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From Working Memory to Language Learning through Verbal Fluency Development in Children Ages 6 to 9

De la memoria de trabajo al aprendizaje de la lengua a través del desarrollo de la fluidez verbal en niños de 6 a 9 años

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Abstract

Learning and academic performance has been examined in the literature from various perspectives, exploring diverse contextual and personal variables. This study focuses on language learning and, particularly, the evolution of verbal fluency in the early development of executive functions. A sample of 89 boys and girls aged 6 participated in the project until the age of 9. The research design adopted was longitudinal, quantitative, exploratory, and descriptive, addressing the interaction of the mentioned variables over three years. The main objective was to analyze how working memory and its development in early stages (at age 6) explain adequate development of verbal fluency and academic performance in Spanish Language and Literature at age 9. Results indicate that working memory at age 6 explains verbal fluency (25.4%) and academic performance (32.4%) at age 9. Additionally, the study suggests a mediation model in which working memory acts as an antecedent, verbal fluency as a mediator, and academic performance in Spanish Language and Literature as a dependent variable, explaining up to 68.8% of variance. Findings highlight that a robust executive development in the early stages contributes to efficient linguistic progress, both in terms of academic performance and cognitive development, confirming how the latter can mediate and enhance language learning through the development of executive factors.

Keywords: working memory; executive functions; verbal fluency; academic performance.

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Resumen

La literatura científica ha examinado el aprendizaje y el rendimiento académico desde diversos enfoques, explorando variables contextuales y personales. Este estudio se enfoca en el proceso de aprendizaje del lenguaje y la evolución de la fluidez verbal a lo largo del desarrollo temprano de las funciones ejecutivas. Se utilizó una muestra de 89 niños y niñas de 6 años que participaron en el proyecto hasta los 9 años. El diseño de investigación fue longitudinal, cuantitativo, exploratorio y descriptivo, abordando la interacción de las variables a lo largo de tres años. El objetivo principal fue analizar cómo la memoria de trabajo y su desarrollo en las primeras etapas (6 años) explican un adecuado desarrollo de la fluidez verbal y el rendimiento académico en Lengua Castellana y Literatura a los 9 años. Los resultados señalan que la memoria de trabajo a los 6 años explica la fluidez verbal (25,4%) y el rendimiento académico (32,4%) a los 9 años. El modelo de mediación en el que la memoria de trabajo actúa como antecedente, la fluidez verbal como mediadora, y el rendimiento académico en Lengua Castellana y Literatura como variable dependiente, explica un 68,8% de la varianza. Los hallazgos indican que la memoria de trabajo contribuye de forma relevante al desarrollo de la fluidez verbal y al rendimiento lingüístico. Los hallazgos destacan que un desarrollo ejecutivo sólido en las primeras etapas contribuye a un progreso lingüístico eficiente, tanto en el rendimiento académico como de desarrollo cognitivo.

Palabras clave: memoria de trabajo; funciones ejecutivas; fluidez verbal; rendimiento académico

Introduction and objectives

The first stage of formal education takes place between the ages of 6 and 12, and it is during this period that the foundations for pupils' subsequent cognitive development are laid. One of the cognitive processes that significantly influences academic performance is the verbal factor, as it is essential for optimal learning, not only because of its importance in language development, but also because of its influence and necessity for achieving learning objectives in other areas. In this regard, the verbal factor carries greater weight in academic performance in mathematics than other variables such as memory. The explanation lies in the fact that, for most learning, language is necessary; but not only that, but calculation tasks activate the brain's language areas, making it essential for mathematical reasoning and problem-solving (López, 2016). Both comprehension and expression, whether oral or written, are consistent due to the relevance of verbal information during the early stages of education, as its influence extends to other cognitive processes (Gómez-Veiga et al., 2014).

Without detracting from the importance of written language as a complex constellation of behaviours—the result of numerous factors and subject to various influences, yet essential for reaching a certain level of development—spoken language is a means of reflecting contextual, intrapersonal and interpersonal reality, and literacy is essential for communication and for learning in general. It is recognised that various factors contribute to cognitive ability, such as verbal, spatial and quantitative skills, memory, processing

speed, etc. (Ardila, 2011) and that academic achievement will be the combination or association of cognitive concepts of ability (verbal factor and reasoning) and speed with working memory (Colom and Flores-Mendoza, 2001).

