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Literacy improves the comprehension of object relatives

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ABSTRACT

While there is a considerable body of research indicating that the acquisition of literacy has profound effects on many aspects of language and cognition, to our knowledge, very little is known about its effects on morpho-syntax. In this paper, we explore the effects of literacy on the comprehension of Spanish object relative clauses, a structure which is typically acquired by literate children about the age of 10, i.e., after a considerable amount of exposure to written language. We tested three groups of native Spanish speakers (semi-literates, late-literates and high-literates) using a picture selection task. Subject relatives were used as a control condition. All three groups performed at ceiling on subject relatives (group means of 95% or above). In contrast, we observed very large differences in performance on object relatives, with the semi-literate group performing at chance (51% correct) and the late-literate group slightly above chance (65% correct). Performance in the high-literate group was much better, although not quite at ceiling (82% correct). The results appear to support the hypothesis that literacy helps in the acquisition of some aspects of grammar. This could be partly due to differences in IQ, metalinguistic awareness, working memory and/or executive functioning. The results are also consistent with the 'training wheels' hypothesis (Dąbrowska, 2020), according to which the availability of written representations facilitates the acquisition of difficult structures by easing memory load and enabling speakers to process sentences at their own pace.

1. Introduction

Until recently, most linguists took it as self-evident that all native speakers of a particular language converge on (more or less) the same grammar (see, for example, Birdsong, 2004: 83; Bley-Vroman, 2009: 179; Chomsky, 1976; Crain, Thornton, & Murasugi, 2009: 124; Lidz & Williams, 2009: 177; Long, 2013: 17; Montrul, 2008: 4; Smith, 1999: 41; Trudgill, 1992: 130). This belief has been challenged by a number of studies that have demonstrated the existence of considerable individual differences in native speakers' knowledge of the grammar of their language (for reviews, see Dąbrowska, 2012, 2015; Hulstijn, 2015; Kidd, Donnelly, & Christiansen, 2018). Many, though not all, of these differences are related to schooling and/or print exposure: highly educated speakers, and speakers who read more, typically perform considerably better than people with less education or less print exposure. Importantly, the aforementioned studies tested comprehension rather than production (so the observed differences are not simply a matter of stylistic choice); they tested structures which do not vary across dialects (so the observed differences cannot be attributed to dialectal variation); and they employed strict control conditions to ensure that the participants had understood the task, were cooperative, etc.

It is important to note that the 'low educated' participants in these studies had all learned to read in childhood and had received at least 10, and more typically 12 years of full-time education. This raises the question of how the grammatical abilities of speakers who have never learned to read, or who only have rudimentary reading skills, compare to those of their literate peers. There is a considerable amount of evidence that the ability to read has profound effects on an individual's linguistic system (for reviews, see Dąbrowska, 2020; Huettig & Pickering, 2019). A number of studies have demonstrated that literate speakers have larger vocabularies, command a wider range of registers, have higher levels of metalinguistic awareness and more finely grained phonological representations, and are also more likely to predict upcoming information when processing spoken language (Dąbrowska, 2020; Huettig, 2015; Huettig & Pickering, 2019). However, very little is known about what effect, if any, the acquisition of literacy has on speakers' morphosyntactic representations. Although it is often asserted that children fully master the grammar of their native language in the

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preschool years (see, for example Hirsh-Pasek & Golinkoff, 1999: 2; Hoff, 2009: 1; Pinker, 1995: 145), a large number of studies have shown that morphosyntactic development continues well into adolescence (see Berman, 2007; Frizelle, Thompson, Duta, & Bishop, 2019; Hunt, 1977; Kaplan & Berman, 2015; Keijzer, 2007; Nippold, 1998; Ravid, 2004; Reed, Griffith, & Rasmussen, 1998; Scott, 1988) and even early adulthood (Hartshorne, Tenenbaum, & Pinker, 2018). The later developments are often linked to experience with written language (Chomsky, 1972; Fletcher, 1981; Montag & MacDonald, 2015; Scholes & Willis, 1987), but since in the populations in which these studies were conducted virtually all children attend school, it is difficult to disentangle the effects of cognitive maturation and literacy.

There are a number of ways in which experience with written language could, in principle, affect speakers' grammatical representations. First, there is the quality of the input. Complex structures are more frequent in written language — or at least, in some written genres — than in conversation (Cameron-Faulkner & Noble, 2013; Roland, Dick, & Elman, 2007). To the extent that increased exposure results in stronger representations, speakers with more exposure to written language might be expected to acquire stronger representations of these more complex structures. Experience with written representations could also affect grammatical development by revealing distinctions that are difficult to discern in spoken language. For example, in Russian, the spelling often shows grammatical contrasts that are difficult to perceive acoustically (e.g. gender), and this may be the reason why literacy helps with grammatical development in situations of limited input — as in the case of heritage language speakers, i.e. speakers who learn a minority language in a home setting and the majority language at school and in other formal contexts. Consequently, heritage speakers who are literate in Russian are more likely to acquire these distinctions (Romanova, 2008). Similarly, the conventional spelling of a word may help the language learner to segment it into morphemes, which in turn helps with learning morphological patterns (Nunes, Bryant, & Bindman, 2006).

An alternative – though not mutually exclusive – account of how literacy might facilitate the acquisition of some aspects of morphosyntax is the 'training wheels' hypothesis put forward by Dąbrowska (2020). Spoken utterances are ephemeral. We are able to hold material in short term memory for a very brief period only; if an utterance is not processed immediately, it is lost (cf. the 'now-or-never' bottleneck, Chater & Christiansen, 2018). In contrast, a written or printed sentence remains on the page, easing working memory load and allowing skilled readers to process it at their own pace. In a similar vein, when producing written text, we have more opportunity to reflect and edit than when speaking. In other words, writing provides a 'processing crutch' which enables skilled readers and writers to comprehend and produce more complex language than they would be able to do otherwise. Processing instances of a difficult construction in writing results in entrenchment; and once the structure is sufficiently entrenched, the language user will be able to process it in the spoken medium as well. As a result, highly literate speakers are able to produce and understand more difficult constructions than speakers who have not learned to read and write or emergent readers and writers who need to devote a considerable amount of effort to decoding and encoding processes. In this way, the written representation acts as 'training wheels' for more complex language.

Finally, literacy may also affect speakers' mental grammars in a more indirect way. Literacy and schooling more generally are associated with increases in IQ (Barnes, Tager, Satariano, & Yaffe, 2004; Ritchie & Tucker-Drob, 2018). There is also evidence suggesting that literacy improves metalinguistic awareness (Correa & Dockrell, 2007; Karanth, Kudva, & Vijayan, 1995; Kurvers, Vallen, & van Hout, 2006; Nagy & Anderson, 1995) as well as working memory for language (Demoulin & Kolinsky, 2016) and executive control generally (Purpura, Schmitt, & Ganley, 2017). It is not difficult to see how these abilities may in turn affect morphosyntactic development. Better metalinguistic awareness helps learners notice patterns in the input, while greater working memory capacity and higher IQ facilitate pattern manipulation. In order to process non-canonical sentences, speakers often need to suppress a well-entrenched processing routine: for example, to correctly interpret passives or object relatives, speakers of SVO languages must suppress the tendency to interpret the first noun in a NVN sequence as the agent of the verb. Consequently, the ability to inhibit an irrelevant response is a good predictor of individual differences in the ability to process such structures (Hachmann, Konieczny, & Müller, 2009; Ye & Zhou, 2008), and is likely to help with their acquisition as well.

