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Comprehension of object relatives in Spanish: the role of frequency and transparency in acquisition and adult grammar

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Abstract: This study investigates the relative roles of frequency and transparency in native speakers' comprehension of Spanish object relative sentences by comparing performance with two variants of the construction that differ in these properties. Experiment 1 suggests that seven- to eight-year-old children's processing of object relative sentences is consistently facilitated by variant frequency and likely relies on separate representations for each variant as two different, although related constructions. Experiment 2 turns to adult comprehension of the two variants, showing similar accuracy and reaction time patterns for both variants for this population. This second outcome could be interpreted as a decrease in frequency effects over time, in line with the power law of practice, as an experience-based increase in the ability to make use of redundant markers, or both.

Keywords: relative clauses; Spanish; first language acquisition; object relatives; Construction Grammar

1 Introduction

A central question for usage-based models of Construction Grammar (CxG) theory is what properties of the input facilitate or hinder the acquisition of constructions. Frequency is often highlighted, since constructions that are experienced more

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frequently are learned faster and processed more easily (Ambridge et al. 2015; Bybee 2017; Divjak 2019; Ellis 2002). The present study investigates frequency at a schematic, coarse level of granularity (Lieven 2010) by exploring whether higher frequency of specific schematic variations of a structure can have a facilitating effect on comprehension and acquisition.

While other input properties may have received considerably less attention than frequency, some have also been identified as factors facilitating acquisition. A case in point is transparency. Widely understood as the degree to which the meaning of the whole structure can be inferred from the meaning of its parts, transparency has been shown to facilitate the processing of noun compounds (El-Bialy et al. 2013; Marelli and Luzzatti 2012), verb–noun pairs (Gyllstad and Wolter 2016) and idioms (Liu and Su 2021). In this study, we explore a particular aspect of transparency, namely how clearly semantic roles such as agent and patient can be identified in a sentence. Many unambiguous sentences contain local ambiguities which may lead to processing difficulty (Dąbrowska 2004). However, languages often offer speakers means of adding extra cues to help identify semantic roles. Such extra cues make sentence meaning more transparent, which may be useful in the acquisition and processing of complex structures.

In the present study, we attempt to shed light on the relative roles of frequency and transparency on the comprehension and representation of Spanish subject and object relatives by seven- to eight-year-old children and by adult native speakers of Spanish. In the three sub-sections that follow, we first introduce Spanish relatives, and then subsequently discuss the potential effects of frequency and transparency on the comprehension of this type of structures. Finally, we reflect on how the outcome of this study may inform CxG theory regarding the issue of identifying individual constructions when dealing with highly similar structures.

1.1 Spanish relatives

Relative clauses are subordinate structures that modify a noun. These include subject relatives (SRs), in which the head noun is understood to be the subject of the verb in the subordinate clause (e.g., *the man that saw my friend*). In object relatives (ORs), by contrast, the head noun is the object of the verb in the subordinate clause (e.g., *the man that my friend saw*). In these sentences, when the verb is in the active voice, the subject corresponds to the role of agent and the object corresponds to the role of patient. ORs in languages like English, Italian and Spanish are known to be acquired late (e.g., Arosio et al. 2009; Kidd and Arciuli 2016) and are relatively difficult to process even for adults (e.g., del Río et al. 2012; Holmes and O'Regan 1981; Street 2017). The relative difficulty of ORs (vs. SRs) has been attributed to several different yet

non-exclusive factors, such as (i) the presence of syntactic gaps in the object position (e.g., Miyamoto and Nakamura 2003), (ii) the heightened working-memory demands they impose (e.g., Gibson 1998), and (iii) their less prototypical syntactic structure (e.g., Kidd et al. 2007; Reali 2014; Reali and Christiansen 2007).

In Spanish, the first relatives emerge in children's speech relatively early, approximately around age 3 (Montrul 2004). However, ORs are rare at this stage and, in experimental settings, even older children often replace them with SRs (Pérez-Leroux 1993). In fact, a recent study on the comprehension of Spanish SRs and ORs by children aged 6 and 7 using a simple picture-selection task showed that children performed well below chance (27 % correct) on ORs, whereas performance on SRs was at ceiling (Llompart and Dąbrowska 2024).

Relative clauses in Spanish are normally introduced by the complementizer *que*. SRs mainly have an SVO word order (1), just like simple transitive clauses.

(1) *el niño que abraza al abuelo*
the boy that hug:3s to:the grandpa
'the boy that hugs the grandpa'

In ORs, the subject can come either before (as in 2a) or after the verb (as in 2b). Note that when the subject is post-posed the only difference between (1) and (2b) is the presence of the preposition *a* 'to'[1] in the subject relative (1).

(2) a. *el niño que el abuelo abraza*
the boy that the grandpa hug:3s
'the boy that the grandpa is hugging'
b. *el niño que abraza el abuelo*
the boy that hug:3s the grandpa
'the boy that the grandpa is hugging'

The preposition *a* is obligatory on direct objects when these are human and specific. In ORs, it can also be used before the complementizer when the head noun (in this case *el niño* 'the boy') is human and specific, as in (3a) and (3b); in this case it must be followed by the definite article.[2]

(3) a. *el niño al que el abuelo abraza*
the boy to:the that the grandpa hug:3s
'the boy that the grandpa is hugging'

1 When the preposition *a* is followed by the definite masculine singular article *el*, the two are contracted into *al*. This is not the case with the remaining definite articles (i.e., *a la, a los, a las*).
2 Note that in non-restrictive RCs, other, less common variants with the pronouns *cual* 'which' and *quien* 'who' are also possible when preceded by the preposition *a*.

b. *el niño al que abraza el abuelo*
the boy to:the that hug:3s the grandpa
'the boy that the grandpa is hugging'

The two variants of Spanish ORs, henceforth referred to as the plain-variant[3] (i.e., no preposition) in (2) and the *a*-variant in (3), exhibit crucial differences in frequency and transparency, making them a suitable testing ground for how these properties facilitate or hinder the comprehension and perhaps even the acquisition of these structures. In this study, we focus on the OSV word order, as in (2a) and (3a), to avoid potential confusion of spoken OR sentences like (2b) with SRs like (1), especially with children, who are less familiar with the ORs (see Llompart and Dąbrowska 2024, for a more detailed discussion of this). In the following section, we outline the differences between the two variants, explore the possible influences of frequency and transparency at different stages of acquisition, and introduce the design we used to test our predictions.

1.2 Spanish relatives: frequency and transparency

In the present study, we used a picture selection task to examine the comprehension of SRs and both the plain-variant and the *a*-variant ORs with the verb in clause-final position (e.g., *el niño (al) que el abuelo abraza* 'the boy that the grandpa is hugging') in seven- to eight-year-old children (Experiment 1) and adults (Experiment 2). The aim of this design is to explore the relative role of frequency in relation to that of transparency in facilitating the comprehension of these structures at two different stages of development.

