Revista Latinoamericana de Psicología

https://revistalatinoamericanadepsicologia.konradlorenz.edu.co/

ORIGINAL

The relationship between narrative comprehension, working memory and vocabulary in Uruguayan 4- to 8-year-old children: A longitudinal study

Florencia Reali [a], **Johanna Rivera Ibaceta** [b], **Karen Moreira Tricot** [b,*]

[a] *Departamento de Neurociencia y Aprendizaje, Universidad Católica del Uruguay, Montevideo, Uruguay*
[b] *Universidad de la República, Montevideo, Uruguay*

Received 22 October 2024; ***accepted*** 14 March 2025

Abstract | **Introduction:** Narrative comprehension in young children is influenced by receptive vocabulary, working memory, inference skills, executive control, and attention functions. Most previous studies have analysed different aspects of these associations using cross-sectional correlational analyses. In this study, we conducted a longitudinal evaluation of the relationship between memory, vocabulary, and narrative comprehension skills in a sample of 4 to 8-year-old children. **Method:** Comprehension was assessed by evaluating 120 Uruguayan children's abilities to retrieve structural categories during storytelling and their performance on comprehension questions. To capture longitudinal data while controlling for individual variability, linear mixed-effects (LME) analyses were conducted to examine the effects of time, age, memory abilities, and receptive vocabulary on comprehension. **Results:** The data revealed progress in the development of comprehension, memory, and receptive vocabulary skills. The results of the LME analyses revealed significant fixed effects of vocabulary, working memory, and time, which varied depending on the comprehension task. **Conclusion:** Receptive vocabulary appears to play a strong role in comprehension, particularly in performance on comprehension questions. Working memory (but not short-term memory) seems to play a more relevant role when comprehension measures involve retelling of the story.

Keywords: Narrative comprehension, young children, working memory, receptive vocabulary, longitudinal design

La relación entre comprensión narrativa, memoria de trabajo y vocabulario en niños uruguayos de cuatro a ocho años: un estudio longitudinal

Resumen | **Introducción:** La comprensión narrativa en niños pequeños está influenciada por vocabulario receptivo, memoria de trabajo, habilidades de inferencia, control ejecutivo y atención. La mayoría de los estudios previos han analizado estos aspectos con análisis correlacionales transversales. Este estudio evaluó longitudinalmente la relación entre memoria, vocabulario y habilidades de comprensión narrativa en niños de cuatro a ocho años. **Método:** Se evaluó la comprensión de 120 niños uruguayos, analizando su habilidad para recuperar categorías estructurales durante la narración y su

* Corresponding author.
E-mail: moreirak@psico.edu.uy

https://doi.org/10.14349/rlp.2024.v56.27

desempeño en preguntas de comprensión. Para capturar datos longitudinales y controlar la variabilidad individual, se realizaron análisis de efectos mixtos lineales (ELM) para examinar los efectos de tiempo, edad, habilidades de memoria y vocabulario receptivo sobre la comprensión. **Resultados:** Los datos mostraron desarrollo progresivo de comprensión, memoria y vocabulario receptivo. Los análisis ELM revelaron efectos fijos significativos de vocabulario, memoria de trabajo y tiempo, pero estos variaron según la tarea de comprensión. **Conclusión:** El vocabulario receptivo cumple un papel clave en la comprensión, especialmente en el desempeño medido mediante preguntas. La memoria de trabajo (no la memoria a corto plazo) desempeña un papel más relevante en tareas que requieren recuento de la historia.

Palabras clave: Comprensión narrativa, niños pequeños, memoria de trabajo, vocabulario receptivo, diseño longitudinal

The development of comprehension during preschool years is essential for school success, as early narrative abilities are key precursors to reading comprehension (Paris & Paris, 2003). Comprehension requires the construction of a coherent mental representation of the information present in the text, be it either written or oral (Barreyro et al., 2023). This process involves the entertaining of a "situation model", a construction that integrates the text based on the comprehender's knowledge (Kintsch, 1998). Situation models contain information about settings, characters, actions, events, and the relations among them (Pinto-Camargo & Barreyro, 2024).

Over the last few decades, many studies have shown that preschoolers' story comprehension involves a number of interrelated cognitive and linguistic abilities. To fully comprehend an oral narrative, children must understand and encode the events described in the story, a process that involves the conceptual connection of the different parts of the narrative. A range of cognitive abilities influence this process, including vocabulary size, inference-related abilities, background knowledge of situations and facts and memory abilities (Escobar & Espinoza, 2024; Graesser & Olde, 2003; Lynch et al., 2008; Strasser & del Río, 2014; van Dijk & Kintsch, 1983).

At the ages of 3, 4 and 5, children engage in low-level narrative comprehension processes; however, these abilities evolve gradually, becoming more complex by middle childhood. During preschool years, children become capable of encoding information relative to characters and problem-solving (Trabasso & Nickels, 1992), but continue to show difficulties in the understanding of the temporal unfoldings of the story, particularly at the age of 3 and 4. Around the age of 5, children start to understand causal aspects of the story more thoroughly and to show more clear inferential abilities (Lynch et al., 2008; Trabasso & Nickels, 1992; van den Broek et al., 2005). Between 3 and 5, the ability to understand action structure and a character's mental states becomes manifest (Curenton, 2010), although it remains limited (Nicolopoulou & Richner, 2007). Other narrative abilities, such as coherence and rhetorical comprehension, continue to develop throughout middle childhood (Karmiloff-Smith, 1985). However, the pace of development depends on a child's experience, such as background knowledge, emotional and contextual factors (Skarakis-Doyle & Dempsey, 2008; van den Broek et al., 2005).