In this paper, we present a study which investigates the comprehension of object relatives by native speakers of Spanish who are beginning to learn to read and write, or have learned to do so, in late adulthood, and compare their performance with that of age-matched controls who became literate in their childhood. We decided to focus on object relatives for several reasons. First, relative clauses in general and object relatives in particular are acquired relatively late in development. Although relative clauses appear in children's spontaneous speech about age 3 (Diessel & Tomasello, 2000), they are relatively rare and syntactically less complex than those produced by adults. For example, Pérez-Leroux (1993) elicited subject, object and oblique relatives from Spanish-speaking children aged from 3 to 7. Pérez-Leroux found that the children had a strong preference for subject relatives and frequently transformed the sentence so that the message could be expressed using a subject relative even where other types of relative clauses were being elicited. In addition, they often produced truncated relatives after the main clause, with no syntactic connection to the main clause. This is exemplified in (1), which contains an embedded subject relative (*un hombre que le está echando maní a las gallinas* 'a man who is throwing peanuts to the hens') and a truncated relative (*a las que están en el corral* 'to those that are inside the fence'), which is understood to modify the prepositional object in the main clause (*las gallinas* 'the hens'). Such unintegrated relative constructions accounted for over 66% of all relatives produced by the children. The children also produced some embedded relatives, including embedded object relatives; these, however, were extremely rare (less than 4% of the embedded relatives).

(1) *Hay un hombre que le está echando maní a las gallinas. A las que están en el corral.*
'There is a man who is throwing peanuts to the hens. To those that are inside the fence'.

There is also a large body of research demonstrating that children up to about age 10 have difficulties comprehending sentences containing object relatives (see the discussion section below). A recent study (Llompart & Dąbrowska, 2021) which investigated the comprehension of relative clauses by Spanish-speaking six-year-olds found that they were at ceiling (99% correct) on subject relatives but below chance (29% correct) on object relatives. To our knowledge, there are no other studies testing Spanish children's comprehension of object relatives; however, there are several such studies on a closely related language, namely Italian. Thus, Belletti, Friedmann, Brunato, and Rizzi (2012) tested Italian-speaking children aged 3;9 to 5;5 (mean age 4;7) and found that they were 84% correct on subject relatives, but only 55% correct on object relatives. There was no correlation between age and performance on object relatives, while comprehension of subject relatives improved slightly with age. Arosio, Panzeri, Molteni, Magazù, and Guasti (2017) tested somewhat older children and found that comprehension of object relatives increased steadily from 64% correct at age 5;0 to 91% at age 10;10.

These findings are suggestive, as it has been proposed that written language begins to have an effect on children's spoken language only after about several years of schooling (Scholes & Willis, 1987). But there is also more direct evidence linking the acquisition of relative clauses, and object relatives in particular, to reading. Cilibrasi, Adani, and Tsimpli (2019) tested typically developing children aged from 7;5 to 11;7 and found a significant correlation between reading skills and comprehension of relative clauses. Furthermore, there was an

interaction between reading skills (as measured by reading rate) and construction: the slower the reading rate, the greater the differences in performance on subject and object relatives; in children with very good reading skills, the difference disappeared altogether. Consistent with this, object relatives have been shown to be particularly difficult for children with dyslexia (Arosio, Panzeri, Molteni, Magazù, & Guasti 2017; Casalis, Leuwers, & Hilton, 2013) and for adult heritage language speakers (O'Grady, Lee, & Choo, 2001; Sanchez-Walker, personal communication), who are typically schooled only in the majority language, and consequently have low literacy skills in the heritage language.

Thus, the object relative construction is a plausible candidate for a structure whose acquisition might be supported by written language. If this is the case, they should be particularly difficult for illiterate and late-literate speakers — a prediction we investigate in this paper.

2. Spanish relatives

Both subject and object relatives in Spanish are introduced by the complementizer *que*.[1] In the subject relative construction, as in its English counterpart, the word order is the same as in the simple transitive clause, namely SVO (see example 2 below). In object relatives, where the NP corresponding to the patient is the head, the subject can come either before (3a) or after (3b) the verb. Thus, the word order in object relatives can be either O[SV] or O[VS], with the latter being more frequent when the subject is a full NP (Reali, 2014). When the relativized NP is both animate and specific, the relative pronoun is optionally marked with the preposition *a* 'to', as in (4). The use of *a* is obligatory on the direct object, as exemplified in (2).

(2) *la abuela que besa a la niña* (subject relative)
'the grandmother that is kissing the girl'

(3) a. *la abuela que la niña besa* (object relative with a topicalized subject, 'plain' variant)
b. *la abuela que besa la niña* (object relative with a postposed subject, 'plain' variant)
'the grandmother that the girl is kissing'

(4) a. *la abuela a la que la niña besa* (object relative with a topicalized subject, prepositional variant)
b. *la abuela a la que besa la niña* (object relative with a postposed subject, prepositional variant)
'the grandmother that the girl is kissing'

Note that 'plain' object relatives (i.e., those without the *a* marker on the complementizer) are locally ambiguous, particularly the variant with postposed subjects: in the above examples, the subject relative in (2) and the object relative in (3b) both begin with *la abuela que besa.* There is considerable evidence (Betancort, Carreiras, & Sturt, 2009) that when processing such sentences, speakers initially assume that the head NP (*la abuela*) is the subject of the verb. This assumption needs to be revised on encountering the second noun phrase (*la niña*): since the obligatory object marker is missing, *la niña* cannot be the object, and therefore the entire sentence has to be reanalysed. Recovering from the garden path requires additional processing effort, making plain object relatives relatively difficult to process. In the prepositional variant, in contrast, the subordinate clause is unambiguously marked as an object relative from its onset, which reduces the processing effort.

Another complication is that in rapid speech, the preposition *a* is often elided if the preceding word ends in *-a*, so the subject relative in (2) and the object relative with a postposed subject in (3b) are often pronounced almost in the same way. When the direct object is masculine, as in (5a), the *a* and the definite masculine determiner *el* are contracted to *al.*

(5) a. *la abuela que besa al niño*
'the grandmother that is kissing the boy'
b. *la abuela que besa el niño*
'the grandmother that the boy is kissing'

Thus, a preposition-less subject relative with a masculine head is pronounced differently from the corresponding object relative (5b); however, the difference is in just one vowel phoneme in an unstressed syllable. Hence, comprehension errors involving sentences like those in (5) could be due simply to perceptual factors.

For these reasons, in the experiment described here we used the prepositional variant of the object relative with a topicalized subject, i.e., the variant exemplified in (4a).

3. Method

3.1. Participants

Throughout most of the 20th century, adult literacy rates in Spain were relatively low in comparison with other European countries. However, with the passing of the General Education Act of 1970, primary education became compulsory for all children (McNair, 1981). At the same time, adult literacy programmes were rolled out throughout the country, resulting in a substantial decrease in illiteracy rates. According to the UNESCO Institute of Statistics (n.d.), the current adult literacy rate in Spain is 98.1, and the majority of illiterate Spaniards are elderly women.

Illiterate people are a disempowered and stigmatized group, and one of the most challenging aspects of conducting research with such participants is gaining access and persuading them to participate. We were able to overcome this obstacle by making use of the third author's extensive network of contacts established in the course of almost 30 years of research in Polígono Sur,[2] a neighbourhood in Seville which is one of the most disenfranchised areas in Spain and in Europe at large. This enabled us to develop a strong relationship with the director and teachers of the Polígono Sur Adult Education Centre (CEPER) and enlist their support in recruiting low-literacy adults.

The experimental participants, therefore, were all attending adult literacy classes at the CEPER. Most participants had never attended school in childhood, either because they had to care for younger siblings while their parents worked or because they had to work to help support their family from a very young age. A few did attend, but only for a short time and irregularly, so they never learned to read in childhood. Most participants had attended adult literacy classes for two or more years, either at Polígono Sur or at another centre. However, performance was often quite irregular due to illness or family commitments (caring for spouses, grandchildren or other relatives). In addition, some participants had received informal literacy instruction from a family member or friend. For these reasons, it was difficult to establish exactly how much literacy instruction individual participants had received. For the purpose of this study, we divided the Polígono Sur participants into two groups, which we refer to as 'semi-literates' and 'late-literates'. The

[1] There are also variants with the relative pronouns *quien* 'who(m)' or *cual* 'which one', but these are much less frequent and occur predominantly in written language.

