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# Fluid Intelligence, Working Memory, Reading Fluency and Comprehension in Chilean School Children

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# Abstract

**Introduction**: Existing studies of the variables that can impact reading comprehension at intermediate levels of Primary Education are not entirely conclusive. The present study analyzes the contribution to reading comprehension made by domain-general skills, such as fluid intelligence (*Gf*) and working memory (WM), and domain-specific skills, such as accuracy and speed.

**Method**: A sample of 98 Chilean third graders participated in the study. Measures of fluid intelligence, working memory, reading fluency (speed and accuracy) and reading comprehension were administered.

**Results**: The study revealed the significant contribution made by the general and specific domains to reading comprehension. The unique contribution of *Gf* and WM to the prediction of reading comprehension was similar to that of reading speed. Accuracy was not found to make a significant contribution.

**Discussion** and **Conclusions**: The implications and relevance of the findings with regard to psycho-pedagogical and educational practice at intermediate levels of Primary School are discussed.


**Keywords:** Fluid intelligence, working memory, reading fluency, reading comprehension.

# Resumen

**Introducción.** Los estudios acerca de las variables que pueden impactar la comprensión de lectura en niveles intermedios de enseñanza no son del todo concluyentes. Este estudio analiza la contribución de variables cognitivas de dominio general, tales como la inteligencia fluida (*Gf*) y la memoria de trabajo (MT), y de dominio específico, tales como exactitud y velocidad, a la comprensión lectora.

**Método.** Participaron en este estudio 98 escolares chilenos de tercer año básico. Se tomaron medidas de inteligencia fluida, memoria de trabajo, fluidez lectora (exactitud y velocidad) y comprensión de textos.

**Resultados.** El estudio evidenció la contribución significativa de ambos dominios, general y específico, a la comprensión lectora. La contribución única de *Gf* y MT en la predicción de la comprensión lectora fue similar a la contribución de velocidad de lectura. La exactitud no realizó contribución significativa.

**Discusión y conclusiones.** Se discuten las implicaciones y relevancia de los hallazgos para la práctica psicopedagógica y educacional en niveles intermedios de enseñanza básica en relación con la comprensión de lectura de textos.

**Palabras Clave:** Inteligencia fluida, memoria de trabajo, fluidez lectora, comprensión lectora.

## Introduction

The skill of reading plays a fundamental role in personal development and is essential for autonomous existence in society. People who fail to acquire the skill find themselves at a severe disadvantage (Solé, 2002). For this reason, one of the many challenges facing the education system today is to ensure that schoolchildren learn to read correctly. However, the task of teaching and learning the skill is far from straightforward. The complex nature of reading and the number of processes it involves make it a highly demanding task whose acquisition may only be considered complete once the subject is able to construct and integrate a mental representation of the meaning of a text (Cuetos, 2008).

In the year 2000, the USA's National Reading Panel (NRP) identified five main components involved in learning to read: phonemic awareness, phonics, fluency, vocabulary and comprehension (NRP, 2000). Phonemic awareness and phonics are fundamental during the early stages of learning to read (Bravo, Villalón & Orellana, 2002; Bizama, Arancibia & Saéz, 2011; Bizama, Arancibia & Sáez, 2013; Kim & Pallante, 2012). However, for those schoolchildren who have already mastered phoneme-to-grapheme conversion, the key aspects of reading development are fluency and reading comprehension (Arán-Filippetti & López, 2016; González-Trujillo, Calet, Defior & Gutiérrez-Palma, 2014).

Ultimately, the objective of reading is to understand and learn from a text (Nichols, Rupley & Rasinski, 2008). However, to achieve this objective is no simple exercise; according to Gómez-Veiga, Vila, García-Madruga, Contreras and Elozúa (2013), reading comprehension is a highly complex cognitive task that is the result of multiple mental processes. In other words, to achieve good levels of comprehension requires the proper functioning of both domain-specific and domain-general skills. It has been systematically confirmed that good levels of decoding and fluency – both of which are domain-specific skills – are fundamental to the development of reading comprehension (Sprenger-Charolles, Colé & Serniclaes, 2006; Verhoeven & Leeuwe, 2008; Verhoeven & Perfetti, 2008). As for domain-general skills, working memory (WM) appears to have a strong influence on reading comprehension. However, findings do not always agree on this point (Cain, Oakhill & Bryant, 2004; Carretti et al., 2009; Fuch et al., 2012), as will be covered later. There are other domain-general skills which may make meaningful contributions to reading comprehension,

although less research has been conducted on these. One such skill is fluid intelligence (*Gf*) (Alloway & Gregory, 2013; Tiu, Thompson & Lewis, 2003).

