analysis of observational studies according to STROBE initiative

manipulation to assist reading and decision-making in spelling. In turn, although Brazilian Portuguese and Spanish are less opaque languages, they are not considered fully transparent, such as Finnish, for instance. In this vein, morphological manipulation could mediate reading comprehension and spelling of words considered to be morphologically complex or irregular.

With regard to design, we observed a need for the authors of the articles used in this review to compare the development or performance of schoolchildren in the morphological awareness tasks at different times. It was carried out by means of sorting the sample into different school grades/years/curricula, including the most initial stages of reading instruction, as well as the years in which appropriation of the alphabetical principle is consolidated. Due to the focus of the studies, the most common design was the observational cross-sectional analysis. In addition, cohort and control case studies were found.

The samples had a minimum number of 52 and maximum of 4780 individuals, and all of the studies selected were carried out with children or adolescents between 5 and 13 years old. The fact that these samples are composed by this age group considers the beginning of schooling, since written language needs to be explained through school learning. Thus, all studies found used schoolchildren and carried out the tests in the school environment. The samples had less than 170 students, only one sample[27] presented a higher number (4780 students). This sample considered all elementary schools in a district in the USA, where the tests were applied along with annual collective tests common to all schools in the district.

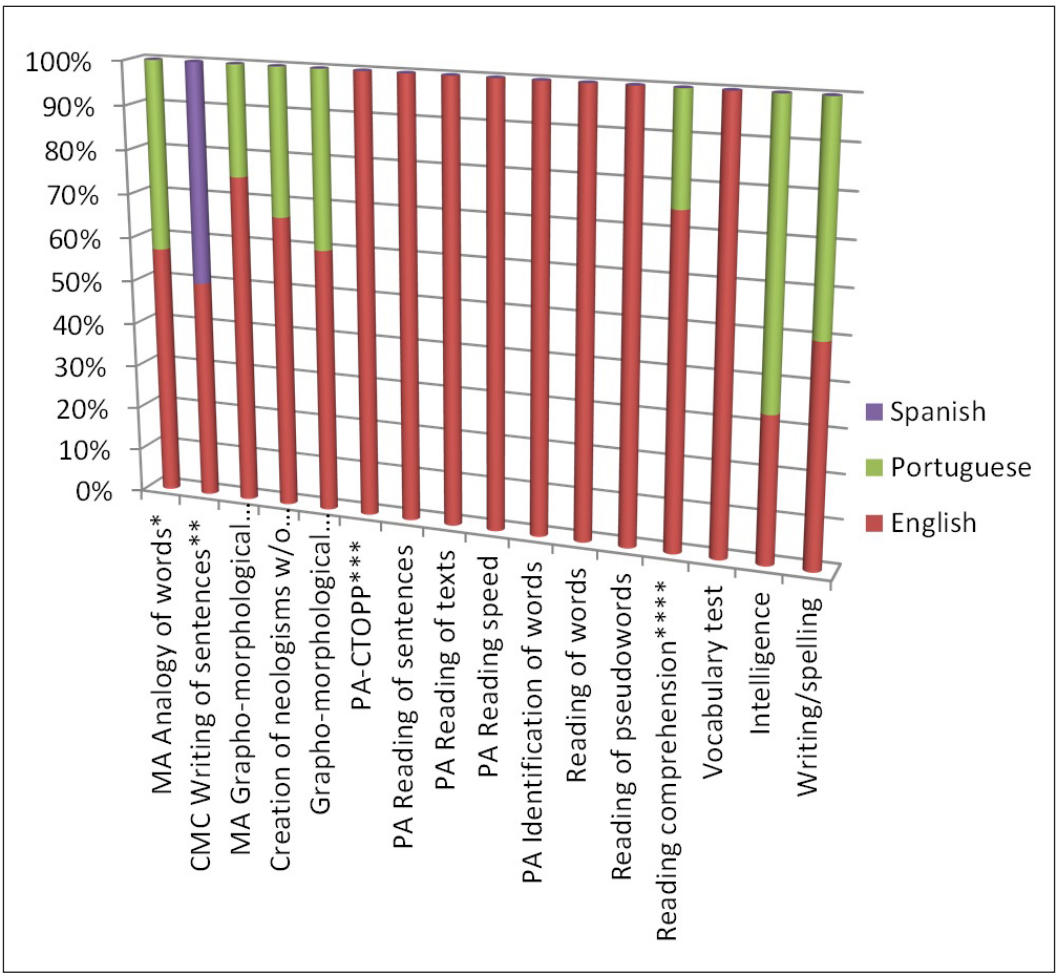
The selected articles presented a great variability in tests which assessed reading and writing[18,20,21,25-27], and their selection was carried out according to the objective of each study. However, in the English language articles we observed a greater diversity of tests, as well as the use of instruments to control confounding variables (variables that may lead to erroneous results, if not statistically controlled, since they are related to the dependent and independent variable at the same time).