The discussion can be centred on the question: what specific factors account for learning? To answer this, it should be noted that learning encompasses both the process and knowledge, and that the latter is linked to verbal reasoning as a facilitator of comprehension, organisation and concept formation, which enables the acquisition of further knowledge (Almeida et al., 2008). It is argued that when the verbal factor is identified as a predictor of academic performance, it refers to the combination of comprehension, reasoning and verbal analogical relationships; in short, to what is termed verbal intelligence. This verbal intelligence is understood as the general ability to handle verbal concepts, comprehend them in a variety of contexts and use them meaningfully (Yuste et al., 2014). Furthermore, amongst the components of the verbal domain—such as production, comprehension or expression—verbal fluency is of particular interest as it indicates the ease with which verbal production, accurate reading or even expression is carried out, but also serves as an explanatory guide to the response behaviour of the communicator-receiver dyad (Hudson, 2011; Rasinski et al., 2017). These linguistic processes have also been linked to grammatical complexity and discourse organisation from an early age (Delgado-Cruz et al., 2025). However, it should be noted that other factors, such as developmental age or academic level, influence the level of verbal fluency achieved. Consequently, observable differences in academic performance will arise, as semantic and phonological aspects will highlight children's strengths and weaknesses (Fumagalli et al., 2017; Guevara and Soto, 2018). Consequently, in educational practice, a wide variety of skills are evident, highlighting a link between verbal fluency and the subject of language (McArthur et al., 2016). Some authors emphasise that verbal fluency, as a task of linguistic production, engages processes such as attention or working memory—which are more characteristic of executive functions—and is therefore considered a good indicator of executive functioning (García et al., 2012).

Cognitive psychology has demonstrated the importance of executive functions in achieving optimal performance when carrying out various tasks. The scientific literature indicates that executive functions, and specifically working memory, are essential for proper language development, as they consider that the basis of learning, such as literacy, lies in the processing and organisation of information (Cortés-Pascual et al., 2019; Sesma et al., 2009). It also emphasises the ability to store and retrieve temporary information, as well as to select, update and transform data, thereby playing a role in cognitive processes such as language comprehension (Anderson and Reidy, 2012). Thus, working memory comprises four components: the central executive system, the phonological loop, the visuospatial sketchpad and the episodic loop; and it is precisely the phonological loop that is essential for language acquisition (Baddeley, 1996).

However, whilst the importance of the verbal factor and executive functions for learning has been highlighted—specifically verbal fluency and working memory—learning must be

linked to academic performance. The latter is nothing more than a quantitative assessment (expressed as a mark) of the level of knowledge attained in accordance with a specific age and level. In other words, it aims to reflect the quality, efficiency and productivity of learning, the objective of which is to achieve academic success (Lamas, 2015). Working memory is linked to academic performance in the early years of schooling, as it develops rapidly in early childhood, improving with age, and reaching full development by the age of 10–12 (López, 2013). This variable correlates more or less strongly, depending on the subject area, which points to the specific development of certain skills and competences for academic performance (Cortés-Pascual et al., 2019). Furthermore, it has emerged as a good predictor of outcomes in both language and mathematics, such that any learning difficulty can be explained by a deficit in this variable, which is reflected in school results (Abreu et al., 2014; Alloway and Alloway, 2010; Best et al., 2011; Hall et al., 2015; Tsubomi and Watanabe, 2017). It can be further specified that it is absolutely essential as language complexity increases (Sesma et al., 2009). Therefore, the validity of a specific demand for a particular academic domain is suggested, where the occurrence of impairments leads to a decline in performance (Passolunghi and Lanfranchi, 2012). In addition to its predictive function, working memory acts as a good mediator for both general and specific performance, such that verbal working memory mediates language performance (Bruijn et al., 2018). When language deficits are detected in a pupil, low levels of memory are also observed, even lower than those found in mathematics, from which it follows that the verbal factor exerts a significant influence on other cognitive processes (Moll et al., 2015; Willcutt et al., 2013).

