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Full Length Article

Universal patterns in the acquisition of negation and disjunction: Parallels between L1 and L2

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ABSTRACT

A fundamental question in language acquisition is how learners balance input and prior knowledge to infer meaning. Here, we present novel evidence about the mechanisms guiding adults' second language learning. We examined their interpretation of disjunction ("or") in negative sentences (e.g., "John didn't eat the cucumber or the pepper") as a test case. Languages vary in the assignment of scope to logical operators such as negation and disjunction, depending on their syntactic relationship. When multiple interpretations are possible, how do learners assign meaning? Does the native language of L2 learners influence this process? We report three key findings. First, native speakers of Mandarin and Spanish prefer an interpretation where "or" scopes over negation, meaning "John ate either the cucumber or the pepper, but *not both*" (the "not both" superset interpretation), whereas L2 learners from both backgrounds favor the opposite, subset (stronger) interpretation, where "John ate *neither* vegetable" (the "neither" subset interpretation). This pattern resembles child first language acquisition. Second, this preference persists even when the surface order of negation and disjunction does not match the native speaker's preferred interpretation, indicating that learners reconstruct underlying structure during interpretation, rather than rely on surface cues. Third, this tendency is stronger in less proficient learners and shifts with increasing proficiency. These findings suggest that L2 learners employ strategies similar to those of children acquiring their first language, initially favoring the stronger possible interpretation. These results shed new light on universal mechanisms guiding both first and second language acquisition.

1. Introduction

The influence of first language (L1) on second language (L2) acquisition and the potential shared mechanisms between L1 and L2 learning are central questions in language studies (Bley-Vroman, 2009; Epstein et al., 1996; Schwartz & Sprouse, 1996; White, 2003). Acquiring a second language poses distinct challenges as compared to the acquisition of the first language, often stemming from biological factors and influence from the learner's native language (Johnson & Newport, 1989; Lenneberg, 1967; Schwartz & Sprouse, 1996). Unlike children, adult L2 learners approach language acquisition with cognitive resources and strategies that both overlap with and diverge from those used in first language acquisition. This debate could be framed in terms of whether L1 experience constrains L2 acquisition uniformly across linguistic domains, or whether its influence is more pronounced in some areas, such as phonology, but comparatively weaker in syntactic and interpretative processing, where adult learners may instead draw on mechanisms similar to those operative in L1 acquisition. Evidence from phonological development suggests that the L1 exerts a particularly strong and lasting constraint on perception. During the first year of life, infants undergo a process of perceptual narrowing, which significantly alters the representational systems available for language acquisition (Werker & Lalonde, 1988; Werker & Tees, 1984). By 10–12 months of age, infants' perceptual abilities have become specialized to the phonetic features of their mother tongue. This perceptual reorganization leads to a decline in sensitivity to non-native contrasts, while enhancing the ability

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to discriminate native language sounds. Because this early tuning fixes the phonetic categories through which later input is processed, it continues to influence how adult L2 learners perceive and categorize L2 sounds, with this perceptual bias persisting even among advanced learners (Brown, 2000; Dupoux et al., 2008; Pallier et al., 2001). When it comes to higher-level linguistic processes such as syntactic parsing, the picture looks different. Psycholinguistic research has provided evidence that adult L2 learners tend to process linguistic input using strategies that closely resemble those of native speakers, rather than strategies carried over from the L1 (Cheng et al., 2021; Frenck-Mestre & Pynte, 1997; Kilborn & Ito, 1989; Papadopoulou & Clahsen, 2003). The asymmetry between strong L1 constraints in phonology and the at least partial availability of native-like strategies in syntax raises the question of whether comparable shared mechanisms might also operate at the level of semantic and pragmatic interpretation.

Here, we investigate L2 learner's process of form-meaning mapping, by looking at the interpretation of sentences containing two logical operators, that is, cases in which sentence meaning hinges on the structural hierarchy between disjunction ("or") and negation. We tested the interpretation of disjunction words (*o* for Spanish; *huòzhě* for Mandarin) in negative sentences with disjunction across four language groups: L1 Mandarin speakers, L1 Spanish speakers, L1 Spanish speakers learning Mandarin as L2, and L1 Mandarin speakers learning Spanish as L2. Previous work on the interpretation of scope ambiguities in L2 learners generally showed L1 transfer of interpretative preferences, especially at low and intermediate proficiency levels (Chung, 2013; Marsden, 2009; Miyamoto & Yamane, 1996). To preview, we report three key findings: *(a)* while both L1 Mandarin and L1 Spanish speakers preferentially interpret sentences such as (1) as *not both* (superset interpretation; OR > NEG), L2 learners in both groups favor the *neither* (subset) interpretation (NEG > OR), an early-stage pattern also seen in child language acquisition (Crain & Khlentzos, 2008; Geçkin et al., 2017; Pagliarini et al., 2022); *(b)* this L2 preference persists even when the linear order of negation and disjunction aligns with the scope configuration preferred by adult L1 speakers (Gao et al., 2018); *(c)* the strength of scope assignment preferences correlates with proficiency. Less proficient L2 learners exhibit scope preferences that diverge from those of L1 speakers, while advanced learners show preferences more aligned with L1 and the target language. Points *(a)* and *(b)* indicate that L2 meaning assignment is shaped by learning mechanisms parallel to those observed in child L1 acquisition and that they cannot be accounted for in terms of L1 transfer. Point *(b)* also demonstrates that L2 preferences are so robust that learners apply them to generate their preferred scope assignment, where negation c-commands disjunction, regardless of the linear order of these elements in the sentence. Point *(c)* highlights that proficiency modulates this relationship. Therefore, we provide evidence that L2 interpretations are not influenced by preferred interpretations in the native language. Instead, as we argue, they may be guided by general biases toward the subset interpretation that are applied to language-specific phenomena.

1.1. Scope relation between disjunction and negation

Cross-linguistic differences have been attested in the interpretation of negated sentences containing disjunction in the verb phrase such as (1a) (Crain, 2012; Goro, 2004; Lungu et al., 2021; Pagliarini et al., 2022; Szabolcsi, 2002, 2004).

(1) a. Mary didn't order tea or coffee.

b. Mary didn't order tea and Mary didn't order coffee. (*neither* interpretation)

c. Mary didn't order tea or Mary didn't order coffee. (*not both* interpretation)

In some languages, English for example, (1a) can be ambiguous, potentially meaning either *neither* or *not both* (Szabolcsi, 2002); yet a sentence such as (1a) is typically interpreted with the *neither* reading, that is $\neg A \wedge \neg B$, as in (1b), where the negation scopes over the disjunction (NEG > OR) (Crain et al., 2002; Geçkin et al., 2017; Gualmini & Crain, 2002, 2005; Lee, 2010; Lee & Schwartz, 2024; Pagliarini et al., 2022; van Hout et al., 2024). In other languages, Mandarin for example, equivalents to the English sentence (1a) are interpreted as *not both* as in (1c), that is $\neg A \vee \neg B$, wherein the disjunction scopes over negation (OR > NEG) (Cochard et al., 2023; Crain et al., 2013; Gao et al., 2018, 2021; Geçkin et al., 2015, 2017; Goro & Akiba, 2004a; Goro & Akiba, 2004b; Guasti et al., 2021; Jing, 2008; Jing et al., 2005; Pagliarini et al., 2021, 2022; Verbuk, 2006). Recently, it has been shown that the non-preferred scope interpretation is accessible to some extent given an appropriate context (Cochard et al., 2023; Jing, 2008; Larralde et al., 2021; Lungu et al., 2021) or a specific prosodic contour (van Hout et al., 2024). However, most of the studies confirmed that, when a neutral intonation is adopted, adults' interpretation falls in line with the preferred reading in the language.

This cross-linguistic variation has also been explained in terms of the Disjunction Parameter (Crain, 2012; Goro, 2004), a lexical parameter governing the polarity status of disjunction cross-linguistically. On the positive value of the parameter (+PPI), the disjunction element must be interpreted outside the scope of negation regardless of its surface position. As a result, when a +PPI disjunction element appears in object position, as in (1), the parameter triggers a scope assignment in which disjunction takes scope over negation (OR > NEG). In contrast, when a disjunction element is −PPI, it can be interpreted locally within the scope of negation (NEG > OR). These two values stand in a subset/superset relation, with the −PPI value generating the smaller, more restricted language. Importantly, the two possible interpretations themselves stand in a subset-superset relationship: the *neither* interpretation asymmetrically entails the *not both* (superset) interpretation (if it is true that "neither A nor B," it must also be true that "not A or not B"); thus, the *neither* interpretation defines a subset of the possible meanings because it asserts that both disjuncts are false, whereas the *not both* interpretation defines a superset because it encompasses a broader range of possibilities, allowing for the possibility that one (or both) disjunct is false.

1.2. Acquiring disjunction in negative contexts: evidence from L1 and L2

Research on the acquisition of sentences containing both negation and disjunction has revealed a consistent pattern across languages, whereby children initially assign the *neither* interpretation, regardless of the preferred interpretation in the adult language of their community (Cochard et al., 2023; Crain, 2012; Gao et al., 2018, 2021; Geçkin et al., 2015, 2017; Goro & Akiba, 2004a; Goro & Akiba, 2004b; Guasti et al., 2021; Jing et al., 2005; Pagliarini et al., 2018; Pagliarini et al., 2021; Pagliarini et al., 2022). These results have been accounted for in terms of a built-in constraint called the Semantic Subset Principle (SSP) (Berwick, 1985; Crain et al., 1994), according to which all learners initially assign negation wide scope over disjunction (NEG > OR), leading to the *neither* (subset) interpretation, regardless of the scope preference adopted by

adult speakers of their language.[1] As learners encounter evidence supporting the *not both* interpretation of negative sentences with disjunction (superset interpretation), specifically instances where only one disjunct is false, they will be driven to shift their preference according to the adult language use. In other words, the SSP posits that child learners initially adopt the subset interpretation and, as they accumulate more linguistic input, begin to recognize contexts where the broader, superset interpretations are appropriate, eventually aligning their interpretations with those of adult speakers. In this way, children do not face a serious learnability problem. When an expression has two possible values, one yielding a superset interpretation that entails the subset interpretation, a learner who initially guessed the superset language would face a problem: in the absence of negative evidence, any input from a subset target language would remain consistent with the (wrong) superset initial hypothesis, giving the learner has no way to retreat to the correct, more restrictive grammar. Because children instead begin with the subset compatible value, they avoid this Subset Problem.[2] The predictions made by the SSP are consistent with those derived from the Strongest Meaning Hypothesis (SMH) (Dalrymple et al., 1994; Dalrymple et al., 1998; Winter, 1996, 2001), which posits that speakers favor interpretations yielding the strongest truth-conditional meaning compatible with contextual constraints. Both the SSP and SMH reflect a preference for grammars or interpretations with narrower coverage, favoring more restrictive hypotheses when multiple options are possible. Alternatively, this preference could be understood in a Bayesian framework, providing a complementary perspective on learning strategies. Within this framework, learners update their beliefs about possible interpretations following Bayes' rule, adjusting posterior probabilities based on prior expectations and the evidence available in the input. Subset preferences could then arise in (at least) two ways: either through posterior inference over the input, that is when the prior is uniform and the higher likelihood of the subset interpretation alone drives the posterior, or through a non-uniform prior that itself encodes an innate bias favoring the stronger, subset interpretation (Lasnik & Lidz, 2016; Pagliarini et al., 2022; Pearl, 2017, 2022).[3]

Prior L2 studies on the acquisition of negative disjunctive sentences yield mixed results. Grüter and colleagues (Grüter et al., 2010) show that English-speaking L2 learners of Japanese successfully acquire the scopal properties of disjunction and negation in Japanese, preferring the *not both* interpretation. Conversely, Japanese-speaking L2 learners of English also prefer the *not both* interpretation, reflecting the interpretive properties of their L1. Chen et al. (2023) report that English-speaking L2 learners of Mandarin prefer the *neither* interpretation in Mandarin, which may also be explained by L1 transfer. Similarly, Lee and Schwarz (Lee & Schwartz, 2024) identify comparable transfer patterns between Korean and English. However, interpreting the findings by Lee and Schwarz is complex, because both Korean and English L1 speakers prefer the *neither* interpretation (NEG > OR). This shared preference makes it difficult to determine whether the observed effects reflect genuine L1 transfer or a broader, universal bias favoring narrower subset interpretations. Finally, Silleresi et al. (2025) provide evidence for backward transfer effects in bilingual children. Testing bilingual children (L1 Italian, L2 English) against monolingual Italian peers, they found that the bilinguals showed a strong preference for the *neither* interpretation in their L1 Italian, whereas monolingual Italian children accepted it only about half of the time. This pattern points to a super-additive effect of bilingualism on the SSP: rather than merely acquiring the subset interpretation in their L2 English (where it is the default), the bilingual children appear to have had that interpretive preference reinforced and transferred back into their L1, yielding a stronger, more consistent application of the SSP than would be expected from L1 exposure alone.

