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Impact of Affective and Cognitive Variables on University Student Reading Comprehension

Mabel Urrutia [1,*], Sandra Mariángel [2], Esteban J. Pino [3], Pamela Guevara [3], Karina Torres-Ocampo [4], Maria Troncoso-Seguel [3], Claudio Bustos [5] and Hipólito Marrero [6,7]

[1] Facultad de Educación, Universidad de Concepción, Concepción 4070386, Chile
[2] Facultad de Educación, Universidad Católica de la Santísima Concepción, Concepción 4090541, Chile
[3] Departamento Ingeniería Eléctrica, Facultad de Ingeniería, Universidad de Concepción, Concepción 4070386, Chile
[4] Facultad de Humanidades y Arte, Universidad de Concepción, Concepción 4070386, Chile
[5] Departamento de Psicología, Facultad de Ciencias Sociales, Universidad de Concepción, Concepción 4070386, Chile
[6] Facultad de Psicología y Logopedia, Universidad de La Laguna, 38200 La Laguna, Spain
[7] Instituto Universitario de Neurociencia (IUNE), Universidad de La Laguna, 38200 La Laguna, Spain
* Correspondence: maurrutia@udec.cl

Abstract: The problem of reading comprehension at the university level has not been sufficiently explored in the field of education research. Understanding written texts is an essential prerequisite for academic success during university. Consequently, reading comprehension challenges can influence the dropout rate at the university level. On the other hand, research has been conducted from a cognitive perspective, without considering affective variables such as reading motivation and its relationship with linguistic and psychological variables. In this study, five questionnaires were administered to a sample of 65 teaching students from different disciplines. The questionnaires dealt with linguistic dimensions such as reading comprehension, at lexical, textual, and discursive levels; psychological aspects such as reading motivation; and cognitive aspects such as working memory. The results obtained through bivariate and mediation analyses show the mediating role of vocabulary in reading comprehension and other cognitive and affective variables. In this context, working memory has a positive indirect effect on more explicit processing tasks in reading comprehension of long texts associated with discourse comprehension. Finally, intrinsic motivation has a positive indirect effect on reading fluency and also on the comprehension of short texts. It also correlates positively with vocabulary tasks. These results are relevant in order to establish a reading profile of university students who have reading comprehension problems, as found in this study.

Keywords: reading comprehension; reading motivation; vocabulary; working memory; university students

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1. Introduction

Reading skills imply better academic performance, lower academic dropout rates, better access to a salary, and greater social mobility, ensuring active participation of expert readers in today's society [1–3]. Consequently, it is a relevant topic for university students. According to the results of the 2013 *Programme for the International Assessment of Adult Competencies* (PIAAC), only 11% of young students worldwide show higher levels of reading comprehension, and 48.8% of this population only make low-level inferences to understand texts [4]. Young people in Chile, where this research is conducted, also achieve low performance in the cognitive competence of reading comprehension compared to other OECD countries, which has been the case over the last 17 years [5]. Chile is still below average in international standards and is ranked below level 2 of four performance levels [6]. In addition, only 5% of higher education graduates in Chile manage to score at

the highest performance level in reading comprehension [7]. As can be seen, the lack of reading comprehension persists at the university level, despite the relevance of the topic and the attention it has received nationally. This can be observed in the latest SIMCE test, with a significant decrease in the national average in reading [8].

The study of reading comprehension has been the subject of several studies [9–16] that have attempted to address the problem solely from a cognitive perspective or from the development of cognitive strategies in reading [17–24], without investigating the explanatory correlational relationship between psychological and linguistic variables in reading comprehension. However, cognitive variables such as executive functions, or affective variables like motivation, are decisive for the use of metacognitive strategies [25] and allow readers to better cope with the challenges of reading [26]. Therein lies the importance of studying the relationships between these variables, especially in university students who have received less attention than those at the school level.

The objective of this study is to identify the cognitive and affective variables that have the greatest impact on reading comprehension in order to explain their influence on the development of reading from the lowest levels of comprehension, such as lexical competence, to more complex levels of reading, such as understanding written texts. Similarly, this research aims to determine the relationship between the linguistic and psychological variables of reading comprehension in students of university teaching programs, in order to understand the phenomenon of reading in a more comprehensive way. The results of this research could have an impact on the didactic methodology used to develop these skills in higher education.

When a reader faces a written text, they must overcome several obstacles to achieve comprehensive reading, as decoding the text is supplemented by the integration of linguistic meaning and other important factors such as the reader's objectives, goals, and previous experiences; their motivations towards reading; and their conceptual skills. All of these factors demand the use of high cognitive resources. The focus of this research is constructivist in nature, as it considers that the construction of meaning and text representation in reading comprehension involves various cognitive processes ranging from bottom-up processes—a type of processing that ranges from the most superficial patterns (decoding letters and words of the text) to the understanding of more complex structures (meaning construction)—to top-down processes—a construction of meaning from more complex structures such as the meaning of the text to the integration of orthographic information. Both types of processing interact during the comprehension of a written text, so that a rapid decoding of words (vocabulary) facilitates the construction of sentence and text meaning, while an efficient construction of the representation of text meaning facilitates the integration of new pieces of information and access to words while reading [27–29].

Traditionally, reading comprehension models have focused on processes, namely, the real-time description of activation (or suppression) mechanisms in working memory [17], while representation theories have aimed to unveil the structures and processes of meaning. Within this realm, theories such as situation models [30], mental models [31], indexing models [32], and embodied theories of meaning [33,34] can be found. However, none of them have provided a satisfactory explanation of cognitive, affective, and linguistic dimensions as a whole. As a cognitive dimension, the situation models theory could explain the underlying difficulty of integrating previous knowledge into the texts administered in this research and its relation to working memory. At the linguistic level, Perfetti's Lexical Quality Model [9] gives central importance to vocabulary in reading comprehension; a variable measured using two types of vocabulary tests in this research. Lastly, in terms of affective aspects, self-determination theory considers motivation from a multidimensional perspective through a continuum that distinguishes various ranges of extrinsic motivation up to intrinsic motivation [35]. Each of these models successfully explains the phenomenon of linguistic comprehension in each of its dimensions. The present study contemplates an exploratory study of the relationship between cognitive, linguistic, and affective variables, which will be explained according to each of the existing models.

