



The Compositionality of Logical Connectives in Child Italian

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Abstract

This paper investigates the interpretation that Italian-speaking children and adults assign to negative sentences with disjunction and negative sentences with conjunction. The aim of the study was to determine whether children and adults assign the same interpretation to these types of sentences. The Semantic Subset Principle (SSP) (Crain et al., in: Clifton, Frazer, Rayner (eds) *Perspective on sentence processing*, Lawrence Erlbaum, Hillsdale, 1994) predicts that children's initial scope assignment should correspond to the interpretation that makes sentences true in the narrowest range of circumstances, even when this is not the interpretation assigned by adults. This prediction was borne out in previous studies in Japanese, Mandarin and Turkish. As predicted by the SSP, the findings of the present study indicate that Italian-speaking children and adults assign the same interpretation to negative sentences with conjunction (conjunction takes scope over negation). By contrast, the study revealed that some children differed from adults in the interpretation they assigned to negative sentences with disjunction. Adults interpreted disjunction as taking scope over negation, whereas children were divided into two groups: one group interpreted disjunction as taking scope over negation as adults did; another group interpreted negation as taking scope over disjunction, as predicted by the SSP. To explain the findings, we propose that Italian-speaking children initially differ from adults as dictated by the SSP, but children converge on the adult grammar earlier than children acquiring other languages due to the negative concord status of Italian, including the application of negative concord to sentences with disjunction.

Keywords Child language · Disjunction · Conjunction · Negation · Negative concord · Italian

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Introduction

In classical logic, the truth conditions associated to disjunction ‘ \vee ’ correspond to inclusive-*or*. An expression of the form $A \vee B$ is true in three circumstances: when only A is true, when only B is true, and when both A and B are true. Therefore an expression of the form $A \vee B$ is only false in circumstances in which both A and B are false. Negation reverses the truth conditions, so a formula of the form $\neg(A \vee B)$ is true only if both A and B are false. This is stated by one of De Morgan’s laws of propositional logic: $\neg(A \vee B) \Rightarrow \neg A \wedge \neg B$ (where ‘ \Rightarrow ’ represents logical entailment and ‘ \wedge ’ is conjunction). That is, a negated disjunction is logically equivalent to the conjunction of two negated expressions (i.e., the two disjuncts from the original formula). We will express this logical equivalence by saying that a negated disjunction generates a conjunctive entailment.

Natural languages sometimes mirror classical logic in generating a conjunctive entailment when disjunction appears in simple negative sentences. Example (1) is a simple negative sentence with disjunction in English, i.e., where disjunction and negation reside in the same clause. When English disjunction appears in the scope of negation, as in (1), it generates a conjunctive entailment, as the logical equivalence of (1) and (2) indicates. Therefore, the English expression for disjunction, OR, is interpreted in accordance with De Morgan’s law, i.e., as inclusive-*or*. In other words, a ‘neither’ interpretation is assigned by English speakers to sentences such as (1). Another language that patterns this way is German. In this class of languages, negation takes scope over disjunction (NEG>OR).

- (1) John doesn’t drink coffee or tea.
 (2) John does not drink coffee **and** John does not drink tea.

In another class of languages, including Japanese and Mandarin Chinese, disjunction does not generate a conjunctive entailment in simple negative sentences. In this class of languages, disjunction is interpreted as taking scope over local negation (OR>NEG). The word-by-word analogues to sentence (1) in Japanese and Mandarin Chinese are assigned a ‘not both’ interpretation by adult speakers, as indicated in (3). The interpretation assigned by adult speakers of Mandarin and Japanese can be paraphrased using an English cleft structure, where disjunction takes scope over negation in the surface syntax: *It is coffee or tea that John does not drink*. The meaning of this English cleft sentence is logically equivalent to (3), where the primary logical connective is disjunction.

- (3) John does not drink coffee **or** John does not drink tea.