Regarding frequency, the plain-variant is much more frequent than the *a*-variant in Spanish, especially in spoken language. According to Butler (1992), the mean frequency of plain ORs in a corpus of educated spoken Spanish is 5696 per million words, while prepositional ORs only occur, on average, 351 times per million words, making the plain variant about 16 times more frequent. According to usage-based models of acquisition, all else being equal, more frequent forms are acquired earlier than less frequent ones (Abbot-Smith and Tomasello 2006; Bybee 2010; Dąbrowska and Szczerbiński 2006; Rubino and Pine 1998). Therefore, it is sensible to expect that Spanish children, likely having had much more exposure to plain ORs, have acquired them to a larger extent and are better at comprehending them than the less frequent

3 Note that we are using "variant" in as neutral a way as possible with regard to our research question. With the use of "variant" we do not mean to assume that they are indeed variants of the same construction.

prepositional variant. Note, however, that here we focus on overall variant frequency differences, and it should be noted that such differences might be driven by the animacy of the head NP, i.e., the *a*-variant can only occur in ORs with animate heads, where the use of this variant might be almost categorical (see Llompart and Dąbrowska 2024). Similarly, there are frequency differences between the two possible word orders, with OVS being more frequent than OSV (Reali 2014). While this may affect the ratio of frequency differences between the two variants, there are no fine-grained analyses, to our knowledge, that allow us to quantify these. Given the large size of the overall variant frequency differences, however, we still expect the plain-variant to be more frequent than the *a*-variant for the word order presently investigated (OSV). Moreover, the corpus used by Butler (1992) is limited to the Madrid region and the frequency difference might be subject to some degree of dialectal variation. Hence, the 16:1 ratio of frequency for plain- versus *a*-variant ORs (Butler 1992) should be understood as an estimate.

Frequency effects have been shown to be most facilitative during early acquisition and eventually reach asymptote, a trend that is commonly referred to as the power law of practice (Ellis and Schmidt 1998; Ellis 2002). In line with this, the Competition Model (Bates and MacWhinney 1989) proposes a specific way in which cue properties hold different relevance throughout acquisition whereby cue validity, entailing both frequency and reliability of the cue, is expected to be the most important factor in the earliest stages of acquisition. Experimental evidence has shown that in both Hebrew (Sokolov 1988) and German (Dittmar et al. 2008), frequency alone accounted for the earliest acquisition of L1 structures. Based on this, in our case, we expect the frequent plain-variant to show a larger advantage in children's OR comprehension at the age of acquisition of ORs (Experiment 1) than in automatized adult processing (Experiment 2).

As hinted above, transparency has been mostly researched with reference to the extent to which the semantics of the components of a structure are predictive of the meaning of the structure as a whole (El-Bialy et al. 2013; Gyllstad and Wolter 2016; Kjaerbaek and Basboll 2016; Liu and Su 2021; Marelli and Luzzatti 2012). In this sense, 'blueberry' would be considered more transparent than 'catwalk' because the meaning of the compound can be more easily inferred from the meaning of the single words within, i.e., 'blue' and 'berry' versus 'cat' and 'walk' (El-Bialy et al. 2013). In contrast, we use the term to refer to the syntactic transparency of a sentence in relation to the clarity of the functional grammatical roles within it. This formulation ties in nicely with Slobin's Operating Principle E, which states that "underlying semantic relationships should be marked overtly and clearly" (Slobin 1973, p. 202). In language acquisition, Principle E has been used to explain why some constructions or systems are acquired earlier than others. For example, Aksu-Koç and Slobin (1986) argue that Turkish children learn the nominal and verbal morphology of their

language early and efficiently because the relevant morphemes are highly salient, obligatory and generally associated with one single function. Similarly, Kupisch, Müller and Cantone (2002) argue that the Italian gender system is easier to acquire than the French one because it is more transparent. In the case of Spanish relatives, the *a*-variant can be considered more transparent because the preposition *a* unambiguously rules out the possibility that the following relative clause is a SR. In other words, the functional grammatical role of the first NP is marked as an object immediately prior to the relative clause.

The redundant marker in the *a*-variant also holds a high value in terms of predictive online processing. The initial element of a structure is typically the subject, which in many cases corresponds to the agent, and note that the basic and arguably most frequent word order in Spanish is SVO (Leonetti 2017). Therefore, sentences with that order can be interpreted following the basic processing heuristic that the first NP in a sentence corresponds to the agent, and hence, is taken as the functional subject. According to predictive processing approaches, basic heuristics can drive syntactic analysis decisions, such as role assignment, in the temporary absence of disambiguating cues, which makes the processing of non-canonical structures more costly given the need for re-interpretation (Ferreira and Lowder 2016). Hence, adult's slower processing of ORs (vs. SRs) has been argued to arise because of an erroneous initial interpretation of the sentence as an SR following the first NP = agent heuristic, which gives rise to difficulties at the point of re-interpretation, i.e., the point at which the participant realizes that the initial interpretation was incorrect (Betancort et al. 2009; del Río et al. 2012; Reali 2014). The cost of re-interpretation, measured in grammaticality judgements and response times, increases along with the distance between the head and the disambiguating word (Ferreira and Henderson 1991), hence earlier disambiguation should facilitate processing. Spanish SRs show differential object marking (DOM), i.e., when both NPs are animate and specific, the preposition *a* must precede the last NP indicating that it functions as an object. Hence, the absence of this marking at the onset of the last NP of ORs is the only cue to an OR interpretation in the plain-variant, and this makes it the point of re-interpretation if one has been following the first NP = agent heuristic. Because of this, an earlier and redundant marker for the first NP as an object, as that found in the *a*-variant, i.e., *a* + article after the first NP (e.g., *el abuelo* ***al*** *que* ***el*** *niño abraza*; cues signaling OR interpretation in bold), should facilitate processing in comparison to the plain-variant, because it signals that the first NP has to be an object before the onset of the relative clause, potentially ruling out the SR interpretation earlier in the sentence.

Accordingly, transparency of grammatical relations predicts that the *a*-variant, once acquired, should be easier to process. Nonetheless, note that this facilitation effect is fully dependent on the correct interpretation of the specific syntactic-

semantic information carried by *a* + article. Simple transitives and SRs follow DOM rules, whereby specific animate direct objects must be marked. In these cases, *a* + article is simply used to designate the following element as a direct object.[4] However, when *a* + article occurs followed by the relativizer *que* in ORs, it signals that the relativized element functions as a direct or a prepositional object (and hence not subject) in the following the relative clause. In ORs, as we have seen, this marker is optional and can be omitted. Therefore, it is unclear whether young children have been exposed to enough exemplars of *a*-variant ORs to be able to use this information, especially given that function words are not particularly salient. Indeed, it might be the case that a lack of experience with *a* + article in this position introduces confusion during the early acquisition of ORs. This ties in with the notion of 'functional readiness' introduced by Bates and MacWhinney (1989, p. 55), who proposed that functional unavailability of a linguistic form will inevitably result in a failure to create a mental representation of a form-meaning pair.