[2] For socio-economic and demographical information about Polígono Sur, see 'Diagnóstico de Zonas con Necesidades de Transformación Social' (Ayuntamiento de Sevilla, https://www.sevilla.org/servicios/servicios-sociales/publicaciones/diagnostico-zonas-necesidades-transformacion-social.pdf) and 'Monografía comunitaria Polígono Sur: aprendemos a con-vivir mejor' (Fundación Atenea, http://convivirpoligonosur.fundacionatenea.org/2017/02/13/monografia-comunitaria-poligono-sur-aprendemos-a-con-vivir-mejor/).

Table 1
Group characteristics according to age.

Group	Mean	SD	Median	IQR	Min-Max
Semi-literates	68.6	8.4	69	62–74	52–89
Late-literates	70.9	7.9	72	68–79	49–79
High-literates	67.7	6.0	68	63–72	59–77

Note: IQR = interquartile range.

semi-literate group ($N = 20$) were attending level 1 and 2 courses, which means that they knew the alphabet and were able to read simple words and even short sentences, but were unable to read longer texts with understanding. The late-literate participants ($N = 15$) were attending level 3 courses and were able to read longer texts; a few reported reading whole novels.

In addition, we recruited 14 age-matched control participants, who we will refer to as the 'high-literate' group. These participants were recruited through a University of the Third Age ('Aula Abierta de Mayores') under the auspices of the Universidad Pablo de Olavide in Seville. They had all learned to read in childhood and had achieved at least a secondary school diploma; most had a university degree.

All participants were female and had no known neuropsychological disorders.[3] Participants' ages ranged from 49 to 89 (mean 69.1, SD 8.5). We had originally planned to include only participants aged below 75. However, several older women from the Adult Education Centre, including one 89-year-old, insisted on participating, so we decided to include them in the sample, and control for age statistically. Details about the distribution of participants according to age are given in Table 1.

3.2. Materials

3.2.1. Relative clause comprehension task

Most studies that investigate the processing of relative clauses by adults use sentences containing two verbs and three NPs (e.g. *The reporter that attacked the senator admitted the error*). Such sentences pose considerable demands on working memory. Since our participants were elderly, and since we were more interested in whether they were able to process relatives at all, it was important to minimize demands on working memory. For this reason, we used stimuli containing only two noun phrases and one verb (plus a lead-in phrase which was the same across all stimuli).

We tested the comprehension of relative clauses using a picture selection task modelled on that used by Belletti, Friedmann, Brunato, and Rizzi (2012). Each item in the test consisted of two pictures depicting reversible transitive events involving two animate participants (e.g. a boy pushing a girl and a girl pushing a boy) and an auditorily presented relative clause. The participant's task was to choose the picture that went with the description given by the experimenter. An example of a test item is given in Fig. 1. A complete list of the verbal stimuli can be found in Appendix A.

There were four experimental lists, each containing 16 subject relatives and 16 object relatives, and 16 pairs of pictures. Within each list, each picture pair was presented twice, once with a subject relative and once with an object relative, with the same noun as the head. Each of the participants depicted in a picture pair was the head noun in two lists: for example, in lists 1A and 1B, the descriptions were *el niño que empuja a la niña* 'the boy that is pushing the girl' (subject relative) and *el niño al que la niña empuja* 'the boy that the girl is pushing' (object relative), while in lists 2A and 2B, the other noun (in this case, the girl) was the head. The items were presented in four different semi-random orders, with the constraint that subject and object relatives corresponding to the same picture pair were never immediately adjacent to each other. The location of the target picture (left or right) was counterbalanced within conditions.

3.2.2. Nonverbal IQ measure

In addition to the relative clause comprehension task, participants also completed a non-verbal intelligence test, the Raven's Coloured Progressive Matrices (CPM). The CPM is designed for use with children aged from 5 to 11, the elderly, and mentally handicapped adults. It comprises of 3 sets of 12 problems of increasing difficulty. Each problem consists of a series of patterns with a missing part. The respondent's task is to select the missing part from an array of options printed at the bottom of the page. A point is awarded for every correct answer, so the maximum possible score is 36.

3.3. Procedure

All participants were tested individually in a quiet familiar location (the library at the Adult Education Centre in the case of the semi- and late-literate participants, and the teacher's room at the Aula de Mayores or, in a few cases, the participant's home in the case of the high-literates). The testing session began with the experimenter telling the participant a little about herself to establish rapport and then explaining what was going to happen during the experiment. She then asked if the participant was happy to continue and if she agreed to be recorded. If the participant agreed, the experimenter conducted an informal interview during which she collected information about the participant's age, literacy level (for the semi- and late-literate groups) or education (for the high-literate group), reading ability and reading habits. This was followed by the relative clause comprehension task, a nonce verb production task (not discussed here), and the Raven's Coloured Progressive Matrices test. There were short breaks between and, when this appeared advisable, within tasks to ensure that the participants did not become fatigued. The experimenter kept detailed notes during the task, which were later checked against the recording.

Since elderly low-literate adults are clearly vulnerable participants, we took great care to ensure that they were relaxed and happy to participate. The experimenter provided encouraging feedback throughout the experiment ("Yes, good", "You're doing very well", etc.), and asked at the end of each task if the participant was comfortable and happy to continue. Most participants were enthusiastic about their involvement in the study and very willing to interact with the experimenter.

The relative clause comprehension task was presented to the participants as a game. This helped to make the task both culturally relevant and non-threatening. Participants were given a booklet containing pairs of pictures as described above. The stimuli where printed on the right-hand side only; the left hand page was left blank. The task began with the experimenter explaining the task (see the experimental script in Appendix B for details). This was followed by a warm-up item in which the participant was presented with pictures of an old man bandaging a woman's arm and the woman bandaging the old man's arm, and a prompt containing a simple transitive sentence (*Señáleme el dibujo en el que el abuelo venda a la mujer* 'Show me the picture in which the grandfather bandages the woman'). The experimenter pointed out that both pictures showed a woman and an old man, but that they were different, and repeated the prompt. If the participant responded appropriately, the experimenter confirmed that this was the correct answer and proceeded with the task. If the participant appeared uncertain about what she was supposed to do, the experimenter repeated the instructions and added an additional practice item, which was the same pair of pictures and a simple transitive in which the roles were reversed (*Señáleme el dibujo en el que la mujer venda al hombre* 'Show me the picture in which the woman bandages the old man'). Throughout the

[3] One of the late-literate participants believed she had a mental impairment. However, she had never been clinically assessed and her long-time teacher did not believe this to be the case. Her IQ score was well within the group range, so she was included in the study.

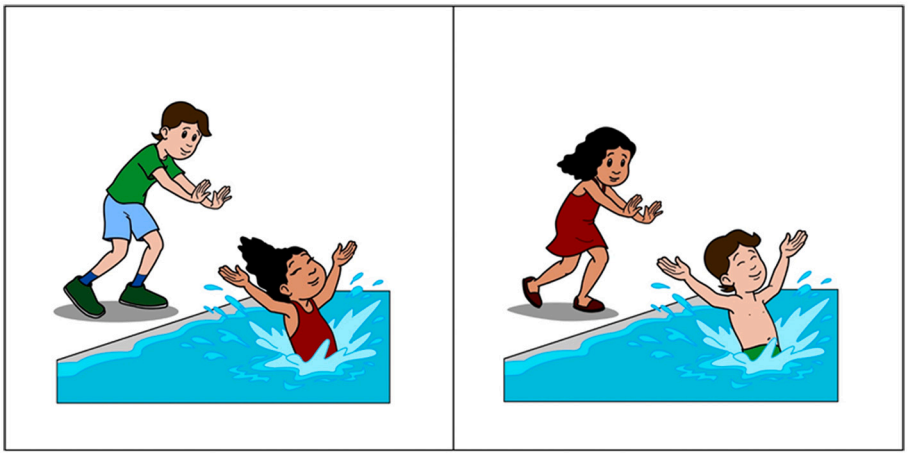

Fig. 1. Example of a test item. The corresponding prompt was *Señáleme: el niño que empuja a la niña* 'Show me: the boy that is pushing the girl' (subject relative) or *Señáleme: el niño al que la niña empuja* 'Show me: the boy that the girl is pushing' (object relative).