While processing a narrative, the integration between the information provided by the story and top-down knowledge may impose significant cognitive effort (Kendeou et al., 2009). Young comprehenders, not only need to encode individual story events, but also conceptually connect their different parts and characteristics, relying on inferential abilities (Currie & Cain, 2015; van Dijk & Kintsch, 1983). It has been observed that the inference of semantic relations varies significantly with age: while young children often recognise relations between external events, older children and adults recognise connections to internal events and states of mind, intentions, inferences, and internal causal relations (Barreyro et al., 2020; Graesser & Olde, 2003).

The processing of a narrative involves executive functions, as the processing of structured event unfolding is similar to motor or sequential knowledge recruiting the prefrontal cortex (Wood & Grafman, 2003; Ylvisaker et al., 2008). The comprehension of complex causal structure relies, in part, on working memory abilities, which refer to a temporal- and capacity-limited memory system that processes complex cognitive tasks. A major portion of work has shown that there are significant individual differences in memory abilities in children and adults, which, in turn, reflect in language processing abilities (e.g., Van Dyke et al., 2014).

The developmental trajectory of executive functions in early childhood has been the target of intensive research in the past few decades. Traditionally, executive functions have been studied according to three main elementary components: working memory, response inhibition (self-control and cognitive inhibition), and flexibility (attention shifting). All three components appear to be present in preschool years (Diamond, 2013). However, it has been pointed out that individual components of executive functions differentiate progressively and are intertwined in early stages, reaching a stage of clear identification of the three factors later in childhood (Karr et al., 2018). Specifically, working memory abilities continue to improve during childhood and early adulthood, however, young children are more challenged by interference than older children because the development of inhibitory control occurs gradually over time (Diamond, 2013). A recent study by Cheng and Kibbe (2022) explored changes in working memory, specifically in the age bracket of 4- to 7-year-olds. They found that children's ability to hold information in working memory develops significantly across that age

range, and they linked the improvement to the ability to update information, a task that imposes a significant cost to working memory performance.

The interweaving of linguistic abilities, narrative comprehension and executive functions in early childhood

Not being fluent readers yet, comprehension in 4- to 7-year-olds entails the understanding of narratives delivered orally in the form of wordless book narrations (Chaparro-Moreno et al., 2017; Strasser et. al, 2010), animated videos (Altun, 2020; Kim, 2016), adults reading aloud or spontaneous narration (Gorman et al., 2016; Kendeou et al., 2009; Lynch et al., 2008; Silva & Cain, 2015). The most common forms of assessment of comprehension at these ages comprise the analysis of responses to questions referring to literal or inferential information (Silva & Cain, 2015) or the analysis of children's recall (Kim, 2016; Moreira et al., 2022, 2023; Moreira, 2023).

Many have studied the influence of receptive vocabulary and other cognitive variables on comprehension in young children (Barreyro et al., 2023; Cain & Oakhill, 2014; Florit et al., 2009; Strasser & del Rio, 2014). Strasser and del Rio (2014) examined the influence of working memory, vocabulary size and depth, inhibitory control, theory of mind, and sustained attention abilities on the comprehension of narrated stories from wordless picture books. They found that comprehension is affected by vocabulary size, working memory, inference abilities, and control and attention executive functions. Florit et al. (2009) showed that both short-term memory and working memory predicted listening comprehension abilities after controlling for verbal abilities in 4- and 5-year-old children, with working memory explaining additional variance over and above short-term memory. Their results also showed a strong relation between verbal abilities and listening comprehension. Other studies have also documented an association between working memory and narrative comprehension in preschoolers (Altun, 2020; Dicataldo & Roch, 2020; Escobar & Espinoza, 2024; Florit et al., 2009). Pinto Camargo and Barreyro (2024) studied the role of productive vocabulary, working memory, theory of mind and sustained attention in narrative comprehension skills in Spanish-speaking children between 7 and 11 years of age. They found that the factors that were more strongly associated with comprehension measures were vocabulary and working memory. In another study, Tonér and Gerholm (2021) explored the relationship between language and executive functions in 47 mono- and multilingual Swedish children aged 4–6. Most tasks correlated with one or several language measures. Consistent with Florit et al. (2009), in regard to memory capacities, both WM and STM correlated more with language measures, with a stronger effect of WM.

Barreyro et al. (2020) found that both working memory and sustained attention influence comprehension in 5- and 6-year-olds, and that age has also a significant effect on the comprehension of general information and the ability to generate inferences. Importantly, they concluded that age effects appear to be mediated by sustained attention abilities.

One of the areas in which the interweaving of working memory and comprehension becomes particularly manifest is the understanding of causal structure. As discussed above, similar to adults, young and older children are sensitive to the causal structure of narratives. In audio or visual narratives, 4- and 6-year-old children are more likely to recall events that have more causal connections than events with fewer connections (Trabasso & van den Broek, 1985). By the age of 5, children show the ability to tell narratives in causally coherent episodes (Trabasso & Nickels, 1992). This demonstrates that, when narrating episodes, older preschoolers draw some connections between characters' actions and the motivation for those actions, a surprising ability given the complexity of the cognitive operations involved. That is, when making causal inferences, comprehenders need to understand the character's motivations or the intentions underlying their actions.

Young preschools (3-or 4-year-olds), however, may not readily grasp such intangible causes compared to more concrete aspects of the narrative (Thompson & Myers, 1985). By the age of 5 or 6, some are ready to make inferences that involve connecting causes and consequences that are distant from each other in the text (see Lynch et al., 2008 for a review). Such connective operations are particularly challenging when they involve information from different episodes (van Dijk & Kintsch, 1983), and in order to succeed children must rely on executive functions, and particularly working memory. Thus, it is not surprising that younger children with more limited working memory abilities are less likely to make these types of inferences. Lynch et al. (2008) showed a marked increase in the number of causal connections between 4-year-olds and 6-year-olds, as indicated by the mean percentage recall of story events.