1.1. The Impact of Psychological Variables on Reading Comprehension

Motivational dimensions have been shown to be crucial for reading and have been highlighted as predictors of reading comprehension [23,36–40]. The cognitive goals that guide the processing of information when reading a text operate in parallel with the motivational goals that lead to reading and contribute to the persistence of reading practices. This highlights the importance of motivational variables in the reading process because they could be a factor in students' reading preferences. In this regard, Logan, Medford, and Hughes [41] state that intrinsic motivation plays a relevant role in less proficient readers in aspects of lexical reading comprehension, specifically in decoding low-frequency words when compared to high-frequency words as task frustration can be overcome by the desire to develop these language skills due to intrinsic motivation, even outside of academia. However, there are also studies [42] that suggest that intrinsic motivation could benefit good readers more. Authors such as Andreassen and Brâten [43] propose that intrinsic motivation, on the one hand, contributes to the use of more complex cognitive processing strategies (e.g., text interpretation and reflection) and to deeper text comprehension, reflected in inferential processing. Extrinsic motivation, on the other hand, promotes more superficial processing of texts [44–47].

Studies conducted by Law [48] and Clinton [49] establish a relationship between reading motivation and comprehension or the generation of inferences during reading. These relationships are considered the very core of the comprehension processes, both at a local and a global level [50]. Intrinsic motivation enhances the reader's effort to perform a task, such as establishing causal relationships within the text, or between the text and the reader's knowledge of the world, in order to achieve a coherent representation of the text [27,41,49,51,52].

Working memory is a key executive function of cognition, especially relevant for reading comprehension at a micro- and macrostructural level [53], particularly when establishing individual differences in complex tasks. It plays an important role in the retention and manipulation of information. This is an essential aspect for maintaining textual representations and knowledge of the world in parallel, as in the case of making inferences [54]. Working memory also contributes to the representation and storage of long-term memory and favors the activation of relevant information that is useful for the activation of situation models [10,55–57]. Working memory is also linked to vocabulary, as it is necessary for the acquisition of new words [58].

1.2. Linguistic Variables in Text Comprehension

When a reader is confronted with a written text, they have to overcome several obstacles in order to achieve comprehensive reading, since the process of decoding the text is accompanied by the integration of linguistic meaning and other important factors. These include the objective, goals, and motivations of reading, as well as the conceptual skills of the reader, which involve a high demand on cognitive resources. In this way, the understanding of a text becomes a process of prediction and continuous inference between the information in the text and that of the individuals themselves. This process takes place immediately—"online"—as the individual reads the words of a discourse [59,60].

The cognitive processes required for reading take place at different levels, from the lowest (e.g., lexical access) to the highest. Such processes require establishing coherence between sentences, extracting main ideas, or making inferences based on the reader's knowledge of the world in order to construct a situation model of the written story [61]. While the situation model represents the state of affairs of the real world, it is not a faithful representation of the world. Because of this, only a part of the situational information is selected and remains activated at a given moment [30,44,62].

In short, understanding a text involves the execution and interpretation of multiple cognitive processes that comprise three levels: the surface code (lexical and syntactic level), the base text (propositions and inferences), and the situation model (construction of a mental representation of the text) [27,29]. It is the constructive and dynamic process in

which the reader plays an active role in the construction of a situation model based on the semantic cues of the text and the social information received from the environment. In this sense, reading is a complex, problem-solving process in which the integration of one mental model with another plays a fundamental role [17].

The recognition of written words requires basic cognitive micro- and macro-processes in order to understand a text. Failure at this level implies a failure in the discursive macro-processes of meaning integration [63,64]. This is the case for less skilled readers, who often make semantic substitution errors, have difficulties in reading pseudowords, have a slower rate of lexical processing, and have dyslexic problems. These difficulties have a considerable impact at higher levels, where reading difficulties are sometimes compensated for by pre-reading skills that come from verbal comprehension [55,64].

Expert reading comprehension, therefore, depends on successfully identifying words, a process that involves a well-specified representation of the form (phonology and orthography) of the word and its meaning. In this way, according to Perfetti's [9] Lexical Quality Hypothesis, the quality of a word's representation involves aspects of form and content that lead the most skilled readers to activate a word in a precise and flexible way, according to their knowledge of word usage, to ensure coherence among syntactic constituents in a text. Therefore, vocabulary plays a crucial role in the linguistic processes of reading comprehension [9].

Decoding a word involves the combination of different levels of linguistic processing (orthography, phonology, morphology, syntax, and semantics), as well as the use of attentional resources and the storage and retrieval of information from memory [65–67], which affects the reading system. Establishing the relationships between these different psychological and linguistic variables, as well as their importance in the reading process, poses a challenge for psycholinguistic research.

2. Methodology

The design of this study is correlational, employing a cross-sectional approach [68], since it analyzes the relationship between dependent variables of reading comprehension, such as the percentage of correct answers and reading times, and the independent variables of a cognitive (working memory), linguistic (vocabulary), and motivational (motivation to read) nature at a given moment.

2.1. Participants

In order to estimate the sample size, a linear regression model with five coefficients was used, to achieve a minimum of 20% of explained variance. For a test with a significance level of 5% and power of 80%, a minimum sample size of 57 people was required.

Considering the sample dropout rate, a total of 65 volunteer students (58 females and 7 males) between the ages of 18 and 30 years (M = 21.3, SD = 2.31) participated in the study. The type of sample used was a non-probability convenience sample. All participants were university students in teaching programs at a university in the Biobío region, Chile. The following exclusion criteria were considered: (a) having a history of uncorrected sensory alterations (e.g., vision); (b) having a history of neurological disorders (e.g., epilepsy, migraine, etc.); (c) having a history of substance abuse; (d) having a history of learning disorders (e.g., dyscalculia); and (e) having a history of language disorders (e.g., dyslexia, aphasia, etc.). All participants received financial compensation for transportation expenses.

2.2. Instruments

- Tasks for the measurement of reading comprehension

LECTUM 7-Reading Comprehension Test [69]: This test involves the comprehension of explicit and implicit information at the textual, pragmatic, and critical levels in two argumentative texts—one expository and one narrative text—with 32 multiple-choice questions to be answered in 90 min. Each correct item is worth 1 point. It is a normed test

for Chilean students in the 4th year of high school, with a reliability of 0.87 (FORM A) and 0.83 (FORM B).

Inter-American Series Comprehensive Reading Test (Universidad del Valle de Guatemala [UVG], 1980–1986) [70]: This test measures Inter-American Vocabulary, Comprehension Speed, and Comprehension Level. It was developed with five levels of difficulty in English and Spanish: Level 1 (ages 6–7); Level 2 (ages 7–8); Level 3 (ages 9–11); Level 4 (ages 12–14); and Level 5 (ages 15–18) (Guidance Testing Associates, 1980). For this research, the Pretest Form Level 5 in Spanish was used.

Reading Speed Task: This task automatically measures reading time in milliseconds of high- and low-familiarity short texts. Each text has 2 sentences (11 to 13 words) with the same syntactic structure. Participants then answer whether the word on the screen was a word or a non-word. Reading speed is determined by the average number of words read per minute in each sentence and in the target word. To construct the texts; length, syntactic complexity, lexical frequency, and familiarity were controlled. Three measures were considered in this task: the first phrase (VL1), the second phrase (VL2), and the target word (VL3).