2. Experiment

The present research introduces a test that probes whether previously observed effects reflect genuine L1 transfer or a broader, universal bias favoring narrower subset interpretations not tied to L1 experience. To address this question, we tested the interpretation of disjunction words (*o* for Spanish; *huòzhě* for Mandarin) in negative sentences with disjunction (see Section 2.1.3 for details) across four language groups: L1 Mandarin speakers, L1 Spanish speakers, L1 Spanish speakers learning Mandarin as L2, and L1 Mandarin speakers learning Spanish as L2.

After establishing that both Spanish and Mandarin qualify as superset languages, that is, languages in which the native speakers prefer the *not both* interpretation (OR > NEG), we examine preferences in L2 learners of Spanish and L2 learners of Mandarin. This design allows us to determine whether a preference for the *neither* interpretation in the L2 population is truly driven by L1 transfer or reflects a more universal bias for the subset interpretation in second language acquisition.

2.1. Method

2.1.1. Participants

2.1.1.1. Mandarin. 30 adult native speakers of Mandarin (mean age 24;77 years; SD: 6;6; 14 females) and 30 L2 learners of Mandarin (mean age 27;13 years; SD: 5;6; 18 females; proficiency level: 10 beginner; 15 intermediate; 5 advanced) were tested. Seven additional L2 learners of Mandarin were tested but not included in the sample due to failing in successfully completing the testing session. The native speakers were recruited through the researchers' personal network in Zhenjiang (China). They were tested individually in a quiet place. The L2 learners of Mandarin were recruited from several Chinese language teaching institutions in Spain, including ClicAsia in Barcelona ($n = 8$), Confucius Institute in Madrid ($n = 12$) and in Barcelona ($n = 10$). They were tested individually in a quiet place.

2.1.1.2. Spanish. 30 adult L1 speakers of Spanish (mean age 24;60 years, SD: 4;65; 17 females) and 30 L2 learners of Spanish (mean age 22;5; SD: 2;35; 23 females; proficiency level: 6 beginner; 15 intermediate; 9 advanced) were tested. The L1 speakers were recruited through the researchers' personal network from Fraga, Spain. They were tested individually in a quiet place. 20 Mandarin L2 learners of Spanish were

[1] Under a *Parametric Scope Account* à la Goro (Goro, 2004, 2007; Shimada & Goro, 2021), the SSP is a specific learning algorithm restricted to determining the default value of the PPI parameter, distinct from more global versions that constrain children's initial interpretive preferences broadly (Crain et al., 1994; Moscati & Crain, 2014; Notley et al., 2012).

[2] A further learnability issue concerns the scarcity of relevant input: as discussed in Section 3.1, positive evidence for the wide-scope interpretation of negated disjunction appears to be almost entirely absent in child-directed speech (Sano et al., 2024), raising a poverty-of-the-stimulus problem distinct from the negative evidence issue discussed here. See Section 3.1 for further discussion.

[3] An alternative account attributes the *neither* interpretation to strengthening rather than scope (Bleotu et al., 2026; Cochard et al., 2023; Otani et al., 2020; Shimada & Goro, 2021). On this view, children access a restricted set of alternatives to negative disjunction (only ¬A, only ¬B), and recursive exhaustification of these alternatives yields the *neither* reading ¬A ∧ ¬B via the same mechanism proposed for children's conjunctive readings of positive disjunction (Singh et al., 2016). This predicts a correlation between conjunctive readings in positive contexts and *neither* readings in negative contexts. This correlation was found by Cochard et al. (2023), but Otani et al. (2020), Shimada and Goro (2021), and Bleotu et al. (2026) did not find it, and favor a scope-based account instead. For L2 learners, the same logic would predict that those who derive *neither* readings under negation should also give conjunctive interpretations of positive disjunction, though this remains to be tested. We acknowledge strengthening as theoretically viable but find the available evidence, including our own, more consistent with a scope account; we do not pursue the issue further here.

recruited online from Shanghai and Nanjing and were tested in person individually in a quiet place. They were all students with an undergraduate major in Spanish Philology; the other 10 L2 learners were recruited through the researchers' personal networks and were tested on the campuses of the Universitat Pompeu Fabra and and the Universitat de Barcelona. They were all master's or doctoral students studying in Barcelona.

During recruitment, participants were asked whether they knew English or any other foreign language. Only those with low proficiency in other languages were included in order to minimize the influence of other languages on task performance.

2.1.2. Procedure

The Research Ethics Committee (CERec) of the Universitat Autònoma de Barcelona granted ethical approval for this study (reference number CEEAH 6550). All participants provided written informed consent prior to their participation in the study.

First, participants completed a questionnaire gathering demographic and linguistic information, including their age, gender, native language (L1), proficiency in the target second language (L2), and other foreign languages they had learned. For L2 proficiency, participants selected one of three levels based on the Common European Framework of Reference for Languages (CEFR): beginner (A1–A2), intermediate (B1–B2), or advanced (C1–C2). After completing the questionnaire, participants moved on to the experimental phase of the study, which was a truth-value judgment task (TVJT; Crain & Thornton, 1998), i.e. participants had to judge whether a given sentence was true or false under the conditions offered. The experiment was programmed and carried out with LabVanced. The L1 groups were tested in their native language. For the L2 groups, the stories and instructions were presented in both Mandarin and Spanish to facilitate task comprehension. However, the experimental session itself was conducted solely in their L2. The Mandarin version provided both the Chinese characters and the corresponding pinyin (or phonetic transcription). All experimental items were presented to the participants in written form as in previous work (Grüter et al., 2010).

2.1.3. Materials

The truth value judgment task was adapted from previous work (Goro, 2007) (Fig. 1). Participants first read an introductory story (details in the *Appendix*, Table A1), followed by a training phase (details in the *Appendix*, Table A2). In the training phase, participants were familiarized with the experiment and instructed about the system of awards. They watched an animated presentation in which each animal ate either two, one, or no vegetables. When an animal ate only one vegetable, the remaining vegetable was placed in the fridge; when an animal ate neither vegetable, both vegetables were placed in the fridge (see Fig. 1, Panel A). Participants were then asked to choose a reward based on how many vegetables the animal had eaten: a gold medal for two vegetables eaten, a silver medal for one vegetable eaten, and a sad face for no vegetables eaten. After each choice, participants were given feedback on whether they had awarded the correct prize. Each animal appeared only once, and the order of presentation of conditions was pseudorandomized. Participants were allowed to complete the experiment even if they produced incorrect answers. After completing the training phase, participants moved on to the experimental task. Again, participants watched an animated presentation in which each animal was assigned a reward, but this time an animal friend wanted to know what each animal had eaten and could only infer this from the prize it had won. The prize therefore served as the sole cue to the truth-conditions of the sentence: a gold medal indicated that both vegetables had been eaten, a silver medal indicated that one vegetable had been eaten (i.e., one disjunct was false; see Fig. 1 Panel B and C), and a sad face indicated that neither vegetable had been eaten (i.e., both disjuncts were false). Participants were told that an animal friend had written down what he thought, and their task was to decide whether the statement was true or false based on the rewards. When participants judged a sentence to be false, they were asked to provide a written justification. Because the sentences were presented in written form, prosody had no influence on their judgments.

Examples from both Mandarin and Spanish test trials are illustrated in (2)–(5). In both languages, the position of the disjunction phrase was manipulated: it could appear in the verb phrase (henceforth OR in VP) or in a topicalized position (henceforth Preposed OR). In Spanish, the object can be preposed as long as it is linked to a resumptive pronoun. Consequently, when the disjunctive phrase is preposed in Spanish, a clitic pronoun has been added. In our experiment, the singular clitic pronoun was used. In Mandarin, in the case of a preposed object, there is no resumptive pronoun. Both in Mandarin and Spanish, participants completed 16 test trials, with four trials per condition/position combination, plus 8 fillers (all corresponding to the gold medal reward) (the full lists of sentences is reported in the *Appendix*, Table A3). Test trials and fillers were presented in pseudorandomized order.

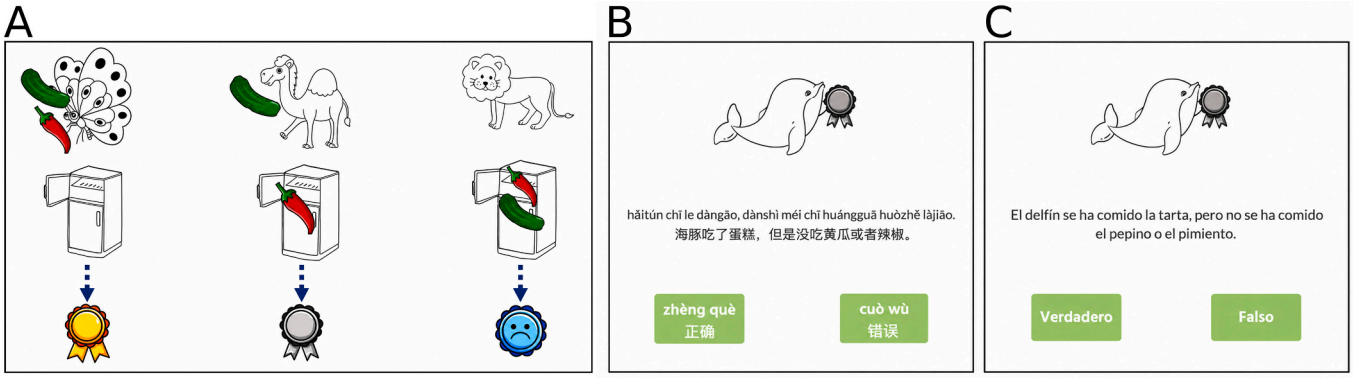


Fig. 1. Schematic depiction of the experiment. (A) Animations shown during the training phase. Vegetables moving toward the refrigerator indicate they were not eaten; vegetables moving toward the animals indicate they were eaten. Participants assigned a reward to each animal based on the number of vegetables eaten: two vegetables earned a gold medal (filler condition), one vegetable earned a silver medal (*one disjunct false* condition), and no vegetables earned a sad face (*two disjunct false* condition). (B) Example test page for the *one disjunct false* condition, Mandarin version. (C) Example test page for the *one disjunct false* condition, Spanish version. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