It follows from all this that it is essential to detect emerging deficiencies in the executive function of working memory that affect the development of verbal fluency, as an element of language development, which enables the achievement of learning objectives not only in the area of language, but also proves effective in other academic areas. In this regard, and highlighting the relationship between learning difficulties in linguistic development and executive function, various studies have been published, such as those by Hall et al. (2015), Oberer et al. (2018), Quílez-Robres et al. (2021a) and Ribner et al. (2017), amongst others, although they introduce nuances regarding the fact that relational patterns do not always remain consistent throughout the research, with behaviour changing according to age, and they emphasise that the proper development of working memory in early childhood influences academic performance. There are also discrepancies, such as that reported by Gustavson et al. (2019), who suggest that verbal fluency is better related to executive functions in a unifactorial rather than a multifactorial manner (inhibition, working memory, etc.). However, there appears to be little doubt regarding this connection between verbal fluency and working memory, as numerous studies, based on gender differences, investigate this relationship (Hirnstein et al., 2023; Hyde, 2014).

Frequently, and mostly in an educational context, studies emerge that investigate the factors influencing pupils' academic performance, both generally and in specific subjects. Their sole purpose is to identify the deficiencies that hinder the normal development of the

learning process. The verbal component appears as a fundamental element for the proper functioning of linguistic skills, but also as a foundation for the other areas. It has previously been concluded that reading proficiency in children generally develops from the age of 6 or 7, with mastery of reading words, and extends to pseudowords by the age of 8 or 9 (Rosselli et al., 2006). Based on this, the aim of this study is to investigate the influence that the proper development of working memory at the age of six has on academic performance in the language domain at the age of nine, specifically in terms of verbal fluency. We are also interested in the predictive value of the variables and their possible mediating role. We expect to find that good executive function development at age 6 is associated with effective progress in verbal fluency and with performance in Spanish Language and Literature at age 9. We also expect that working memory is a good predictor of verbal fluency and academic performance in the aforementioned subject area. Finally, it is expected that verbal fluency will stand out for its mediating role between executive function and academic performance.

Method

Participants

The sample consisted of 89 primary school pupils who began participating in the project at the age of 6 (Year 1) and continued until the age of 9 (Year 3). The gender distribution was 39 girls (43.8%) and 50 boys (56.2%), all of whom attended schools in the Autonomous Community of Aragon (Spain).

The sampling method used was non-probabilistic convenience sampling, selecting a network of three schools belonging to the same educational institution, each located in a different province of Aragon. The inclusion criteria were:

- a) being enrolled at one of the participating schools,
- b) falling within the age range under study (6–9 years),
- c) having no previous diagnosis of learning disorders or other conditions that might interfere with the project's implementation.

Although participants underwent an Intelligence Quotient (IQ) assessment as part of the overall project, this variable is not part of the objective of the present study and is therefore not included in the descriptive or inferential analyses presented here.

Instruments

Academic performance was assessed using the final marks (0–10) obtained by the students in the 2020–2021 academic year, specifically focusing on the mark for the subject of Spanish Language and Literature.

Verbal fluency was measured using the Effective Reading Games by Grupo Editorial Bruño (2017), a test that meets international PISA standards and the reading proficiency criteria established by MECES. This instrument includes age-appropriate reading tasks,

through which the number of words read per minute is recorded and reading comprehension is assessed via true/false questions. It is important to note that this test incorporates, within its structure, an assessment of prior reading level, as reading fluency and speed form part of the same construct, which is systematically captured within the test itself.

Executive functions were assessed using the Behaviour Rating Inventory of Executive Function, Second Edition (BRIEF-2), in its Spanish adaptation (Gioia et al., 2017). The family version consists of 63 Likert-type items (never, sometimes, frequently) and provides scores across nine executive domains: inhibition, flexibility, emotional control, initiative, working memory, planning, self-monitoring, organisation of materials, and task monitoring. The instrument demonstrates high reliability, with Cronbach's alpha coefficients exceeding .85 across all scales.