Turning to negative sentences with conjunction, the relevant law of propositional logic is $\neg(A \wedge B) \Rightarrow \neg A \vee \neg B$. In English, negative sentences with conjunction are interpreted in accordance with this law, with negation taking scope over conjunction in sentences such as (4). Therefore, example (4) is judged to be true in the same circumstances as sentence (5), where the primary logical connective is disjunction.

- (4) Mark doesn’t speak French and German.
 (5) Mark does not speak French **or** Mark does not speak German.

In contrast to English, adult speakers of Mandarin and Japanese interpret sentences such as (4) as having a ‘neither’ meaning rather than a ‘not both’ meaning. So, the sentences in Mandarin and Japanese that are analogous to (4) are judged to be true only if Mark doesn’t speak French and doesn’t speak German. This interpretation corresponds to the English cleft

sentence in which conjunction takes scope over negation in the surface syntax: *It is French and German that Mark doesn't speak*.

To summarize, human languages are found to assign a different scope for sentences that contain negation and disjunction, and for those that contain negation and conjunction. In English sentences where negation has scope over either of these connectives in the surface syntax, adult English speakers interpret negation to take scope over both connectives at the level of semantic interpretation. By contrast, when negation has scope over either one of these connectives in the surface syntax, speakers of Japanese and Mandarin Chinese analyse both conjunction and disjunction as taking scope over negation at the level of semantic interpretation. Adult speakers of Mandarin and Chinese assign the 'inverse scope' interpretation.

Following a suggestion by Szabolcsi (2002), Goro (2004) and Crain (2012), we will attribute the cross-linguistic variation in scope assignment to two lexical parameters. One of these lexical parameters is called the Disjunction Parameter and the other is called the Conjunction Parameter. The Disjunction Parameter governs the interpretation of disjunction in simple negative sentences, as well as in several other downward entailing linguistic environments. The Conjunction Parameter governs the interpretation of conjunction in simple negative sentences.

On the 'plus' value of these lexical parameters, the logical concepts OR and AND are analysed as Positive Polarity Items, so this value can be designated as +PPI. On the alternative 'minus' value, the logical concepts OR and AND are not analysed as Positive Polarity Items, so they are marked –PPI.¹ By definition, an expression that is +PPI cannot be interpreted in the scope of negation, regardless of its position in surface syntax. In English and German, both disjunction and conjunction are –PPI, so neither of these logical concepts is a Positive Polarity Item. In Mandarin Chinese and in Japanese, the expressions for disjunction and conjunction are +PPI, hence these expressions are assigned the 'plus' value of both lexical parameters.²

The aim of the present study is, first, to determine whether the Italian expressions that designate disjunction and conjunction ('*o*' and '*e*' respectively) are +PPI or –PPI. Intuitively, both expressions take scope over negation for adult speakers of Italian, so Italian is expected to fall into the class of languages that includes Mandarin and Japanese i.e., languages in which disjunction and conjunction are +PPI. The second aim of the present study is to investigate the acquisition of scope relations for both of these logical expressions. The study is based on two experimental hypotheses. The first experimental hypothesis is that children acquiring Italian will initially differ from adults in the assignment of scope relations to negative sentences with disjunction. The second experimental hypothesis is that children acquiring Italian will initially adopt the same scope assignments as adults in response to negative sentences with conjunction. The source of these predictions is a principle of language learnability called the Semantic Subset Principle (SSP) (Crain et al. 1994). This principle and empirical evidence in support of it are discussed in the next two sections.

¹ Two potential misunderstandings are worth noting from the outset. First, it is important to note that expressions that are –PPI are not Negative Polarity Items (NPIs). Rather, they are interpreted in situ. It is worth noting, second, that De Morgan's laws do not govern logical connectives that take scope over negation. So, languages in which disjunction or conjunction takes scope over negation do not violate De Morgan's laws. If a logical connective takes scope over negation, it has the same truth conditions in negative sentences as it does in affirmative sentences.