Reading comprehension draws on a variety of skills from different domains, but there is uncertainty as to which skills are the most relevant in each domain, and which domain makes the most important contribution. The present work will provide evidence concerning the unique contribution to performance in reading comprehension of the domain-general skills of reading speed and accuracy, and of the domain-specific skills of *Gf* and WM among Chilean children in their third year of primary education.

*Fluid intelligence, working memory and reading comprehension*

A number of studies have addressed the various processes and variables that contribute to fluent reading and good comprehension, highlighting the role of cognitive components in the development of reading skills (Bravo Valdivieso, Villalón & Orellana, 2004; Cuetos, González & De Vega, 2015; Fumagalli, Barreiro & Jaichenko, 2017; Korzeniowski, Cupani, Ison & Difabio, 2016).

One such cognitive component is intelligence. Fluid intelligence is the ability of a subject to solve new problems, identify relationships, conceptualize, reason and think abstractly, and is independent of culture and formal education (Rossi, Neer & Lopetegui, 2008; Stelzar, Andrés, Canet-Juric & Introzzi, 2016). It is therefore unsurprising that *Gf* is fundamental to the acquisition of new skills, including reading. In fact, some authors have suggested that *Gf* may be of great importance to learning during the early school years (Batey, Furnham & Safiullina, 2010; Kaufman & Beghetto, 2009). However, to what extent is *Gf* related to reading comprehension? The literature reports mixed results on this subject. For example, Ningrum and Wibowo (2017) demonstrated a meaningful contribution of intelligence to reading comprehension in a group of 32 secondary school students in Indonesia. Similarly, Primor, Pierce and Katzir (2011) found that Raven's Progressive Matrices test scores predicted performance in narrative text comprehension among fourth graders – both with and without reading difficulties – in Israel. However, Corso, Cromley, Sperb and Salles (2016) found no direct link between intelligence – again measured using Raven's Progressive Matrices – and reading comprehension among fourth and sixth graders in Brazil. This divergence in results inspired the inclusion of this factor in the present work as a possible predictor variable for reading comprehension.

Another cognitive process suggested by some studies as being of relevance to performance in reading comprehension is WM. WM is the ability to simultaneously manipulate and retain the information relevant to an active task, as well as the executive attention control needed for the coordination of these functions (Baddeley, 1996). Analyses presented in the literature concerning the contribution of WM to reading comprehension are similarly inconclusive. A number of studies have reported the importance of WM as a predictor of reading ability in English-speaking schoolchildren (Kim & Pallante, 2012; Ziegler, Bertrand, Toth, Czepe, Reis, Faisca, Saine, Lyytinen, Vaessen & Blomert, 2010) and in Spanish-speaking schoolchildren (Arán-Filippetti & López, 2016; Gómez-Veiga et al., 2013). A study by Arán-Filippetti and López (2016) involving a sample of 168 Spanish-speaking children and adolescents between the ages of 9 and 15 years showed that WM explained 22% of variance in reading comprehension. Similarly, a study by Gómez-Veiga et al. (2013) involving a sample of 77 Spanish children in their third year of primary education shows a pattern of positive and significant relationships between *Gf*, WM and narrative text reading comprehension in this age group. However, other findings have shown a different effect of WM on reading comprehension. Seigneuric and Ehrlich (2005) conducted a cross-sectional study of 74 French-speaking first graders (7 years), second graders (8 years) and third graders (9 years) in order to examine the contribution of WM capacity to reading comprehension. The results showed evidence of WM capacity as a direct predictor of reading comprehension in third graders only, and not in pre-school children. Similarly, in a major meta-analysis study, Carretti, Borella Cornoldi and De Beni (2009) suggested that the association between WM and reading comprehension varies according to the modality of attention control required and the type of information to be manipulated (verbal or visuospatial). In other words, it is plausible that poor performance in reading comprehension among students with low WM depends partly on the WM modality involved.

