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EXPLORING FACTORS BEYOND PHONOLOGICAL INSTRUCTION IN PRIMARY EDUCATION

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Abstract

It is well known that explicit metaphonological instruction, particularly in the early years, is essential for reading acquisition. Despite the scientific consensus phonics instruction has not always been implemented in the classroom (Castles et al., 2018). The present explored which factors contributed to reading comprehension in primary education students who had not been taught to read using phonological methods, and hence performed poorly on metaphonological tasks (i.e. below normed expected mean per school year). Ninety-two Spanish students completed two reading comprehension tests (sentence and text level) and several reading skills tests: metaphonology, orthography, superficial and deep vocabulary, morphosyntax and reading strategy. Reading strategy refers to extent to which reading is based primarily on semantic content of words but not grammatical information. T-tests contrasting scores on sentence comprehension with the normed expected scores for each children showed that the students were significantly below the norms, but not classed as having a specific reading difficulty. Correlations showed a strong relationship between scores in the two reading comprehension tests in all the other measures (all *p*s < .001). In a backward regression with sentence comprehension as the outcome variable (r = .835), the skills that emerge as predictors are age (21.09%, p < .05), reading strategy (28.36%, p < .01), morphosyntax (22.69%, p < .01), and orthography (23.75%, p < .05). A similar analysis on text comprehension (r = .641) includes age (31,87%, p < .01), morphosyntax (27.24%, p < .01), deep vocabulary (23.42%, p < .05) and superficial vocabulary (21.70%, p < .05). These findings indicate that, even with low scores in the metaphonological tasks, the students' reading comprehension scores increase with age, although they do not reach the expected average reading levels. Performance in the comprehension tests seems to be achieved by students using an alternative mechanism based on the combination of grammatical and semantic information. We would also like to point out the slightly higher relevance of deep vocabulary (quality of the semantic relation between words; see Perfetti, 2007) than superficial vocabulary (number of known words) in text comprehension. In conclusion, in the absence of metaphonology, morphosyntactic-semantic information takes a primary role to advance reading skill. More research needs to be done on this topic, especially in secondary education, where the texts' complexity requires that students activate mechanisms associated with expert reading.

Keywords: *Metaphonology, grammar, deep vocabulary, reading comprehension, reading strategy.*

1. Introduction

Phonology has been included in traditional reading models as crucial to reading (see Simple View of Reading; Hoover & Gough, 1990; Hoover & Tunmer, 2022). Research over years has seemingly reached a consensus: word recognition is based on metaphonological information that readers decode to form the orthographic representations stored in the mental lexicon (as established in dual route models, see (Coltheart, 1978, 2012). Therefore, phonics instruction at the beginning of the primary school (also during last year in kindergarten) increases reading levels and prevents difficulties. Nevertheless, this message about scientific-based way of teaching reading has not been transferred to classrooms (Castles et al., 2018). Most models also take into account that when reading a sentence or a text to recognise words in isolation is not enough. These complex reading structures require the use of other language comprehension skills for a successful reading.

Vocabulary stands out among language comprehension skills. This skill goes beyond lexical recognition, making available all the necessary information to use words correctly. Recent studies have shown it is important to know each word in the text (superficial vocabulary), but the connections between

words (deep vocabulary) are also essential (Perfetti, 2007; Perfetti & Stafura, 2014). It is the deep vocabulary that allows the reader to link words by meaning (same or opposite), to identify the same semantic family and also to recover some previous information to infer from existing in the sentence or text (Oakhill, 2020). Together with vocabulary, morphosyntactic (grammatical) aspects are also necessary for reading, and failure to process them has been associated with lower reading levels (Tsunoda, 2023). Some readers use the keyword strategy (KWS). That is, they focus only on content words while reading, not processing functional words (those carrying most of the grammatical information). Readers, who use the KWS tend to commit important mistakes in comprehension tasks (Domínguez et al., 2016; De las Heras et al, 2022), getting only a small part of the full meaning of what they are reading.