A recent longitudinal study examined how vocabulary and verbal working memory relate to inference development from preschool to middle childhood (Currie & Muijselaar, 2019). In this study, participants were assessed on inference making, vocabulary breadth, vocabulary depth, and verbal working memory each year starting at four years of age until grade 3. Their results showed that inference making was predicted by vocabulary and verbal working memory, particularly at younger ages. Importantly, vocabulary breadth and depth explained inference making and verbal working memory throughout the early grades, highlighting the importance of vocabulary knowledge in the development of inference ability both within and across time, as well as the intertwined nature of vocabulary and verbal working memory in early development. Korecky-Kröll et al. (2019) found significant correlations between phonological working memory and vocabulary size for monolingual and bilingual children (German and Turkish), and between vocabulary size and narrative competence but not directly between phonological working memory and narrative competence. They suggested that working memory and narrative competence are different domains of language competence, but that vocabulary size may act as a mediating

variable between them. Moreover, they suggest that the relative importance of different domains depends on how narratives are delivered. For instance, we may expect more engagement of working memory abilities when the story is narrated without graphic support.

Some important antecedents to our work, in the case of Spanish, is a recent study by Barreyro et al. (2023), which explores the effects of vocabulary depth, working memory, TOM, and sustained attention in the comprehension of oral narratives and the generation of inferences in children aged 7 to 11. They found that vocabulary depth and working memory variables were associated with almost all measures of narrative comprehension. However, they used a cross-sectional design and focused on older children. Here, we look at the role of these factors using a longitudinal sample in younger children aimed at exploring how these variables influence comprehension over time.

Taken together, the reviewed research demonstrates that narrative comprehension differs in different age groups in preschool years, similar to verbal and memory skills. How closely does the progression of narrative abilities during preschool years match the progression of vocabulary and memory skills? Although it is clear that the developmental trajectories of working memory and narrative comprehension are deeply intertwined from ages 4 to 7, most studies have used cross-sectional designs. One problem with comparing different age groups is that group differences are due to both age and individual differences among participants within groups. A way to bypass such difficulties is through longitudinal research, as it controls for individual differences, and therefore, differences due to the progress of time can be more purely assessed during development. Along these lines, the main objective of this paper is to study the relation between verbal skill, memory abilities and narrative comprehension via a prospective longitudinal study sampled over Uruguayan children of ages 4 to 8.

In particular, we are interested in answering the following questions: 1. Does the association between comprehension, memory and receptive vocabulary show a linear development trajectory over time, considering a three-year window (initial age 4-6)? 2. To what extent does comprehension improve over time when controlling for the development of memory and receptive vocabulary?

Method

Participants

An initial sample of 155 children were recruited, however, after desertion across time, 120 participants completed the study (3 children did not complete tasks at time 1, 13 children deserted from times 1 to 2, and 19 children from times 2 to 3). The final sample was composed of neuro-typical Uruguayan children (48,6% girls) attending a middle-class private school. Children's ages at initial data collection ranged from 4 to 6 (Mean age = 68,5 months, *SD* = 10,4 months). In Uruguay, children are enrolled in school grades according to their chronological age, and, at the beginning of the study, participants were enrolled in preschool levels (Level 4, 5 and the first year of primary school) At Time 1 (T1), 33,3% of the participants were 4 years old, 25% were 5 years-old and 41,7% were 6 years-old.

Participants and their tutors were informed about the study and asked for their consent if agreed. They came from a middle socioeconomic status according to the index of socio-economic level (INSE) presented by the Centro de Investigaciones Económicas (CINVE) in Uruguay (Perera & Cazulo, 2016).

Participants had no sensory, cognitive or linguistic difficulties according to school reports, and their mother tongue was Spanish.

Materials

Comprehension task story

Children were exposed to a short narrative (delivered orally without graphical support) and then were asked to retell it back to the researcher. A short story (120 words in 18 utterances) was used taken from the text *¿Quién se sentó sobre mi dedo?* (tr. "Who sat on my finger?") (Manrique & Sánchez, 2017). The story was selected based on difficulty judgments requested from 22 experienced early education teachers. They were asked to place the story in one of 4 possible categories: very simple, somewhat simple, somewhat difficult or very difficult. 27% of the teachers evaluated it as something simple, 68% evaluated it as somewhat difficult and 4% evaluated it as very difficult.

The original version of the story described the adventures of a rabbit who gets lost in the woods and faces an enemy (a cougar). The story described sequences of actions performed by the characters, including descriptions of mental states. The story was segmented into grammar components according to their sequential occurrence and then coded according to episode structure defined by Stein and Glenn (1979). The essential episode structure includes initiating events, attempts, and direct consequences. All components fitting into these categories were designated as an element within an episode structure. Appendix 1 illustrates the coded story segmented into 18 different story grammar components, distributed into six different categories (major setting (2), minor setting (2), initiating events (3), internal responses (4), attempts (3), consequences (4).

As the task was run at three points in time, three versions of the story were developed, structurally equivalent, which took place in different settings (1. woods, 2. forest and 3. sea) and using different pairs of animal protagonists (1. rabbit vs cougar, 2. bird vs snake and 3. fish vs octopus). The three versions did not vary in the number of words and phrases, and maintained the same structure and order in terms of plot and number and distribution of story grammar components. The story was followed by five oral comprehension questions adapted to each version of it.

Digit span (WISC III)

Forward and Backward digit span were used to assess short term memory (STM) and working memory (WM)

in the auditory-verbal modality (Gathercole et al., 1999). In this task the child was asked to reproduce a forward digit sequence (STM) and backwards digit sequence (WM). In both modalities the first sequence contains 2 digits (max 8), with two trials. The child received 1 score for each correct answer.