² There are exceptions to this generalization. One exception arises when negation appears outside the clause that contains either conjunction or disjunction. In sentences with this syntactic structure, the polarity sensitivity of conjunction or disjunction is lost, such that negation takes a wide scope. This is characteristic of Positive Polarity Items more generally (see Crain 2012). The present paper focuses on "simple" negative sentences, i.e., ones in which negation and either conjunction or disjunction resides in the same clause.

The Semantic Subset Principle

The prediction that children will not acquire the meanings of logical expressions by attending to adult usage invites us to ask why children would assign different values to lexical parameters than adults do, and how they change their initial value when it differs from that of adult speakers of the local language. Both of these questions are answered by invoking a principle of language learnability, i.e., the subset principle. The principle of language learnability was proposed in response to the empirical discovery that children do not have access to negative evidence, such as corrective feedback (Bowerman 1988; Brown and Hanlon 1970; Marcus 1993; Morgan and Travis 2017; Pinker 1990). In the absence of negative evidence, it is critical for children acquiring any language to initially assign a specific value to certain lexical parameters, including both the Disjunction Parameter and the Conjunction Parameter. Negative sentences with disjunction, and those with conjunction can be mapped onto two different interpretations. Whenever sentences contain two (or more) logical operators, there is a potential for scope ambiguity. A potential problem for language learnability arises whenever the ambiguity involves interpretations that are in a subset/superset relation, i.e., where the meanings generated by sentences on the alternative values stand in an asymmetrical entailment relation. The Semantic Subset Principle (SSP) (Crain et al. 1994; Moscati and Crain 2014) is a learning principle that guides children's initial selection of one value of these lexical parameters: children are compelled to initially select the value that generates interpretations that make sentences true in the narrowest range of circumstances (the subset value), as stated in (6), which is the initial formulation of the SSP, by Crain et al. (1994, p. 455):

- (6) If the interpretative component of UG makes two interpretations, A and B, available for a sentence S, and if interpretation A makes S true in a narrower range of circumstances than interpretation B does, then interpretation A is hypothesized before B in the course of language development.

In the case of lexical parameters, children's initial interpretation will sometimes be based on a parameter value that differs from the value that is adopted by adult speakers of the local language. If language learners initially hypothesize an interpretation that makes a sentence true in the narrowest range of circumstances, as dictated by the SSP, then children will be able to revise their initial non-adult value of the parameter using positive evidence in languages where adults adopt the superset value of the parameter. The positive evidence of parameter resetting will consist of sentence/meaning pairs that make sentences false on the value of the parameter that is initially adopted by children. This solution to the learnability problem supposes that 'detectable errors' that expose differences between the grammars of children and adults prompt parameter resetting (for discussion, see Wexler and Culicover 1980, chapter 4).

In the case of the Disjunction Parameter, the SSP instructs children to initially adopt the subset value, i.e., –PPI. On this value, negation takes scope over disjunction (NEG > OR). This value of the Disjunction Parameter generates the 'neither' interpretation. In contrast to child language learners, the value assigned to the Disjunction Parameter by adult speakers of many languages is +PPI (e.g., Japanese, Mandarin Russian, Turkish). This value generates the 'not both' interpretation. The terms *stronger* and *weaker* refer to the information that is conveyed by the meanings of sentences that are licensed by the alternative values of a lexical parameter, where a value that licenses sentences with *stronger* semantic interpretations is one that makes sentences true in fewer circumstances. From this information-theoretic perspective, the +PPI setting of the Disjunction Parameter makes negative sentences with disjunction true in a superset of the circumstances that correspond to the –PPI value of the parameter. To avoid problems of language learnability in the absence of negative evidence, the

SSP predicts that children acquiring languages in which the adult value is +PPI will initially license fewer interpretations than adult speakers do in response to negative sentences with disjunction. Because adults license interpretations that are initially excluded by children, these interpretations can be used by children to jettison the original parameter value in favour of the one that is adopted by adult speakers of the local language.