- Tasks for the measurement of language skills

Vocabulary Test: vocabulary subtask of the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) [71], which assesses lexical knowledge by defining a series of words presented orally one at a time in an individual interview. The definitions were recorded using a protocol and a score was assigned based on standards established in the application manual.

- Tasks for the measurement of cognitive abilities

Working Memory Tasks: two subtasks of the Wechsler Adult Intelligence Scale-Fifth Edition (WAIS-IV) [71] were used: (a) *Letter–Number Sequence*; participants had to listen to and memorize a sequence of numbers and letters that increased in complexity and order. (b) *Digit Retention*: participants had to listen to a sequence of numbers and repeat them in the same order, in reverse order, and in ascending order. A correct answer was worth 1 point, while an incorrect answer was worth 0 points.

- Tasks for the measurement of motivation towards reading

Motivation for Reading Questionnaire: A Chilean-Spanish-adapted version of the Motivation for Reading Questionnaire by Wigfield et al. [72] was used, which consists of 53 statement items rated on a 4-point, Likert-type scale (e.g., "*very different from me*", "*a little different from me*", "*a little like me*", and "*very similar to me*"). Eleven subcategories are considered, which are grouped into four higher categories: self-efficacy, intrinsic motivation, extrinsic motivation, and social elements. The reliability obtained for the total scale, in its adaptation to Chilean Spanish, was $\alpha = 0.93$ [73].

2.3. Procedure

All participants were informed of the tests to be administered in this study before signing the informed consent form, in accordance with the protocols of the Institutional Ethics, Bioethics, and Safety Committee. The procedure was conducted in one session, divided into two parts. The first part consisted of offline questionnaires and the second part was an online reading task. The data were collected during August and September 2022.

The reading comprehension, vocabulary, and working memory tests and the Motivation For Reading Questionnaire were administered independently, followed by the reading speed task in a different session. The online reading test configuration consisted of the presentation of 90 stories to each participant. Each story was made up of three parts: two phrases and a target word. These were auto-administered by the participant. The phrases were displayed one at a time, centered on the computer screen. The target word was one word, also displayed in the center of the screen. The online test measured the reading speed for each phrase and target word.

3. Statistical Analysis

To determine the relationship between psychological and linguistic variables in reading comprehension, an analysis was carried out using the R package (version 4.03) [74]. Firstly, a descriptive analysis of the data was carried out to obtain centrality and dispersion statistics for each of the study variables. Secondly, the relationships among all study variables were examined for age, study program, and sex through the use of non-parametric tests. Thirdly, a bivariate analysis was carried out, in which the relationship between all variables was plotted to verify the linearity of the relationship between each pair. Once this assumption was verified, the Pearson correlation matrix was calculated.

Finally, a mediation analysis was performed to determine the causal path from the psychological variables related to reading to the linguistic variables. In this way, psychological variables would affect vocabulary, which, in turn, would affect reading performance. This analysis makes it possible to deconstruct the total effect of the psychological variables associated with reading on reading performance into two parts: an indirect effect, which refers to the changes in reading performance caused by changes in vocabulary, and a direct effect, which includes changes related to the psychological variables associated with reading that cannot be attributed to vocabulary [75].

The mediation effect was calculated by multiplying the effect of the psychological variables associated with reading on vocabulary by the effect of vocabulary on reading performance. As a statistical test of the indirect effects, the bootstrap confidence interval was used in the product of the regression coefficients of vocabulary in the psychological variables associated with reading by the regression coefficients of reading performance in vocabulary. The effect is considered significant if the bootstrap interval does not contain zero [76].

4. Results

4.1. Descriptive Data Analysis

An exploratory analysis was carried out to examine the frequency distribution of the data. Table 1 shows the descriptive statistics of the independent, dependent, and mediating variables. In the case of the Lectum test, using the scales for the last level of education for in which the test is adapted, a mean Z-score of 0.81 was obtained, which corresponds to a 78–79 percentile. A total of 10 students (15.9%) performed below the average of students in the school system. In the category of implicit questions of the Lectum test, using the scales for students at the last school level for which the test is adapted, the mean Z-score was 1.12, which corresponds to a percentile of 82–86. A total of six students (9.5%) scored below the reference mean. On the other hand, in the explicit questions, a mean Z-score of 0.34 was obtained, corresponding to a percentile of 61–80. In this case, a total of 21 students (33%) performed below the average of students in the school system.

Table 1. Descriptive psychological variables, vocabulary, and reading performance.

Variables	*M*	*SD*	Min	Max
Psychological variables				
Working memory—WAIS	39.81	7.93	0.00	63.00
Self-efficacy	13.51	3.87	0.00	21.00
Intrinsic motivation	32.35	8.19	0.00	44.00
Extrinsic motivation	19.52	7.87	0.00	38.00
Social elements	17.86	5.85	0.00	31.00

Table 1. *Cont.*

Variables	*M*	*SD*	Min	Max
Mediating linguistics				
WAIS Vocabulary	31.98	8.66	0.00	49.00
Inter-American Vocabulary	28.03	7.45	10.00	44.00
Reading performance				
Explicit—Lectum	9.92	3.09	2.00	16.00
Implicit—Lectum	13.98	3.83	4.00	22.00
Inter-American Speed	11.98	3.97	2.00	26.00
Inter-American Comprehension Level	22.73	6.21	13.00	38.00
Reading Speed 1	133.60	39.09	60.34	241.00
Reading Speed 2	162.80	45.47	76.86	295.60
Reading Speed 3	39.17	9.12	19.92	59.43

Note: the achievement level corresponds to the standardization of the scale from 0 to 100. Mean (*M*), standard deviation (*SD*), minimum (min), and maximum (max) values. Implicit—Lectum: questions related to inferences from the text; Explicit—Lectum: questions related to literal content of the text; Reading Speed 1: reading speed, phrase 1; Reading Speed 2: reading speed, phrase 2; Reading Speed 3: reading speed, phrase 3.

With regard to the inter-American test, if we take the scores associated with the 50th percentile for the city of Guatemala for males and females as a reference, according to the Educational Research Center of the Universidad del Valle de Guatemala, four of the six males (66%) were below 78 points and 39 of the 58 females (68%) were below 69 points. These results are in line with the cut-off score for the 50th percentile [70].

4.2. Demographic Variables and Their Relation with the Variables of This Study

4.2.1. Relation with Age

In the analysis of the relation between age and the variables of this study, we can see a significant and negative relation with extrinsic motivation (−0.48) and social elements (−0.30). This implies that as age increases, extrinsic motivation decreases. The results are shown in Table 2.

Table 2. Results by age.