Peabody Picture Vocabulary Test (PPVT) (Dunn et al, 2006): This is a test of receptive vocabulary. The test has a straightforward structure. Children see a page on an easel with four pictures. For each item, the examiner says a word, and the children respond by selecting one picture out of four that best illustrates that word's meaning.

Procedure

Data was collected within the premises of the school where the participants attended, during three subsequent points in time (T1, T2 and T3) between May 2021 and June 2024. The time separation between story retell data collection was approximately one year (mean 11.74 months, from T1 and T2, and 12.13 months from T2 and T3). Storytelling sessions and working memory and vocabulary assessments took place in a quiet room on the school campus (in three sessions in T1; and two sessions in T2 and T3).

Individual sessions with each child were conducted. Sessions comprised the reading aloud of the story by trained investigators, the subsequent child´s retelling of the story back to the researcher, and the comprehension questions, lasting between 5 and 10 minutes. During the session the experimenter read aloud the story, and subsequently, the child was asked to narrate it back to the researcher. After that, participants were asked to answer 5 comprehension questions about the contents of the story.

Comprehension measures

Identification of story grammar components

Retold narratives produced by children were audio recorded and transcribed verbatim. Two of this paper´s authors coded children's narratives to assess whether each individual story grammar component of the story (see Appendix 1) was present or absent in participant´s productions. We counted the number of grammar components that the child was able to narrate back to the experimenter (range 0-18). The presence of ideas related to the story grammar component was counted as one point, regardless of whether or not the exact words were used by the child. Errors regarding the content of the story (for example, a change in the agency of an action "the cougar deceived the rabbit" instead of "the rabbit deceived the cougar") resulted in the absence of credit. When extra information was added−—bits absent in the original story yet not contradictory—, that information was not counted as a point, but it was not penalised either. To assess inter-coder reliability, both coders analysed narratives produced by 15% of the children, using the same coding criteria. Reliability was measured by inter-rater agreement for category coding. The value of Kappa was obtained for individual story categories in the story, ranging from a minimum *Kappa* of .79 to a maximum of 1 (see Appendix 1).

Comprehension questions

Children's answers to comprehension questions were coded according to answer content. Answers were assigned a score from 0 to 2, depending on question content and accuracy. A complete description of question scoring is presented in Appendix 2. An overall score from 0 to 10 was calculated by adding the scores of individual questions. Reliability was established by inter-rater agreement, resulting in *Kappa* values of .79 for incorrect responses, .75 for partially correct responses, and .87 for correct responses.

Results

Comprehension scores included two measures: 1. Grammar Components Identification (GCI) scores that corresponded to the number of grammar components retrieved by individual participants during retelling, and 2. Comprehension Questions (CQ) scores. Comprehension scores (mean and *SD*) at T1, T2 and T3 are presented on Table 1, per age group. As shown on the Table, children improved with time in the three groups analysed. In general, a series of individual linear regression analyses revealed a linear progression over time of variables controlled by age group (GCI, $b = 2{,}2$; $p < .001$; CQ, $b = 0.6$, $p = .019$; STM, $b = 2{,}7$; $p < .001$; WM, $b = 0.63$, $p < .001$; Receptive vocabulary, $b = 25$, $p < .001$).

We used JAMOVI (The Jamovi Project, 2024) to perform a linear mixed-effects (LME) analysis to assess the effects of different predictors on grammar component identification (GCI) and comprehension question (CQ) scores as dependent variables. A first model (Model 1) was run for the two dependent variables, with Time, Working Memory (WM), Short-Term Memory (STM), and Vocabulary (Voc) entered as fixed effects. Responses were grouped by subjects, and intercepts for subjects were included as random effects to account for by-subject variability. GCI increased linearly over time for all three age groups, while CQ increased linearly over time only for the initial-age-4 group (see Table 1), suggesting a possible interaction between age and time on CQ performance. For this reason, we ran two more models, entering Age (Model 2) and Age plus an interaction term Age × Time (Model 3) as fixed effects. All models converged and fit the data significantly (all LRT chi-squares > 65; $p < .001$), displaying differential patterns of fixed effects depending on the dependent variable. A summary of main fixed effects and coefficients of predictors is presented on Table 2.

In the case of the GCI, the results indicated that working memory was a significant predictor of comprehension when controlling for all other factors across all models. Receptive vocabulary was also a significant predictor of GCI when controlling for memory and time. Time and age are related variables: in Model 1, time significantly predicted GCI, but this effect diminished when age was introduced into the model.

For CQ, receptive vocabulary was a robust significant predictor of comprehension when controlling for

Table 1. Variable descriptives

Age Group (age at onset)	CQ T1 *Mean (SD) Range: 0-10*	CQ T2 *Mean (SD) Range: 0-10*	CQ T3 *Mean (SD) Range: 0-10*	GCI T1 *Mean (SD) Range: 0-18*	GCI T2 *Mean (SD) Range: 0-18*	GCI T3 *Mean (SD) Range: 0-18*
4	5.21 (2.37)	5.81 (2.47)	6.81 (1.86)	5.68 (3.64)	6.43 (3.75)	8.54 (3.66)
5	6.74 (1.9)	6.26 (2.25)	6.44 (2.33)	6.67 (3.56)	7.96 (3.66)	8.19 (3.90
6	7.02 (1.7)	6.7 (1.43)	7.17 (1.62)	7.7 (3.8)	8.52 (3.28)	9.72 (3.44)

Notes. CQ = comprehension questions scores; GCI = Grammar Components Identification scores, corresponding to the number of grammar components retrieved.