(2) El gorila se ha comido la tarta,
the gorilla REFL AUX eaten the cake,
pero no se ha comido el pepino o el pimiento.
but NEG REFL AUX eaten the cucumber or the pepper.
"The gorilla has eaten the cake, but it has not eaten the cucumber or the pepper."
[Spanish; OR in VP]

(3) El ratón se ha comido la tarta,
the mouse REFL AUX eaten the cake,
pero, el pepino o el pimiento, no se lo ha comido.
but the cucumber or the pepper NEG REFL CL.M.SG AUX eaten
"The mouse has eaten the cake, but the cucumber or the pepper, it has not eaten."
[Spanish; Preposed OR]

(4) Láng chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo.
wolf eat PFV cake, but NEG eat cucumber or pepper
"The wolf has eaten the cake, but it has not eaten the cucumber or the pepper."
[Mandarin; OR in VP]

(5) Hóuzi chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī.
monkey eat PFV cake but cucumber or pepper NEG eat
"The monkey has eaten the cake, but the cucumber or the pepper, it has not eaten."
[Mandarin; Preposed OR]

Therefore, the experiment employed a 2 × 2 factorial design with two within-participant factors: Condition and Position. The condition factor manipulated the number of false disjuncts (which corresponds to the amount of vegetables not eaten), each corresponding to an award (*one disjunct false* = silver medal; *two disjuncts false* = sad face). The Position factor varied the placement of the disjunction 'OR' (OR in the Verb Phrase vs. Preposed OR). Group (L1 vs. L2) served as a between-participants factor. For the L2 groups, we also considered proficiency as an additional between-participants factor with three levels (Beginner, Intermediate, and Advanced).

2.1.4. Predictions

If participants prefer the *neither* interpretation (NEG > OR), we expect them to accept the *two disjuncts false* condition and to reject the *one disjunct false* condition upon hearing a sentence like ((2)–(5)). If they prefer the *not both* interpretation (OR > NEG), we expect them to accept the *one disjunct false* condition. In case of the preference for the *not both* interpretation, there are two possible scenarios with respect to the *two disjuncts false* condition: participants might accept this condition because $\neg A \vee \neg B$ not only includes the possibility that at least one disjunct is false, but also the circumstance where both disjuncts are false; or participants might reject it due to sensitivity to the pragmatic inference of *exclusivity*. The *exclusivity* inference is a type of scalar implicature triggered by the Maxim of Quantity (Grice, 1975), a conversational principle that guides speakers to provide the most informative and relevant utterances. Consequently, when disjunction takes scope over negation, this inference leads to the interpretation that a disjunctive statement like '(not) A or B' is true only if either A or B is false, but not if both are false. In other words, to fully explain how meaning is assigned to these sentences, the role of pragmatic reasoning must also be incorporated. Although disjunction (OR) is semantically inclusive, its use often triggers a pragmatic *exclusivity* inference - a scalar implicature arising from conversational norms. When disjunction takes wide scope over negation, this *exclusivity* inference becomes operative: if a weaker statement (e.g., *A or B*) is used instead of a stronger alternative (*A and B*), hearers infer that the stronger alternative does not hold (Fox, 2007; Gazdar, 1979; Katzir, 2007; Sauerland, 2004). Consider (6a-c):

(6) a. It is the tea or the coffee that Mary did not drink.

b. It is the tea and the coffee that Mary did not drink.

c. It is the tea or the coffee, but not both, that Mary did not drink.

In (6a), disjunction scoping over negation yields a weaker assertion than (6b). Adhering to Grice's Maxim of Quantity, the use of (6a) triggers the *exclusivity* inference in (6c), negating the possibility of both A and B.

As for the Preposed OR condition, two competing interpretations are possible. If participants rely on linear order, the disjunction phrase scopes above negation, yielding the *not both* (superset) interpretation. This would correspond to accepting the condition *one disjunct false* and rejecting the condition *two disjuncts false*. However, if participants access the *neither* (subset) interpretation, they cannot do so via linear order alone; instead, they must reconstruct the disjunction phrase to its base position below negation (see Gao et al., 2021 for parallel findings with children; see also Fernández-Sánchez & Ott, 2020 and Huang et al., 2009 for reconstruction effects in Spanish and Mandarin respectively). This corresponds to accepting the *two disjuncts false* condition and rejecting the *one disjunct false* condition. If so, the preference for the *neither* interpretation will align with those observed in the SVO order, irrespective of differences in linear order. If L2 learners exhibit a universal bias toward subset interpretations during acquisition, they should preferentially select the *neither* (subset) interpretation even when their first language (L1) typically favors the *not both* (superset) interpretation. Proficiency level may further modulate this universal tendency: beginners might demonstrate stronger adherence to maximal-strength interpretations compared to more advanced learners.

2.2. Results

All participants performed at near-ceiling levels during the training and all participants reached at least 80% accuracy in the filler items. The mean accuracy rate for training trials and for the filler trials is reported in Table 1.

All data analyses were conducted in R version 4.5.0 (R Core Team, 2025). The mean percentages of acceptance by condition are summarized in Fig. 2 for Spanish and Fig. 3 for Mandarin. Binary responses from both the Spanish and Mandarin groups were first fitted using mixed-effects logistic regression (Bates et al., 2018), using Group, Condition, Position and their interactions as predictors and random intercepts for participants and items. Following mixed-effects simplification (Matuschek et al., 2017), variance estimates for both random intercepts converged to zero (participant: $\sigma^2 \rightarrow 0$; item: $\sigma^2 \rightarrow 0$), indicating no meaningful between-subject or between-item variability beyond fixed effects. A likelihood ratio test confirmed that including random intercepts for participants and items did not significantly improve model fit ($\chi^2(2) = 0$, $p = 1$), indicating no meaningful between-subject or between-item variability beyond fixed effects. Therefore, we fitted a generalized linear model (GLM) with a binomial distribution and logit link function using the Iterative Reweighted Least Squares algorithm separately for each language pair (L1 Spanish vs. L2 Spanish; L1 Mandarin vs. L2 Mandarin). Group (L1; L2), Condition (*one disjunct false*; *two disjuncts false*), Position (OR in VP; Preposed OR) and their interactions were used as predictors for both language comparisons. Group, Condition, and Position were coded with treatment coding, with L1 group, the *two disjuncts false* condition, and OR in VP position serving as reference levels, respectively. Post-hoc pairwise comparisons were carried out using the emmeans package (Lenth, 2024), with Bonferroni correction applied.

Finally, to assess whether our sample size was sufficient to detect the observed effects, we conducted a simulation-based power analysis (1000 iterations) using the estimated coefficients from the fitted model as the assumed true effects. The results of the power analyses are reported in the *Appendix*, Tables A4 and A5. Power was adequate for all detected main effects and two-way interactions (power = 1.00) reported in the two following sections.

Table 1
Mean accuracy rate of training trials and fillers (SD in parentheses).

	L1 Mandarin	L1 Spanish	L2 Mandarin	L2 Spanish
training	0.98 (0.13)	1 (0)	0.99 (0.11)	0.99 (0.15)
filler_false	1 (0)	1 (0)	0.91 (0.29)	0.99 (0.09)
filler_true	0.98 (0.13)	1 (0)	1 (0)	1 (0.06)

2.2.1. L1 Spanish vs L2 Spanish

When comparing L1 Spanish vs L2 Spanish, we found significant effects of Group ($\beta = -1.64$, SE = 0.28, $z = -5.80$, $p < 0.001$) and Condition ($\beta = -1.94$, SE = 0.29, $z = -6.71$, $p < 0.001$). Position was not significant. Significant two-way interactions were observed between Group and Condition ($\beta = 3.11$, SE = 0.40, $z = 7.86$, $p < 0.001$). Coefficients and full regression results can be found in the *Appendix*, Table A4. The pairwise comparisons of estimated marginal means (EMMs, Bonferroni correction) revealed that L1 Spanish speakers in the *one disjunct false* condition were significantly more likely to accept the response compared to L2 Spanish speakers in the same condition ($\beta = 1.66$, SE = 0.20, $z = 8.29$, $p < 0.001$); L1 Spanish speakers in the *two disjuncts false* condition were significantly less likely to accept the response compared to L2 Spanish speakers in the same condition ($\beta = -1.53$, SE = 0.20, $z = -7.77$, $p < 0.001$).

2.2.2. L1 Mandarin vs L2 Mandarin

The comparison between L1 Mandarin and L2 Mandarin revealed similar results. Group ($\beta = -2.70$, SE = 0.38, $z = -7.14$, $p < 0.001$) and Condition ($\beta = -5.04$, SE = 0.49, $z = -10.22$, $p < 0.001$) were significant, whereas the effect of Position did not reach significance. Significant two-way interactions were observed between Group and Condition ($\beta = 5.78$, SE = 0.56, $z = 10.35$, $p < 0.001$). Coefficients and full regression results can be found in the *Appendix*, Table A5. The pairwise comparisons of estimated marginal means (EMMs, Bonferroni correction) showed that in the *one disjunct false* condition, L1 Mandarin speakers were significantly more likely to accept the target sentence compared to L2 Mandarin speakers ($\beta = 2.73$, SE = 0.27, $z = 10.21$, $p < 0.001$). In the *two disjuncts false* condition, L1 Mandarin speakers were significantly less likely to accept the target sentence compared to L2 Mandarin speakers in the same condition ($\beta = -2.95$, SE = 0.28, $z = -10.38$, $p < 0.001$).