In sum, facilitation for the *a*-variant could be predicted on the grounds of transparency and a reduced load during predictive processing. Due to the limited experience that children likely have with this variant, however, it could be that these facilitation effects only develop at later stages of acquisition. On the other hand, frequency facilitation would point towards an advantage for the plain-variant, which is likely to impact earlier stages of acquisition to a greater extent than adult processing. However, these differences in comprehension between the two variants would only be expected in case that they are not acquired simultaneously as the same construction, which raises an important question that will be considered in the next section.

1.3 One or two constructions?

Given the similarities between the two variants of Spanish ORs, the potential asymmetries in processing and comprehension proposed in the previous section could also inform another interesting question, namely whether the two structures can be subsumed as the same construction or are better characterized as two separate constructions. This would be of particular interest for CxG, given that one of the recurring questions within this tradition is how to define which structures fall under the same construction and which constitute different constructions (Hilpert 2014).

4 While there is some research documenting the production of DOM in Spanish children (e.g., Rodríguez-Mondoñedo 2008), no studies, to our knowledge, have previously investigated children's comprehension of *a* + article in the context of DOM.

To our knowledge, it is not clear whether these two structures should be treated within a CxG theory of language acquisition as two entirely independent constructions, two closely related constructions or the same construction with/without an optional element (i.e., *a* + article). In support of the latter interpretation is the fact that the form of the two variants is exactly the same except for the optional element, whose use is motivated by (though not fully predictable from) general rules dictating obligatory marking of animate and specific direct objects, i.e., DOM. Besides, the meaning conveyed is also essentially identical. Building on that, it is more economic for any grammar to treat them as the same construction – and indeed, most reference grammars of Spanish state that *que* alternates with *al que* and *a la que* in non-restrictive ORs (see, for example, Alarcos-Llorach 2000; RAE-ASALE 2009), thus implying that they should be considered variants of the same construction. In this respect, Spanish ORs could be regarded as similar to English complement clauses introduced by *that*, as in (4), where the complementizer can be omitted with little difference to the meaning. Consequently, the sentences in (4a) and (4b) are usually described as different realizations of the same construction rather than two different constructions.

(4) a. She thinks that he will come.
b. She thinks he will come.

On the other hand, one could argue that the two variants of the Spanish object relative are, in fact, different (though related) constructions. The two variants differ in formality/register: the *a*-variant is associated with more formal styles and also with written language, whilst the plain variant is more common in spoken language in general (Butler 1992; Reali 2014). In addition to this, while the use of *a* is motivated by a general principle of Spanish grammar, the fact that DOM is obligatory with animate and specific NPs in canonical transitive sentences, yet optional in ORs, indicates that the properties of the prepositional variant are not entirely predictable from general principles of Spanish grammar, and hence the two variants could be regarded as different constructions.

While it is not really possible to decide between the possibilities listed above on the sole basis of linguistic data (e.g., corpus studies), psycholinguistic experiments such as the one conducted here allow us to test predictions linked to each of them. In Experiment 1, we used a pre-test – training – post-test design whereby the seven- and eight-year-olds were tested on the two variants at pre-test and post-test but were only trained on the distinction between SRs and ORs with one of the two variants.

With such a design, we focused on (i) the ease of comprehension of the two OR variants at pre-test, and (ii) post-test performance with the two variants, as the two key metrics to gauge whether the two structures belong to one or two separate categories. If the plain-variant and the *a*-variant were cognitively represented as two

entirely independent constructions, one would predict that children may show differences in how accurately the two variants are comprehended and, crucially, transfer of learning from the trained variant to the untrained variant would not be expected. If, by contrast, we hypothesize that they are represented as the same construction but one of the variants has an additional optional element, we would expect either similar performance for both or better performance for the variant with the additional element (*a*-variant), as well as an equal amount of improvement for the trained and the untrained variant. Finally, if their mental representations constituted two different yet closely related constructions, the most likely scenario would be one in which performances at pre-test differ and there is improvement on both variants but more on the trained one than the untrained one. For the adults in Experiment 2, we decided against conducting a training study because we expected them to have acquired both variants and to be able to comprehend them quite well prior to any training.

2 Experiment 1

The aim of Experiment 1 is to explore the early acquisition stage of Spanish plain- and *a*-variant ORs. For this, we tested seven- to eight-year-old children's comprehension of the structures before and after receiving training on one of the variants. We do not expect children of these ages to have fully acquired these structures, and based on previous results (Llompart and Dąbrowska 2024), we expect explicit training to significantly improve performance. As discussed above, the questions that we aim to answer with this design are whether children's comprehension rates are different for the two variants, and to what extent training with one variant may benefit comprehension of the other variant. These enquiries will shed light on the questions of the relative role of higher frequency in relation to greater transparency, as well as of whether these structures appear to be acquired as one or two separate constructions.

2.1 Methods Experiment 1

2.1.1 Participants

46 children (21 females) aged from 7;1 to 8;2 (mean 7;8) took part in this study. All children were native speakers of Spanish and were recruited from a school located in the Seville area (i.e., Colegio San Antonio María Claret). Participants were randomly assigned to one of two groups so that 23 children were included in Group A and 23 in

Group B. As it will be further discussed below, the only difference between Group A and Group B is the type of ORs on which participants were trained during the training phase of the picture selection task. Informed consent was obtained from the parents and the study was conducted in accordance with the Declaration of Helsinki. Ethics approval was obtained from the Ethics Committee of the Friedrich Alexander University Erlangen-Nuremberg.

2.1.2 Materials and procedure

The children were tested individually by an experimenter who was a native speaker of Spanish in a quiet room at the school. The experiment consisted of three parts: a pre-test, a training phase and a post-test, with short breaks between the parts. The children completed all three phases in a single experimental session that lasted approximately 50 min.

The picture selection task was modeled after that used by Llompart and Dąbrowska (2024). The materials were 16 pairs of pictures (32 pictures in total) and 96 Spanish sentences. The pairs of pictures depicted transitive actions with two animate participants (e.g., a boy and a grandpa) and they differed in who carried out the action described by the verb (e.g., a boy hugging a grandpa vs. a grandpa hugging a boy). There were four different pairs of participants in the pictures: (i) a boy and a grandpa, (ii) a girl and a grandma, (iii) a teenage boy and a man and (iv) a teenage girl and a woman. Each pair was depicted performing four different actions, amounting to a total of 16 different actions.