Language comprehension skills mentioned are included in the National Reading Panel as indispensable in reading (NICHD, 2000). Importantly, theories agree that both decoding and language comprehension are not enough on their own (only together) to support effective reading. But what happens when students do not receive phonological instruction? Which skills predict reading comprehension in absence of competent levels in phonology?

2. Method

2.1. Participants

Ninety-two students from a school of Spain were evaluated. Distribution by school year (yr) and descriptive statistics are available in Table 1. None of the participants had been previously diagnosed as having a reading or language disorder. They scored above the reading difficulty cut-off in sentence comprehension test [$t(91) = 10.241$; $p < .001$] and none of them had a severe difficulty in text comprehension test (measured with PROLEC, see below). Eight participants presented a mild difficulty in text comprehension (yr1 N = 1; yr2 N = 5; yr3 N =2).

Table 1. Descriptive statistics for describing participants.

		Age			Sex	
	N	M	*SD*	Range	F (%)	M (%)
ALL	**92**	**108.2**	***(20.7)***	**72-142**	**49 (53.3)**	**43 (46.7)**
yr1	14	77.5	(*3*)	72-82	7 (50)	7 (50)
yr2	14	88.7	(2.9)	84-93	8 (57.1)	6 (42.9)
yr3	15	100.1	(*3.5*)	95-106	8 (53.3)	7 (46.7)
yr4	16	112.6	(*3.5*)	107-118	4 (25)	12 (75)
yr5	13	124.2	(*3.2*)	120-130	10 (76.9)	3 (23.1)
yr6	20	135.6	(*3.6*)	131-142	12 (60)	8 (40)

2.2. Materials

Tasks assessed reading comprehension at two different levels (sentence and text) and a wide range of reading skills. Most of the assessments belong to the PEALE battery (Domínguez et al, 2013), and the ones that were sourced elsewhere are indicated below. Similarly, we only mention the time limit when included in the assessment.

- **Text comprehension** (PROLEC; Cuetos et al., 2007). Includes four texts, each with four comprehension questions. Participants are asked to read carefully and answer the questions with the correct information. Scores range from 0 to 16 (one point for each correct answer).
- **Sentence comprehension** (TECLE; Marín and Carrillo, 1999). Contains 64 sentences with one missing word. Participants choose one between four possible answers (the three distractors are a meaning inconsistent real word and two types of non-words: one with similar orthography and one with similar phonology to the correct answer). Scores are corrected to control for random choosing ([correct answer – (errors/n-1)])*. Time is limited to five minutes.
- **Reading strategy** (DEPC). Similar to TECLE, was created for assessing the KWS (see Introduction). Distractors are words with similar lexical frequency to the correct answer. In order to answer correctly, participants are required to use both grammatical and semantic information in the sentences. The time limit is five minutes.
- **Morphosyntax**. Two tasks were used: syntax (STX) and morphology (MRF). Both are similar to TECLE, but the distractors are functional words in STX (i.e.: "con" [with], "entre" [between]) and incorrectly derived words in Spanish in MRF. These tasks require participants to activate grammatical information while reading. The time limit for each task is five minutes.

* This formula for controlling the random effect is used in every test, unless otherwise stated in the description.

- **Superficial vocabulary** (PPVT-II; Dunn et al, 2006). Includes 156 prints with four images each, only one of them consistent with a word given orally. Participants are asked to choose the picture that best matched the word given orally. Score is obtained by calculating number of correct answers – errors.
- **Deep vocabulary**. Two tasks were used. The definition task (WISC-V; Wechsler, 2015) demands participants to define a word briefly including distinctive information. Scores range from 0 to 54. The synonym task (VOC) presents 42 words and demand participant to choose between three options (correct and two foils) the most meaning-similar.
- **Orthography** (ORT). The task contains 50 pairs formed with the correct an incorrect spelling version of a Spanish word. The task requires that participants activate orthographic representations to answer accurately.
- **Metaphonology**. Two tasks were used: counting syllables (METASYL) and counting phonemes (METAPHON). Both includes 90 items (referring common objects) and requires participants to mentally count both decoding structures. The time limit for each task is three minutes.