2.2.3. Justification

In addition to acceptance/rejection responses, we collected justifications from participants whenever they gave a "no-response" to a test sentence. We coded the L2 participants' justifications for rejecting target sentences in the *one disjunct false* condition into eight categories. Table 2 (L2 Spanish) and Table 3 (L2 Mandarin) present, for each category, the justification code, one representative example, and the number of occurrences of such justification types for each L2 group. In both groups, the most frequent justification type is "one" (L2 Spanish: $n = 56$ for; L2 Mandarin: $n = 68$) which is compatible with a *neither* interpretation (see

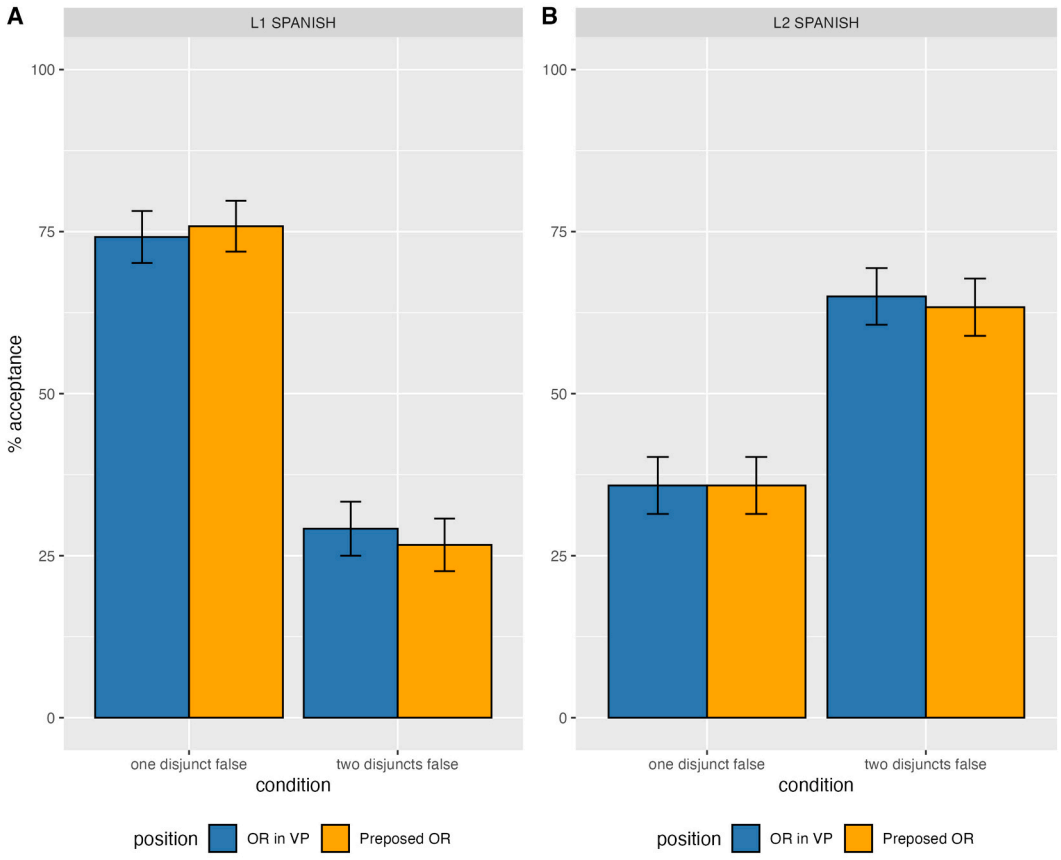


Fig. 2. Percentage of target sentence acceptance by Condition (*one disjunct false* vs two *disjuncts false*) and Position (OR in VP vs Preposed OR). Panel A displays the results of the L1 Spanish group; Panel B displays the results of the L2 Spanish group. In both panels, the left bar represents the OR in VP condition; the right bar represents the Preposed OR condition. Error bars indicate the standard error of the mean.

Pagliarini et al., 2022 for similar results from child language). In addition, many participants explicitly referenced the fact that the animal did not eat two vegetables or that it had to receive the sad face reward (L2 Spanish: $n = 42$; L2 Mandarin: $n = 55$), indicating that they have accessed a *neither* interpretation. Such justifications are also attested in child language, but to a much lesser extent (see Pagliarini et al., 2022).

2.2.4. Individual results

Table 4 displays participants' individual response patterns across groups. Results were divided into four categories: acceptance of *two disjuncts false* and rejection of *one disjunct false* is considered as an indication of preference for *neither* interpretation; acceptance of *one disjunct false* and rejection of *two disjuncts false* is considered as an indication of preference for *not both* interpretation plus implicature calculation; acceptance of *one disjunct false* and acceptance of *two disjuncts false* in considered as preference for *not both* interpretation but without implicature calculation. Results that do not fit previous categories were considered as mixed results. Given that the experiment included 4 items per condition per position, we consider a response consistent if it matched in 3 out of 4 items. The results demonstrate that a preference for the *not both* interpretation consistently prompted the computation of the *exclusivity* inferences (which corresponds to the acceptance of the *one disjunct false* condition and the rejection of the *two disjuncts false* condition). Furthermore, the distribution of individual response patterns among L2 speakers, as illustrated in Figs. 4 and 5, shows that individual responses were consistent across conditions and exhibited a distribution closely resembling those previously observed in children (Pagliarini et al., 2021, 2022). Consistent with the existence of a universal bias, both groups of L2 learners exhibited a preference for the *neither* interpretation (subset), even though their L1 group's preferred interpretation is the *not both* (superset) interpretation.

2.2.5. The role of proficiency level

We then examined whether the proficiency level predicted responses in each L2 group, see Fig. 6. To address small-sample bias in the proficiency-split analyses, we used Firth's penalized likelihood logistic regression as implemented in the *logistf* package in R (Heinze & Schemper, 2002). Firth's method modifies the score function of the standard logistic regression likelihood by incorporating a penalty term, which removes biases present in maximum likelihood estimates under small or sparse samples (Firth, 1993). Therefore, we fitted a logistic regression model with Firth's penalized likelihood separately for each L2 group (L2 Spanish; L2 Mandarin), predicting response as a function of the two-way interaction between Condition (*one disjunct false*; *two disjuncts false*) and Proficiency (Beginner, Intermediate, Advanced). Position was excluded as a fixed factor in the models testing Proficiency, as analyses comparing L1 and L2 populations demonstrated no significant effect of Position (see Tables A4 and A5 in the *Appendix*). This decision was further supported by model comparisons between a full model (including Proficiency, Condition, and Position) and a reduced model (including only Proficiency and Condition), which confirmed that Position did not significantly improve model fit (Spanish: $\chi^2(3) = 0.64$, $p = 0.89$; Mandarin: $\chi^2(3) = 0.38$, $p = 0.94$). Post-hoc pairwise comparisons were carried out using the emmeans package (Lenth, 2024), with Bonferroni correction applied.

Again, to assess whether our sample size was sufficient to detect the observed effects, we conducted a simulation-based power analysis (1000 iterations) using the estimated coefficients from the fitted model as the assumed true effects. The results of the power analyses are reported in the *Appendix*, Tables A6 and A7. Power was adequate (ranging from 0.81 to 1.00) for all main effects and two-way interactions reported in the following two sections, with the exception of the Condition × Proficiency (Beginner) interaction for Mandarin proficiency, where power

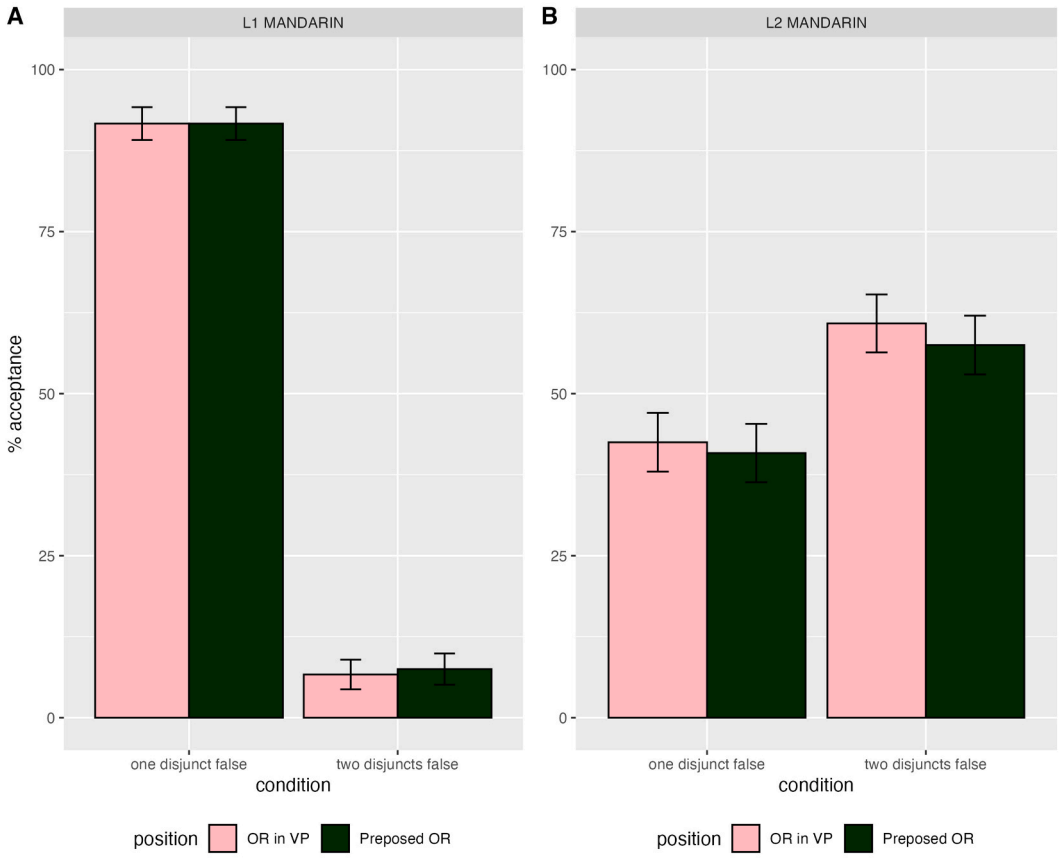


Fig. 3. Percentage of target sentence acceptance by Condition (*one disjunct false* vs *two disjuncts false*) and Position (OR in VP vs Preposed OR). Panel A displays the results of the L1 Mandarin group; Panel B displays the results of the L2 Mandarin group. In both panels, the left bar represents the OR in VP condition; the right bar represents the Preposed OR condition; Error bars indicate the standard error of the mean.

Table 2
Justification codes and count of justifications for the rejection of the *one disjunct false* condition given by L2 Spanish speakers.

Justification code	Example of justification	Count
One	Se ha comido una. *English: It ate one (veggie)*	56
Or-exclusive	Se ha comido el pepino o el pimiento. *English: It ate the cucumber or the pepper.*	15
Silver-one	Con medalla de plata. Se ha comido por lo menos un tipo de verdura. *English: As it has the silver medal. It ate at least one veggie.*	36
Has-silver medal	Ha ganado la medalla de plata. *English: He won a silver medal.*	5
Should-sad face	Debería tener una cara triste. *English: It should have got a sad face.*	23
Neg-two	No ha comido dos verduras. *English:It did not eat two veggies.*	3
Neg-sad face	No se ha comido los dos, por eso es cara triste. *English: It did not eat veggies, it corresponds to sad face.*	12
Neg-plural clitic	No se los ha comido. *English: It didn't CL.M.Pl eat.*	3
Nothing	No se ha comido ninguna verdura. *English: It did not eat any veggie.*	1
	Total	154

Table 3
Justification codes and count of justifications for the rejection of the *one disjunct false* condition given by L2 Mandarin speakers. In the case of the L2 Mandarin learners, 3 learners replied in Mandarin, and 17 in Spanish.

Justification code	Example (original)	Count
One	Ta chile yige shucai. *English: It ate one veggie.*	68
Or-exclusive	Debe de comer huanggua o lajiao. *English: It ate the cucumber or the pepper.*	8
Silver-one	Comió una de las verduras ya que tiene la medalla de plata. *English: It ate one veggie since it has the silver medal*	8
Should-sad face	Debe ser la cara triste. *English: it should be sad face.*	16
Neg-and	Huanggua he lajiao mei chi. *English: It did not eat the cucumber and the pepper.*	8
Neither-nor	No ha comido ni pepino ni pimiento. *English: It did not eat neither the cucumber nor the pepper.*	5
Neg-two	No ha comido dos verduras. *English: It did not eat two veggies.*	2
Nothing	No comió ninguna verdura. *English:* It did not eat any veggie.	24
	Total	139

was lower (0.67).