Procedure

In accordance with ethical protocols, authorisation and cooperation were obtained from both the participating schools and the families whose children would be included in the project. This was formalised through the signing of collaboration agreements and informed consent forms. Subsequently, the research design was submitted to the Research Ethics Committee of the Autonomous Community of Aragon (CEICA), which issued a favourable decision on 27 February 2019, with reference number "No. 04/2019". To carry out the sampling process, the school guidance departments collaborated with the principal investigator. The various tests were administered during form periods, with sessions lasting 45 minutes. All these activities were carried out at the end of the third term of the 2018–2019 academic year for the assessment of executive functions, and during the 2020–2021 academic year for the collection of data on academic performance in Spanish Language and Literature and verbal fluency.

Data analysis

Firstly, a descriptive statistical analysis was carried out on the variables under study. Subsequently, as the distribution analysis confirmed that all variables followed a normal distribution, the relationship between the variables (academic performance, verbal fluency, and executive functions) was examined using Pearson's correlations. Next, various regression analyses were carried out to determine the predictive power of the models established between the early development of executive functions and the subsequent development (3 years later) of verbal fluency and academic performance in Spanish Language and Literature, as well as the relationship between verbal fluency and academic performance itself, taking working memory as the independent variable at the age of 6, and as dependent variables, academic performance in Spanish Language and Literature and the measure of verbal fluency at age 9. Finally, having observed the relationship between the variables under study, a mediational analysis was conducted between academic

performance in Spanish Language and Literature and working memory, taking verbal fluency as the mediator in the established relationship. The analyses were carried out using the statistical software IBM SPSS *Statistics Viewer* 25 and the PROCESS macro (Preacher and Hayes, 2008).

Results

A descriptive and correlational analysis was carried out, including all the variables under study. In the case of executive functions, their nine dimensions were considered separately. As shown in Table 1, a high and statistically significant positive correlation was found between verbal fluency and academic performance at age 9 ($r = .801$, $p < .01$). Furthermore, various executive functions assessed at age 6 showed significant correlations with both dependent variables (academic performance and verbal fluency). In this regard, each pair of values indicates the relationship between the corresponding executive function and academic performance and verbal fluency, respectively. The results were as follows:

- Initiative: $r = .318 / .352$, $p < .05$
- Working memory: $r = .507 / .596$, $p < .01$
- Planning: $r = .396 / .596$, $p < .01$
- Task monitoring: $r = .419 / .455$, $p < .01$
- Organisation of materials: $r = .242 / .427$, $p < .05$

In contrast, other dimensions traditionally relevant in the literature—such as inhibition, self-monitoring and emotional control—did not show significant correlations with any of the dependent variables in this study.

Table 1

Pearson correlations between the study variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|--------|---------|--------|--------|--------|-------|--------|--------|--------|--------|----|
| 1. Verbal fluency (9 years) | | | | | | | | | | | |
| 2. Reading ability in the target language (9 years) | ,801** | | | | | | | | | | |
| 3. Inhibition | -,117 | -,076 | | | | | | | | | |
| 4. Self-monitoring | -,134 | -,152 | ,641** | | | | | | | | |
| 5. Flexibility | -,011 | - | ,224 | ,264* | | | | | | | |
| 6. Emotional Control | -,009 | -,038 | ,615** | ,548** | ,430** | | | | | | |
| 7. Initiative | - | - | ,335** | ,403** | ,387** | ,198 | | | | | |
| 8. Working Memory | ,318** | ,352** | | | | | | | | | |
| 9. Planning and Organisation | - | -,439** | ,548** | ,404** | ,276* | ,200 | ,677** | ,749** | | | |
| 10. Task Monitoring | ,396** | ,507** | ,596** | | | | | | | | |
| 11. Organisation of Materials | - | - | ,482** | ,387** | ,163 | ,234* | ,352** | ,611** | ,618** | | |
| | ,419** | ,455** | | | | | | | | | |
| | -,242* | - | ,520** | ,382** | ,245* | ,288* | ,492** | ,615** | ,692** | ,642** | |
| | | ,427** | | | | | | | | | |

** The correlation is significant at the 0.01 level (two-tailed).

* The correlation is significant at the 0.05 level (two-tailed).

Furthermore, as can be seen in Table 2, two linear regression models were carried out in an attempt to identify the executive factors capable of explaining a certain percentage of the variance in academic performance and verbal fluency. Thus, it was observed in both models that only working memory was significant and explanatory with regard to academic performance in Spanish Language and Literature ($R^2 = .329$) and with regard to the development of verbal fluency ($R^2 = .254$).