Variables	*r*	*p*-Value
Psychological variables		
Working memory—WAIS	0.15	0.26
Self-efficacy	−0.18	0.17
Intrinsic motivation	−0.10	0.46
Extrinsic motivation	−0.48	0.00
Social elements	−0.30	0.02
Mediating linguistics		
WAIS Vocabulary	0.14	0.29
Inter-American Vocabulary	0.04	0.76
Reading performance		
Explicit—Lectum	0.00	0.99
Implicit—Lectum	0.10	0.45
Inter-American Speed	0.22	0.09
Inter-American Comprehension Level	0.09	0.49
Reading Speed 1	0.14	0.27
Reading Speed 2	0.07	0.59
Reading Speed 3	0.12	0.37

Note: r: Pearson correlation coefficient; *p*-value: significance level; Implicit—Lectum: questions related to inferences from the text; Explicit—Lectum: questions related to literal content of the text; Reading Speed 1: reading speed, phrase 1; Reading Speed 2: reading speed, phrase 2; Reading Speed 3: reading speed, phrase 3.

4.2.2. Sex

In the analysis of differences by sex in the variables of the study, significant differences were found using a Mann–Whitney U test, favoring males in working memory—WAIS, $p = 0.004$, $d = 1.32$, and in WAIS Vocabulary, $p = 0.042$, $d = 0.82$. In the second reading task, males ($M = 118.6$) also showed faster speeds than females ($M = 168.40$), $p = 0.012$, $d = 1.16$. In all cases, Cohen's D was higher than 0.8, pointing to strong differences. The results are shown in Table 3.

Table 3. Differences by sex between variables.

Variables	Female		Male		Statistic	*p*-Value	Effect Size (*d*)
	M	*SD*	*M*	*SD*			
Psychological variables							
Working memory—WAIS	38.73	7.29	48.43	8.08	U = 64.50	0.00	1.32
Self-efficacy	13.48	3.94	13.71	3.60	U = 183.00	0.78	0.06
Intrinsic motivation	32.00	8.28	35.14	7.43	U = 147.50	0.29	0.38
Extrinsic motivation	19.57	7.72	19.14	9.70	U = 213.50	0.71	0.05
Social elements	17.95	6.01	17.14	4.74	U = 223.00	0.56	0.14
Mediating linguistics							
WAIS Vocabulary	31.21	8.66	38.14	6.20	U = 102.50	0.04	0.82
Inter-American Vocabulary	27.55	7.24	31.86	8.63	U = 136.00	0.19	0.58
Reading performance							
Explicit—Lectum	9.80	3.11	10.86	2.97	U = 155.00	0.37	0.34
Implicit—Lectum	13.86	3.95	15.00	2.71	U = 155.00	0.37	0.30
Inter-American Speed	11.93	4.00	12.43	3.95	U = 166.00	0.52	0.13
Inter-American Comprehension Level	22.54	6.20	24.29	6.53	U = 167.00	0.53	0.28
Reading Speed 1	137.30	38.21	104.00	35.34	U = 282.00	0.06	0.88
Reading Speed 2	168.40	43.42	118.60	38.80	U = 312.00	0.01	1.16
Reading Speed 3	39.73	9.11	34.70	8.42	U = 251.00	0.23	0.56

Note: mean (*M*), standard deviation (*SD*), significance level (*p*–value). Implicit—Lectum: questions related to inferences from the text; Explicit—Lectum: questions related to literal content of the text; Reading Speed 1: reading speed, phrase 1; Reading Speed 2: reading speed, phrase 2; Reading Speed 3: reading speed, phrase 3.

4.2.3. Study Programs

In order to study the relation between the participants' study program, three groups were formed. The groups were considered homogeneous between them. The first group was formed of students from single-subject teaching programs, such as natural sciences and chemistry, music, physical education, visual arts, mathematics, and English. The second group was formed of students from special education teaching programs. The third group was formed of students from primary education teaching programs.

A Kruskal–Wallis test showed significant differences only for working memory—WAIS and vocabulary—WAIS. When analyzing the differences for working memory between the three groups, a multiple comparison test estimate showed a significant difference only between single-subject teaching programs ($M = 44.69$) and special education ($M = 38.80$), $p = 0.04$, reflecting better performance for the first group. For vocabulary, the most relevant difference were found between single-subject teaching programs ($M = 35.85$) and the primary education teaching programs ($M = 27.10$). However, this difference was not statistically significant $p = 0.06$. The results are shown in Table 4.

Table 4. Results by study program.

Variables	Primary Education Teaching		Special Education		Subject Teaching		Statistic	*p*-Value	*p*-Adjust
	M	*SD*	*M*	*SD*	*M*	*SD*			
Psychological variables									
Working memory—WAIS	37.50	13.66	38.80	5.34	44.69	7.64	$X^2(2) = 6.99$	0.03	0.43
Self-efficacy	13.00	5.31	14.12	3.36	12.00	3.96	$X^2(2) = 2.36$	0.31	1.00
Intrinsic motivation	31.10	11.72	33.83	6.81	28.77	8.39	$X^2(2) = 3.71$	0.16	1.00
Extrinsic motivation	17.70	8.08	20.23	7.67	18.77	8.67	$X^2(2) = 0.81$	0.67	1.00
Social elements	17.80	7.24	18.27	5.87	16.61	4.86	$X^2(2) = 1.55$	0.46	1.00
Mediating linguistics									
WAIS Vocabulary	27.10	11.82	31.95	7.52	35.85	7.95	$X^2(2) = 6.91$	0.03	0.43
Inter-American Vocabulary	24.20	8.59	27.75	6.91	31.85	6.94	$X^2(2) = 5.54$	0.06	0.75
Reading performance									
Explicit—Lectum	8.80	2.44	9.78	3.27	11.23	2.65	$X^2(2) = 4.00$	0.14	1.00
Implicit—Lectum	12.70	3.89	13.88	3.90	15.31	3.45	$X^2(2) = 3.47$	0.18	1.00
Inter-American Speed	12.20	6.03	11.55	3.29	13.15	4.08	$X^2(2) = 2.57$	0.28	1.00
Inter-American Comprehension Level	20.20	4.05	22.77	6.39	24.54	6.72	$X^2(2) = 2.48$	0.29	1.00
Reading Speed 1	124.50	31.87	139.00	38.79	124.10	44.50	$X^2(2) = 1.84$	0.40	1.00
Reading Speed 2	158.50	32.33	170.70	44.72	142.10	52.08	$X^2(2) = 3.28$	0.19	1.00
Reading Speed 3	39.03	12.40	39.98	8.58	36.82	8.16	$X^2(2) = 1.09$	0.58	1.00

Note: mean (*M*), standard deviation (*SD*), significance level (*p*–value). Implicit—Lectum: questions related to inferences from the text; Explicit—Lectum: questions related to literal content of the text; Reading Speed 1: reading speed, phrase 1; Reading Speed 2: reading speed, phrase 2; Reading Speed 3: reading speed, phrase 3.