2.2. Procedure

All answers were given on paper. Tests were administrated in groups in the children classroom, so some of the tests applied (text comprehension, PPVT-III and definition tasks) were adapted (see Hernández et al., 2023). The whole battery was administered through four sessions (five in the younger groups), up to a maximum of 50 minutes each. Results are part of a collaborative project with the school that made the request. Informed consent forms were used with the families ensuring ethical principles for research on human subjects in the Declaration of Helsinki (World Medical Association, 2013).

3. Results

The reading levels (as direct scores[†]) were low in comparison to the expected mean in sentence comprehension [t(91) = -2.860; p = .005]. The metaphonological skills were also significantly lower than the expected in both counting syllables [t(91) = -6.221; p < .001] and counting phonemes [t(91) = -7.136; p < .001] tasks. For interpretability, the analysis below was done with punctuations converted to percentages (Table 2). All variables included correlated strongly (all *p*s < .001).

Table 2. Descriptive statistics for sentence and text comprehension and reading-skills tests (punctuations %).

	Text comprehension	Sentence comprehension	Reading strategy	Morpho-syntax	Superficial vocabulary	Deep vocabulary	Orthography	Meta-phonology
M	75.5	42.8	40.7	43.9	69	50.1	50.8	28.9
DT	*17*	*22.6*	*24.4*	*21.9*	*7.2*	*16.3*	*33.4*	*12.3*
Range	31.3-100	3.7-100	-1.6-93.8	3.4-93	50-81.9	14.8-83.5	-32-100	3.3-71.5

Parallel backward regression analyses were carried out with each of the comprehension tasks as outcome variable and age, metaphonology, orthography, superficial and deep vocabulary, morphosyntax and reading strategy as predictors. The text comprehension regression also included sentence comprehension as predictor. It has to be noted that first model in both analyses is more significant (see Table 3).; that is because includes all variables. The last model for each outcome variable shows a depurated model only with the most powerful variables in predicting reading.

Table 3. Model summary of backward regression analysis with comprehension tasks as outcomes.

Outcome variable: sentence comprehension					Outcome variable: text comprehension				
Model	R^2	R^2adj	F Change	p	Model	R^2	R^2adj	F Change	p
1	0.850	0.837	67.918	< .001	1	0.672	0.640	21.252	< .001
2	0.849	0.839	-0.364	1.000	2	0.670	0.643	-0.427	1.000
3	0.846	0.837	-2.046	1.000	3	0.665	0.641	-1.401	1.000
4	0.843	0.835	-1.597	1.000					

Age was a significant predictor of reading comprehension (see Table 4), indicating that reading level increases by scholar year. More importantly, reading strategy was included in the final model as the main predictor, following by orthography and morphosyntax.

[†] Sentence comprehension and metaphonology expected means are only available for direct punctuations. See TECLE (Marín and Carrillo, 1999) and PEALE battery (Domínguez et al, 2013) respectively.

Table 4 Model 4 in the regression analysis with sentence comprehension as outcome variable (TECLE).

	B	Std. Error	b	t	p
(Intercept)	-10.011	7.055		-1.419	0.159
Age	0.191	0.090	0.174	2.109	0.038
Reading strategy	0.326	0.115	0.351	2.836	0.006
Morphosyntax	0.308	0.136	0.298	2.269	0.026
Orthography	0.106	0.045	0.157	2.375	0.020

The backward regression analysis for text comprehension also includes age in the final model (see Table 5) but it this case as the strongest predictor. Morphosyntax in the strongest reading skill predictor, followed by the semantic variables: first deep and second superficial vocabulary. Reading strategy and orthography were also included as predictors but with negative (and non-significant for orthography) index.