For each of the 32 pictures, we constructed (i) an SR (*el niño que abraza al abuelo* 'the boy that is hugging the grandpa'), (ii) a plain-variant OR (*el abuelo que el niño abraza* 'the boy that the grandpa is hugging') and (iii) an *a*-variant OR (*el abuelo al que el niño abraza* 'the boy that the grandpa is hugging'). All the content words used in the sentences were high-frequency items which were expected to be easily comprehended by our participant group (e.g., *niño* 'boy', *abuela* 'grandma', *abrazar* 'to hug', *tocar* 'to touch').

Two lists of 48 sentences were created, each containing 16 SRs, 16 plain-variant ORs and 16 *a*-variant ORs. Each sentence consisted of the imperative form *Señala…* 'Point to … ' followed by a relative clause. In version 1, the three sentence types corresponding to each picture pair required pointing to the same participant (e.g., the boy) and in version 2, they required pointing to the other participant (e.g., the grandpa). Version 1 was used for the pre-test and training and version 2 was used in the post-test. This way, the children saw the same picture pairs in the post-test as in the pre-test and training, but they heard a prompt with the roles reversed. This allows us to rule out simple memorization effects from any improvements we may find after training. That is, if the children simply learned to associate particular

pictures with particular sentences during training, this would not help them in the post-test.

The pre-test and post-test consisted of 48 trials, each encompassing one of the lists of 48 sentences as described above, with 16 SRs, 16 plain-variant ORs and 16 *a*-variant ORs. The sentences were presented in a pseudorandom order with the constraints that there could be no more than two sentences of the same type or with the same pair of participants in a row and that sentences involving the same action had to be at least two trials apart. On each trial, the children were shown a pair of pictures and were orally instructed to point to one specific referent which appeared in one of the pictures. Participants could answer either by directly pointing to the pictures or by saying "1" or "2", as the pictures were labelled 1 and 2 as shown in Figure 1. Once an answer had been provided, the experimenter moved on to the next trial. Participants received no feedback on their responses. The pre-test and post-test parts of the task were the same for all participants regardless of the group to which they were assigned.

The training part of the task had 32 trials because all participants only completed training with one of the OR variants. The training trials for participants in Group A included 16 trials in which the target sentences were SRs and 16 in which they were *a*-variant ORs. For Group B, 16 SRs were presented as well as 16 plain-variant ORs. The training was divided into two blocks of 16 trials, with 8 SRs and 8 a- or plain-variant ORs in each. In the first block, the children were shown pairs of pictures and the experimenter described each picture in turn using an SR and an OR with the same head noun (*Éste es el niño que abraza al abuelo y éste es el niño (al) que el abuelo abraza* 'This is the boy that is hugging the grandpa, and this is the boy that the grandpa is hugging') while pointing to the relevant referent. Immediately

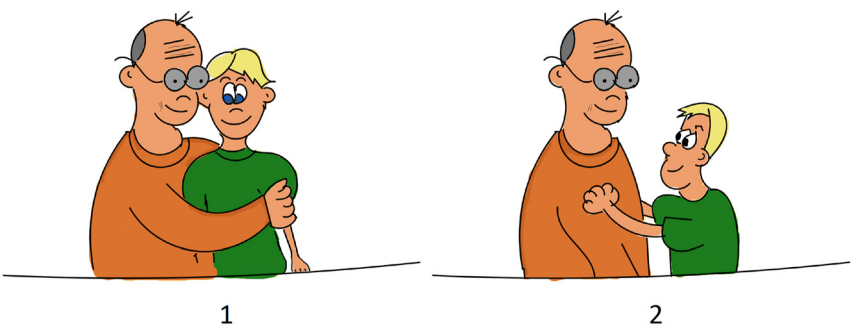

Figure 1: Example of a test item. The corresponding prompt was either '*Señala el niño que abraza al abuelo*' (point to the boy that is hugging the grandpa) or '*Señala el niño (al) que el abuelo abraza*' (point to the boy that the grandpa is hugging).

afterwards, they were asked to repeat the two sentences while pointing to the matching pictures.

In the second training block of 16 trials, the procedure was the same as in the preceding pre-test, except for the fact that children were given feedback on their responses. Thus, they were shown the pairs of pictures and asked to point to the correct referent (e.g. *Señala el niño (al) que el abuelo abraza* 'Point to the boy that the grandpa is hugging'). If they selected the matching picture, the experimenter confirmed their choice as correct (e.g., *Sí, éste es el niño (al) que el abuelo abraza* 'Yes, this is the boy that the grandpa is hugging'). If they selected the wrong picture, the experimenter provided negative feedback (e.g., *No, éste es el niño que abraza al abuelo* 'No, this is the boy that is hugging the grandpa') and then pointed to the target picture and repeated the correct description (e.g., *Éste de aquí es el niño (al) que el abuelo abraza* 'This one here is the boy that the grandpa is hugging').

2.2 Results Experiment 1

The datasets and code used in all analyses are available at https://osf.io/f7ymg/ (Open Science Framework). Figure 2 provides a visualization of response accuracy during the pre-test and post-test for the two groups (A and B) and the three sentence types (SRs, plain-variant ORs and *a*-variant ORs). An inspection of Figure 2 suggests that children were at ceiling for the SRs throughout the study and they also appear to be consistently more accurate with the plain-variant ORs than with the *a*-variant ORs.

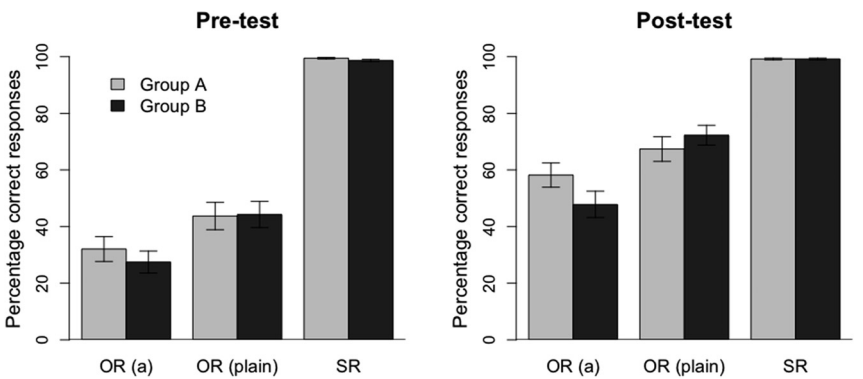

Figure 2: Percentage of correct responses by sentence type (*a*-variant OR, plain-variant OR, SR) and group (A, B) at each time of testing (pre-test, post-test) in Experiment 1.