4.2.4. Study Program vs. Sex

The study program vs. sex analysis did not show reliable results, as most males were found in the single-subject teaching programs. There were no males in special education programs and a single male in the primary education teaching program. Due to this, results by sex must be taken into consideration with caution, as they are not representative and may be influenced by the single-subject study programs.

4.3. Bivariate Analyses

Table 5 shows the Pearson correlation matrix for the study variables. Among the psychological variables, positive correlations were found mainly between intrinsic motivation, self-efficacy, and social elements. Specifically, a strong correlation was found between intrinsic motivation and self-efficacy ($r = 0.83$), as well as moderate correlations between these variables and social elements (r between 0.36 and 0.69). The relationship between working memory and the rest of the psychological variables is weak, since no significant relationships were found.

Regarding the mediating linguistic variables, the WAIS Vocabulary and the inter-American test vocabulary show a moderate relationship ($r = 0.28$). Both show significant direct relationships with working memory, specifically $r = 0.59$ with WAIS Vocabulary and $r = 0.38$ with Inter-American Vocabulary. There are no other significant relationships with psychological variables.

Table 5. Correlation matrix of psychological, mediating, and discursive linguistic variables.

	Psychological Variables								**Linguistic Mediating Variables**				**Discursive Linguistic Variables**									
	Intrinsic Motivation		**Self-Efficacy**		**Extrinsic Motivation**		**Social Elements**		**WAIS Vocabulary**		**Inter. Vocabulary**		**Implicit Lectum**		**Explicit Lectum**		**Inter. Speed**		**Inter. Level Comp.**		**Reading Speed 1**		**Reading Speed 2**		**Reading Speed 3**	
Working Memory	−0.11		−0.13		0.07		−0.14		0.59	**	0.38	**	0.28	*	0.22		0.37	**	0.33	**	0.05		−0.02		0.21	
Intrinsic Motivation	1	**	0.80	**	0.36	**	0.69	**	−0.12		0.14		0.07		−0.01		−0.16		−0.06		0.16		0.24		0.04	
Self-Efficacy			1	**	0.36	**	0.69	**	0.02		0.00		0.10		0.07		−0.15		−0.02		0.22		0.32	*	0.03	
Extrinsic Motivation					1	**	0.58	**	0.13		0.05		−0.15		0.18		−0.14		−0.14		−0.12		−0.01		−0.12	
Social Elements							1	**	−0.08		0.03		−0.03		−0.03		−0.11		−0.17		0.00		0.08		−0.17	
WAIS Vocabulary									1	**	0.28	*	0.29	*	0.39	**	0.42	**	0.30	*	0.02		−0.03		0.01	
Inter. Vocabulary											1	**	0.26	*	0.27	*	0.51	**	0.53	**	0.14		0.10		0.15	
Implicit Lectum													1	**	0.52	**	0.30	*	0.22		0.13		0.07		0.08	
Explicit Lectum															1	**	0.10		0.10		−0.04		−0.06		−0.02	
Inter. Speed																	1	**	0.54	**	0.24		0.22		0.33	**
Inter. Level Comp.																			1	**	0.40	**	0.37	**	0.30	*
Reading Speed 1																					1	**	0.94	**	0.61	**
Reading Speed 2																							1	**	0.62	**
Reading Speed 3																									1	**

Note: Inter. Vocabulary: Inter-American Vocabulary. Inter. Speed: Inter-American Speed (fluency). Inter. Level Comp: Inter-American Level of Comprehension. Reading Speed 1: reading speed, phrase 1. Reading Speed 2: reading speed, phrase 2. Reading Speed 3: reading speed, phrase 3. *: $p < 0.05$; ** $p < 0.01$.

With regard to the discursive variables, there is a strong relationship between the implicit and explicit dimensions of the Lectum test (r = 0.52), and a strong relationship between verbal fluency and Comprehension Level (r = 0.54). Conversely, the implicit dimension of the Lectum test presents moderate relationships with fluency (r = 0.30), with fluency and Reading Speed 3 (r = 0.33), and with Comprehension Level with Reading Speed 2 and 3. Very strong relationships are observed between Reading Speed 1 and Reading Speed 2 (r = 0.94), while strong relationships were found between Reading Speed 3 and 2, (r = 0.62).

The mediating linguistic variables, WAIS Vocabulary and Inter-American Vocabulary, show weak to moderate relationships with the discursive variables, with correlations ranging from r = 0.26 to r = 0.53. Specifically, significant correlations were observed between WAIS Vocabulary and Inter-American Vocabulary, with Implicit Lectum, Explicit Lectum, Inter-American Speed, and Inter-American Level of Comprehension.

4.4. Analysis of the Mediation Model

To analyze the data, a mediation model was used, wherein the psychological variables, specifically motivation (intrinsic, extrinsic, self-efficacy, and social elements) and memory were considered as independent variables (IV); reading comprehension (Implicit-Lectum, Explicit-Lectum; Comprehension Speed, and Comprehension Level) and reading speed 1, 2, and 3 were considered as dependent variables (DV); and lexical knowledge (WAIS Vocabulary and Inter-American Vocabulary) were used as mediating linguistic variables (MV). The mediation diagram used is shown in Figure 1.