Table 5. Model 3 in the regression analysis with text comprehension as outcome variable (PROLEC).

	B	Std. Error	b	t	p
(Intercept)	-9.687	14.288		-0.678	0.500
Orthography	-0.086	0.050	-0.169	-1.727	0.088
Age	0.331	0.104	0.402	3.187	0.002
Reading strategy	-0.265	0.132	-0.379	-2.015	0.047
Morphosyntax	0.411	0.151	0.529	2.724	0.008
Superficial vocabulary	0.459	0.211	0.195	2.170	0.033
Deep vocabulary	0.296	0.126	0.284	2.342	0.022

4. Discussion

The present work is one of the few that studies the contribution to reading of a wide range of skills. It should be noted that none in this group had been diagnosed with a reading difficulty, but they scored poorly on the sentence comprehension task (and we found some mild difficulties on the text comprehension task). They also scored lower than expected mean on phonological tasks due to a lack of phonological instruction.

Our results showed that models including all variables could explain 83.7% of the variance for sentence comprehension and 64% for text comprehension. This is more than typically explain by SVR based models (i.e.: decoding and general language comprehension variables) when including in regression analysis, where could explain up to 68% for English primary school children (Ripoll et al., 2014; Savage, 2006; Savage et al., 2015) and up to 55% for a similar group in Spanish (Tapia et al., 2022). That is suporting newer theoretical accounts such as the Active View of Reading (Duke & Cartwright, 2021), which aims to include reading variables with explanatory power on their own and envisages including the relationship between them.

Given the exploratory nature of the present research, we used backward stepwise regression because it allowed us to identify the strongest predictors in the model(s). The main predictor for sentence comprehension was reading strategy (28.36%): not using the KWS was associated with increased reading levels. This is consistent with previous research (Domínguez et al., 2016). Morphosyntax was also a significant predictor (22.69%) for sentence comprehension, also highlighting the importance of processing functional words while reading. The last significant predictor for sentence comprehension was orthography (23.75%), indicating that having enough stored orthographic representations facilitates choosing a semantically appropriate word to complete a sentence.

Regarding reading comprehension both vocabulary variables were significant predictors, with deep vocabulary (23.42%) being slightly stronger than superficial vocabulary (21.70%). This is consistent with previous studies (Perfetti, 2007; Perfetti & Stafura, 2014) showing that vocabulary depth plays an essential role in accessing the full meaning of a text, as well as in inferring information that allows deep comprehension of the message (Oakhill, 2020). Noticeably, morphosyntax was the strongest predictor of reading comprehension (27.24%,), showing that processing grammatical information is indispensable for linking semantic information while reading (Tsunoda, 2023).

One important finding was that metaphonology was not a significant predictor for either comprehension task, although according to traditional models (Hoover & Gough, 1990; Hoover & Tunmer, 2022) it is an essential factor for reading. It is possible that the lack of phonological skills in this group of children who had not received explicit phonological instruction can explain that participant's sentence comprehension was below expected norms and there were some mild difficulties in text comprehension. However, we would like to point out that the text comprehension difficulties were found for children in the

first years of primary education, but not later. Moreover, there was an improvement of reading ability with age in the absence of adequate levels of phonology (i.e. age explained 21.09% of the variance for sentence and 31,87% for text reading). These findings suggest that children have developed an alternative mechanism based in lexical-semantic information due to their low phonological level (Savill et al., 2018; Snowling & Melby-Lervåg, 2016). Our findings suggest that orthographic skill could have an important role in reading comprehension, together with grammatical skills and vocabulary. These findings seem consistent with a use of alternative lexical-semantic mechanisms (Savill et al., 2018). However, more research is needed to understand how these skills interact.

Future research by the authors will be focused in answering the following questions: in a collective which a higher level of phonological processing due to an intensive instruction, does phonology have predictive power in reading comprehension above and beyond the rest of variables included in the present study if it is well developed from the early stages of primary education?

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