Moreover, when pre-test and post-test scores are compared, they seem to be higher for the latter for both plain-variant ORs and *a*-variant ORs.

In order to test these impressions, we submitted the trial-by-trial data for all OR trials to a generalized linear mixed-effects model with a logit linking function (lme4 package 1.1–23, Bates et al. 2015) in R (R Core Team 2017; Version 4.2.2). Note that SRs were not included because of the clear ceiling effects observed. The dependent variable of the model was Response (coded 1 for correct and 0 for incorrect) and the predictors of interest were Time (pre-test/post-test), OR variant (a/plain) and their interaction. Both predictors were contrast coded so that pre-test and *a*-variant were coded as –0.5 and post-test and plain-variant were coded as 0.5 (see Brehm and Alday 2022, for a discussion of the importance of providing the numeric values of contrast-coding procedures in psycholinguistic research). The random-effects structure of the model included random intercepts by Participant and Item and random slopes for Time and OR variant over Participant, since these were found to improve the model's fit as assessed through a log-likelihood ratio test (time: χ^2 (3) = 61.26, $p < 0.001$; OR variant: χ^2 (3) = 9.97, $p < 0.05$). The model was run using the "bobyqa" optimizer in the glmer control options. The results are provided in Table 1.

The results of the model revealed that overall, participants were more accurate in the post-test than in the pre-test (i.e., effect of time; pre-test: mean correct responses = 5.90 out of 16 (SD = 4.90), mean % correct = 36.89 % (SD = 28.95); post-test: mean correct responses = 9.83 (SD = 4.75), mean % correct = 61.41 % (SD = 26.46)) and that they were more accurate with the plain-variant than the *a*-variant across the board (i.e., effect of OR variant; *a*-variant: mean correct responses = 6.62 out of 16 (SD = 5.01), mean % correct = 41.37 % (SD = 26.40); plain-variant: mean correct responses = 9.11 out of 16 (SD = 5.11), mean % correct = 56.93 % (SD = 26.77)). The lack of a significant interaction suggests that accuracy differences between the two OR variants did not change dramatically from pre-test to post-test.

A second critical question in Experiment 1 concerned the effects that training had on the comprehension of the two OR variants. More specifically, we were interested in whether participants exhibited higher accuracies in the post-test with the

Table 1: Results of the generalized linear mixed-effects model on the effects of time, OR variant and their interaction on accuracy in picture selection for ORs.

Predictor	*b*	Std. error	*z*	*p*
Intercept	–0.08	0.23	–0.36	0.72
Time	1.52	0.19	8.10	<0.001
OR variant	0.97	0.15	6.63	<0.001
Time × OR variant	0.06	0.20	0.32	0.75

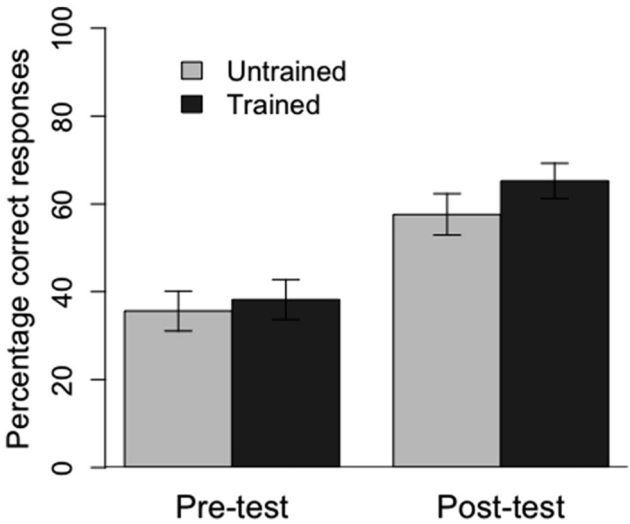

Figure 3: Percentage of correct responses by OR training status (untrained, trained) and time of testing (pre-test, post-test) in Experiment 1.

variants of ORs that were trained than with those that were not, as is suggested by Figure 3. Note again here that the trained variant differed by group, such that, for Group A, this was the *a*-variant and for Group B it was the plain-variant. In Figure 3, however, the groups are pooled together to highlight the trained versus untrained comparison.

Training effects were addressed by means of a second generalized linear mixed-effects model, which this time included post-test OR data only. Response was again the dependent variable and OR variant, Training and their interaction were the predictors of interest. In addition, in an attempt to make our analysis as conservative as possible, we added the individual pre-test scores by participant by variant as a covariate.[5] The model included random intercepts by Participant and Item. Additional random slopes did not improve the model's fit ($p > 0.2$). The model revealed significant effects of OR variant ($b = 0.53$; Std. Err = 0.19, $z = 2.79$; $p < 0.01$) and, critically, Training ($b = 0.35$; Std. Err = 0.13, $z = 2.62$; $p < 0.01$), as well as the expected sizable effect of the pre-test scores ($b = 0.21$; Std. Err = 0.03, $z = 6.60$; $p < 0.001$). The interaction between OR variant and Training was not significant ($b = -0.01$; Std. Err = 0.67, $z = 0.008$; $p < 0.99$). In line with the first analysis, these results confirm that the children were more accurate responding to the plain variant than the *a-variant*

5 An additional model run exclusively on pre-test data revealed that there was no significant difference between the trained and the untrained variants in the pre-test ($b = 0.15$; Std. Err = 0.14, $z = 1.12$; $p = 0.26$).

in the post-test (*a*-variant: mean correct responses = 8.48 out of 16 (SD = 4.86), mean % correct = 52.99 % (SD = 30.38); plain-variant: mean correct responses = 11.17 out of 16 (SD = 4.27), mean % correct = 69.84 % (SD = 26.72)). Secondly, and most importantly, participants were also significantly more accurate with the variant on which they were trained than with the other variant (untrained: mean correct responses = 9.22 out of 16 (SD = 5.08), mean % correct = 57.61 % (SD = 31.76); trained: mean correct responses = 10.43 out of 16 (SD = 4.36), mean % correct = 65.22 % (SD = 27.28)) and this effect was not found to interact with OR variant.

2.3 Discussion Experiment 1

Experiment 1 assessed Spanish 7-and-8-year-old children's comprehension of SRs and two different forms of ORs (plain-variant vs. *a*-variant). Using an intervention design, we measured accuracy in a pre-test as well as in a post-test that followed a short training procedure which, crucially, only involved one of the two OR forms. Our main aim was to shed light on (i) the potential effects of frequency and transparency on the children's comprehension and potential learning through training, and (ii) whether, based on our results, the two variants of the Spanish ORs tested here are better characterized as belonging to the same construction or as two separate constructions during the early stages of acquisition.