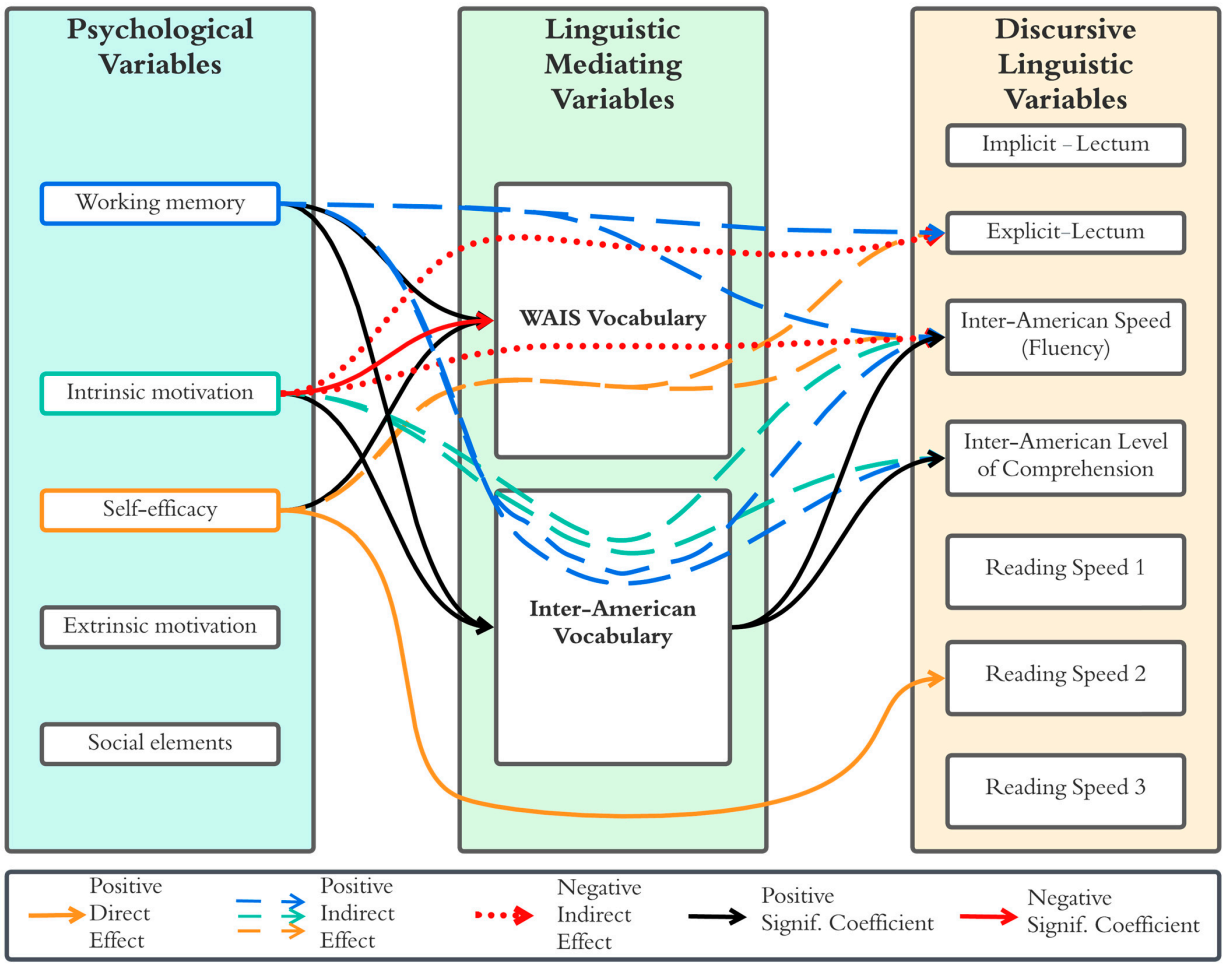

Figure 1. Mediation diagram with independent, dependent, and mediating variables.

First, we analyzed the relationship between the independent and the mediating variables. In the Inter-American Vocabulary regression model, two significant positive coefficients were observed, that of WAIS—working memory, $b = 0.36$, $p < 0.001$, and that of Intrinsic Motivation, $b = 0.414$, $p = 0.048$. In the case of WAIS Vocabulary, the coefficients of WAIS—working memory, $b = 0.63$, $p < 0.001$, and self-efficacy, $b = 1.088$, $p = 0.014$, are significant and positive. The intrinsic motivation coefficient is negative, $b = -0.442$, $p = 0.033$. This negative coefficient can be understood as a suppression effect, since in the bivariate analysis neither of the two variables separately presents significant correlations with WAIS Vocabulary; when they are included in a regression model, both variables intensify their effect, as their coefficients remain significant.

When analyzing the effect of the mediating variables on the dependent variables, we can observe that none of the WAIS Vocabulary coefficients are significant. On the other hand, the coefficients of Inter-American Vocabulary are significant in the prediction model of reading speed, $b = 0.24$, $p = 0.002$, and Level of Comprehension, $b = 0.43$, $p < 0.001$.

Regarding the direct effects, that is, the effects of the independent variables on the dependent variables unmediated by the moderating linguistic variables, it is worth noting that self-efficacy is the only one of the motivational variables that has a significant direct effect on the reading speed of phrase 2. This means that self-efficacy can explain reading speed (phrase 2) without the mediation of vocabulary, $c = 7.187$, $p = 0.04$.

Regarding the mediation analysis itself, the results show that self-efficacy has an indirect effect on reading skills, mediated only by WAIS Vocabulary, specifically in Explicit—Lectum, $ab = 0.113$, 95% IC = [0.003; 0.325], and Comprehension Speed, $ab = 0.140$, 95% IC = [0.004; 0.436].

Intrinsic motivation has an indirect effect on reading ability; the effect is mediated by WAIS Vocabulary for Explicit-Lectum, $ab = -0.045$, 95% IC = [−0.147; −0.005], and Comprehension Speed, $ab = -0.057$, 95% IC = [−0.190; −0.0004]. These coefficients are negative because of the negative coefficient of intrinsic motivation on WAIS Vocabulary, which is associated with a suppression effect. Meanwhile, Inter-American Vocabulary mediates the relationship between intrinsic motivation and Level of Comprehension, $ab = 0.180$, 95% IC = [0.016; 0.433], and Comprehension Speed, $ab = 0.101$, 95% IC = [0.016; 0.267].

Another independent variable that had an indirect effect on reading comprehension was working memory. Specifically, the results of the mediation model showed that WAIS Vocabulary mediated the relationship between working memory and Explicit—Lectum, $ab = 0.06$, 95% IC = [0.005; 0.143], and Comprehension Speed, $ab = 0.081$, 95% IC = [0.007; 0.198]. Inter-American Vocabulary mediates the relationship between working memory and Comprehension Level, $ab = 0.156$, 95% IC = [0.006; 0.313], and Comprehension Speed, $ab = 0.088$, $ab = 0.088$, 95% IC = [0.023; 0.174].

5. Discussion

5.1. Teaching-Program Students Have Reading Comprehension Problems

According to the results obtained in the reading comprehension tests, teaching-program students have reading comprehension problems at different levels, as reflected in the different dimensions of the assessments. It is worth noting that the tests used were adapted to the last level of secondary school education. However, the Lectum test was used at the university level as a diagnostic test. This was applied at the institution of the participants, and its score discriminates against the reading skills of the population, detecting the least proficient readers. In general, in the diagnostic tests taken at the university level using this test, students obtained low scores. Particularly noteworthy are the low scores obtained in the explicit questions, which are associated with reading comprehension strategies, such as locating information in texts.

A previous study conducted in a university setting using the Lectum test [20] found low performance among university students in their first year of study. The Lectum test allowed researcher to distinguish between proficient and less proficient readers in that sample, and participants classified as less proficient also showed low performance in textual-type questions, similar to the findings of this research. A determining factor in

the individual differences found between the profiles of expert readers and less skilled readers is the variable of having undertaken previous studies. This means that if students have academic experience, it will determine their reading quality. In short, the Lectum test discriminates between the discursive competencies of university students, which, in our case, remain at a low performance in general.