Table 2. Main effects on comprehension scores

	Model 1 (Fs)	Model 2 (Fs)	Model 3 (Fs)	Coefficients´ 95% Confidence Interval (Model 3) [Lower – Upper limit]
Comprehension Questions				
Time	2.32 ^{t}	1.93	**3.8** *	[0.14 – 6.68]*
WM	0.3	0.34	0.3	[-0.13 – 0.24]
STM	0.14	0.15	0.1	[-0.16 – 0.16]
Voc	**30.9** ***	25.62***	**25.19** **	[0.02 – 0.04]***
Age		0.01	**3.78** ^{t}	[0.002–1.25]^{t}
Age x Time			**5.35** *	[-0.6–1.5]*
R^2 (conditioned) df = 5,6,7	0.247	0.247	0.264	
Grammar Categories Identification				
Time	3.37 *	0.9	1,4	[-1.5—8.5]
WM	**6.65** **	6.9*	**2.89** **	[0.11—0.76]**
STM	0.52	0.39	1.09	[-0,04—0.12]
Voc	**8.08** **	3.11^{t}	**3.07** ^{t}	[-0.00247—0.004]
Age		1.72	**3.05** ^{t}	[-0,11—1.98]^{t}
Age x Time			1.39	[-0.6—0.15]
R^2 (conditioned) df = 5, 6, 7	0.49	0.501	0.512	

Note. The Table presents the *F* values for Fixed Effects Omnibus tests. *$p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$; *t* $p \leq .10$.

memory skills and time across the three models. Model 3 shows that the interaction between age and time was significant, as performance on comprehension questions increases over time only for the youngest group. STM scores were not a significant predictor of either comprehension measure.

Discussion

This study was aimed to explore the relation between memory, vocabulary and narrative comprehension abilities in a group of 120 Uruguayan children aged 4 to 8. The data showed a progression of comprehension abilities, memory skills and receptive vocabulary across time. To study the relation between variables, we implemented LME models to explore the ways in which memory, receptive vocabulary, time and age affected narrative comprehension using two different measures (GCI and CQ). One advantage of using LME analysis is that it enables the assessment of the effects of individual variables over time by controlling for other predictors, while taking into account individual variance inherent to a longitudinal within-subjects design. A clear pattern emerging from our results is that the effect of variable on comprehension depends on the dependent measure considered. First, receptive vocabulary and working memory are robust predictors of retelling and questions (respectively) when controlling for all other factors. However, the relative weight of vocabulary and memory depends on the comprehension task. Second, time and age effects can be measured for comprehension scores, but their relative weight seems to depend on the concurrent development of vocabulary and memory abilities. Retelling measures (GCI) were significantly predicted by working memory abilities in all models considered. Receptive vocabulary was also a significant predictor, particularly and quite robustly in the case of comprehension questions performance. The effect of time on CQ performance was moderated by the effect of age.

Taken together our findings add to the existing evidence of the importance of vocabulary and working memory abilities in narrative comprehension in early childhood.

The role of different dimensions of vocabulary in early comprehension has been demonstrated in the literature (e.g., Khan et al, 2021; Tonér & Gerholm, 2021). A substantial body of research indicates that both vocabulary size and depth are strongly associated with text and discourse comprehension (Barreyro et al., 2023; Cain & Oakhill, 2014; Florit et al., 2009; Strasser & del Rio, 2014). Here we focus on the role of receptive vocabulary, concerning the dimension of "size", the quantity of words known by a child. Our results add to this literature in showing the importance of receptive

vocabulary in narrative comprehension. Similarly, our results add to previous work documenting the importance of working memory in the development of comprehension. Most previous studies, however have used cross-sectional designs (Altun, 2020; Dicataldo & Roch, 2020; Escobar & Espinoza, 2024; Florit et al., 2009; Pinto-Camargo & Barreyro 2024; Tonér & Gerholm, 2021). One of the contributions of the present study is to show that the associations between vocabulary, memory abilities and comprehension hold longitudinally when controlling for individual differences, time and age as factors. Moreover, we have measured forward and backward digit span to assess short term memory (STM) and working memory (WM) in the auditory-verbal modality (Gathercole et al., 1999). Short term memory was not a significant predictor of any of the comprehension measures when controlling for the other factors, while working memory was. This difference is consistent with previous cross-sectional work that shows an effect of working memory and short-term memory on comprehension (Florit et al., 2009).

Other studies looking at the influence of these factors in other related abilities, such as inferential abilities, have also emphasised the role of working memory and vocabulary. For instance, Currie and Cain (2015) showed an effect of working memory and vocabulary on inference abilities in children from three different age groups (5–6, 7-8, and 9–10 years of age) using a cross-sectional design. More recently, Currie and Muijselaar (2019) examined how vocabulary and verbal working memory relate to inference development using a longitudinal design on children from preschool to middle childhood.

Our results are also consistent with the work of Pinto-Camargo and Barreyro (2024) exploring the effects of vocabulary, working memory, and other cognitive factors on oral narrative comprehension in Spanish-speaking children aged 7 to 11 using a cross-sectional design. They found that vocabulary and working memory variables were associated with almost all measures of narrative comprehension. We extend these findings to a sample of younger children.

One of the distinctive patterns in the present data is that the relative weight of vocabulary and working memory on comprehension depends largely on the task used. Receptive vocabulary was a strong predictor of comprehension questions across time and different age groups. On the other hand, working memory is a robust predictor of comprehension measured through story retelling. This suggests that different components of the comprehension process play a differential role on different tasks. Response-to-question accuracy is largely dependent on the child's receptive vocabulary that plays a role in encoding, integration and inference processes. Memory abilities are also involved in inference and evaluation, but they play a key role in the retrieval processes upon which retelling tasks rely. This may explain the differential results in the two tasks considered here.

Korecky-Kröll et al. (2019) studied narrative abilities in 4-year-olds, finding correlations between working memory and vocabulary size, as well as between vocabulary size and narrative competence, but no direct link between working memory and narrative competence. They proposed that vocabulary size might serve as a mediator between working memory abilities and narrative competence, and that the engagement of working memory depends on how the story is delivered. Consistently, when these variables are simultaneously controlled for in the current LME model, the effect of vocabulary on question performance outweighs the effect of working memory, however, for the retelling task, working memory plays a more significant role as a performance predictor.