Table 2
Performance on Raven's Coloured Progressive Matrices by group.

Group	Mean	SD	Median	IQR	Min-Max
Semi-literates	19.7	5.5	21	10.0–23.3	10–31
Late-literates	22.4	5.5	21	19.0–26.5	14–32
High-literates	30.6	2.3	31	28.3–32.8	27–34

Note: IQR = interquartile range.

Table 3
Number of target responses (and standard deviations) by group and condition.

	Semi-literates	Late-literates	High-literates
Subject relatives	15.2 (1.4)	15.5 (0.7)	15.9 (0.3)
Object relatives	8.2 (3.0)	10.5 (4.2)	13.5 (3.5)

Note: The maximum possible score is 16.

experiment, the experimenter repeated the prompt, with the same neutral intonation, whenever the participant hesitated or asked to hear it again. The experimenter noted the participants' responses on a scoring sheet, and the entire session was also video and/or audio recorded for later checking.

4. Results

4.1. Descriptive statistics

4.1.1. Raven's CPM

The group results for the Raven's Coloured Progressive Matrices are summarized in Table 2. As can be seen from the table, performance varied considerably, particularly in the semi-literate and late-literate groups. The CPM was originally standardized on children aged from 5½ to 11½. According to these norms (Raven, Court, & Raven, 1990), the mean score obtained by the semi-literates and late-literates are equivalent to the median scores for children aged 7½ and 8 respectively. According to Spanish norms (Raven, Court, & Raven, 1996), both groups are just below the median for 7-year-olds. The CPM was also standardized on a sample of elderly people by Smits, Smit, Van den Heuvel, and Jonker (1997). According to these norms, the mean scores for the semi-literates and late-literates are just below and just above the 10th percentile respectively (corresponding to standard scores of 80 and 82), while the mean for the high-literates corresponds to the 75th percentile, or a standard score of 110.[4]

While the scores obtained by the semi- and late-literate groups are very low, they are not out of line with what is known on the relationship between intelligence and education. According to a recent meta-analysis (Ritchie & Tucker-Drob, 2018), one year of schooling raises IQ by 1 to 5 points, so the observed difference in IQs is well within the expected range. As another reference point, we compare our participants' results with those observed by Marcopulos, McLain, and Giuliano (1997), who tested 110 older adults (mean age 76.5, SD 7.9) with limited education (mean 6.7 years, SD 2.1). The mean score for the entire sample was 17.5 (SD 6.0); and the mean for the least educated participants (0–4 years of schooling) was 13.0. Compared to this group, our semi- and late-literates did very well. This supports the information we obtained during the intake interviews, namely, that our participants' failure to learn to read in childhood was due to lack of access to schooling rather than a learning impairment.

4.1.2. Relative clause comprehension

Participants in the semi- and late-literate groups often hesitated and changed their mind (see below). Since many of the initial responses were difficult to interpret (e.g. when a participant whispered, or did not finish a word), we decided to use the final response for scoring purposes. The 'final response' was operationalized as the last answer that the participant gave before turning the page to go on to the next item. However, we recorded all the responses, as the hesitations offer a complementary perspective on the participants' difficulties (see below).

Performance on the relative clause comprehension task is summarized in Table 3. As shown in the table, all three groups did very well in the control condition (subject relatives), indicating that they had understood the task and were cooperative with the researcher. In contrast to this, we observed large group differences in performance on object relatives. The performance of the semi-literate group (8.2 items out of 16, or 51.2% correct) was not significantly different from chance ($t(19) = 0.30$, $p = 0.769$). The other two groups were significantly above chance ($t(14) = 2.33$, $p = 0.035$ for late-literates; $t(13) = 5.80$, $p < 0.001$ for high-literates).

It should be pointed out that the means presented in Table 3 mask considerable individual differences in performance on object relatives.

[4] The Smits, Smit, Van den Heuvel, and Jonker (1997) norms are based on Sets A and B from the CPM. The figures given in the text are based on a conversion provided by Spreen & Strauss, 1998 (p. 87).

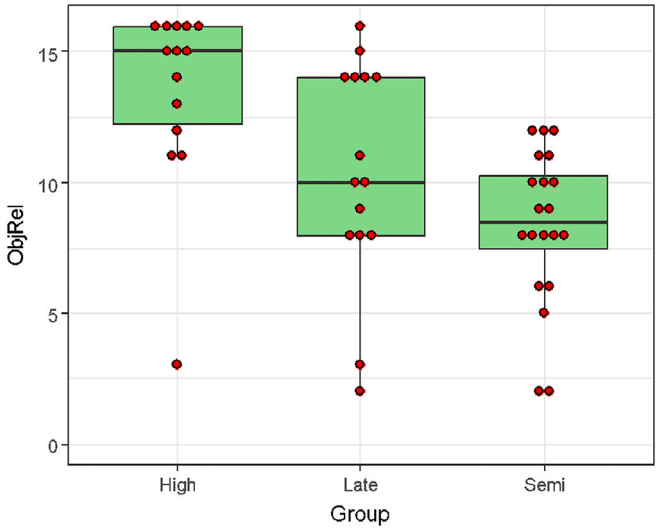

Fig. 2. The distribution of individual scores on object relatives across groups.

Table 4
Proportion of trials with self-corrections and hesitations by group and condition.

Group	Self-corrections				Other hesitations			
	Subject rels.		Object rels.		Subject rels.		Object rels.	
	M	(SD)	M	(SD)	M	(SD)	M	(SD)
High-literates	0.0	(0.0)	0.4	(1.6)	0.0	(0.0)	0.4	(1.6)
Late-literates	0.8	(2.2)	8.3	(11.0)	2.1	(3.9)	17.5	(25.0)
Semi-literates	2.8	(3.8)	9.1	(9.2)	2.2	(4.2)	21.3	(15.6)

This is clear from Fig. 2, which shows the distribution of individual scores in each group. According to the binomial distribution, we can be 95% confident that an individual scoring 12 or above out of 16 is performing above chance, while individual scores of 4 or below are below chance level.

As shown in the figure, in the high-literate group we have one clear outlier, who scored 2, i.e., clearly below chance. All other participants scored 11 or above; and 11 out of 14, or 79%, were above chance. In the late-literate group, we appear to have three subgroups. Two participants performed below chance (scoring 2 and 3); seven participants performed at chance (scoring between 8 and 11); and the remaining six performed above chance (scores from 14 to 16). Finally, in the semi-literate group, we have two outliers who scored 2, with the remaining participants clustering around the mid-point of the scale. Interestingly, however, 3 participants did perform above chance (although only just).

Thus, it appears that our participants adopted one of three distinct strategies. The majority of participants in the high-literate group, but also a few of the late-literates and semi-literates, were able to draw on their knowledge of the syntax of object relatives and thus achieved above-chance performance. The majority of participants in the late-literate and semi-literate groups, and apparently two of the high-literates, appeared to have adopted a guessing strategy. Finally, the five participants who performed below chance (two semi-literates, two late-literates and one high-literate) appear to have adopted a strategy of interpreting object relatives as if they were subject relatives, a strategy that is sometimes found in children (Arosio, Adani, & Guasti, 2009; Labelle, 1990). These results indicate that, although there is a strong relationship between literacy and the ability to process sentences containing object relatives, literacy is neither necessary nor sufficient for the comprehension of object relatives.