With regard to the skills evaluated in each language, all of the skills listed were tested in the English language articles. This fact reiterated the interest of English-speaking countries in understanding and dealing with the relations between morphological awareness and reading and writing skills, given the degree of arbitrariness and opacity of the language. Portuguese, on the other hand, presented the second highest number of skills evaluated, which reflects the degree of arbitrariness of the language as well as its relative morphological and phonographic structure, less arbitrary than English (Figure 3).

There was a predominance of grammatical analogy tests, morphological decision, and creation of neologisms for assessment of morphological awareness; and testing of receptive vocabulary with pictures and WISC III digit span tests for assessment of vocabulary[19,21,23,25,26]. The predominant use of tests of grammatical analogy, morphological decision, and creation of neologisms to evaluate morphological awareness corroborates recent studies in Brazilian Portuguese[9,21] that have tested such evidence through appropriate statistical analysis and concluded that they present greater evidence of validity to assess the morphological awareness skill, however with differentiated levels of correlation for each school grade and component assessed (derivational or inflectional morphology).

Some studies[19,23,26] also considered the use of phonological awareness tests together with the application of multivariate statistical analyses to control the influence of phonological awareness on the results, since this could be positively influencing reading performance[28,29] and, consequently, masking performance in the morphological awareness skill. Another skill controlled[21,23] by means of the Wechsler Intelligence Scale for Children - WISC III[30] was cognitive development. In their study, Mota et al.[21] assessed the reliability coefficient for the subtest used, and verified that it presented positive indexes of internal consistency.

The results varied according to the objectives and variables selected for the studies, but most of them evidenced the relationship between morphological awareness and reading and writing skills. Children that show good results in morphological awareness tests present better results in reading tests, reading



Caption: *Morphological Awareness grammatical analogy/Grammatical categorization; **Combined /morphologically complex; ***Phonological awareness - Comprehensive Test of Phonological Processing; ****Comprehension of extract/text/reading
Figure 3. Proportion of skills assessed, distributed per language of studies found

comprehension, and writing compared to children with inferior performance in morphological awareness tests. These findings contribute to the thought that, even in less opaque languages, reflection on the morphological structure of words contributes to reading and writing performance[3,4,7,8,16,18,21].

By analyzing the results of each article included in the review, positive correlations can be observed between morphological awareness tests and reading and writing skills. Furthermore, a relationship between morphological awareness and the speed of reading and word identification was observed[19].

Taking the relevant limitations into account, most of the studies consider, respectively, the need for tests with greater validity and reliability for the assessment of morphological awareness[22,26], as well as the need for inclusion of tests for later control of phonological awareness, vocabulary, and general knowledge, thus reducing the increase of influences and confounding factors[12,18,21,24,31]. Some authors also stress the need for caution in the analyses and generalization of morphologic awareness tests. Since the tests do not present standardized scores and ultimately allow correlation analysis, the authors point out that analysis of association and causality would be challenges for future studies and would allow a better understanding of the influence of morphological awareness on the skills assessed[22,26].

CONCLUSION

This study demonstrated that most of the research carried out in the last five years and published in Pubmed and Portal Capes databases revealed a strong correlation between morphological awareness and reading and writing skills. It was observed that children with better results in morphological awareness tests also presented better results in reading and writing, compared to those with inferior performance in morphological awareness or who did not undergo morphological intervention.

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Author contributions

AAMS was responsible for searching, tabulating, data analysis, and production of the manuscript; VOMR was responsible for general guidance of the work and data analysis.