In the case of the Conjunction Parameter, the SSP instructs children to initially adopt the +PPI value of the parameter. The ‘plus’ value of the Conjunction Parameter generates the *stronger* ‘neither’ interpretation because it licenses the scope assignment on which conjunction takes scope over negation (AND > NEG). On the alternative value of the Conjunction Parameter, –PPI, negation takes a wide scope, NEG > AND. The –PPI value generates the *weaker* ‘not both’ interpretation. On the +PPI value of the Conjunction Parameter, sentences are true in a subset of the circumstances that correspond to the value –PPI. Therefore, the SSP predicts that English-speaking children and adults will differ in the interpretations they assign to negative sentences with conjunction. Non-linguistic contexts that make simple negative sentences with conjunction true on the ‘not both’ interpretation will serve as the impetus for children to reset the Conjunction Parameter from the initial +PPI value that is instigated by the SSP.

Literature Review

The emergence of knowledge about the interpretation of negative sentences with disjunction and negative sentences with conjunction is directly relevant to the “nature versus nurture” controversy. This has led to investigations of children’s interpretation of negative sentences with these logical expressions in several languages. We will review the findings from some representative studies.

Crain and colleagues (Crain et al. 2002) presented sentences like (7) to English-speaking children (ranging in age from 3;11 to 5;9) using a variant of the Truth Value Judgment Task (TVJT) called the Prediction Mode (see Crain and Thornton 1998). In English, both OR and AND are –PPI. On a typical trial, a puppet produced sentence (7) as the story unfolded, as a prediction about what would happen at the completion of the story.

(7) The girl who stayed up late will not get a dime *or* a jewel.

At the end of the story, the girl who stayed up late received a jewel, but not a dime. The child participants were then asked whether the puppet’s prediction had been right or wrong; if the child participants provided a negative judgment (rejecting the puppet’s statement), then the experimenter asked the child to tell “what really happened?” in the story. The findings of this study were taken as evidence that both English-speaking children and adults interpreted (7) to entail that the girl would receive neither a dime nor a jewel. Thus, both children and adults generated a conjunctive entailment and therefore assigned a ‘neither’ interpretation to sentences like (7) (see also Chierchia et al. 2001; Gualmini and Crain 2002, 2004).³

The interpretation of disjunction in simple negative sentences was also investigated in Japanese (Goro and Akiba 2004a, b; Goro 2007), a language in which both OR and AND

³ Children’s justifications for rejecting the puppet’s statement reinforced this analysis of the findings. For example, children justified their rejections to (7) by pointing out that the girl who stayed up late had received a jewel. This justification indicates that children interpreted negation as taking scope over disjunction in the test sentences (NEG > OR). This scope assignment is logically equivalent to a conjunction of two negated expressions: *The girl who stayed up late will not get a dime and The girl who stayed up late will not get a jewel.*

are +PPI. Japanese-speaking children (ranging in age from 3;7 to 6;3) and adults were tested using a TVJT in what is called the Uncertainty Mode. In the experiment, participants were asked to judge the truth of sentences like (8); if participants provided a negative judgment, then the experimenter asked them to tell what really happened in the story. Since the test sentences were presented in the Uncertainty Mode, it was felicitous for the puppet to use the past tense form of the verb. The experimental context was designed to make it clear to the participants that only one of the disjuncts was true, but it was not clear which disjunct was true. This was achieved by removing the food items mentioned in the test sentences, and indicating how many food items the character in the story had eaten using a system of rewards, where characters who had eaten only one item were rewarded with a silver medal. All of the relevant test trials were ones in which the character had a silver medal.

- (8) Butasan-wa ninjin *ka* piiman-wo tabe-*nakat*-ta.
 Pig-TOP carrot or pepper-ACC eat-NEG-PAST.
 ‘The pig didn’t eat the carrot or the pepper’.