Table 2
Regression models

| Model | Variable | R | Adjusted R ² | SE | B | β | t | p |
|---------------------------|--|-------|-------------------------|--------|-------|---------|-------|--------------|
| 1 (RA Language) | | 0.375 | 0.329 | 1.191 | | | | |
| | Initiative | | | | 0.041 | 0.061 | 0.434 | 0.666 |
| | Working Memory | | | | - | - | - | 0.001 |
| | | | | | 0.240 | 0.571 | 3.475 | |
| | Planning and Organisation Task Supervision | | | | 0.037 | 0.082 | 0.472 | 0.638 |
| | | | | | | | | |
| | Organisation of Materials | | | | - | - | - | 0.366 |
| | | | | | 0.070 | 0.126 | 0.911 | 0.366 |
| | | | | | - | - | - | 0.572 |
| | | | | | 0.051 | 0.081 | 0.568 | 0.572 |
| 2 (Verbal Fluency) | | 0.304 | 0.254 | 14.263 | | | | |
| | Initiative | | | | 0.019 | 0.002 | 0.017 | 0.987 |
| | Working Memory | | | | - | - | - | 0.012 |
| | | | | | 2.134 | 0.447 | 2.592 | |
| | Planning and Organisation Task Supervision | | | | - | - | - | 0.685 |
| | | | | | | | | |
| | | | | | 0.387 | 0.075 | 0.408 | 0.685 |
| | | | | | - | - | - | 0.077 |
| | | | | | 1.649 | 0.262 | 1.793 | 0.077 |
| | | | | | | | | |
| | Organisation of Materials | | | | 1.795 | 0.251 | 1.659 | 0.102 |

Note. R² = Coefficient of determination; SE = Standard error; Sig = p-value.

Finally, and given the relationships established between working memory, verbal fluency and academic performance in Spanish Language and Literature, an explanatory mediation model was analysed, with academic performance at age 9 as the dependent variable, working memory (at age 6) as the independent variable and verbal fluency (at age 9) as the mediating variable that strengthens the relationship between variables. As can be seen in Figure 1, the model explained 68.85% of the variance in academic performance ($R^2 = .689$).

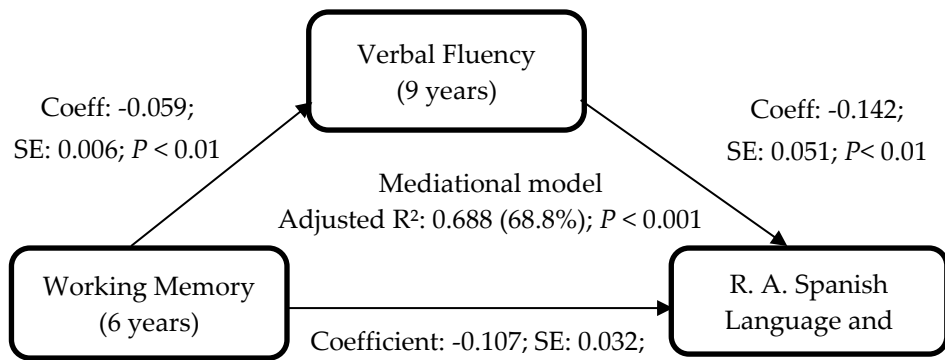


Figure 1. Mediation predictive model of performance in Spanish Language and Literature.

Discussion

At the outset of this study, the aim was to analyse the possible relationship between executive functions at age 6 and verbal fluency and academic performance in the subject of Spanish Language and Literature at age 9. Furthermore, the study sought to examine the predictive value of executive function components and the possible mediating effect of the variables under investigation. The results show a highly significant relationship between verbal fluency and academic performance in the subject of Spanish Language and Literature, with working memory emerging as a predictor and verbal fluency as a mediator. It is significant that difficulties in verbal fluency indicate shortcomings when it comes to achieving good results in the language subject, as indicated by previous studies conducted in different settings, such as those by Abreu et al. (2014) or McArthur et al. (2016), who came to suspect that there was a relationship between the cognitive skills of verbal fluency and reasoning, which in turn influenced not only academic achievement but also the students' motivation and self-esteem. All this indicates that the development of specific skills is necessary for academic performance. Therefore, there is a feedback loop between different cognitive variables which, in turn, influence personal variables. Thus, when pupils perceive a deficient level of their spoken language, their performance is impaired, as low levels of memory are detected, to a greater extent in the language domain than in mathematics. This highlights that the verbal factor exerts a significant influence on the rest of the cognitive processes (Moll et al., 2015; Willcutt et al., 2013). This issue presents a challenge, given the need for early detection of language development problems, in order to minimise their impact on learning and implement specific interventions.