L2 Spanish proficiency. The analysis revealed significant effects of Condition, Proficiency and their interaction on the response variable. The *two disjuncts false* condition was less likely to be accepted compared to *the one disjunct false* condition ($\beta = -1.43$, SE $= 0.35$, $\chi^2(1) = 17.48$, $p < 0.001$, 95% CI [−2.13, −0.75]). Beginner and Intermediate participants showed significantly lower acceptance rates compared to Advanced participants ($\beta = -4.20$, SE $= 0.87$, $\chi^2(1) = 60.70$, $p < 0.001$, 95% CI [−6.42, −2.79]; $\beta = -1.55$, SE $= 0.32$, $\chi^2(1) = 25.34$, $p < 0.001$, 95% CI [−2.18, −0.93], respectively). Significant interactions indicate that the effect of condition depends on proficiency level: in the *two disjuncts false* condition responses increased significantly for Beginners ($\beta = 9.46$, SE $= 1.68$, $\chi^2(1) > 100$, $p < 0.001$, 95% CI [6.85, 14.52]) and Intermediates ($\beta = 2.99$, SE $= 0.45$, $\chi^2(1) = 47.64$, $p < 0.001$, 95% CI [2.12, 3.88]) relative to Advanced participants. Coefficients and full

Table 4
Individual responses.

Group	Position	*neither*	*not both plus* implicature	*not both without* implicature	Mixed results
L1 Mandarin	OR in VP	2	27	0	1
L1 Mandarin	Preposed OR	2	27	0	1
L2 Mandarin	OR in VP	18	12	0	0
L2 Mandarin	Preposed OR	16	11	0	3
L1 Spanish	OR in VP	7	22	0	1
L1 Spanish	Preposed OR	6	22	1	1
L2 Spanish	OR in VP	18	11	0	1
L2 Spanish	Preposed OR	18	11	0	1

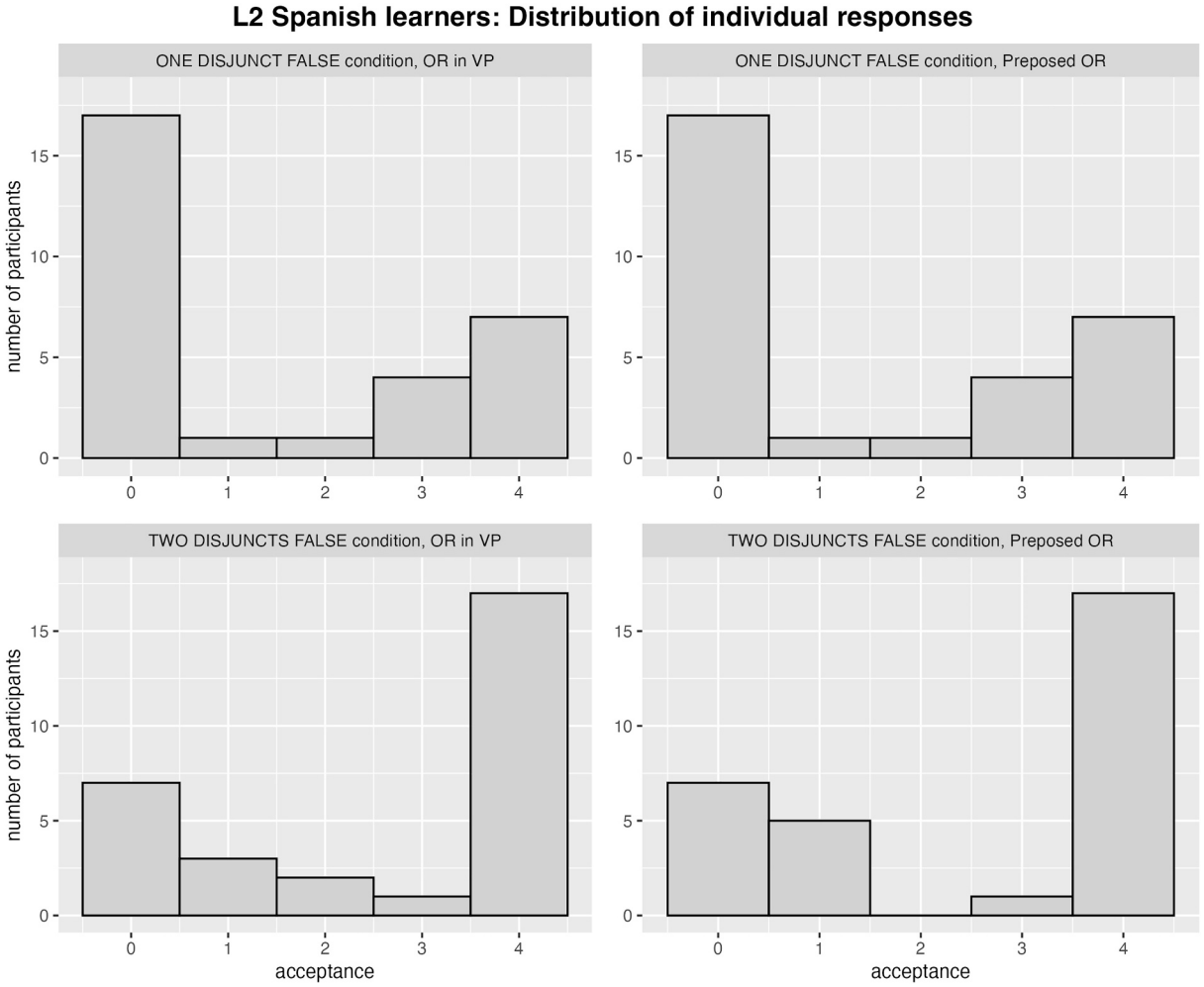


Fig. 4. Distribution of individual responses in L2 Spanish for each condition. The y-axis reports the number of participants for each number of items accepted (x-axis). 0 stands for 0 items accepted; 1 stands for 1 item accepted; 2 stands for 2 items accepted; 3 stands for 3 items accepted; 4 stands for 4 items accepted.

regression results can be found in the *Appendix*, Table A6. Pairwise comparisons of estimated marginal means (EMMs, Bonferroni correction) showed that Advanced learners were more likely to accept the *one disjunct false* with respect to Beginner and Intermediate learners ($\beta = 4.02$, SE $= 0.87$, $t = 4.84$, $p < 0.001$; $\beta = 1.55$, SE $= 0.32$, $t = 4.9$, $p < 0.001$, respectively) and that Beginner learners were less likely to accept the *one disjunct false* with respect to Intermediate learners ($\beta = -2.65$, SE $= 0.85$, $t = -3.11$, $p < 0.5$). As for the *two disjuncts false* condition, Advanced learners were less likely to accept it compared to Beginner and Intermediate learners ($\beta = -5.26$, SE $= 1.44$, $t = -3.64$, $p < 0.01$; $\beta = -1.44$, SE $= 0.32$, $t = -4.58$, $p < 0.001$).

L2 Mandarin proficiency. The results revealed that Intermediate participants were significantly different from Advanced participants ($\beta = -1.05$, SE $= 0.37$, $\chi^2(1) = 8.12$, $p < 0.01$, 95% CI [−1.79, −0.32]), while the difference between Beginner and Advanced participants showed a trend that did not reach significance. Importantly, significant interactions indicate that the effect of condition depends on Proficiency: Beginners showed increased acceptance in the *two disjuncts false* condition compared to Advanced participants ($\beta = 1.34$, SE $= 0.55$, $\chi^2(1) = 5.99$, $p < 0.05$, 95% CI [0.27, 2.43]), and this effect was even stronger for Intermediate participants ($\beta = 2.13$, SE $= 0.53$, z $= 4.06$, $\chi^2(1) = 16.80$, $p < 0.001$, 95% CI [1.11, 3.17]). Coefficients and full regression results can be found in the *Appendix*, Table A7. Pairwise comparisons of estimated marginal means (EMMs, Bonferroni correction) showed that in the *two disjunct false* condition, Advanced learners were marginally less likely to accept the target sentence in comparison to Intermediate learners ($\beta = -1.08$, $SE = 0.37$, $t = -2.91$, $p = 0.06$). In general, the results indicate a systematic influence of proficiency: beginners

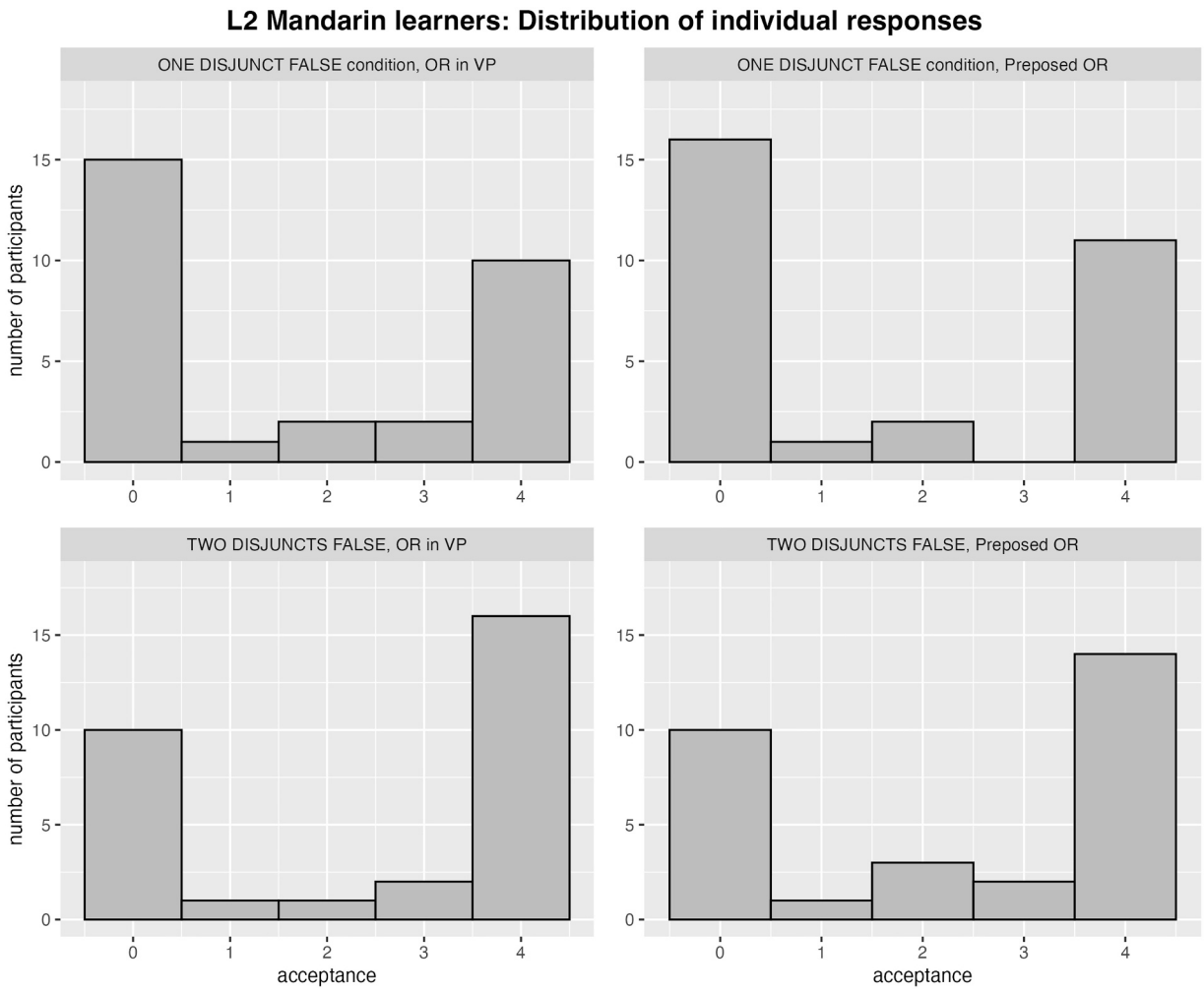


Fig. 5. Distribution of individual responses in L2 Mandarin for each condition. The y-axis reports the number of participants for each number of items accepted (x-axis). 0 stands for 0 items accepted; 1 stands for 1 item accepted; 2 stands for 2 items accepted; 3 stands for 3 items accepted; 4 stands for 4 items accepted.

demonstrated a strong tendency to interpret sentences in accordance with a subset bias. As learners advanced in proficiency, their interpretations progressively aligned with the target grammar.