As indicated earlier, participants in the lower literacy groups were often unsure of the response. Table 4 provides a quantitative summary of how frequently participants changed their mind ('self-corrections') or hesitated in another way, where 'other hesitations' include long pauses (4 seconds or more), requests for repetition and self-repetitions. (All of these are exemplified in the transcript in Appendix C; see also section 5.1 below for further discussion.) The hesitation phenomena show a very clear pattern which is the reverse of that observed in Table 3: they are much more common in object relatives than in subject relatives; and they are much more frequent in the low-literacy groups than among the high-literates. In fact, self-corrections are about 20 times more frequent in the low-literate groups compared to the high-literates; and other hesitations are between 40 and 50 times more frequent in the low-literate groups.

Table 5
Estimates of fixed effects for the final model.

	Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)	0.840	0.194	4.324	<0.000
HighVsRest	1.555	0.682	2.282	0.022
LateVsSemi	0.945	0.435	2.175	0.030
CPM	0.510	0.228	2.237	0.025
Age	0.181	0.167	1.084	0.278
LateVsSemi:CPM	1.147	0.472	2.431	0.015
LateVsSemi:Age	0.799	0.363	2.200	0.028

Model formula: Response ~ HighVsRest + LateVsSemi + scale(CPM) + scale (Age) + LateVsSemi:scale(CPM) + LateVsSemi:scale(Age) + (1|Participant) + (1|Item).

4.2. *Literacy, age and IQ as predictors of performance*

To examine which factors contribute to differences in comprehension, we fitted a generalized mixed-effects model with a logistic linking function using the lme4 package (version 1.1.27.1, Bates, Maechler, Bolker, & Walker, 2015) in R (version 4.1.1, R Core Team, 2021). We used the bobyqa optimizer as models with the default optimizer did not converge. Model R^2 was computed using the MuMiN package (version 1.43.17, Barton, 2020). The data and the R code used in the analysis are provided in Appendices D and E.

The dependent variable was Response on the object relative trials (coded 1 for correct and 0 for incorrect). We excluded the subject relative trials because the vast majority of participants were either at or near ceiling in this condition. The independent variables of interest are group (semi vs. late vs. high), age and CPM score. We also examined possible interactions between group and CPM and group and age. Group was coded as two linearly independent contrasts: HighVsRest and LateVsSemi. HighVsRest contrasted the high-literates (coded 0.5) with the other two groups (coded −0.25). LateVsSemi contrasted the late-literates (coded 0.5) and the semi-literates (coded −0.5); the high-literate group were coded as 0. With this coding scheme, a positive regression coefficient for HighVsRest would indicate that the high-literate group performed better than the other two groups, while a positive coefficient for LateVsSemi would indicate that the late-literates performed better than the semi-literates. The remaining predictors (Age and CPM) were scaled. All predictors were therefore centred on zero, which means that the intercept was mapped onto the mean of the means rather than on a particular combination of factor levels. The advantage of this scheme is that any observed effects can be interpreted as main effects, as in a traditional ANOVA (see Llompart & Reinisch, 2017, 2020 for a similar approach).

The initial model thus included 8 fixed effects (i.e. the four predictors and four interactions: HighVsRest:CPM, LateVsSemi:CPM, HighVsRest: Age, LateVsSemi:Age), as well as random intercepts for participants and items. We then examined simpler models by removing non-significant predictors from the model one at a time, beginning with the one with the highest *p* value, and comparing the resulting models using likelihood ratio tests (see Appendices E and F for details). This resulted in the

Table 6
Estimates of fixed effects for the follow-up analyses.

	Estimate	Std. Error	z value	Pr(>|z|)
Semi-literates				
(Intercept)	0.047	0.203	0.233	0.816
CPM	−0.055	0.179	−0.304	0.761
Age	−0.273	0.182	−1.504	0.133
Late-literates				
(Intercept)	0.895	0.323	2.771	0.006
CPM	0.907	0.288	3.151	0.002
Age	0.532	0.278	1.912	0.056
High-literates				
(Intercept)	2.545	0.616	4.135	0.000
CPM	0.104	0.547	0.191	0.849
Age	0.502	0.568	0.883	0.377

Model formula: Response ~ scale(CPM) + scale(Age) + (1|Participant) + (1|Item).

removal of HighVsRest:CPM and HighVsRest:Age. Age was retained, since it interacted with LateVsSemi. We also examined models with all random slopes motivated by the design, but since these did not improve model fit (as determined by likelihood ratio tests) these were not included in the final model. The model selection procedure is summarized in Appendix F.

The final model (Table 5) showed that both of the group variables were significant predictors of performance: that is to say, high-literates performed better than the other two groups, and late-literates performed better than semi-literates, with the former difference being considerably larger than the latter. There was also a significant effect of CPM (participants with higher CPM scores also had higher comprehension scores). The effect of Age was not significant. There were, however, significant interactions between LateVsSemi and CPM and LateVsSemi and Age.

To explore these interactions, we fitted three additional models with CPM and Age as fixed effects and the same random effects structure as the final model (i.e., random intercepts for participants and items) for each group separately. The results of these follow-up analyses are summarized in Table 6. As can be seen from the table, neither CPM nor Age have an effect on performance in the semi-literate and late-literate groups, and the model fit is very poor, with a marginal R^2 of 0.02 and 0.05, respectively. In the late-literate group, in contrast, both predictors make a significant contribution, and the marginal R^2 is 0.19. Furthermore, the regression coefficient is positive for both predictors: in other words, both higher CPM and (surprisingly) older age are associated with better performance.

Table 7
Performance on subject and object relatives (% correct) in earlier studies.

Study	Language	Participants	% correct		Stimuli and task
			SR	OR	
Caplan, Dede, Waters, & Tripodis, 2011 (Exp. 1)	English	Adults aged from 19 to 90	81	75	Self-paced reading + speeded plausibility judgements 2 verbs and 3 full NPs
del Río et al., 2012	Spanish	Young adults	92	86/88[1]	Self-paced reading 2 verbs and 3 full NPs
Gibson, Desmet, Grodner, Watson, & Ko, 2005 (Exp. 1)	English	Young adults	81[2]	80[2]	Eye tracking 2 verbs and 3 full NPs
Gordon, Hendrick, & Johnson, 2001 (Exp. 1)	English	Young adults	93	87	Self-paced reading 2 verbs and 3 full NPs
Gordon, Hendrick, & Johnson, 2001 (Exp. 2)	English	Young adults			Self-paced reading
		3 lexical NPs	91	80	2 verbs and 3 full NPs
		2 lexical NPs + pronoun	95	96	
Gordon, Hendrick, & Johnson, 2001 (Exp. 3)	English	Young adults			Self-paced reading
		3 lexical NPs	90	79	2 verbs and 3 full NPs
		2 lexical NPs + name	94	91	
Gordon, Hendrick, Johnson, & Lee, 2006 (Exp. 1)	English	Young adults			Eye tracking
		Descriptions	86	88	2 verbs and 3 full NPs
		Names	94	94	
Grodner & Gibson, 2005	English	Young adults	88	85	Self-paced reading 2 verbs and 3 full NPs plus additional PP after the verb
Arancibia Gutiérrez, Véliz, M., Riffo, & Roa Ureta, 2014	Spanish	Young adults (mean age 22)	95	93	Self-paced reading 2 verbs and 3 full NPs
		Older adults (mean age 72)	90	89	
Holmes & O'Regan, 1981	French	Young adults	87	77/68	Eye tracking 2 verbs and 3 full NPs
James, Fraundorf, Lee, & Watson, 2018	English	Young adults	81	71	Self-paced reading 2 verbs and 3 full NPs
King & Just, 1991 (Exp. 1)	English	Young adults			Self-paced reading
		High span, no memory load	82	88	2 verbs and 3 full NPs
		High span, memory load[3]	83	79	
		Low span, no memory load	76	66	
		Low span, memory load[3]	69	63	
O'Grady, Lee, & Choo, 2001	Korean	Young adults, heritage speakers	65	41	Picture selection (3 alternatives) 2 verbs and 3 full NPs
Reali & Christiansen, 2007 (Exp. 1 & 2)	English	Young adults	97	96	Self-paced reading 2 verbs, 1 pronoun and 2 full NPs