Ultimately, there is a need to explore the contribution made by *Gf* and WM (domain-general cognitive variables) to reading comprehension in Spanish-speaking children who have already learned the code and are subsequently presented with reading comprehension tasks at school, and to compare it with that of domain-specific variables such as reading fluency and its components (*accuracy* and *speed*), which have also been proposed as predictors by the specialized literature.

*Reading fluency and text comprehension*

Reading fluency is defined as the ability to read a text rapidly, accurately and with proper expression (Allington, 2006; Garzón, Jiménez & Seda, 2008; NRP, 2000). Based on this, the three components of reading fluency are *accuracy* or precision, *speed* and *prosody*.

Reading *accuracy* refers to command of the mechanisms that underlie phonographemic decoding of written language. This means that children must master the grapheme-phoneme conversion rules and automate decoding processes in order to store orthographic word representations in the mental lexicon (Fumagalli et al., 2017) and thus avoid making mistakes when reading. In Spanish, the level of accuracy is fairly high given the characteristics of the language's orthographic system, even in the case of children with difficulties (Ziegler, Bertand, Toth, Csépe, Rais, Faisca & Blomert, 2010).

The second component of fluency – reading *speed* – can be explained as the number of words read in the space of a minute (Torgesen & Hudson, 2006). Subjects with reading deficiencies read fewer words per unit of time than those with a good reading rhythm. This leads slow readers to read less, which may result in them falling behind their classmates over the course of their school career (Calero, 2014).

In recent years, work conducted on the subject of reading has increasingly focused on reading fluency given its critical role in the learning process and its important contribution to reading comprehension (Baker, Biancarosa, Bousselot, Smith, Baker & Tindal, 2014; Gómez-Zapata, Defior & Serrano, 2011; Hudson, 2011; Hudson, Lane & Pullen, 2005; Paige, Rasinski, Magpuri-Lavell & Smith, 2014). Rasinski and Samuels (2011) maintained that the relationship between fluency and comprehension is fundamental to accomplished reading given that, if reading lacks fluency, key concepts of the text may not be captured, and this would affect the eventual extraction of meaning. Similarly, Meisinger, Bradley, Schwanenflugel and Kuhn (2010) studied the relation between reading comprehension and fluency in 50 English-speaking children aged between 8 and 12 years. The results showed that fluent readers achieved a level of comprehension that was in line with that expected for their age. However, children with deficits in reading fluency obtained below-average scores in the comprehension test. Thus, the greater the deficiency in fluency, the more severe the effect on comprehension.

The majority of evidence regarding the contribution of fluency to comprehension applies to the English language, but the number of studies linking the two skills in the context of the Spanish language has been growing in recent years (Calet, Defior & Gutiérrez-Palma, 2015; Alvarez-Cañizo, Suárez-Coalla & Cuetos, 2015). It has been found that while many Spanish-speaking children learn to read accurately during the early grades, they read slowly and have difficulty understanding the content (De Mier, Borzone & Cupani, 2012). A study conducted by Outón and Suárez (2011) involving Galician- and Spanish-speaking schoolchildren in their second year of primary education at 22 schools demonstrates the link between difficulties with reading fluency and text comprehension in the two languages. The authors conclude that those children whose level of reading accuracy falls short of that expected for their age fail to free up cognitive resources with which to construct the meaning of the text.

In summary, reading comprehension is a highly complex skill based on multiple processes – both domain-general and domain-specific – which must operate in parallel. While the influence of domain-specific skills on comprehension has been systematically proven, results regarding the influence of domain-general skills such as WM and *Gf* remain the subject of debate. There has also been little study of the degree of influence on comprehension of the two domains, even though this information is of fundamental importance to the creation of strategies and interventions to promote the development of the skill.

*Aims*

Building on this background, the aims of this study were to establish the contribution to reading comprehension of the domain-specific skills of *accuracy* and *speed*, and of the domain-general skills of working memory and fluid intelligence in schoolchildren in their third year of primary education. The unique contribution of each domain to reading comprehension was also studied.

## Method

### *Participants*

The initial sample comprised 101 male and female students selected from three different third year primary teaching groups at state-run teaching institutions in the city of Concepción, Biobío Region, Chile.

The following exclusion criteria were used: a) presents special educational needs due to sensory or motor disability or severe communication disorders, certified by the appropriate professional as established by Supreme Decree No. 170/2009 which regulates Special Education in Chile; and b) presents an intelligence quotient of less than 80 in the G Factor intelligence test (Cattell & Cattell, 2001).