To our knowledge this is the first study that implements a longitudinal design to study the relationship between memory, vocabulary and narrative comprehension (using retelling and comprehension questions as measures) in early childhood. The results show that the association between comprehension and working memory holds longitudinally across time, when controlling for individual differences, receptive vocabulary and time as a factor. Additionally, the data highlights the robustness of the relationship between comprehension and vocabulary over time.

A limitation of our research is the final sample size of participants who completed the entire study. Because of the longitudinal design spanning over three years of data collection, the retention rate was 77,4% (Method). Another limitation of the sample is that it only included children from a medium socio-economic status and results could vary in other SES contexts. We have measured narrative comprehension looking at the spontaneously recovered structure of simple categories during retelling and accuracy in comprehension questions. In future studies, it would be interesting to look at a broader range of skills related to comprehension abilities, such as inferential and logical reasoning skills. Additionally, it would be important to assess the extent to which comprehension abilities of oral narratives prior to the acquisition of written language predict reading comprehension in later school years.

Ethics statement

This study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Facultad de Psicología, Universidad de la República (Montevideo, Uruguay) for studies involving humans.

Acknowledgments

This study is part of a larger project aimed at exploring the relationship between Narrative Abilities and Executive Functions with financial support from National Agency for Research and Innovation (ANII - Uruguay), FCE_3_2020_1_161971 and FCE_3_2022_1_172639

References

Altun, D. (2020). Twice upon a mind: Preschoolers' narrative processing of electronic and printed stories. *Early Childhood Education Journal, 49*, 349-359. https://doi.org/10.1007/s10643-020-01079-9

Barreyro, J. P., Fumagalli, J., Álvarez-Drexler, A., Calero, A., & Formoso, J. (2023). El vocabulario y la generación de inferencias en la comprensión de narraciones en niños preescolares. *Revista Caribeña de Investigación Educativa, 7*(1), 205-222. https://doi.org/10.32541/recie.2023.v7i1.pp205-222

Barreyro, J. P., Formoso, J., Alvarez-Drexler, A., Leiman, M., Fernández, R., Calero, A., Fumagalli, J., & Injoque-Rifle, I. (2020). Narrative comprehension in 5 and 6-year-old children: Effects of working memory and sustained attention. *Interdisciplinaria*, *37*(1), 1-27. https://doi.org/10.16888/INTERD.2020.37.1.16

Chaparro-Moreno, J., Reali, F., & Maldonado-Carreño, C. (2017). Wordless picture books boost preschoolers' language production during shared reading. *Early Childhood Research Quarterly, 40*, 52-62. https://doi.org/10.1016/j.ecresq.2017.03.001

Cain, K., & Oakhill, J. (2014). Reading Comprehension and Vocabulary: Is Vocabulary More Important for Some Aspects of Comprehension? *L'Année psychologique, 114*(4), 647-662. https://shs.cairn.info/journal-l-annee-psychologique1-2014-4-page-647?lang=en.

Cheng, C., & Kibbe, M. M. (2022). Development of updating working memory in 4–7-year-old children. *Developmental Psychology, 58*(5), 902-912. https://doi.org/10.1037/dev0001337

Curenton, S. M. (2010). Understanding the landscapes of stories: The association between preschoolers' narrative comprehension and production skills and cognitive abilities. *Early Child Development and Care*, *181*(6), 791-808. https://doi.org/10.1080/03004430.2010.490946.

Currie, N. K., & Cain, K. (2015). Children's inference generation: The role of vocabulary and working memory. *Journal of Experimental Child Psychology, 137,* 57-75. https://doi.org/10.1016/j.jecp.2015.03.005

Currie, N. K., & Muijselaar, M. M. L. (2019). Inference making in young children: The concurrent and longitudinal contributions of verbal working memory and vocabulary. *Journal of Educational Psychology, 111*(8), 1416-1431.https://doi.org/10.1037/edu0000342

Diamond, A. (2013). Executive functions. *Annual Review Psychology, 64*, 135-168. https://doi.org/10.1146/annurev-psych-113011-143750

Dicataldo, R., & Roch, M. (2020). Are the effects of variation in quantity of daily bilingual exposure and socioeconomic status on language and cognitive abilities independent in preschool children? *International Journal of Environmental Research and Public Health, 17*(12), 4570. https://doi.org/10.3390/ijerph17124570

Dunn, L. M., Dunn, L. M., & Arribas, D. (2006). *Peabody. Test de vocabulario en imágenes*. Tea Ediciones.

Escobar, J. P., & Espinoza, V. (2024). Direct and indirect effects of inhibition, working memory and cognitive flexibility on reading comprehension of narrative and expository texts: Same or different effects? *Reading & Writing Quarterly*, *41*(2), 1-17. https://doi.org/10.1080/10573569.2024.2400993

Florit, E., Roch, M., Altoè, G., & Levorato, M. C. (2009). Listening comprehension in preschoolers: The role of memory. *British Journal of Developmental Psychology, 27*(4), 935-951. https://doi.org/10.1348/026151008x397189

Gathercole, S. E., Service, E., Hitch, G. J., Adams, A. M., & Martin, A. J. (1999). Phonological short-term memory and vocabulary development: Further evidence on the nature of the relationship. *Applied Cognition Psychology, 13*, 65-77. https://doi.org/c3rxc3

Gorman, B. K., Bingham, G. E., Fiestas, C. F., & Terry, N. P. (2016). Assessing the narrative abilities of Spanish-speaking preschool children: A Spanish adaptation of the narrative assessment protocol. *Early Childhood Research Quarterly* (36), 307-317. https://doi.org/10.1016/j.ecresq.2015.12.025