Regarding the inter-American test, the percentage of students scoring below the reference scale is quite high and is distributed evenly between males and females (66% and 68%, respectively), despite the fact that the percentage of females in the sample was much higher than that of males. This test was included because, unlike the previous one, which focuses more on semantic aspects, the inter-American test measures different linguistic dimensions, such as vocabulary, verbal fluency, and comprehension of microtexts. Furthermore, the time factor played a predominant role as, in this test, each section had to be answered in a time determined by the examiner. These results are in line with those found within the framework of the Teaching Career Law, which shows poor performance in written communication skills among university teaching-program students, as more than 70% perform at the second-lowest level of performance in a vital ability necessary to meet the high standards of quality and excellence required of teachers in Chile [77].

Most of the texts that made up the reading comprehension tests of both the Lectum and the inter-American test are expository and argumentative in nature. Therefore, the students' low performance on explicit questions may be attributed to failures in representing the base text, as the information from these texts is new to the students. On the other hand, the construction of the situation model also fails because students do not have sufficient prior knowledge to link the ideas and update them efficiently [30]. Situation models are characterized as dynamic representations constructed in real time and can be updated with new information [62]. The situation model perspective proposes that the entities and properties that are present in the described situation are fully represented in the "focus" of the working memory and are, therefore, highly accessible. The results of this research indicate that working memory influences both the micro and macro levels of the inter-American test. This can be explained by the indirect positive effects found in the task related to sentence completion—involving the more local sentence level—and the indirect positive effects of working memory in text comprehension tasks—involving macro levels associated with meaning comprehension. Thus, students' failures occur in both the textual representation and situation models.

In short, according to the constructivist approach that encompasses this research, university students in the sample failed both at the bottom-up processes, given the difficulties they show in vocabulary in both tests applied, and at the top-down level, as a result of the difficulties students show in the comprehension of longer texts in the Lectum test [27–29].

5.2. Cognitive and Affective Variables Related to Demographic Differences

According to the self-determination theory, motivation is a dynamic construct that changes over time in order to achieve specific goals [78]. As a result, age is not a relevant factor when experiencing such changes. The results of this study showed significant negative correlations between extrinsic motivation toward reading and age. This has the implication that as age increases, there is decreased attention to the rewards and benefits associated with reading, as well as social elements, represented by family and friends [42]. This might be due to the fact that, as time passes, readers discover their reading interests and reading can become more of a recreational activity or be focused only on university subjects. However, it might also be due to the existence of other interests that can become more relevant as readers age. Similar studies have found a negative correlation between extrinsic motivation and age in the workforce [79,80]. In the educational setting, studies focus mostly on school education. In a sample with ages ranging from 9 to 17 years old, Gillet et al. [81] found a decrease in extrinsic motivation as age increased, due to the fact that secondary education students have more freedom to choose their fields of study. Nevertheless, in terms of motivation towards reading, Kelley and Decker [82] found a general decrease

in motivation towards reading in adolescence when comparing eighth grade students to seventh and sixth grade students. One of the main reasons put forth in this research was the lack of value attributed to reading, which relates directly to extrinsic motivation.

On the other hand, the role of working memory in reading comprehension is fundamental for the temporary storage and manipulation of information and helps to explain individual differences in this linguistic skill in terms of efficacy while processing information [83]. Thus, students from single-subject teaching programs usually deal with texts that are more narrowly focused on their field of study, as opposed to child-related teaching programs that study a broader range of subjects. The use of specific knowledge, typical for working memory, in reading comprehension is a determinant factor for better performance [84]. It is possible that this might have modulated the sex effects found for males. Contrary to these results, most of the studies show better performance of females when compared to males, both in reading comprehension and in motivation towards reading [37,85–87]. Future research using a representative sample for both sexes might shed more light into the relation between these cognitive variables and reading comprehension in university students.

5.3. The Role of Vocabulary as a Mediating Variable in Reading Comprehension

As seen in studies on word recognition, lexical access, and lexical richness, among others [76,88,89], vocabulary plays an important role in reading comprehension. However, the majority of these studies are correlational in nature. In this study, we conducted an analysis according to a mediation model with various cognitive and linguistic variables, where vocabulary stood out as a mediating variable in reading comprehension. Vocabulary plays a relevant role in reading comprehension in the different tasks of the inter-American test, which emphasizes the selection of the excluded term at a semantic level. Likewise, vocabulary played an important role in the WAIS Vocabulary test, by defining the concepts in terms of oral vocabulary. These results are in line with those obtained by Feller et al. [90], who concluded that vocabulary significantly mediates the relationship between word reading and comprehension. Similarly, a study by Tran et al. [91] found similar results in a test of vocabulary breadth and depth in a sample of 103 adults with low literacy skills. Using hierarchical multiple regression analyses, they concluded that both vocabulary tests contribute significantly to reading comprehension by 79.2%. In a study with adult readers that assessed reading and learning disabilities, Tighe et al. [92] also found that decoding and oral vocabulary were the most prominent predictors of reading comprehension. In this sense, Guerra and Kronmüller [89] propose that, in a Chilean context with young students with or without university education, lexical knowledge plays a more important role than other individual skills in understanding online inference generation and contributes to improving comprehension of the mechanisms underlying efficient reading.

Notwithstanding the above, a study by Talwar et al. [93] found that decoding was a better predictor of reading comprehension than vocabulary in an adult sample with an average age of 42.19 years. Talwar et al. [93] suggest that the effect of vocabulary on reading comprehension depends on the type of assessment, e.g., oral or written, and the type of reader. In this way, oral vocabulary assessment does not have a greater impact on readers with an intermediate reading profile. This finding is in line with the results of this study since written vocabulary correlated positively with verbal fluency and reading comprehension of short texts. This was not the case for the WAIS vocabulary test, which utilized an oral text. These findings are interesting in an adult population (as in the study by Talwar et al. [93]) and in university students (as in our study), since the vocabulary and decoding skill variables have been investigated mostly in younger populations.

On the other hand, Talwar et al. [93] posit that vocabulary seems to have a greater impact in short texts (i.e., the inter-American test in this study) than in longer texts (such as in the Lectum test), in which working memory has a greater impact. These results are in line with those of this study, as the written vocabulary test—which involved determining the excluded term at the semantic level—correlated positively with comprehension in short

texts but not in longer texts, such as those found in the Lectum test. These results align with the Lexical Quality Hypothesis, which posits that vocabulary plays a relevant role at the syntactic level in establishing local coherence in text comprehension [9].