(continued on next page)

Table 7 (*continued*)

Study	Language	Participants	% correct		Stimuli and task
			SR	OR	
Stine-Morrow, Ryan, & Leonard, 2010	English	Old adults (mean age 71) Young adults (mean age 20)	79 82	64 73	Self-paced reading Comprehension questions 2 verbs and 3 full NPs
Street, 2017	English	High-educated adults Low-educated adults	96 95	95 71	Picture selection 1 verb and 2 NPs
Adani, 2011	Italian	3-year-olds 4-year-olds 5-year-olds 6-year-olds 7-year-olds	91 93 90 96 93	53/36[1] 83/59[1] 74/54[1] 85/55[1] 89/70[1]	Picture selection 1 verb and 2 NPs (1 sg and 1 pl)
Arosio, Adani, & Guasti, 2009	Italian	5-year-olds 7-year-olds 9-year-olds 11-year-olds Young adults	94 99 100 100 100	65/24[1] 84/43[1] 90/44[1] 98/76[1] 100/96[1]	Picture selection 1 verb and 2 NPs (1 sg and 1 pl)
Arosio, Panzeri, Molteni, Magazù, & Guasti, 2017	Italian	5-year-olds 7-year-olds 9-year-olds 10-year-olds 7-year-olds w/ SLI 10-year-olds w/ dyslexia	89 94 99 98 96 99	64 73 77 91 47 58	Picture selection 1 verb and 2 NPs
Belletti, Friedmann, Brunato, and Rizzi, 2012	Italian	Children aged 3;9 to 5;5	84	55	Picture selection 1 verb and 2 NPs
Cilibrasi, Adani, and Tsimpli, 2019 (match condition)	English	Children aged 7;5–11;7	73	65	Picture selection (4 alternatives) 2 verbs and 3 NPs
Friedmann & Costa, 2010 (Exp. 1)	Hebrew	Children aged 3;11	95	61	Picture selection 1 verb and 2 NPs
Friedmann & Costa, 2010 (Exp. 2)	Portuguese	Children aged 4;2	93	69	Picture selection 1 verb and 2 NPs
Friedmann & Costa, 2010 (Exp. 3)	Hebrew	Children aged 4;4	82	63	Name agent of verb in relative clause 2 verbs and 2 NPs; third participant marked by inflection on main clause verb
Friedmann & Costa, 2010 (Exp. 5)	Hebrew	7-year-olds 9-year-olds 11-year-olds	81 95 94	78 92 90	Name agent of verb in relative clause 2 verbs and 2 NPs
Kidd & Arciuli, 2016	English	6- to 8-year olds	90	55	Picture selection 1 verb and 2 NPs

Notes
[1]The figures given are for object relatives with topicalized and postposed subjects, respectively.
[2]These figures were averaged across four conditions: Subject-modifier, non-embedded; Subject-modifier, embedded; Object-modifier, non-embedded; Object-modifier, embedded.
[3]The figures were averaged across two memory load conditions.

5. Discussion

As predicted, high-literates were significantly better at understanding sentences containing object relatives than both of the low-literate groups, and late-literates achieved higher scores than the semi-literates, who did not perform above chance as a group. However, there were also large individual differences in performance in all three groups. In contrast, all three groups were close to ceiling on subject relatives. IQ was also a significant predictor, although it was to some extent confounded with literacy (high-literates had higher IQs than the two low-literate groups). Furthermore, in the low-literate participants, IQ interacted with literacy such that the effects of literacy were only observable in participants with higher CPM scores. There was also a significant interaction between group and age: age did not affect performance in the high- and semi- literate groups; in the late-literate group, in contrast, older participants achieved higher scores.

5.1. Competence or performance?

As explained in the introduction, the ability to produce and comprehend object relatives emerges late in children. Furthermore, a large number of studies have shown that object relatives are a difficult structure even for university educated young adults, in that, in comparison with subject relatives, they are processed more slowly and incur higher error rates. These findings are usually interpreted in terms of processing demands rather than lack of knowledge: that is to say, the consensus is that university-educated young adults have mastered the construction but experience some difficulty when reading (and possibly also producing) its instances due to their non-canonical word order, the longer distance between the filler and the gap and/or the presence of an intervening NP. Could our semi-literate and late-literate participants' performance on object relatives be attributed simply to difficulties with processing? Several facts speak against such an interpretation.

First, the tasks used in studies investigating the differences in the

processing of subject and object relatives in adults are much more demanding than the one used in our study. The upper part of Table 7 provides an overview of sixteen experiments investigating the processing of subject and object relatives by adults which also supply numerical data about comprehension accuracy. As shown in the table, most of these studies used sentences with two verbs and three NPs (e.g. *The reporter that attacked the senator admitted the error* vs. *The reporter that the senator attacked admitted the error*) and sometimes additional modifiers – in other words, the stimuli themselves were more difficult to process than our stimuli, which consisted only of a relative clause embedded in the carrier phrase *Show me…*. Apart from Street (2017) and O'Grady, Lee, & Choo (2001), which will be discussed later, the question of interest in all of these studies was which parts of the sentence had longer reading times, and therefore the stimuli had to be presented in a way that allowed researchers to measure reading times for individual words. While some of the studies used eye tracking, the majority used self-paced reading. In the latter paradigm, a sentence presented one word at a time, and the participant has to press a button to move on to the next word. Needless to say, this is an unnatural method of reading a sentence, which is likely to add to the processing difficulty. In both paradigms, the comprehension probe is presented after the stimulus containing the relative clauses has disappeared from the screen, so participants have to maintain the stimulus in working memory while processing the comprehension probe. This further increases the task demands. In our study, as in most studies using a picture selection task, both pictures were visible while the participant heard the sentence, and the stimulus contained only the invariant carrier phrase *Show me…* and the relative clause. Furthermore, in our study, the experimenter repeated the sentence whenever the participant hesitated or asked to hear it again. All of these design elements reduce the burden on working memory; and while working memory demands cannot be eliminated entirely — all language processing requires some working memory resources — we contend that the demands posed by our task were relatively small, and therefore our results provide a relatively accurate reflection of participants' underlying knowledge. It is worth noting in this connection that educated young adults and older children tested using picture selection perform at ceiling on both subject and object relatives. For example, the highly educated adults tested by Street (2017) scored 96% correct on subject relatives and 95% on object relatives. The adult control group tested by Arosio, Adani, & Guasti (2009) scored 100% in both conditions, and the oldest children in the study (mean age: 11;3) scored 100% on subject relatives and 98% on object relatives with topicalized subjects.

Secondly, the differences between comprehension accuracy for subject and object relatives observed in studies with literate young adults are relatively small (typically around 5–6%), and sometimes absent altogether. For example, the Spanish-speaking participants tested by del Río, Lopez-Higes, and Martin-Aragoneses (2012) averaged 92% correct on subject relatives and 86% correct on object relatives with topicalized subjects — a difference of 6%. Another study with Spanish-speaking participants, conducted by Arancibia Gutiérrez, Véliz, Riffo, and Roa Ureta (2014), found a difference of just 2% (95% vs. 93%) in young adults and just 1% (90% vs. 89%) in older adults. Only two adult studies listed in Table 7 report a difference of more than 20 percentage points. The first of these (O'Grady, Lee, & Choo 2001) tested comprehension of subject and object relatives by heritage language speakers (who typically have very low literacy skills in the heritage language), and the second (Street, 2017), low-educated adults (unskilled workers with no more than 11 years of formal education).