The results of the Goro and Akiba studies revealed a major difference in the pattern of responses between the child and the adult participants for test sentences like (8): on one hand children assigned a ‘neither’ interpretation (NEG>OR) in accordance with De Morgan’s laws; on the other hand, adults assigned a ‘not both’ interpretation (OR>NEG), thereby making De Morgan’s laws inapplicable. To explain the adult pattern of responses, Goro and Akiba argued that, for adults, the Japanese expression for disjunction, *ka*, is +PPI. Therefore, disjunction is not interpreted in the scope of local negation, regardless of its position in the surface syntax. It is straightforward to see that the ‘neither’ interpretation makes sentences true in a narrower range of circumstances than the ‘not both’ interpretation. As noted earlier, the SSP compels child language learners to initially assign the – PPI setting to disjunction, regardless of the value that is adopted by adult speakers of the local language. This explains why the child participants interpreted Japanese sentences with *ka* in the same way as child and adult English-speakers did, and also why the child participants differed in their scope assignments from adults. The finding that children and adults initiate different scope assignments renders it highly implausible to suppose that the acquisition process is governed exclusively by the input, as Japanese-speaking children do not start from adults’ scope assignments.

The same pattern of responses by children and adults that was found in the Goro and Akiba study of Japanese-speaking children was also reported in a study of children acquiring Mandarin Chinese (Crain 2012). In Mandarin, both the words for OR and AND are +PPI. Although Mandarin-speaking adults assign a ‘not both’ interpretation to the Mandarin equivalent to sentence (8), Mandarin-speaking children were found to generate a conjunctive entailment and therefore assigned a ‘neither’ interpretation to these sentences.

In addition to negative Japanese sentences with disjunction, Goro (2007), and Goro and Akiba (2004a, b) investigated negative sentences with conjunction (...*mo* ... *mo*) such as (9).

- (9) Butasan-wa ninjin *mo* piiman *mo* tabe-*nakat*-ta.
 Pig-TOP carrot also pepper also eat-NEG-PAST.
 ‘The pig didn’t eat both the carrot and the pepper’.

In this case, the child participants evinced the same pattern of linguistic behavior as adults did; both groups assigned a ‘neither’ interpretation, thus conjunction was interpreted as taking scope over negation (AND>NEG). This finding was also consistent with the SSP.

Further support for the SSP was offered in a study by Geçkin et al. (2016) about the interpretations that Turkish-speaking children and adults assign to negative sentences with disjunction and to negative sentences with conjunction. Turkish is more complex than the other languages discussed so far. As (10) and (11) illustrate, Turkish disjunction is expressed by two distinct morphemes, *ya... ya da* and *veya*. Both expressions are tolerated in both disjunction phrases that are case-marked and in ones that are not case marked. Geçkin et al. 2016 propose that *veya* and *ya da* are – PPI in Turkish, but that the accusative case marking is +PPI (see also Geçkin et al. 2017). Turkish conjunction is expressed by *hem (de)*. As with disjunction phrases, conjunctive phrases can either be case-marked or not in Turkish. The following examples are from Geçkin et al. (2016), where DIM refers to the diminutive affix.

- (10) Domuz-cuk *ya* havuc-u *ya da* biber-i *ye-me*-di.
 This animal-DIM either carrot-ACC or pepper-ACC eat-NEG-PAST.
 Meaning: ‘It was either a certain carrot or a certain pepper that this animal didn’t eat’.
- (11) Domuz-cuk havuç *veya* biber *ye-me*-di.
 This animal-DIM carrot or pepper eat-NEG-PAST.
 Meaning: ‘This animal didn’t eat carrots and this animal didn’t eat peppers’.
- (12) Domuz-cuk *hem* havuc-u *hem (de)* biber-i *ye-me*-di.
 This animal-DIM both carrot-ACC both also pepper-ACC eat-NEG-PAST.
 Meaning: ‘This animal didn’t eat a certain carrot and this animal didn’t eat a certain pepper’.
- (13) Domuz-cuk *hem* havuç *hem (de)* biber *ye-me*-di.
 This animal-DIM both carrot both (also) pepper eat-NEG-PAST.
 Meaning: ‘This animal didn’t eat carrots and this animal didn’t eat peppers’.