3. Discussion

In our experiment, we investigated whether the semantic interpretations assigned by L2 speakers are shaped by influences from their L1 or driven by universal biases, such as a preference for interpretations with narrower coverage (subset interpretations). We included L2 learners with different L1 backgrounds, Mandarin and Spanish, to investigate the role of first language transfer in L2 acquisition. Both Mandarin and Spanish were empirically classified as superset languages, meaning that native speakers of these languages tend to prefer the *not both* (superset) interpretation of negative sentences containing disjunction.[4] We found that *(a)* L2 learners of both Mandarin and Spanish preferred the *neither* (subset) interpretation, diverging from the patterns observed in their respective L1 groups and in their target L2 languages, but aligning with those seen in children during first language acquisition (Crain & Khlentzos, 2008; Geçkin et al., 2017; Pagliarini et al., 2022) (see Figs. 4 and 5); *(b)* both groups of L2 learners reconstructed the preposed disjunction phrase to interpret disjunction within the scope of negation, as predicted in the case of preference for the *neither* interpretation (see Gao et al., 2018 for similar results in L1 acquisition). This means that the L2 speakers' preference for subset interpretations persists even when the linear order of negation and disjunction matches the scope configuration favored by adult native L1 speakers; *(c)* related to point *(b)*, both L1 and L2 participants demonstrated consistent judgments across different linear orders (Table 2); *(d)* learner proficiency systematically modulates interpretive preferences: beginners show a strong bias toward subset interpretations, mirroring the universal tendencies observed in first language acquisition. As proficiency increases, L2 learners' interpretations become increasingly target-like, indicating that exposure facilitates convergence to the target language. This progression - from subset-driven patterns to native-like convergence - implies that higher proficiency reduces initial universal biases while promoting specialization in the target grammar's rule system. In other words, this shift reflects a transition from reliance on universal patterns toward mastery of language-specific rules.

Our findings are consistent with the hypothesis that L2 acquisition is shaped by learning mechanisms parallel to those observed in child L1 acquisition, rather than being driven by first language transfer. They suggest that L2 learners, like children acquiring their first language,

[4] While the results show that both Spanish and Chinese native speakers favor the "not both" (OR > NOT) readings, a crosslinguistic difference between the two groups is worth noting: the "neither" interpretation was not categorically excluded by Spanish speakers, approximately 25% of whom accessed this interpretation. This pattern is consistent with recent evidence suggesting that the two scope interpretations are not governed by a strict binary division between +PPI and –PPI languages (see Lungu et al., 2021 for further discussion).

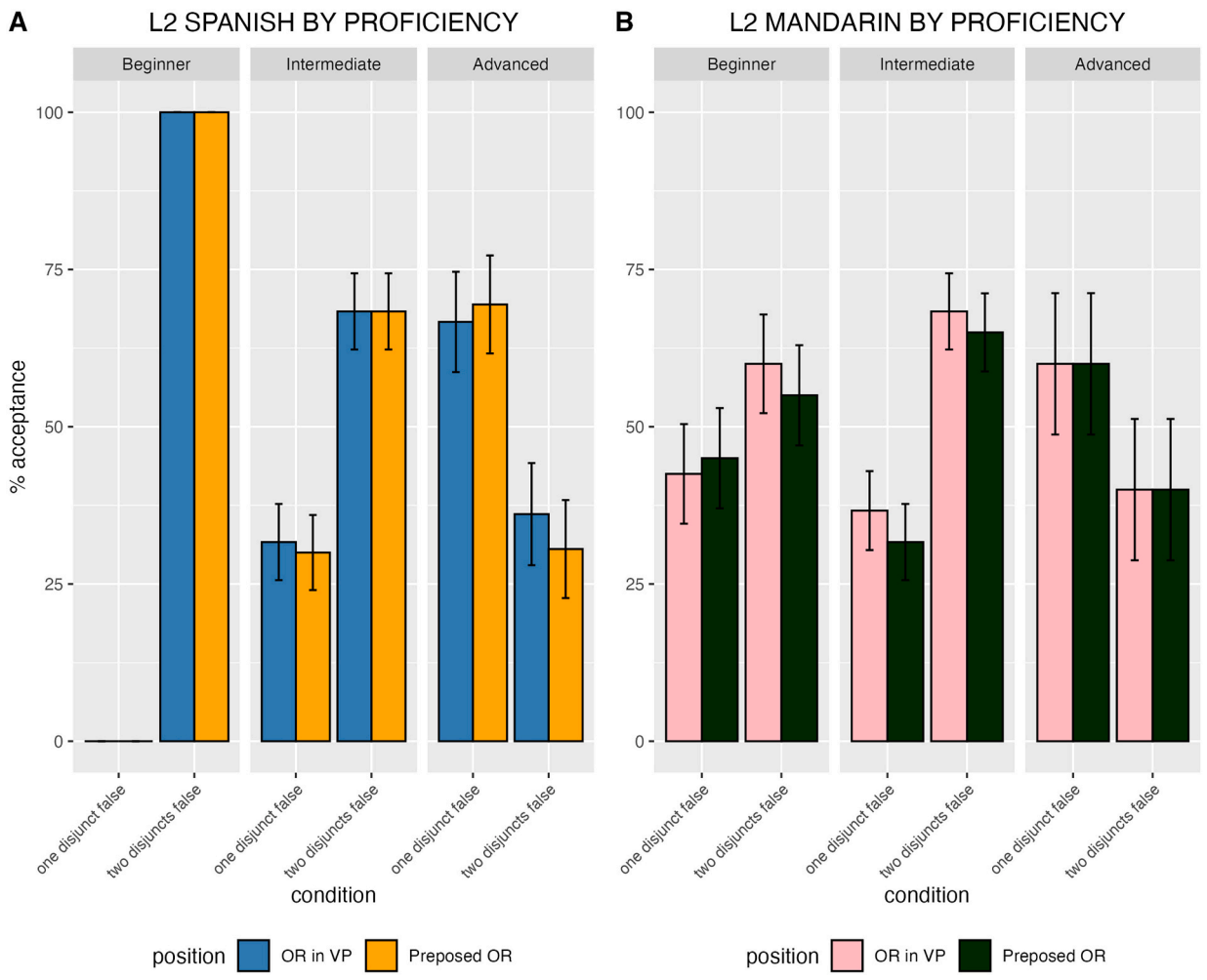


Fig. 6. Effect of Proficiency in the L2 groups. Percentage of target sentence acceptance by Condition (*one disjunct false* vs. *two disjuncts false*); Position (OR in VP vs. Preposed OR) and Proficiency (Beginner vs. Intermediate vs. Advanced). Panel A displays the results of the L2 Spanish group; Panel B displays the results of the L2 Mandarin group. In each facet in both panels, the left bar represents the OR in VP condition; the right bar represents the Preposed OR condition Error bars indicate the standard error of the mean.

operate under both freedom and constraints. Crucially, L2 acquisition follows a similar developmental trajectory in Spanish and Mandarin, regardless of the native language. Furthermore, the L2 linguistic environment critically shapes acquisition outcomes, with proficiency modulating this relationship (Chung, 2013; Marsden, 2009; Miyamoto & Yamane, 1996).

As for L1 language acquisition, it has been proposed that, when presented with sentences associated with multiple meanings such as negative disjunctive sentences, children follow the Semantic Subset Principle (SSP) (Berwick, 1985; Crain et al., 1994). The SSP guides children to initially interpret disjunction within the scope of negation, that is, to assign a *neither* interpretation, even when adults of the target language they are acquiring preferentially adopt a superset interpretation, which in this case corresponds to *not both*. Subsequently, children revise their initial non-adult preference by leveraging positive evidence in the languages where adults exhibit the superset interpretation. Similarly, we find that L2 learners' assign the *neither* (subset) interpretation even when in both their L1 and target L2 the *not both* (superset) interpretation is preferred. Furthermore, our results show that L2 learners' preferences are sufficiently robust to drive the application of reconstruction mechanisms, enabling them to generate their preferred scope assignment (where negation c-commands disjunction) irrespective of the linear order of these elements in surface syntax. Within a Universal Grammar framework, our results suggest that the Semantic Subset Principle (SSP) (Berwick, 1985; Crain et al., 1994) - originally proposed for first language acquisition - may also apply to second language learners. These findings are likewise compatible with frameworks such as the Strongest Meaning Hypothesis (SMH) (Dalrymple et al., 1994; Dalrymple et al., 1998). When considering a Bayesian account of language acquisition (Lasnik & Lidz, 2016; Pearl, 2017, 2022), given that the input L2 learners receive both in their native and target language does not need to be biased toward subset interpretation, our results suggest that L2 learners operate using a non-uniform prior, representing an innate bias favoring the stronger, subset interpretation (Pagliarini et al., 2022).

The convergence of these perspectives highlights a common tendency: both adult and child learners favor interpretations or grammatical systems that are more restrictive and thus provide more precise, informative meanings. Crucially, this preference persists even when the L1 or target L2 exhibits superset interpretations (e.g., Mandarin and Spanish L2 learners diverging from their L1/L2 preferences), highlighting a universal strategy favoring narrower subset interpretations rather than L1 transfer. Whether the subset preference observed here reflects an innate, biologically specified principle encoded in UG, or an instance of a more domain-general tendency toward conservative interpretation under uncertainty, remains an open theoretical question that our data alone cannot adjudicate. What our results do show is that this preference emerges broadly across both L1 and L2 learners, the

latter spanning different L1 backgrounds, suggesting it is not reducible to a particular learner population but reflects a more general property of the learning process. Importantly, the parallels with first language acquisition patterns further suggest that the same acquisitional pressures are operative in both L1 and L2 learning.

3.1. Negated disjunction in the L2 learner grammar

The present findings belong to a growing body of L2 research on the interpretation of negated disjunction. Our results align with Chen et al. (2023) and Lee and Schwartz (2024), who similarly found a strong *neither* preference across learners of different L1 backgrounds. Chen et al. (2023) provide evidence from English-speaking L2 learners of Mandarin, while Lee and Schwartz (2024) draw on English-speaking L2 learners of Korean and Japanese-speaking L2 learners of Korean. Together, these findings suggest that the preference for the subset interpretation is not reducible to transfer from any particular L1. Crucially, our findings extend this line of evidence by demonstrating that the subset preference persists even when the surface order of negation and disjunction does not correspond to the learners' preferred interpretation, indicating that learners reconstruct underlying structure rather than rely on surface linear order. This is a result that has not been previously documented in this domain. At the same time, our findings contrast with Grüter et al. (2010) and Okuma (2025), who found evidence of L1 transfer, particularly at lower proficiency levels.