As we have seen earlier, the pattern of performance observed in our semi-literate and late-literate groups is very different. For the semi-literate group, the difference in performance on subject vs. object relatives is 42% (95% vs. 53%), while for the late-literates, it is 32% (97% vs. 65%). The difference observed in the high-literate group (15%) is higher than in most earlier studies, but it is by no means an outlier: for example, Stine-Morrow, Ryan, and Leonard (2010) also observed a difference of 15% in their older participants.

The second half of Table 7 lists a number of studies which examined comprehension of subject and object relatives by children learning their first language. Most of the studies tested comprehension using a method very similar to that employed here: a picture selection task and stimuli consisting only of an invariant lead-in phrase such as *Show me* plus a relative clause. The differences in performance on subject and object relatives observed in these studies are typically larger than those found in studies with adult participants, but not as large as those observed in our data. The only data sets that show a comparable gap in performance on the two constructions are studies involving very young children (3- and 4-year-olds: Adani, 2011; Friedmann & Costa, 2010) and older children with Specific Language Impairment and developmental dyslexia (Arosio, Panzeri, Molteni, Magazù, & Guasti, 2017).

To summarize: Studies involving highly literate adults found either no differences between subject and object relatives (when participants were tested using picture selection) or relatively small differences (when the experimental task was more demanding). In these studies, less-than-perfect performance can be plausibly attributed to performance limitations: these participants have clearly mastered both types of relative constructions, but occasionally make errors, particularly when task demands are high. However, when participants perform close to chance on object relatives and close to ceiling on subject relatives, such an explanation is not feasible. When this pattern of results is observed — as in very young children, older children with language or reading impairments, or semi-literate or late-literate adults — we must conclude that the speakers have not mastered the object relative construction.

In order to provide further evidence that the semi- and late-literate participants' problems with object relatives are not simply due to linguistically irrelevant performance factors, we offer an extended analysis of a conversation about the penultimate item in the test that ensued between B, a 59-year-old semi-literate with a CPM score of 31, and the experimenter (E). A transcript of the conversation is provided in Appendix C. On hearing the prompt, B initially provides a correct paraphrase, but then hesitates (line 3). The experimenter repeats the prompt (line 9) and B provides a second paraphrase which reverses the agent and patient roles, and again, immediately rejects it (line 11). The experimenter repeats the prompt again (line 13), and the participant repeats it quietly two times, repeats the incorrect paraphrase, and then asks the experimenter if the first picture is the correct response (lines 15–17). The experimenter explains that she cannot see the pictures from where she is seated (line 21). Recalling that the same pair of pictures occurred earlier in the test, B wonders if the prompt is the same as before, and concludes that it is not (lines 23–24). Then she again provides the incorrect paraphrase, says that picture 1 is the correct one, but expresses doubt (line 33). The experimenter responds in a noncommittal way (line 35), and B asks for confirmation that she gave the right response (line 37). E asks if she would like to hear the prompt again, the participant says yes, and E repeats the prompt for the fourth time (lines 43). B repeats it one more time, and finally decides that the second picture is the correct one (line 46). This utterance is spoken with a falling intonation, suggesting confidence. Before moving on to the next item, B comments one more time that the prompt was phrased differently in an earlier trial (lines 51–52).

Several observations are in order. The participant is clearly trying very hard to provide the correct answer. It is evident that she is engaged with the task, and alert: she remembered that the same pictures occurred earlier in the test. She also had no difficulty in maintaining the prompt in working memory: in fact, she spontaneously repeated it to herself three times. However, although she ended up giving the correct response on this trial, it is clear that she did not know what the prompt meant: she changed her mind several times, and repeatedly indicated that she was unsure which picture she should choose. B provided the target response for 6 out of 16 items; for subject relatives, her score was 16/16. Her behaviour during the experiment confirms what these figures suggest, namely, that she lacks an object relative construction that she could access in order to process the experimental stimuli.

An important caveat must be made here, however. Corpus-based investigations of relative clauses have shown that object relatives found in spoken texts tend to be quite stereotypical in that the subject is typically either null or pronominal, and the head inanimate (Reali, 2014; Reali & Christiansen, 2007; Roland, Dick, & Elman, 2007). The relative clauses used in our experiment, in contrast, contained two full noun phrases, both of which referred to animate participants. This decision was dictated by the exigencies of the experimental task: in order to test participants' ability to infer agent and patient roles from morphosyntactic cues alone, the stimuli had to describe events that were semantically reversible; and in order to be understandable without additional situational context, they had to contain full NPs.

The strong distributional regularities found in object relatives in spoken texts could lead speakers to extract relatively lexically-specific constructions such as *la INANIMATE que (PRON) TR.VB* and *el INANIMATE que (PRON) TR.VB*, which would then allow them to produce and comprehend relative clauses that match the templates (e.g. *el cuchillo que más uso* 'the knife that I use the most' and *la moqueta que has elegido* 'the carpet that you chose'). Reali (2014) found some evidence for the existence of such relatively specific constructional templates: for example, object relatives with pronominal subjects are processed faster when the subject is placed before the verb (SV), while for object relatives with a full NP subject the opposite is the case. However, Reali found no differences in the comprehension accuracy for the different word order variants. These results suggest that the participants that she tested (university students) had acquired lexically specific templates, which facilitate processing sentences that match the template, but they also had a more general construction, which enabled them to process non-canonical variants. Our results suggest that most of the semi- and late-literate participants in our study do not have such an abstract relative construction; however, it is perfectly possible that they have acquired the more specific variants.

5.2. The (non)effect of age

As noted in the method section, our participants ranged in age from 48 to 89, with a mean age of 69. This was unavoidable: illiteracy in younger adults living in industrialized countries is nearly always associated with severe learning impairment and/or social deprivation. However, the fact that most of our participants were elderly raises the possibility that low scores on the comprehension task could be at least partially due to dementia rather than to low literacy skills. It is important, therefore, to note that our results showed no effects of age in the semi- and high-literacy groups, while in the late-literate group there was a marginally significant relationship in the opposite direction from what one might expect, i.e. older participants tended to do slightly better than younger ones. There was also no correlation between age and CPM scores ($r = 0.13$, $p = 0.359$). This is somewhat surprising, since earlier research found that performance on tasks tapping comprehension of relative clauses and on nonverbal IQ declines in older adults.

The lack of a significant relationship between age and either of these variables is most likely due to the special characteristics of our sample. As explained in the method section, our semi- and late-literate participants were all taking adult education classes. Participation in adult education programmes is self-selective, and as a result, more educated, cognitively more fit, and younger individuals are more likely to enroll in them (Chisholm, Larson, & Mossoux, 2004). It is extremely unusual for individuals who have been illiterate all their lives to decide to begin to learn to read at the age of 60 or even 70. Such individuals are likely to have very high need for cognition in comparison to their peers, and need for cognition is associated with higher IQ (Hill, Foster, Elliott, Shelton, McCain, & Gouvier, 2013). Conversely, people who feel that their mental skills are declining may be more likely to drop out of adult education. Thus, the participants in our sample were likely to be more cognitively fit than other low-literacy adults of the same age, and the oldest participants (such as the 89-year-old who insisted on doing all the tasks) were likely to be particularly fit compared to other individuals with similar backgrounds. This characteristic of the sample is likely to have masked the cognitive effects of aging. To a lesser extent, this is probably also true for the high-literate participants, who were all attending courses at a university of the third age. Be that as it may, the (non)effects of age indicate that the problems with comprehension of object relatives observed in the semi- and late-literate groups cannot be attributed to dementia.

5.3. Reasons for group differences

In the introduction to this paper, we mentioned several possible ways in which literacy might improve syntax. In this section, we briefly consider whether or not these factors are plausible explanations for the group differences in comprehension of relative clauses observed in this experiment.