Based on these exclusion criteria, the final non-probabilistic intentional study sample consisted of a total of 98 Chilean schoolchildren (38 girls and 60 boys) in their third year of primary education. Average age was 8 years and 5 months (SD =.613).

### *Instruments*

In line with the aims of the study, the measurements taken and the instruments used to measure the variables of interest were as follows:

*G Factor Test* by Catell and Catell (2001): this instrument is a cross-cultural general intelligence test designed to measure fluid intelligence. Given the age group of the study sample, *Scale 2 (Form A)* for children over the age of eight years was used. The G Factor Test has been used in a variety of studies of Spanish-speaking schoolchildren in both Spain and Latin America (Jiménez, García de la Cadena, Bizama, Flores, Zambrano & Frugone, 2013) given the high level of reliability with which it is able to assess general intelligence in this group. In terms of its psychometric properties, the reliability index of the test varies between 0.70 and 0.80.

*Digit Span* subtest of the Wechsler Intelligence Scale for Children (WISC III), Chilean Version by Ramírez and Rosas (2010): evaluates short-term auditory memory, sequencing, freedom from distractibility, number facility and mental alertness. The subtest consists of two tasks. *Digits Forward* requires the child to listen to and repeat a sequence of

numbers in the same order as spoken by the interviewer. *Digits Backward* requires the child to repeat the sequence of numbers as spoken by the interviewer, but this time in reverse order. The test has a factor loading of *.63* on the freedom from distractibility index.

*Batería para la Evaluación de la Competencia Lectora para Tercer Año de Educación Básica – EVALEC-3* (Battery for Assessment of Reading Competence for the Third Year of Primary Education – EVALEC-3), Chilean Version 2.0 by García, González and García (2013). Two tasks were administered to assess *Reading Efficiency*:

- *Reading automatization*: this subtest evaluates reading accuracy by measuring command of the mechanisms which underlie phonographemic decoding of written language.
- *Fluency and expressiveness*: this subtest evaluates the processes involved in fluency, expressiveness, rhythm, and reading speed at this educational level. A reading speed test was used for this study whereby the number of words read in the space of a minute was recorded.

In terms of the psychometric properties of these subtests, the Test Manual for *Reading Accuracy* indicates a value of alpha=.899. Although a Cronbach's alpha is not provided for EVALEC-3, *Fluency and Expressiveness*, they are given for levels 2 and 1: above *0.9*. In terms of test validity, factor analysis is reported to produce a result with two factors which together explain 61.015% of variance. Of these, the second factor relates to fluency, expressiveness and reading speed, or to what the authors refer to as *reading efficiency*.

*Prueba de Comprensión Lectora y Producción de Textos – CL-PT* (Reading Comprehension and Text Production Test – RC-TP) by Medina, Gajardo and Fundación Educacional Arauco (2009). This instrument is designed for Chilean schoolchildren from kindergarten to the fourth year of primary education and can be applied on an individual or group basis. It addresses three aspects: Management of Language, Reading Comprehension and Text Production. Given the nature of the study, only the aspect relating to Reading Comprehension was applied. Children in their third year of primary school were required to silently read a continuous narrative text, a continuous informative text, a poster and a city map, and to answer questions about their content. The raw scores were then converted into percentiles.

The reliability index, reported as the test-retest correlation coefficient, ranged from a minimum of *.57* to a maximum of *.76*, where $p<.001$. The construct validity reported for the test ranged from a minimum of *.40* to a maximum of *.59*, where $p<.001$ (Medina & Gajardo, 2009).

*Procedure*

Interviews with the school principals were requested in order to introduce and explain the study. A letter was then sent to the parents or guardians of the schoolchildren requesting their authorization. It was made clear that participation would be voluntary and anonymous. Finally, informed consents were obtained from the participants' parents or guardians prior to beginning the evaluation.

The evaluation took place on school premises. It was conducted over six sessions, each with a duration of between 10 and 60 minutes depending on the requirements of each instrument. During the first and second sessions, intellectual capacity was assessed using the G Factor Test. Application of the instrument took place in small groups of 6 students and with the support of the school psychologist. During the third and fourth sessions, working memory was assessed on an individual basis using the WISC III Digit Span subtest, and the Reading Accuracy and Fluency and Expressiveness tasks from the EVALEC-3 battery were administered. During the fifth session, the reading comprehension subtest from the RC-TP test was applied. During the sixth session, the instruments were applied to those students who had been absent from the previous assessment sessions.