Graesser, A. C., & Olde, B. A. (2003). How does one know whether a person understands a device? The quality of the questions the person asks when the device breaks down. *Journal of Educational Psychology, 95*(3), 524-536. https://doi.org/10.1037/0022-0663.95.3.524

The Jamovi Project (2024). *jamovi*. (Version 2.5) [Computer Software]. https://www.jamovi.org

Karmiloff-Smith, A. (1985). Language and cognitive processes from a developmental perspective. *Language and Cognitive Processes*, *1*(1), 61-85. https://doi.org/10.1080/01690968508402071

Karr, J. E., Areshenkoff, C. N., Rast, P., Hofer, S. M., Iverson, G. L., & Garcia-Barrera, M. A. (2018). The unity and diversity of executive functions: A systematic review and re-analysis of latent variable studies. *Psychological Bulletin*, *144*(11), 1147-1185. https://doi.org/10.1037/bul0000160

Kendeou, P., Bohn-Gettler, C., White, M. J., & van den Broek, P. (2009). Children's inference generation across different media. *Journal of Research in Reading*, *31*(3), 259-272. https://doi.org/10.1111/j.1467-9817.2008.00370.x

Khan, K. S., Logan, J., Justice, L. M., Bowles, R. P., & Piasta, S. B. (2021). The contribution of vocabulary, grammar, and phonological awareness across a continuum of narrative ability levels in young children. *Journal of Speech and Language Hearing Research, 64*(9), 3489-3503. https://doi.org/10.1044/2021_JSLHR-20-00403.

Kintsch, W. (1998). *Comprehension. A paradigm for cognition*. Cambridge University Press.

Kim, Y. G. (2016). Direct and mediated effects of language and cognitive skills on comprehension of oral narrative texts (listening comprehension) for children. *Journal of Experimental Child Psychology*, *141*, 101-120. https://doi.org/10.1016/j.jecp.2015.08.003

Korecky-Kröll, K., Dobek, N., Blaschitz, V., Sommer-Lolei, S., Boniecki, M., Uzunkaya-Sharma, K., & Dressler, W. U. (2019). Vocabulary as a central link between phonological working memory and narrative competence: Evidence from monolingual and bilingual four-year-olds from different socioeconomic backgrounds. *Language and Speech*, *62*(3), 546-569. https://doi.org/10.1177/0023830918796691

Lynch, J. S., van den Broek, P., Kremer, K. E., Kendeou, P., White, M. J., & Lorch, E. P. (2008). The development of narrative comprehension and its relation to other early reading skills, *Reading Psychology, 29*(4), 327-365. https://doi.org/10.1080/02702710802165416

Manrique, S., & Sanchez, L. (2017). Andamiar la comprensión infantil durante la lectura de cuentos: Dispositivo de formación basado en el análisis del propio desempeño. En S. Romero Contreras & S. Concha (Eds.), *Formación docente en el área de lenguaje. Experiencias en América Latina*. Universidad Diego Portales.

Moreira Tricot, K. (2023). *Relaciones entre Funciones ejecutivas y habilidades narrativas en niños de 5 años que crecen en contexto de pobreza* [Tesis Doctoral]. Universidad Nacional de Córdoba.

Moreira, K. A., Rivera, J. A., & Dávila, A. P. (2022). Habilidades de comprensión y producción narrativa en niños montevideanos de 5 años. Una comparación por nivel socioeconómico. *Interdisciplinaria. Revista de Psicología y Ciencias Afines*, *39*(3), 75-91. https://doi.org/10.16888/interd.2022.39.3.4

Moreira, K. A., Tomás Llerena, C., Vercellino Dessent, V., Rivera Ibaceta, J., Dávila Sasía, P., Quiles, S., Tresso González, F., & Rosemberg, C. (2023). Las relaciones entre habilidades narrativas y funciones ejecutivas en la infancia. Una revisión sistemática. *Revista Argentina de Ciencias del Comportamiento*, *15*(1), 1-23. https://doi.org/10.32348/1852.4206.v15.n1.32421

Nicolopoulou, A., & Richner, E. S. (2007). From actors to agents to persons: The development of character representation

in young children's narratives. *Child Development*, *78*(2), 412-429. https://doi.org/10.1111/j.1467-8624.2007.01006.x

Paris, A., & Paris, S. (2003). Assessing narrative comprehension in young children. *Reading Research Quarterly*, *38*(1), 36-76. https://doi.org/10.1598/RRQ.38.1.3

Perera, M., & Cazulo, P. (2016). *Índice de nivel socioeconómico. Propuesta de actualización*. Centro de Investigaciones Económicas (CINVE).

Pinto-Camargo, J., & Barreyro, J. P. (2024). La comprensión de narraciones orales y las diferencias individuales en niños entre 7 y 11 años: vocabulario, memoria de trabajo y teoría de la mente. *Ciencias Psicológicas, 18*(1), e-3477. https://doi.org/10.22235/cp.v18i1.3477

Silva, M., & Cain, K. (2015). The relations between lower and higher level comprehension skills and their role in prediction of early reading comprehension. *Journal of Educational Psychology*, *107*(2), 321-331. https://doi.org/10.1037/a0037769

Skarakis-Doyle, E., & Dempsey, L. (2008). Assessing story comprehension in preschool children. *Topics in Language Disorders*, *28*(2), 131-148. https://doi.org/10.1097/01.TLD.0000318934.54548.7f

Stein, N., & Glenn, C. (1979). An analysis of story comprehension in elementary school children. En R. Freedle (Ed.), *New directions in discourse processing* (pp. 53-120). Norwood, NJ: Ablex.