Our results show a consistent advantage in children's performance with the more frequent, although less transparent plain-variant, which allows for two non-exclusive explanations. Firstly, and in line with previous research (Ambridge et al. 2015; Dittmar et al. 2008; Lieven 2010; Sokolov 1988), the higher frequency of this variant could have facilitated its acquisition. Secondly, as argued in the introduction, children might have lacked sufficient experience with the *a*-variant to benefit from its higher transparency. In this sense, if the specific semantics of the additional marker *a* + article were not easily accessible, these additional elements would not facilitate and could even hinder comprehension. Additionally, we observed that our training led to an improvement in the comprehension of the two OR variants (both trained and untrained) but, crucially, the trained variants were comprehended with greater ease after training. Considered together with the better overall performance with the plain-variant and the clear-cut predictions outlined in Section 1.3, this suggests that the two variants may be learned and stored as two different, although related, constructions during their early stages of acquisition. Motivated by these results, we conducted a second experiment with adult participants to assess whether the advantage for the more frequent variant would persist in Spanish speakers' ultimate attainment.

3 Experiment 2

Experiment 2 tested adult comprehension of plain- and *a*-variant ORs to compare it with children's comprehension in the first experiment. In order to do so, we replicated the pre-test phase of Experiment 1 in a population of adult native Spanish speakers. Given that, in contrast to the children in the previous experiment, we expected adults to have fully acquired the Spanish relatives and show high accuracies in comprehension, we examined both accuracy scores and reaction time data for this population.

Experiment 1 showed that children's comprehension of ORs was asymmetric in that they were more accurate with the plain-variant than the *a*-variant. However, there are two non-exclusive reasons to expect that adults' comprehension of the two variants may be more balanced. Firstly, frequency effects follow the power law of practice, whereby they stabilize and plateau over time, hence becoming less relevant with development (Ellis 2002). Secondly, given that adults are likely to have had more experience with *a* + article in the context of ORs, they might show greater sensitivity to the transparency of the *a*-variant and its associated reduction in predictive processing load.

3.1 Methods Experiment 2

3.1.1 Participants

A total of twenty adults took part in Experiment 2 (9 females), with a mean age of 36.4 (SD = 10.2). Participants spent a mean of 19 years in formal education (SD = 4.78), with master's degree being the highest educational achievement (*N* = 8), followed by university graduation (*N* = 6), vocational training (*N* = 5) and high school (*N* = 1). Our sample was recruited using an online recruitment platform, i.e., Prolific (www.prolific.co), where access to the experiment was limited to adult native speakers of Spanish born in Spain. All participants received financial compensation for their time and provided informed consent before completing the study.

3.1.2 Materials and procedure

Participants completed a picture selection task that was almost identical to the pretest in Experiment 1 but was in this case completed online through Gorilla Experiment Builder (www.gorilla.sc), an online experimental platform. The 32 pictures used in this task were the same as those used in Experiment 1 (see Figure 1). Audio

recordings by a female native speaker of Spanish were produced of the 48 relative clauses used in the pre-test of Experiment 1: 16 SRs, 16 plain-variant ORs and 16 *a*-variant ORs, but in this case without the imperative form *Señala*… 'Point to … '. Participants were given instructions before the task and were also asked to complete two practice trials, in which they heard simple transitive sentences, before they were presented with the test items.

Each trial consisted of a 500 ms fixation screen followed by a 1 s picture preview aimed at eliminating any visual processing delay in reaction time measures. After this, participants automatically heard a sentence recording and were asked to select the picture that matched the spoken sentence. The pictures remained on the screen from preview until a response was recorded via a click on either of the pictures. The order of trials and the position of the correct picture also followed those of the pre-test of Experiment 1 (see Section 2.1.2). The stimuli and task used in Experiment 2, including the practice trials, can be found at https://app.gorilla.sc/openmaterials/630345. The total duration of the task was approximately 5 min. Participants also completed two unrelated tasks for a different study in the same session.

3.2 Results Experiment 2

The number of correct responses to *a*-variant ORs (mean correct responses = 13.95 out of 16 (SD = 2.89); mean % correct = 87.19 (SD = 22.07)) was very close to the number of correct responses to plain-variant ORs (mean correct responses = 14.30 out of 16 (SD = 1.95); mean % correct = 89.37 (SD = 22.03)), as illustrated in Figure 4. Moreover, as shown in Figure 5, response times for correct responses (measured from audio onset) were also remarkably close for *a*-variant (M = 2,872.64, SD = 819.15) and plain-variant ORs (M = 2,896.34, SD = 829.46). In contrast, subject relative sentences show clear ceiling effects in Figure 4 (mean correct responses = 15.60 out of 16 (SD = 0.88); mean % correct = 97.5 (SD = 6.68)) and substantially shorter reaction times in Figure 5 (M = 2,472.75, SD = 730.93).

We performed mixed-effects modeling on trial-by-trial data for both outcome variables. As in Experiment 1, all analyses were conducted on OR data only, since participants were at ceiling with subject relatives. In the first place, a generalized linear mixed-effects model with a logit linking function was run with Response as binary dependent variable (1 = correct, 0 = incorrect) and OR variant as the predictor. OR variant was contrast-coded with the *a*-variant as –0.5 and the plain-variant as 0.5. The random-effects structure of the model included random intercepts by Participant and by Item. Random slopes for OR variant by Participant were left out because they did not improve the fit of the model (χ^2 (2) = 2.66, p = 0.26). The effect of OR-variant was not significant (b = 0.25, Std. Err = 0.26, z = 0.95, p = 0.34).

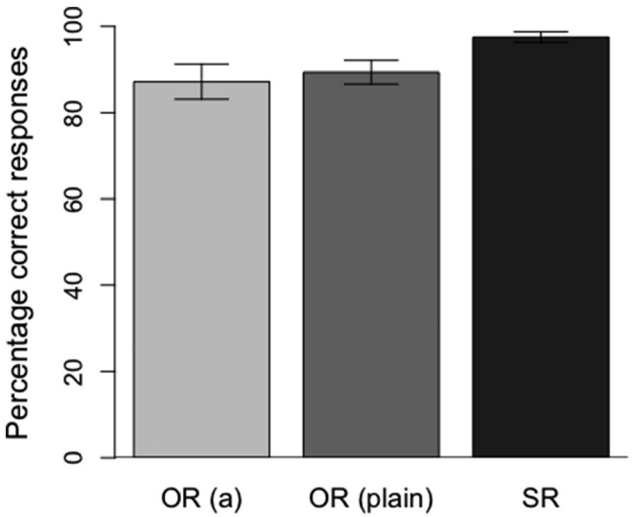

Figure 4: Percentage of correct responses by sentence type (*a*-variant OR, plain-variant OR, SR) in Experiment 2.