*Data Analysis*

Firstly, the normality of the variables was verified. Then the relationship between the independent variables and reading comprehension was measured using the Pearson correlation coefficient, and a multiple linear regression model was created based on the results.

## Results

There are no normality issues with the study's variable distribution (see Table 1). As shown in the table, the asymmetry and kurtosis data are within an appropriate range, as the

absolute values do not exceed 1.5 (Tabachnick & Fidell, 2013). The third-year primary students that took part in the study presented fluid intelligence (*Gf*) and working memory (WM) functions within the expected range for their age and year group. However, the results for reading fluency showed performance levels slightly below the norm. Finally, the results for reading comprehension indicate average performances close to the lower end of the norm and with a high degree of variability.

Table 1. *Descriptive statistics for the study variables*

| | N | Min | Max | Average | SD | Asymmetry | Kurtosis | Norm |
|---|---|---|---|---|---|---|---|---|
| *Gf* | 98 | 76 | 143 | 105.65 | 13,454 | .252 | .422 | 90 -110 |
| WM | 98 | 2 | 18 | 8.78 | 2,626 | .863 | 1,260 | 10 |
| Accuracy | 98 | 8 | 26 | 19.18 | 3,751 | -.385 | .354 | |
| Speed | 98 | 22 | 144 | 100.48 | 256,169 | -.263 | .110 | |
| RC-RS | 98 | 2 | 31 | 16.47 | .181 | .188 | -.171 | 20 |
| RC Percentile | 98 | 2 | 93 | 39.11 | 22,321 | .568 | -.260 | 50 |

*Note*. Min = minimum; Max = maximum; *Gf* = Fluid Intelligence; WM = Working Memory; RC-RS = Reading Comprehension Raw Score; RC Percentile = Reading Comprehension Percentile.

*Relationships between study variables*

A correlation analysis was conducted between all measures in order to examine the relationships between the study variables. The results pointed to a positive and significant relationship between reading comprehension and all of the predictor variables studied. Reading *speed* and *Gf* presented a moderate relationship with reading comprehension, while that of WM and *accuracy* was weaker. The other relationships tested were significant, with the exception of the relationships between WM and reading *speed*, and between WM and reading *accuracy* (see Table 2).

Table 2. *Correlations between study variables*

| | Working Memory | Speed | Accuracy | RC-RS |
|---|---|---|---|---|
| *Gf* | .328** | .312** | .297** | .515** |
| Working Memory | | .065 | .101 | .369** |
| Speed | | | .300** | .437** |
| Accuracy | | | | .269** |

*Note*. *Gf* = Fluid Intelligence; RC-RS = Reading Comprehension Raw Score.

**$p$<.01

Finally, a hierarchical linear regression analysis was conducted in order to study the unique contribution of the domain-specific variables *speed* and *accuracy*, and of the domain-general variables *Gf* and WM in explaining reading comprehension at this educational level. S*peed* and *accuracy* were introduced first and, once their effect had been isolated, *Gf* and WM were introduced (see Table 3).

Table 3. *Hierarchical regression analysis results for prediction of reading comprehension*

| | B | ES *B* | β | *R* | $R^2$ | $\Delta R^2$ |
|---|---|---|---|---|---|---|
| Stage 1 | | | | .46 | .21 | .21 |
| Constant | 2.020 | 3.273 | | | | |
| Speed | .096 | .023 | .392*** | | | |
| Accuracy | .249 | .157 | .151 | | | |
| Stage 2 | | | | .63 | .40 | .19 |
| Constant | -10.965 | 4.237 | | | | |
| Speed | .074 | .021 | .303** | | | |
| Accuracy | .094 | .142 | .057 | | | |
| *Gf* | .150 | .042 | .326** | | | |
| Working memory | .363 | .131 | .236** | | | |

*Note*. *Gf* = Fluid Intelligence.