Furthermore, a significant relationship is also found between the factors comprising executive functions—such as initiative, working memory, planning and organisation, task monitoring, and organisation of materials—and the verbal fluency and performance in

Spanish Language and Literature, although working memory and task monitoring stand out above all others. Generally, the correlations observed range from low to moderate; however, when these are studied and related to specific abilities, the scores in this study are higher, as this specificity activates working memory more powerfully (Friedman and Miyake, 2017). The processes involved, both in verbal fluency and working memory, appear similar and are based on the controlled retrieval of words, on the strategies selected and, to some extent, on the avoidance of repetition, which in turn is linked to task monitoring (particularly in the area of language). The functioning of these mechanisms suggests that both variables mobilise similar or closely related neural regions (Miyake and Friedman, 2012). The results obtained in this study are consistent with those of Quílez-Robres et al. (2021b), who link a similar relationship between these factors and both general and specific academic performance, although they did not specify the different aspects that constitute language development. They are also supported by Gómez-Veiga et al. (2014), who emphasise the relevance of the verbal aspect in the early stages of education as it extends its influence to other cognitive aspects, and by Bruijn et al. (2018), who highlight the importance of working memory in relation to poor reading performance compared to other executive functions. In this regard, the greatest significance of executive components lies in those related to the cognitive index. It is significant that working memory becomes more relevant as language complexity increases (Sesma et al., 2009) and that small differences are observed depending on the demands of a specific academic domain: mathematics or language (Passolunghi and Lanfranchi, 2012), with performance declining when some form of impairment arises, such as reading difficulties (Cortés-Pascual et al., 2019; Moyano et al., 2020). Hall et al. (2015), Oberer et al. (2018) and Ribner et al. (2017) highlight the relationship between a deficit in linguistic development and executive functions. Some researchers even go further and find that a specific language problem is associated with a low level of working memory, and in turn hold working memory responsible for this (Im-Bolter et al., 2006). This is explained by the fact that working memory provides learners with the necessary resources to develop thinking skills, text comprehension and reasoning; in short, to achieve meaningful learning (Gómez-Veiga et al., 2018). However, there are always partial discrepancies, as some point to an inconsistency in the relationship between verbal fluency and the various components of executive functions, considering that this variable has a unifactorial nature. This is supported by the lack of a clear relationship between variables, as verbal fluency is considered to be a component of executive functions, despite the fact that current models do not include it; however, there is also the possibility that this relationship is influenced by individual differences (Gustavson et al., 2019). In short, if the verbal factor supports good academic performance and this is related to working memory, it will be necessary to investigate its predictive power for subsequent academic success. However, it should be noted that not all research agrees with the results obtained in this study. Some studies have found weaker or even non-significant relationships between executive functions and academic performance, particularly when controlling for prior

reading level or sociocultural context. For example, Blair and Razza (2007) observed that working memory does not always predict linguistic performance when oral language development varies significantly among participants or when factors such as receptive vocabulary come into play. Similarly, other research suggests that verbal fluency may behave as a relatively independent construct at certain stages of development, reducing its association with executive functions (Best et al., 2011). These alternative results call for a cautious interpretation of the findings and consideration of the influence of external variables, particularly at early ages.