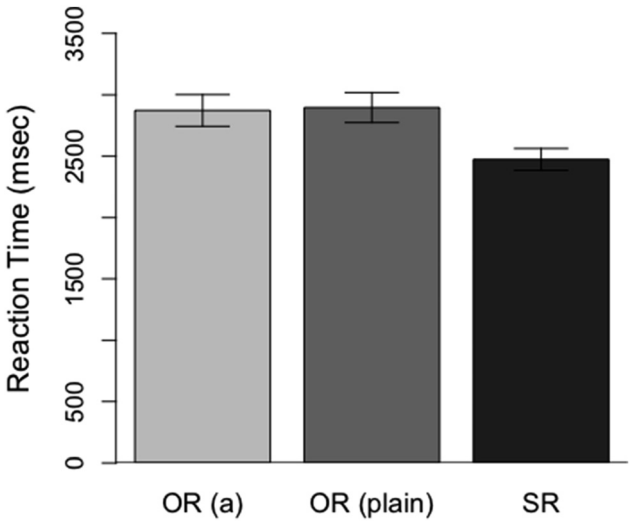

Figure 5: Mean reaction time in milliseconds by sentence type (*a*-variant OR, plain-variant OR, SR) in Experiment 2.

Secondly, a linear mixed-effects regression model was run using Reaction Time (RT) as numeric dependent variable and OR-variant as predictor. Before running any model, for each participant, RTs that were above or below 3 absolute deviations from their individual median were eliminated as outliers (Leys et al. 2013), which removed a total of 46 trials (4.79 %). For this analysis, only trials in which participants provided the correct response (92 % of OR remaining trials) were included. OR-variant was contrast-coded in the same way as in the previous model and subject relatives were again excluded from the analysis. The random-effects structure of this model included random intercepts by Item and by Participant. Random slopes for OR variant by Participant were not included because they did not improve the fit of the model (χ^2 (3) = 0.82, p = 0.84). The model was run using the "bobyqa" optimizer in the lmer control options. Significance was tested using Satterthwaite approximated p-values obtained through the 'lmerTest' package (Kuznetsova et al. 2015). This first model was run on raw RTs, however, after visual inspection of residual distribution plots showing a possible violation of homoscedasticity, the data was transformed with a logarithm function and 4 datapoints with RTs over 6,000 ms were deleted after being identified as outliers. The model was run again with the same fixed effects and random effects structure but using the log-transformed RT as dependent variable. The model rendered a non-significant effect of OR-variant in reaction time (b = 0.02, Std. Err = 0.03, t = 0.51, p = 0.61).

3.3 Discussion Experiment 2

Experiment 2 assessed the comprehension of the same structures in Experiment 1 by adult Spanish speakers. The main aim of this second experiment was to inform the question of whether frequency and transparency may affect comprehension differently in adults and children, particularly in relation to the different stages of acquisition represented by these populations.

Our findings show that adult accuracy for the ORs used in this study was not at ceiling, in line with previous studies (Dąbrowska et al. 2022), and interestingly, that adults showed almost identical accuracies and reaction times for the two OR variants. We argue that this may be explained by a balancing out of frequency and transparency effects. According to the power law of practice, frequency facilitation is likely to decrease in strength over the lifespan. As Ellis (2002: 152) puts it: "the effects of practice are greatest at early stages of learning, but they eventually reach asymptote". This could be taken to suggest that the differences between constructions decrease as the less frequent variant becomes more entrenched. In other words, as speakers accumulate experience with ORs, the frequency-based advantage for the plain variant might decrease. Additionally, the fact that adults perform

equally well with the two variants may indicate that adults are more likely than children to benefit from the higher transparency of the *a*-variant, despite its lower frequency. That is, it is possible that, as the role of *a* + article in these structures is clarified with increased exposure, and thus, presumably, with increased age, the transparency provided by these additional elements might become more beneficial.

4 General discussion

In the following sub-sections we discuss (i) the effects of our training procedure in Experiment 1, (ii) the constructional status of the two variants of OR during acquisition, and (iii) the possible 'balancing out' of frequency and transparency effects in L1 acquisition.

4.1 Training effects

The first relevant finding of Experiment 1 was that accuracy with the two types of ORs was significantly higher in the post-test (61 % correct) than in the pre-test (37 % correct). This indicates that the comprehension of ORs by our participants improved once they had completed the training phase. These results replicate the findings of Llompart and Dąbrowska (2024), who report an improvement in accuracy from 27 % to 60 % using a very similar training procedure but with children who were about one year younger and targeting only the *a*-variant.

These improvements are noteworthy considering that the number of exemplars of the target structure to which the children were exposed during training is very small (16) in comparison to the number of ORs they were expected to have heard before testing. In a corpus of adult spoken Spanish, Butler (1992) reports that the two variants of ORs combined appear with a frequency of about 6,000 instances per million words. Using a much smaller corpus of child speech, Llompart and Dąbrowska (2024) estimate that the frequency of ORs in child-directed speech in Spanish is of about 4 per hour, which means that, by age 7, children will have heard more than 80,000 ORs. Note, however, that ORs which occur in spontaneous conversation are often quite stereotypical and few of them contain two full NPs (see Reali 2014; Llompart and Dąbrowska 2024).

Following Llompart and Dąbrowska (2024), we argue that the improvement we observe is so dramatic because, during training, children were exposed to the target structure in ideal conditions: the relevant exemplars occurred in the presence of a picture that made it clear what the referent was and ORs were explicitly contrasted

with SRs. Hence, frequency of exposure might be most facilitative when linked to high-quality exemplars coupled with explicit attention.

4.2 The constructional status of the two variants of OR during acquisition

To address the issue of whether the two OR variants belong to the same construction or are separate categories, two accuracy metrics in Experiment 1 are of particular interest. The first is the ease of comprehension of the two variants at pre-test (and potentially at post-test). The second is post-test performance with the trained variant versus the untrained variant (remember that the training only included 1 OR variant for each group). Regarding the former, results revealed that children were more accurate with the plain-variant than the *a*-variant in the pre-test, and this difference also held in the subsequent post-test (see Figure 2). Concerning the second metric, post-test data showed an improvement in performance compared to the pre-test for both variants even though participants where only exposed to one variant during training. This was a clear indication that there was transfer of learning from the trained to the untrained variant regardless of which variant was trained. However, performance with the trained variant was better than performance with the untrained variant in the post-test (see Figure 3). Crucially, this was the case even when the pre-test scores were accounted for by including them as a covariate in the model in order to account for participants' prior knowledge.