A further question concerns how learners ultimately acquire the target-like interpretation of negated disjunction, given the scarcity of relevant input. As for L1 acquisition, Sano et al. (2024) have shown that positive evidence for the wide-scope interpretation of disjunction is virtually absent in child-directed speech, raising a learnability problem that parallels other well-known poverty-of-the-stimulus cases. Our data from L2 populations speak partially to this question: the convergence of higher-proficiency learners toward the target interpretation suggests that sufficient exposure, or developmental maturation, or both, may eventually provide the relevant evidence. However, the triggering data enabling this convergence remains an open question that the present study cannot resolve.

3.2. Contribution to current debates in L2 research

The present findings have broader implications for the debate about the role of Universal Grammar in second language acquisition. Under the *Full Transfer/Full Access hypothesis* (Schwartz & Sprouse, 1996), the initial state of L2 acquisition is the final state of L1 acquisition, with Universal Grammar (UG) remaining fully accessible to drive subsequent restructuring when the L1 grammar fails to accommodate new input. An alternative to this view is offered by the *Full Access without Transfer hypothesis* (Epstein et al., 1996), which holds that L2 learners access UG directly, independently of the L1 grammar. Under this account, convergence on UG-consistent representations need not be mediated by prior L1 activation. Our results complicate the full transfer component of the *Full Transfer/Full Access hypothesis* (Schwartz & Sprouse, 1996): despite the fact that both Mandarin and Spanish speakers show a superset preference in their L1, L2 learners from both groups adopt the subset interpretation, suggesting that L1 transfer does not straightforwardly determine the initial interpretive state in the semantic domain.

When L2 learners demonstrate the same kind of knowledge as native speakers, it may be reasonable to argue that the source of this knowledge is not UG directly; rather, it is the L1 grammar (see e.g. Bley-Vroman, 2009; Schachter, 1990); in other words, the L2 learners might show knowledge of some constraints (such as island constraints, see e.g. White & Juffs, 1998), because these have been activated in the L1 grammar, and not because interlanguage grammars are UG-constrained as such. Hence, to eliminate this possibility, in our study we have investigated cases where the L1 and L2 did not differ, and therefore the L1 grammar could not provide the learner with the subset interpretation.

Unlike our findings, Grüter et al. (2010) found evidence of L1 transfer in the acquisition of the scope of disjunction and negation, suggesting that *Full Transfer* extends to semantics. Instead, our learners appear to fall back on a subset-favoring strategy consistent with the operation of universal principles, in line with proposals that L2 acquisition is constrained by UG, particularly at the syntax-semantics interface (Dekydtspotter et al., 2001; Schwartz & Sprouse, 1996; White, 2003). The finding that this preference weakens with increasing proficiency suggests it reflects an initial acquisitional strategy rather than a permanent feature of L2 grammars, consistent with the view that learners gradually converge toward target-like representations as input accumulates.

Our pattern of results supports the hypothesis that L2 acquisition shares foundational learning mechanisms with child L1 acquisition. Like children, L2 learners initially operate under biases that guide them toward subset interpretations. With increasing proficiency, they gradually integrate target language-specific evidence. The observed trajectory, from early subset-driven generalizations to eventual convergence with the L2 target language, mirrors restructuring phases in L1 acquisition, where initial hypotheses are revised through exposure to positive evidence (Wexler, 1998). Notably, this progression occurs in both Spanish and Mandarin L2 learners, suggesting a universal developmental path that transcends specific target languages.

Our findings indicate that, regardless of whether they are interpreted through the Semantic Subset Principle (SSP), the Strongest Meaning Hypothesis (SMH), or Bayesian learning models, both first and second language acquisition rely on shared underlying mechanisms. Early subset preferences reflect a fundamental strategy for managing linguistic ambiguity, while increased proficiency and exposure drive learners toward native-like competence.

3.3. Limitation of the present study and future directions

A limitation of the present study is that our conclusions are based on two experiments each with a moderate sample size (30 participants per group), and the proficiency level comparison are based on relatively small numbers of participants per cell. We conducted a simulation-based power analysis to evaluate whether our sample size afforded adequate power to detect the observed effects. This analysis indicated sufficient power for all main effects and two-way interactions (see *Appendix*, Table A4, A5, A6, A7). While the results of the simulation-based power analysis suggest that our findings are reasonably robust, replication with larger samples (particularly across proficiency levels) would strengthen confidence in these conclusions and allow for a more fine-grained investigation of proficiency-related effects.

Furthermore, future research should target the empirical distinctions between the above-mentioned accounts (Strongest Meaning Hypothesis, Semantic Subset Principle, Bayesian account) by means of manipulations that make the wide scope (*not both*) interpretation of disjunction more accessible. For instance, prosodic manipulations of the type employed by van Hout et al. (2024) could be informative: if L2 learners can access the *not both* interpretation under prosodically felicitous conditions, this would favor the SMH over the SSP, since it would suggest that the wider-scope interpretation is grammatically available but dispreferred, rather than absent from the learner's grammar altogether. However, such manipulations cannot completely rule out the possibility that learners pass through an earlier stage of absolute subset preference, where the wide-scope reading is genuinely unavailable regardless of prosodic context (van Hout et al., 2024). Bayesian learning models generate yet a different prediction: convergence toward the *not both*

interpretation would reflect how learners' prior beliefs about possible interpretations are updated as they encounter relevant input. This account could in principle be distinguished from the others by manipulating input frequency or by tracking individual learning trajectories over time.

4. Conclusions

Our study addressed the long-standing question of whether first and second language acquisition share underlying mechanisms. Here, we show that adult L2 learners interpret disjunction ("or") in negative sentences (e.g., "John didn't eat the cucumber or the pepper") like children in first-language acquisition, rather than following native preferences. Such sentences test scope assignment between negation and disjunction, which varies across languages based on syntactic relations. We report three findings from Mandarin and Spanish natives and their L2 learners. First, natives prefer "or" scoping over negation ("not both" superset), while learners favor the subset ("neither") interpretation, matching child patterns. Second, the L2 learners' preferences for the subset ("neither") interpretation hold irrespective of the linear order of these elements in surface syntax. Third, the tendency strengthens in less proficient learners and weakens with proficiency. Taken together, these results reveal universal strategies in L2 acquisition that closely parallel child L1 development.

CRediT authorship contribution statement

Elena Pagliarini: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jin Yan:** Writing – review & editing, Visualization, Methodology, Investigation, Formal analysis, Data curation. **Anna Gavarró:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition.

Ethics declaration

Written informed consent to take part in the study and to publish the article has been obtained from all participants or their legal representatives. The privacy rights of participants have been observed.

This study was performed in compliance with relevant laws, regulatory frameworks and guidelines where the research took place. This study was approved by the Research Ethics Committee (CERec) of the Universitat Autònoma de Barcelona. (Approval No. CEEAH 6550).

Code availability

The R code used for data analysis has been deposited in the Open Science Framework database (https://osf.io/uhbz4).

Declaration of competing interest

The authors declare no competing interests.

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Appendix

Table A1
Introductory stories for the Spanish version and the Mandarin version of the truth value judgment task.

Spanish	Mandarin
Aquí hay 24 animales. [Picture of the 24 animals]	这里一共有24种动物 (zhèlǐ yīgòng yǒu 24 zhǒng dòngwù). [Picture of the 24 animals]
Estos animales participan en un concurso de comida. Hay una tarta, un pepino y un pimiento. [picture of cake, cucumber, and pepper]	它们参加了一个吃东西比赛. 有一个蛋糕，一个黄瓜和一个辣椒 (tāmen cānjiā le yígè chī dōngxi bǐsài. Yǒu yígè dàngāo, yígè huángguā hé yígè làjiāo). [picture of cake, cucumber, and pepper]
Todos estos animales se han comido una tarta. Pero no a todos ellos les gustan las verduras. Es por eso que obtendrán un premio especial por comer verduras. Así es como funciona: los animales que hayan comido tanto el pepino como el pimiento recibirán una medalla de oro. [Picture of a gold medal]	但是，不是所有的动物都喜欢蔬菜. 所以，它们会因为吃蔬菜获得奖励. 规则如下:既吃了黄瓜也吃了辣椒的动物，会得到一块金牌 (dànshì, búshì suǒyǒu de dòngwù dōu xǐhuān shūcài. Suǒyǐ, tāmen huì yīnwèi chī shūcài huòdé jiǎnglì. Guīzé rú xià: jì chī le huángguā yě chī le làjiāo de dòngwù, huì dédào yíkuài jīnpái). [Picture of a gold medal]
Los que hayan comido solo una verdura, el pepino o el pimiento, no importa cuál, también recibirán un premio: una medalla de plata. [Picture of a silver medal]	如果只吃了一个蔬菜，黄瓜或者辣椒，无论哪一个，会得到一块银牌 (rúguǒ zhǐ chī le yígè shūcài, huángguā huòzhě làjiāo, wú ùn nǎ yī ge, huì dédào yíkuài yínpái). [Picture of a silver medal]
Pero los que no han comido ninguna verdura obtendrán una cara triste. [Picture of a sad face]	如果一个蔬菜都没吃，会得到一个哭脸 (rúguǒ yígè shūcài dōu méi chī, huì dédào yígè kūliǎn). [Picture of a sad face]
Ahora, un amigo de los animales quiere saber qué ha comido cada animal en el concurso según el premio que haya ganado. Dirá lo que piensa, y tu tarea es decidir si lo que dice es verdad o si es falso.	现在，动物们的一个朋友想要根据每个动物获得的奖励知道每个动物所吃的蔬菜. 他会说出它的猜想，请你判断它说的话是否正确. 如果不正确，请写出原因 (xiànzài, dòngwù men de yígè péngyou xiǎng yào gēnjù měi gè dòngwù huòdé de jiǎnglì zhīdào měigè dòngwù suǒ chī de shūcài. tā huì shuō chū tā de cāixiǎng, qǐng nǐ pànduàn tā shuō de huà shìfǒu zhèngquè. Rúguǒ bú zhèngquè, qǐng xiě chū yuányīn).

Table A2
Sentences: training phase.

Item	Award	Veggies eaten	Test Sentence (Spanish)	Test Sentence (Mandarin)
1	Gold medal	2	¿Qué medalla debería llevar la mariposa? = What medal should the butterfly wear?	蝴蝶应该得到什么奖牌? (húdié yīnggāi dédào shénme jiǎngpái?) = What medal should the butterfly wear?
2	Gold medal	2	¿Qué medalla debería llevar el hipopótamo? = What medal should the hippopotamus wear?	河马应该得到什么奖牌? (hémǎ yīnggāi dédào shénme jiǎngpái?) = What medal should the hippopotamus wear?
3	Silver medal	1	¿Qué medalla debería llevar el león? = What medal should the lion wear?	狮子应该得到什么奖牌? (shīzi yīnggāi dédào shénme jiǎngpái?) = What medal should the lion wear?
4	Silver medal	1	¿Qué medalla debería llevar el camello? = What medal should the camel wear?	骆驼应该得到什么奖牌? (luòtuo yīnggāi dédào shénme jiǎngpái?) = What medal should the camel wear?
5	Sad face	0	¿Qué medalla debería llevar el tigre? = What medal should the tiger wear?	老虎应该得到什么奖牌? (lǎohǔ yīnggāi dédào shénme jiǎngpái?) = What medal should the tiger wear?
6	Sad face	0	¿Qué medalla debería llevar la libélula? = What medal should the dragonfly wear?	蜻蜓应该得到什么奖牌? (qīngtíng yīnggāi dédào shénme jiǎngpái?) = What medal should the dragonfly wear?