5.4. The Role of Working Memory in Reading Comprehension

Several authors have emphasized the importance of working memory in reading, especially when keeping information active and to determine the coherence of a text [94–97]. Likewise, they consider that working memory can be considered a predictor of reading ability. Because of this, we evaluated working memory in this study to see if it has a direct effect on reading comprehension. However, authors such as Freed, Hamilton, and Long [98] report that working memory has an indirect effect on reading comprehension, mediated by reasoning in intelligence tests. The authors conclude that only vocabulary has a direct effect on reading comprehension, especially when it comes to recognizing the relevant semantic characteristics of words in a context, as occurs in the vocabulary task of the inter-American test, which we used in this study. Their results are in line with the findings of this research, as we found that working memory has a positive, indirect effect in reading fluency tasks and in the comprehension of short texts in the inter-American test, as well as in the comprehension of explicit questions in long texts, such as those contained in the Lectum test. In this scenario, immediate recall of the information contained in the text is required. Furthermore, positive working memory correlations were found with both types of vocabulary—i.e., oral and written—highlighting the predominant role of vocabulary in reading comprehension.

In this regard, Yang, Shintani, Li, and Zhang [99] also found significant interaction effects between working memory and vocabulary only when the task was a short-term (not long-term) task. However, the role of working memory had a mediating effect on vocabulary in a different context, such as learning words in a second language.

Some authors, such as Cartwright et al. [39], note that executive functions, the central component of which is working memory, together with intrinsic motivation uniquely influence university students' reading comprehension beyond language comprehension and word reading skills. This study investigated the influence of motivation on the linguistic variables of vocabulary and reading comprehension, which will be analyzed in detail in the following section.

5.5. Motivation and Reading

The nature of motivation influences instruction globally and specifically for certain activities. These include students' approach to reading through their engagement in reading activities, the quantity and complexity of selected reading, and the frequency of reading, all of which increase reading comprehension [40,41,100–102].

The results of this research show, by means of the inter-American test, that intrinsic motivation has a positive indirect effect on reading fluency and also on comprehension of short texts. These results are supported by empirical evidence [103,104] of a positive correlation with reading comprehension, especially in relation to dimensions such as curiosity, engagement, and reading challenge.

On the contrary, extrinsic motivation did not correlate with any of the reading comprehension tests according to the results obtained in this study. Empirical evidence supports similar findings in the literature; extrinsic motivation does not correlate or correlates negatively with reading comprehension [43,48]. Nevertheless, the role of extrinsic motivation in reading comprehension is less clear, as some studies [105] argue that some degree of extrinsic motivation is often beneficial for academic success, e.g., for students who have a good perception of competition from their peers. In this regard, McGeown, Norgate, and Warhurts [1] found a positive correlation between extrinsic motivation and good readers on dimensions related to competition for peer recognition and good grades.

5.6. Vocabulary and Reading Motivation

The cognitive goals that guide the processing of information when reading a text act in parallel with the motivational goals that lead to reading and contribute to the persistence of reading practices. In this sense, vocabulary plays a fundamental role as a moderating variable, as well as via its relationships with the other variables. Consequently, according to the results of this study, intrinsic motivation correlates positively with the inter-American vocabulary test, which has a more semantic character in the decoding of words. Conversely, it correlates negatively with the WAIS test, which involves giving meaning to the coding of words.

In line with these findings, Logan, Medford, and Hughes [41] state that intrinsic motivation plays a relevant role for readers with deficiencies in aspects of lexical reading comprehension, specifically in decoding infrequent words when compared to high-frequency words. This is because intrinsic motivation allows them to overcome the frustration of the task due to the desire to develop such linguistic skills. However, there are also studies [42] that suggest that intrinsic motivation would be more beneficial for expert readers. In this sense, as the study population has low reading skills, it is likely that the negative correlation found in the WAIS task relates to this, as well as to the modality and demand of the task—producing definitions in an oral interview. The presence of the evaluator may also have had a negative effect on this task, as the participant had less independence in giving their response. Additional studies are needed to further investigate this relationship, particularly because of the suppression effect that reinforces this negative effect when controlling for self-efficacy.

Self-efficacy had a positive indirect effect in the reading fluency tasks of the inter-American test and in the explicit questions of the Lectum test. This effect could be explained by the relationship between the perception of one's own knowledge and the development of one's skills with the difficulty of the tasks. Self-efficacy implies a high conviction that it is possible to perform a task successfully, especially if it is an easy one [106,107]. In this case, both reading fluency and understanding explicit questions are low-difficulty tasks because they are trained in everyday life and at school [106,108]. Consequently, the indirect positive effect in both tests could be due to the good perception of this performance. In addition to the direct positive internal effect of self-efficacy on reading speed, they emphasize the importance of affective variables in reading comprehension, since a good perception of readers' abilities could contribute to the improvement of their reading skills [109]. However, this could also be due to the application of standardized questionnaires. In this line, Louick et al. [107] found a positive correlation between self-efficacy and standardized reading comprehension tests. The authors found that readers who showed higher self-efficacy obtained higher scores at the beginning of the academic year, but these scores were not maintained over time.

The direct internal positive effect of self-efficacy on reading speed can also be explained by the familiarity of the task, which consisted of self-administered reading, emulating a natural reading situation. However, self-efficacy may be subject to different interpretations, because it is a motivational dimension that exhibits individual differences between participants and internally in each participant [107]. These last results, taken together, emphasize the importance of affective variables in reading comprehension, as a good perception of readers' competence could contribute to improving their reading skills.

5.7. Limitations

Among the limitations of this study is the lack of a validated university test in the target population to establish reading profiles. This may have affected the correct identification of individual differences in reading comprehension. In addition, it would be important for future research to have a similar number of males and females in order to study the gender gap in reading comprehension, which currently favors females.

6. Conclusions

The phenomenon of reading comprehension is a multidimensional one, which makes it very complex to determine which cognitive or affective variables have an impact on reading comprehension. The results of this study reflect that the combination of cognitive and linguistic variables plays a different role in reading comprehension. Because of this, affective dimensions such as self-efficacy and intrinsic motivation have a relevant purpose in reading comprehension. Conversely, working memory has an indirect influence on reading comprehension, though it modulates individual differences linked to the areas of specialization of university students. Among the linguistic variables, vocabulary has a key role as a mediator of reading comprehension. This is one of the most relevant findings of this study.

An approximation of the individual differences in university students by means of the sample of this study evidences the difficulties that university students experience during reading comprehension. Such difficulties can be found in spite of efforts taken in secondary and primary education to improve reading comprehension indices by implementing public policies to incentivize reading in students. These findings can be considered even more concerning as the participants of our sample will become teachers, who will be in charge of promoting reading comprehension in their classrooms.

The results of this study are relevant for the improvement of practices of university faculty members. Our findings should help them understand that the learning process linked to reading comprehension did not sufficiently culminate at the school stage and that further work should be undertaken to improve this competence among university adolescents. Likewise, it should lead them to improve reading practices, taking students' interests and their entry skills into consideration. Reading performance is far from being a unitary issue that can be approached only from a cognitive perspective, as variables such as working memory and reading motivation influence the cognitive and linguistic processes underlying reading comprehension.

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