Taken together, these findings suggest that, in early stages of acquisition, the plain-variant and the *a*-variant of Spanish OR clauses seem to be cognitively represented as two different but related constructions, rather than as the same construction or as two fully independent constructions. If the two variants were the same construction, we would not expect to find a consistent advantage for the plain variant. Additionally, this scenario implies that improvement from pre- to post-test should be the same with both variants regardless of which of the two was used in the training, yet we observed that the untrained variant did not improve to the same extent as the trained variant. Conversely, an account of the variants as two independent constructions would not predict any transfer of learning across variants. This second interpretation would thus not be able to explain why accuracy with the untrained structure also improved from pre-test to post-test. A characterization of the variants as two different yet related constructions, by contrast, can account for the advantage of the plain variant over the *a*-variant as well as for the existence of a limited transfer of learning between variants.

In contrast, the fact that adults showed comparable performance on the two variants is consistent with the idea of a gradual entrenchment of a single, more

abstract OR construction with an optional element. Of course, such an interpretation is speculative in nature, as accuracy data alone do not allow us to make strong claims about the adults' exact mental representations for ORs because similar accuracies in comprehension could in principle be observed even for unrelated constructions. Still, considering our results, it is conceivable that adults, having had more experience with the *a*-variant, have developed a more fully-fledged understanding of the contribution of *a* + article in ORs in relation to other uses of this marker, thus increasing the compositionality of its representation, i.e., *a*-variant = plain-variant + *a* + article. This would in turn gradually increase the entrenchment, and hence accessibility of a more abstract higher-level schema encompassing both variants (Langacker 2010).

4.3 The possible 'balancing out' of frequency and transparency effects in L1 acquisition

The present results allowed us to gain insights on whether the comprehension of ORs in Spanish, both at the initial stages of their acquisition and in what can be considered ultimate attainment, is more strongly facilitated by frequency of occurrence, on the one hand, or transparency on the other hand. Results from the first experiment showed that Spanish seven- and eight-year-olds were more likely to correctly comprehend ORs when they heard the plain-variant than the *a*-variant across the board. In short, children performed better with the variant they had presumably heard more prior to the study, which fits well with the assumption of usage-based models of language acquisition that more frequent forms are likely to be acquired earlier (Abbot-Smith and Tomasello 2006; Bybee 2010; Dąbrowska and Szczerbiński 2006; Rubino and Pine 1998).

Nonetheless, it is worth noting that the difference is fairly small if one considers the extent to which the plain-variant is estimated to be more frequent than the *a*-variant in spoken Spanish. As discussed in the introduction, the corpus data in Butler (1992) show that the plain variant is about 16 times more frequent than the *a*-variant in the speech of adult Spanish speakers. Therefore, based on sheer frequency of occurrence, one would expect a larger difference between the two variants at least in the pre-test (i.e., prior to any training). This suggests that the higher transparency (Slobin 1973) of the *a*-variant could actually have facilitated the acquisition of this infrequent variant to some extent. Accordingly, this could be taken to suggest that frequency does trump transparency in absolute terms when the difference in frequency is very large, but it is unknown whether this is still the case with differences that are less pronounced.

Considering the consistently higher comprehension accuracy in children for the more frequent OR variant in Experiment 1, the absence of a difference in accuracy and processing speed between the two variants in the adult population is in line with the power law of practice: the processing advantage found for more frequent elements is stronger during the early stages of acquisition (Ellis 2002). Moreover, our findings might be explained by a combination of such decrease in the facilitative strength of frequency over time (Ellis 2002), and the emergence of other facilitative factors (see Dittmar et al. 2008 for similar results). In this case, adults could be better able to use the information encoded in *a* + article in the *a*-variant, which could thus facilitate its comprehension by increasing transparency and guiding predictive processing. Children master the common uses of direct object marking in Spanish, where *a* + article designates the following NP as an object, before age 3 (Rodríguez-Mondoñedo 2008). However, in the case of *a*-variant ORs, this marker designates the preceding NP as an object and is overall more often absent than present (Butler 1992), limiting thus the learner's exposure to the specific uses of this marker within ORs. As explained in Section 1.2, once acquired, the information carried by *a* + article in ORs could override the basic first NP = agent heuristic that works against the comprehension of ORs, thus reducing the likelihood of listeners going down the garden-path. Therefore, an experience-dependent emergence of a transparency-based facilitation of the *a*-variant could explain how the lower comprehension rates for the *a*-variant in children eventually level out in adulthood, although this remains speculative, since our data do not allow us to tease the two aforementioned possibilities apart.

5 Conclusion and future directions

The present study assessed the comprehension of two very similar structures that are known to be challenging in L1 acquisition and adult processing; that is, two different forms or variants of Spanish ORs. In Experiment 1, the effects of a short training session on children's comprehension were used as a probe into (i) the facilitating factors for the acquisition of these structures and (ii) their constructional status, while Experiment 2 focused on whether facilitating factors are weighted differently in comprehension by adult native speakers. The main findings of this study point towards a stronger facilitative effect of frequency in children compared to adults, in line with the power law of practice (Ellis 2002). It is also possible, however, that adults become more sensitive to transparency.

Crucially, our first experiment presents a novel approach to delineating constructions in CxG using psycholinguistic data and training paradigms. With this we aim to bridge the gap between CxG theory and language processing by providing linguistic insights rooted in the examination of language use as an online process, a

route that has not been extensively explored within cognitive linguistics. While further experimentation will be needed to assess the promise and effectiveness of our approach, we believe that it can be particularly suitable for cases in which constructional status cannot simply be derived from linguistic usage data. In addition, the results presented here contribute to our understanding of L1 acquisition by providing further supporting evidence for the proposed differential role of frequency at different stages of acquisition (Ellis 2002) in non-canonical structures, and prompt a series of interesting questions to be investigated in future research, especially as far as the balance between frequency and transparency in OR comprehension is concerned. In the first place, an assessment of how children's data compare to those of illiterate or semi-literate adult speakers could be crucial to tease apart the influences of age and literacy on the acquisition of ORs (see Dąbrowska et al. 2022). Secondly, our data call for further studies that directly assess the constructional status of plain- and *a*-variant Spanish ORs in adults, possibly using priming paradigms. Lastly, our findings are indeed suggestive of a differential role of frequency and transparency at different stages of constructional acquisition. However, in order to be able to investigate this matter systematically, it is necessary that the input provided is carefully controlled, so that the magnitude of the frequency differences can be precisely quantified. A suitable as well as timely way to exert such control would be to resort to artificial language learning paradigms with precise input manipulations (e.g., Kenanidis et al. 2023, 2024).

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Data availability: The datasets and code used in all analyses are available at https://osf.io/f7ymg/ (Open Science Framework).
Declarations of interest: The authors declare none.

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