Table A3
Stimuli sentences: test phase.

Item	Condition, award	Position	Test Sentence (Spanish)	Test Sentence (Mandarin)
1	One disjunct false, silver medal	OR in VP	El delfín se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The dolphin has eaten the cake, but it has not eaten the cucumber or the pepper.	海豚吃了蛋糕，但是没吃黄瓜或者辣椒 (hǎitún chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The dolphin has eaten the cake, but it has not eaten the cucumber or the pepper.
2	One disjunct false, silver medal	OR in VP	La hormiga se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The ant has eaten the cake, but it has not eaten the cucumber or the pepper.	蚂蚁吃了蛋糕，但是没吃黄瓜或者辣椒 (mǎyǐ chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The ant has eaten the cake, but it has not eaten the cucumber or the pepper.
3	One disjunct false, silver medal	OR in VP	El lobo se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The wolf has eaten the cake, but it has not eaten the cucumber or the pepper.	狼吃了蛋糕，但是没吃黄瓜或者辣椒 (láng chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The wolf has eaten the cake, but it has not eaten the cucumber or the pepper.
4	One disjunct false, silver medal	OR in VP	El ratón se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The mouse has eaten the cake, but it has not eaten the cucumber or the pepper.	老鼠吃了蛋糕，但是没吃黄瓜或者辣椒 (lǎoshǔ chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The mouse has eaten the cake, but it has not eaten the cucumber or the pepper.
5	Two disjuncts false, sad face	OR in VP	El ciervo se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The deer has eaten the cake, but it has not eaten the cucumber or the pepper.	鹿吃了蛋糕，但是没吃黄瓜或者辣椒 (lù chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The deer has eaten the cake, but it has not eaten the cucumber or the pepper.
6	Two disjuncts false, sad face	OR in VP	El gorila se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The gorilla has eaten the cake, but it has not eaten the cucumber or the pepper.	猩猩吃了蛋糕，但是没吃黄瓜或者辣椒 (xīngxing chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The gorilla has eaten the cake, but it has not eaten the cucumber or the pepper.
7	Two disjuncts false, sad face	OR in VP	El búho se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The owl has eaten the cake, but it has not eaten the cucumber or the pepper.	猫头鹰吃了蛋糕，但是没吃黄瓜或者辣椒 (māotóuyīng chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The owl has eaten the cake, but it has not eaten the cucumber or the pepper.
8	Two disjuncts false, sad face	OR in VP	El caracol se ha comido la tarta, pero no se ha comido el pepino o el pimiento. = The snail has eaten the cake, but it has not eaten the cucumber or the pepper.	蜗牛吃了蛋糕，但是没吃黄瓜或者辣椒 (wōniú chī le dàngāo, dànshì méi chī huángguā huòzhě làjiāo). = The snail has eaten the cake, but it has not eaten the cucumber or the pepper.
9	One disjunct false, silver medal	Preposed OR	El mono se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido. = The monkey has eaten the cake, but the cucumber or the pepper, it has not eaten.	猴子吃了蛋糕，但是黄瓜或者辣椒没吃 (hóuzi chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī). = The monkey has eaten the cake, but the cucumber or the pepper, it has not eaten.
10	One disjunct false, silver medal	Preposed OR	El pato se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido. = The duck has eaten the cake, but the cucumber or the pepper, it has not eaten.	鸭子吃了蛋糕，但是黄瓜或者辣椒没吃 (yāzi chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī). = The duck has eaten the cake, but the cucumber or the pepper, it has not eaten.
11	One disjunct false, silver medal	Preposed OR	La paloma se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido.	鸽子吃了蛋糕，但是黄瓜或者辣椒没吃 (gēzi chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī).

(*continued on next page*)

Table A3 (*continued*)

Item	Condition, award	Position	Test Sentence (Spanish)	Test Sentence (Mandarin)
			= The pigeon has eaten the cake, but the cucumber or the pepper, it has not eaten.	= The pigeon has eaten the cake, but the cucumber or the pepper, it has not eaten.
12	One disjunct false, silver medal	Preposed OR	La cebra se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido. = The zebra has eaten the cake, but the cucumber or the pepper, it has not eaten.	斑马吃了蛋糕，但是黄瓜或者辣椒没吃 (bānmǎ chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī). = The zebra has eaten the cake, but the cucumber or the pepper, it has not eaten.
13	Two disjuncts false, sad face	Preposed OR	El conejo se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido. = The rabbit has eaten the cake, but the cucumber or the pepper, it has not eaten.	兔子吃了蛋糕，但是黄瓜或者辣椒没吃 (tùzi chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī). = The rabbit has eaten the cake, but the cucumber or the pepper, it has not eaten.
14	Two disjuncts false, sad face	Preposed OR	El leopardo se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido. = The leopard has eaten the cake, but the cucumber or the pepper, it has not eaten.	豹子吃了蛋糕，但是黄瓜或者辣椒没吃 (bàozi chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī). = The leopard has eaten the cake, but the cucumber or the pepper, it has not eaten.
15	Two disjuncts false, sad face	Preposed OR	El águila se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido. = The eagle has eaten the cake, but the cucumber or the pepper, it has not eaten.	鹰吃了蛋糕，但是黄瓜或者辣椒没吃 (yīng chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī). = The eagle has eaten the cake, but the cucumber or the pepper, it has not eaten.
16	Two disjuncts false, sad face	Preposed OR	La abeja se ha comido la tarta, pero, el pepino o el pimiento, no se lo ha comido. = The bee has eaten the cake, but the cucumber or the pepper, it has not eaten.	蜜蜂吃了蛋糕，但是黄瓜或者辣椒没吃 (mìfēng chī le dàngāo, dànshì huángguā huòzhě làjiāo méi chī). = The bee has eaten the cake, but the cucumber or the pepper, it has not eaten.
17	Filler true, gold medal	-	El perro se lo ha comido todo. = The dog ate everything.	狗吃了所有的东西 (gǒu chī le suǒyǒu de dōngxi). = The dog ate everything.
18	Filler true, gold medal	-	El gato se lo ha comido todo. = The cat ate everything.	猫吃了所有的东西 (māo chī le suǒyǒu de dōngxi). = The cat ate everything.
19	Filler true, gold medal	-	El oso se lo ha comido todo. = The bear ate everything.	熊吃了所有的东西 (xióng chī le suǒyǒu de dōngxi). = The bear ate everything.
20	Filler true, gold medal	-	El elefante se lo ha comido todo. = The elephant ate everything.	大象吃了所有的东西 (dàxiàng chī le suǒyǒu de dōngxi). = The elephant ate everything.
21	Filler false, gold medal	-	La tortuga no se ha comido nada. = The tortoise ate nothing.	乌龟什么也没吃 (wūguī shénme yě méi chī). = The tortoise ate nothing.
22	Filler false, gold medal	-	El canguro no se ha comido nada. = The kangaroo ate nothing.	袋鼠什么也没吃 (dàishǔ shénme yě méi chī). = The kangaroo ate nothing.
23	Filler false, gold medal	–	La oveja no se ha comido nada. = The sheep ate nothing.	羊什么也没吃 (yáng shénme yě méi chī). = The sheep ate nothing.
24	Filler false, gold medal	–	La vaca no se ha comido nada. = The cow ate nothing.	牛什么也没吃 (niú shénme yě méi chī). = The cow ate nothing.

Table A4
Effects summary: Logistic regression model L1 Spanish vs L2 Spanish (response ~ group*condition*position).

Fixed effects	Estimate	Std. Error	z value	p	Power
(Intercept)	1.05	0.21	5.06	< 0.001	0.99
groupL2 Spanish	−1.64	0.28	−5.80	< 0.001	1.00
conditiontwo disjuncts false	−1.94	0.29	−6.71	< 0.001	1.00
positionPreposed OR	0.09	0.30	0.30	0.77	0.06
groupL2 Spanish:conditiontwo disjuncts false	3.14	0.40	7.94	< 0.001	1.00
groupL2 Spanish:positionPreposed OR	−0.09	0.40	−0.22	0.83	0.05
conditiontwo disjuncts false:positionPreposed OR	−0.21	0.41	−0.51	0.61	0.09
groupL2 Spanish:conditiontwo disjuncts false:positionPreposed OR	0.14	0.56	0.25	0.80	0.05

Table A5
Effects summary: Logistic regression model L1 Mandarin vs L2 Mandarin (response ~ group*condition*position).

Fixed effects	Estimate	Std. Error	z value	p	Power
(Intercept)	2.40	0.33	7.26	< 0.001	1.00
groupL2 Mandarin	−2.70	0.38	−7.14	< 0.001	1.00
conditiontwo disjuncts false	−5.04	0.49	−10.22	< 0.001	1.00
positionPreposed OR	0.00	0.47	0.00	1	0.02
groupL2 Mandarin:conditiontwo disjuncts false	5.78	0.56	10.35	< 0.001	1.00
groupL2 Mandarin:positionPreposed OR	−0.07	0.54	−0.13	0.90	0.04
conditiontwo disjuncts false:positionPreposed OR	0.13	0.69	0.18	0.85	0.05
groupL2 Mandarin:conditiontwo disjuncts false:positionPreposed OR	−0.20	0.78	−0.25	0.80	0.07

Table A6
Effects summary: Firth's penalized logistic regression model on Proficiency, L2 Spanish (response ~ condition*proficiency).

Fixed effects	Estimate	Std. Error	95% CI lower	95% CI upper	$\chi^2(1)$	p	Power
(Intercept)	0.74	0.25	0.27	1.25	9.47	< 0.01	0.84
proficiencyBeginner	−4.20	0.87	−6.42	−2.79	60.70	< 0.001	1.00
proficiencyIntermediate	−1.55	0.32	−2.18	−0.93	25.34	< 0.001	0.99
conditiontwo disjuncts false	−1.43	0.35	−2.13	−0.75	17.48	< 0.001	0.98
conditiontwo disjuncts false:proficiencyBeginner	9.46	1.68	6.85	14.52	> 100	< 0.001	1.00
conditiontwo disjuncts false:proficiencyIntermediate	2.99	0.45	2.12	3.88	47.64	< 0.001	1.00

Table A7
Effects summary: Firth's penalized logistic regression model on Proficiency, L2 Mandarin (response ~ condition*proficiency).

Fixed effects	Estimate	Std. Error	95% CI lower	95% CI upper	$\chi^2(1)$	p	Power
(Intercept)	0.40	0.32	−0.22	1.04	1.57	0.21	0.22
proficiencyBeginner	−0.64	0.39	−1.42	0.11	2.78	0.1	0.36
proficiencyIntermediate	−1.05	0.37	−1.79	−0.32	8.12	< 0.01	0.81
conditiontwo disjuncts false	−0.79	0.45	−1.69	0.08	3.14	0.08	0.45
proficiencyBeginner:conditiontwo disjuncts false	1.34	0.55	0.27	2.43	5.99	< 0.05	0.67
proficiencyIntermediate:conditiontwo disjuncts false	2.13	0.53	1.11	3.17	16.80	< 0.001	0.98

Data availability

Anonymized data have been deposited in the Open Science Framework database (https://osf.io/uhbz4)

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