Strasser, K., Larraín, A., de Lérida, S. L., & Rosa Lissi, M. (2010). La comprensión narrativa en edad preescolar: Un instrumento para su medición. *Psykhe*, *19*(1), 75-87. https://doi.org/10.4067/s0718-22282010000100006

Strasser, K., & del Río, F. (2014). The role of comprehension monitoring, theory of mind, and vocabulary depth in predicting story comprehension and recall of kindergarten children. *Reading Research Quarterly*, *49*(2), 169-187. https://doi.org/10.1002/rrq.68

Thompson. J. G., & Myers, N. A. (1985). Inferences and recall at ages four and seven. *Child Development, 56*(5),1134-1144. https://doi.org/10.1111/j.1467-8624.1985.tb00182.x

Tonér, S., & Gerholm, T. N. (2021). Links between language and executive functions in Swedish preschool children: A pilot study. *Applied Psycholinguistics*, *42*(1), 207-241. https://doi.org/10.1017/S0142716420000703

Trabasso, T., & Nickels, M. (1992). The development of goal plans of action in the narration of a picture story. *Discourse Processes*, *15*(3), 249-275. https://doi.org/10.1080/01638539209544812

Trabasso, T., & van den Broek, P. (1985). Causal thinking and the representation of narrative events. *Journal of Memory and Language*, *24*(5), 612-630. https://doi.org/10.1016/0749-596X(85)90049-X

van Dijk, T. A., & Kintsch, W. (1983). *Strategies of Discourse Comprehension*. Academic Press.

van Dyke, J. A., Johns, C. L., & Kukona, A. (2014). Low working memory capacity is only spuriously related to poor reading comprehension. *Cognition131*(3), 373-403. https://doi.org/10.1016/j.cognition.2014.01.007

van den Broek, P., Kendeou, P., Kremer, K.E., Lynch, J., Butler, J., White, J., & Pugzles Lorch, E. (2005). Assessment of Comprehension Abilities in Young Children. En S. Paris & S.A. Stahl (Eds.), *Children's reading comprehension and assessment* (pp. 107-130). Lawrence Erlbaum Associates.

Wood, J. N., & Grafman, J. (2003). Human prefrontal cortex: Processing and representational perspectives. *Nature Review of Neuroscience, 4*(2), 139-47. https://doi.org/10.1038/nrn1033

Ylvisaker, M., McPherson, K., Kayes, N., & Pellett, E. (2008). Metaphoric identity mapping: Facilitating goal setting and engagement in rehabilitation after traumatic brain injury. *Neuropsychology Rehabilitation, 18*(5-6), 713-41. https://doi.org/10.1080/09602010802201832

Appendices

Appendix 1

Category	Story fragment	Story grammar component	Inter-rater reliability (*kappa value*)
1	Había una vez un conejo que salía todos los días a pasear por el bosque (tr. Once Upon a time there was a rabbit that went out every day for a walk in the forest)	major_setting_1	0.9375
2	Una noche muy oscura (tr. A very dark night)	minor_setting_1	1.0000
3	se perdió entre los árboles. (tr. it got lost among the trees)	initiating_event_1	1.0000
4	De pronto vió una cueva (tr. Suddenly it saw a cave)	initiating_event_2	0.8835
5	y entró. (tr. and it entered)	attempt_1	1.0000
6	Era la cueva del puma más feroz del bosque! (tr. It was the cave of the fiercest cougar in the forest!)	major_setting_2	1.0000
7	El puma se dio cuenta de que un animal se había metido en su cueva (tr. The cougar realized that an animal had gotten into its cave)	consequence_1	1.0000
8	y le puso la pata encima. (tr. and put his paw on it)	initiating_event_3	1.0000
9	El conejo sintió la enorme pata en su espalda (tr. The rabbit felt the huge paw on its back)	internal_response_1	-
10	y empezó a temblar. (tr. and it started to tremble.)	internal_response_2	0.7947
11	Entonces tuvo una idea (tr. Then it had an idea)	internal_response_3/plan	1.0000
12	para salvar su vida. (tr. to save its life.)	internal_response_4/goal	1.0000
13	Como el puma no lo veía (tr. Since the cougar didn't see it)	minor_setting_2	-
14	le mintió (tr. it lied to him)	attempt_2	0.7947
15	Y le gritó con voz fuerte: ¿Quién me agarró el dedo? (tr. And it shouted at him with a loud voice: Who grabbed my finger?)	attempt_3	0.9637
16	El puma se asustó (tr. The cougar got scared)	consequence_2	1.0000
17	porque pensó que el conejito era un monstruo enorme (tr. because he thought the bunny was a huge monster)	consequence_3	1.0000
18	y salió disparado de la cueva. (tr. and he fled out of the cave)	consequence_4	1.0000

Appendix 2

Question	Score	Characterisation of answer contents
¿Cuáles eran los personajes del cuento? (tr. Who were the characters of the story?)	0	Does not answer the question, or mention characters that were not included in the story.
	1	Identifies main character
	2	Identifies two or more characters
¿Qué le pasó al conejito cuando salió a pasear por el bosque? (tr. What happened to the rabbit when he went for a walk in the woods?)	0	Does not answer the question
	1	Substitutes the first event for a different event of the story.
	2	Identifies the first event.
¿Dónde puso la pata el puma? (tr. Where did the cougar put its paw?)	0	Does not answer the question.
	1	On the finger
	2	On the back or body
¿Cuál fue la idea que tuvo el conejo? (tr. What was the rabbit's idea?)	0	Does not answer the question
	1	Action verb related answer (e.g., "to shout")
	2	Intentional/mental verb related answer (e.g., "to lie")
¿Por qué el puma creyó que el conejo era un monstruo enorme? (tr. Why did the cougar think the rabbit was a huge monster?)	0	Does not answer the question or gives a wrong answer
	1	Physical action related answer (e.g., "because he put the foot...")
	2	Mental state related answer or deceive-related answer (e.g., "because the rabbit deceived him...")