Perhaps the most obvious ways in which experience with written language might affect the processing of object relatives has to do with the amount of exposure to this construction. As noted in the introduction, many complex structures, including relative clauses, tend to be more frequent in written language, and therefore speakers with more exposure to written texts may be expected to develop stronger representations of these structures. The problem with such an account is that although relative clauses in general tend to be more frequent in speech than in writing, *object* relatives appear to be more frequent in speech, at least in English (Roland, Dick, & Elman, 2007), and probably also in Spanish (see Llompart & Dąbrowska, 2021).[5] Be that as it may, object relatives are certainly not a rare construction in spoken language: Llompart and Dąbrowska (2021) estimate that they occur in Spanish child-directed speech approximately 4 times per hour.

However, a simple exposure account may work if we examine object relatives found in spoken and written texts in more detail. As pointed out earlier, object relative clauses found in spoken texts tend to be quite stereotypical in that the vast majority of them have pronominal or null subjects and inanimate heads. This may lead language learners to extract fairly specific templates. Written relative clauses, in contrast, are more varied (cf. Montag & MacDonald, 2015). According to usage-based models (e.g. Bybee, 2010), more variation in the specific instantiations of a construction leads to the extraction of more general constructions. It is possible, therefore, that the high-literate speakers' better performance on object relatives is attributable to the fact that they experienced more different types of object relatives rather than simply more tokens.

Another possible explanation based on quality of exposure is that experience with written representations affects grammatical development by revealing distinctions that are difficult to discern in spoken language. As explained earlier, subject relatives and object relatives with postposed subjects in Spanish are both introduced with the complementizer *que* followed by the verb and a noun phrase. Thus, when the NP inside the relative clause is inanimate, the clause is ambiguous. For example, the expression *el autobús que golpeó el coche* can mean either 'the bus that hit the car' (subject relative) or 'the bus that the car hit' (object relative with postposed subject). However, when the noun inside the relative clause is specific and animate, the presence of the *a* marker indicates that the following noun is the object of the verb, and therefore the whole expression must be a subject relative (as in (2), repeated here as (6a)). Conversely, the absence of *a* indicates that the following noun must be the subject, and therefore the entire expression must be an object relative (cf. (3a), repeated here as (6b)). Crucially, however, the disambiguating *a* is consistently available only in writing; in spoken language, the *a* often blends with the final vowel of the preceding verb.

[5] However, Montag and MacDonald's (2015) comparison of child-directed speech and children's literature revealed the opposite pattern.

(6) a. *la abuela que besa **a** la niña*
'the grandmother that kisses the girl' (subject relative)
b. *la abuela que besa la niña*
'the grandmother that the girl kisses' (object relative with postposed subject)

In addition, as discussed earlier, in object relatives with a specific animate object, the preposition *a* can be optionally added before the complementizer, which unambiguously marks the relative clause as an object relative at its onset (see the sentences in (4) above). The variant with *a* is somewhat more formal than the 'plain' variant, and hence presumably more frequent in written texts. If this is indeed the case, then speakers with more experience with written texts will also have more experience with the more clearly marked variant of the construction, and thus more opportunities to master the distinction.

A third possibility discussed in the introduction is the processing crutch/training wheels hypothesis (Dąbrowska, 2020), which proposes that the availability of written representations eases working memory load, thus enabling skilled readers to process more complex structures than they would otherwise be able to process (processing crutch); in the long run, structures which are practiced in the written medium may become sufficiently well entrenched for speakers to be able to access them effortlessly, also when processing oral language (training wheels).

Finally, literacy, and education generally, could also affect speakers' mental grammars in a more indirect way, by improving intelligence, metalinguistic awareness, working memory, inhibitory control and possibly other mental abilities, which in turn facilitate the acquisition of noncanonical constructions such as object relatives. Given the strong association between literacy and CPM, it is tempting to conclude that the effect of literacy is at least partly attributable to group differences in IQ. The fact that higher nonverbal IQ is associated with better comprehension of object relatives in children (Llompart & Dąbrowska, 2021) appears to support such an interpretation. Unfortunately, given the correlational nature of our data, we cannot make any strong causal inferences. It is important to note, moreover, that these various explanations are not mutually exclusive: it is likely that all these factors contribute to more successful processing of object relatives to some degree, and that they interact in various ways. We see an example of such an interaction in our data: in the low-literate participants, IQ had an effect on comprehension only in participants who had achieved a higher level of literacy, i.e. in the late-literate group. It is also highly likely that the causal relations are reciprocal (cf. Cunningham & Stanovich, 1997, 1998; Stanovich, 1986; Stanovich & Cunningham, 1992): reading improves cognition, which improves language, which improves reading and cognition, which improve language, which improves reading, and so on.

In an ideal world, we would observe a large number of adults who are learning to read longitudinally, over a period of years, and collect data on print exposure, reading ability as well as all of the cognitive variables mentioned above. Realistically speaking, such a study would only be feasible in a country with a much lower literacy rate than Spain and other industrialized countries and in the context of a more formal educational setting to enable long-term follow-up. Another interesting avenue of research would involve investigations with children: for example, in order to discriminate between the training wheels and a simple exposure account, one could expose school-aged children who are still acquiring complex syntax to instances of a difficult construction either orally or in writing.

6. Conclusion

We began this paper with the observation that children acquiring their first language master the object relative construction relatively late: adult-like levels in comprehension are reached only about age 10 — in other words, after about 4 years of formal exposure to written language. Furthermore, previous research (e.g. Cilibrasi, Adani, & Tsimpli, 2019) found a relationship between reading speed and comprehension of relative clauses; and object relatives appear to be particularly difficult for populations with relatively little exposure to written language, such as children with dyslexia and heritage language speakers. This led us to hypothesise that the availability of written representations supports the acquisition of object relatives, which in turn leads us to the prediction that semi-literate and late-literate speakers will have more difficulty interpreting sentences containing this construction than age-matched controls who learned to read in childhood, and thus have many years' experience with written language. This prediction was confirmed. As a group, our semi-literate speakers were at chance (53% correct) on object relatives and close to ceiling (95% correct) on subject relatives. The difference in performance on the two sentence types was somewhat smaller in the late-literate group (65% vs. 98%) and much smaller in the high-literate group (84% vs. 99%). Furthermore, while we acknowledge that object relatives pose more demands on the processing system, our results cannot be argued away as 'mere performance': they tell us something about the mental grammars of speakers with little exposure to written language.

As noted earlier, there is mounting evidence against the widely-held assumption that native speakers converge on (more or less) the same grammar. The differences between high-literate and late−/semi-literate speakers we observed in this study suggest that the extent of individual differences in grammatical knowledge may be much larger than earlier research suggested. This finding has profound implications for theories of language acquisition, in that it undermines the convergence argument for Universal Grammar, and demonstrates that a cultural invention such as written representations can support the acquisition of a complex syntactic structure.

To our knowledge, this is the first study which compared the grammatical abilities of highly literate and semi-literate speakers. The study suffers from obvious limitations: we tested just two constructions, subject and object relatives, and because our participants were elderly, we cannot completely rule out the possibility that their poor performance on object relatives was partly a consequence of age-related decline in cognitive abilities. Thus, while our findings seem to support the hypothesis that literacy facilitates the acquisition of 'late blooming' syntactic structures, further research is needed to identify areas of strength as well as weakness in semi-literate and late-literate speakers' mental grammars.

CRediT authorship contribution statement

Ewa Dąbrowska: Conceptualization, Methodology, Formal analysis, Writing – original draft, Project administration, Visualization, Supervision, Funding acquisition. **Esther Pascual**: Methodology, Investigation, Data curation, Writing – review & editing, Funding acquisition. **Beatriz Macías Gómez-Estern**: Investigation, Writing – review & editing, Supervision.

Declaration of Competing Interest

None.

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Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2021.104958.

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