***$p$<.001; **$p$<.001

As shown in Table 3, the results of the regression analysis on the reading comprehension variable reveal that the contribution of the domain-specific skills *speed* and *accuracy*, introduced together at the first stage, was significant ($F$ (2,95) = 12.77, p<.001) and explained 21% of variance in reading comprehension. However, it was *speed* that really made a significant contribution at this first stage. The domain-general variables *Gf* and WM were introduced at the second stage and also made a significant contribution to predicting reading comprehension ($F$ (4,93) = 15.69, p<.001) explaining 19% of variance. At stage two, both variables made a significant contribution, with that of *Gf* being perhaps slightly greater.

In summary, of the 40% of variance in reading comprehension explained by predictor variables in the present study, half was contributed by domain-specific skills and half by domain-general skills.

## Discussion and Conclusions

The aim of the present work was to analyze the contribution to reading comprehension of reading *accuracy* and *speed* – the domain-specific components of reading fluency – and of the domain-general cognitive variables of fluid intelligence (*Gf*) and working memory (WM) among children in their third year of primary education. The study also examined the unique contribution of the two domains in order to establish which of them constitutes the best predictor of reading comprehension development at this level of schooling.

The results indicate that the two domain-general cognitive variables relate positively to reading comprehension, with the contribution made by *Gf* being slightly greater. In fact, the contribution of these processes to comprehension is as relevant as that of the domain-specific skills studied. The results concerning the contribution of WM to reading comprehension are in line with other studies where WM made a unique contribution independent from other specific skills (Arán-Filippetti & López, 2016; Cain et al., 2004; Carretti et al., 2009, Gómez-Veiga et al., 2013). The results concerning the influence of *Gf* also coincide with the findings of other studies in which this factor made a significant contribution to reading comprehension in children of school age (Gómez-Veiga et al., 2013; Primor et al., 2011). The results of the present work differ in part from those of the study by Corso et al. (2016). In their study, the direct influence of *Gf* on comprehension was not significant, but when modelled indirectly using executive functions, its effect was found to be significant. In other words, the executive functions assessed in the study mediated the direct relationship between *Gf* and comprehension.

With regard to the relationship between reading comprehension at the school level studied and the *accuracy* and *speed* components of reading fluency, being domain-specific variables, the present study confirmed that both skills relate positively to the dependent variable, with *speed* emerging as an important predictor variable. The findings of the study are therefore in line with recent research conducted with Spanish-speaking children, which has demonstrated a relevant contribution of reading *speed* to reading comprehension. The findings suggest that students with a slower reading speed tend to achieve lower scores in reading comprehension (Calet, Defior & Gutiérrez-Palma, 2015; Alvarez-Cañizo, Suárez-Coalla & Cuetos, 2015; Outón & Suárez, 2011), emphasizing the importance of *speed* over

*accuracy* at this educational level. It is therefore possible that in the third year of primary education, as children begin to take the orthographic route rather than the phonological, a reading speed close to the speed of speech is of greater importance to effective construction of the sense of a text as it is read.

In summary, the results of the present work suggest that the domain-general skills of *Gf* and WM and the domain-specific skill of reading *speed* make a significant contribution to performance in reading comprehension, with the two domains contributing to a comparable degree. There are some important educational implications in terms of evaluation and intervention.

With regard to psycho-pedagogical evaluation, the results of the present study indicate the importance of measuring reading fluency in terms of *speed* during the third year of primary education, as a deficit at this stage could point to difficulties with reading comprehension. Dynamic assessments, such as those advocated by Baker et al. (2014), are recommended throughout the school year in order to provide reliable measurements of students' individual performance, and by doing so ensure the timely implementation of psycho-pedagogical support. In terms of assessment, inclusion of *Gf* and WM measurements is recommended in order to anticipate the resources required by a student if they are to achieve acceptable performance in reading comprehension tasks.

With regard to psycho-pedagogical intervention, it is recommended that focus be put on reading fluency – that is, reading *speed* – both in typically developing schoolchildren and in those experiencing difficulties with reading comprehension. It would also be interesting to work both on WM and on reasoning and problem solving – the latter being components of fluid intelligence – in order to boost the development of reading comprehension at this level (Alloway & Gregory, 2013).

Finally, certain limitations of the present study should be acknowledged. As the present research constituted an initial study of the contribution of domain-general cognitive variables and domain-specific reading skills in Chilean schoolchildren, future analysis should be conducted using a larger and more diverse sample of students covering the entire primary education age range.

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