In light of this evidence, when breaking down executive functions into factors, it has been found that working memory is the only component that acts as a predictor of verbal fluency and performance in Spanish Language and Literature. However, its percentage is higher for the latter than for the former. As mentioned previously, verbal fluency can be regarded as an innate and genetically determined executive function, whereas performance in Spanish Language and Literature is a dynamic process resulting from learning and influenced by the environment or context. The meta-analysis by Cortés-Pascual et al. (2019) had already concluded that executive functions carry significant predictive weight for future performance, with this being greater in early childhood, hence the decision to focus the study on this age group (6–9 years). It is evident from the reviewed literature that working memory has a high predictive power for academic performance due to its large storage capacity, processing speed and resistance to distractors (Shahabi et al., 2014; Swanson and Alloway, 2012). There is agreement that the two aspects of working memory—auditory-verbal and visuospatial—explain its predictive value for reading comprehension, with the former being related to storage and retrieval (Gómez-Veiga et al., 2013; Nouwens et al., 2017; Sesma et al., 2009). Some authors go into greater detail and link this mnemonic-executive aspect of working memory as a good predictor of future performance in verbal and mathematical tasks (Alloway and Alloway, 2010), whilst others find a direct correlation between working memory and academic performance, such that working memory explains 33% of the variance in reading comprehension (Gómez-Veiga et al., 2013). In other words, it stands out for its effectiveness in predicting outcomes in both language and mathematics (Abreu et al., 2014; Best et al., 2011; Hall et al., 2015; Tsubomi and Watanabe, 2017) and it has been confirmed that a deficit in this variable at age 6 affects learning and, consequently, academic outcomes at age 9.

Given the significance of the research findings, and noting the relevance of the variables analysed to the teaching and learning process, the mediational analysis shows that verbal fluency (at age 9) acts as a strong mediator between working memory (at age 6) and academic performance in the subject of Spanish Language and Literature (at age 9). In other words, it reinforces the relationship already suggested in previous research, which identified executive functions—specifically working memory—as largely responsible for academic success or failure, depending on the presence or absence of deficits in these functions, and analysed the feedback loop between executive components, cognitive

deficits such as verbal fluency, and academic achievement (Cortés-Pascual et al., 2019; Moyano et al., 2020; Quílez-Robres et al., 2021a). This idea is supported by the article by Best et al. (2011), which highlights an indirect relationship between young children's executive functions and academic performance in the area of language via the verbal factor. The mediating effect of these variables has been studied from various angles and has, on some occasions, shown that executive functions in spelling and mathematics have moderated underperformance in areas such as physical activity; on others, it was verbal working memory that performed this function with regard to both general and specific performance, for example, the visuospatial aspect in mathematics (Bruijn et al., 2018). This mediating effect of verbal fluency can be explained by considering that this skill is similar to working memory and is associated with specific factors. In a sense, it is based on the combination of different executive function skills that are capable of capturing learning deficits through underlying mechanisms that generate associations and which, in turn, help to interpret the research findings (Gustavson et al., 2019).

Conclusions

The study of variables such as working memory and verbal fluency and their association with reading skills not only enhances our understanding of the underlying elements of successful reading development but also provides insight into learning difficulties reflected in academic achievement in the subject of Spanish Language and Literature. Accordingly, the findings of this study conclude that executive factors—and specifically, working memory—are good predictors of both the development of verbal fluency and language learning, as measured by academic performance in the subject of Spanish Language and Literature. Furthermore, it is determined that, longitudinally, working memory and its early development may indicate future linguistic development (3 years later) and subsequent efficient language learning. This opens up new theoretical and practical perspectives to be taken into account. One of these theoretical implications lies in the current debate over whether executive functions and each of their components are related to explaining general learning or, conversely, to specific learning. The findings of this study would point to the latter, since, of all the executive factors studied, only working memory proved significant in explaining language learning and linguistic development. Furthermore, from a practical perspective, the design and implementation of educational programmes that incorporate cognitive training, as well as the assessment and measurement of these factors throughout the primary education stage (6–12 years), may help to prevent future language problems related to basic skills such as reading and writing.

As a main limitation of the study, it is worth noting the need to expand the sample and to verify the results for both transparent language learning, such as the learning of Spanish, and opaque languages, such as English. Therefore, it is necessary to extend the study to other educational stages and educational systems other than the Spanish one, and to carry out broader and more robust statistical analyses that include model testing and the

development of structural equations involving not only mediation but also moderation. This may help to devise specific interventions that explore the relationship between executive functions and deficits in cognitive skills such as verbal fluency, thereby improving learning outcomes in early childhood.

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