Children (ranging in age from 4;01 to 5;11) and adults were tested using the Uncertainty Mode of the TVJT, as in the studies by Goro and Akiba (Goro 2007; Goro and Akiba 2004a, b). The results⁴ showed that children acquiring Turkish assigned a ‘neither’ interpretation to negative sentences with disjunction, regardless of case marking, in line with De Morgan’s laws. That is, children analysed negation as taking scope over disjunction (NEG>OR) for disjunctive phrases both with and without the accusative case marker. By contrast, adults only assigned a ‘neither’ interpretation to sentences in which the disjunctive phrase was not case-marked (NEG>OR). Adults assigned a ‘not both’ interpretation (OR>NEG) to sentences in which the disjunction phrase was case-marked. In response to sentences with conjunction, both children and adults assigned a ‘neither’ interpretation (AND>NEG), when they were case-marked and when they were not.

In another experiment, Geçkin et al. (2017) compared the interpretation assigned to negative sentences with disjunction by German-speaking children (ranging in age from 4;01 to 5;08) and Turkish-speaking children (from 4;01 to 5;11). In German, both OR and AND are – PPI. Example (14) is one of the German test sentences and (15) is one from Turkish.

⁴ Geçkin et al. (2016) found similar results for *ya... ya da* and *veya*.

(14) Diese Tier hat nicht die Karotte *oder* die Paprika gegessen.
 This animal did not the carrot or the pepper eat-PAST.
 ‘This animal didn’t eat the carrot or the pepper’.

(15) Bu hayvan-cık *ya* havoc-u *ya da* biber-i *ye-me-di*.
 This animal-DIM either carrot-ACC or pepper ACC eat-NEG-PAST.
 ‘It’s a certain carrot or a certain pepper that the animal did not eat’.

Participants were tested using the Uncertainty Mode of the TVJT. The results showed that both German-speaking children and German-speaking adults assigned a ‘neither’ interpretation to negative sentences with disjunction (NEG > OR), in line with De Morgan’s laws. By contrast, Turkish-speaking children differed from their adult counterparts: Turkish-speaking children also assigned a ‘neither’ interpretation (NEG > OR), whereas Turkish adults assigned a ‘not both’ interpretation (OR > NEG). Importantly, the results by Turkish-speaking children did not differ significantly from those by German-speaking children or German-speaking adults.

Additional confirmation for the SSP was revealed in a study by Notley et al. (2016). These researchers assessed the interpretation of simple negative sentences with conjunction by English- and Mandarin-speaking children. The Mandarin-speaking children ranged in age from 4;1 to 4;8. The children and a control group of adults were tested using the Uncertainty Mode of the TVJT (Goro 2007; Goro and Akiba 2004a, 2004b). All participants, both children and adults, were divided into two groups to assess the contribution of the quantificational adverb *dou* ‘all’ to the interpretation of conjunction in simple negative sentences. Notice that negation precedes conjunction in (16), whereas conjunction precedes negation in sentence (17), because the adverb *dou* ‘all’ is typically associated with expressions that precede it in the surface syntax. This enabled the study to determine whether or not word order has an influence on scope assignment.

(16) Xiaoxiang *meiyou* chi huluobo *he* qingjiao.
 Elephant not eat carrot and capsicum.
 ‘The elephant didn’t eat the carrot and the capsicum’.

(17) Xiaoxiang huluobo *he* qingjiao *dou mei* chi
 Elephant carrot and capsicum both not eat
 ‘The elephant didn’t eat both the carrot and the capsicum’.

The results showed that both Mandarin-speaking children and adults assigned a ‘neither’ interpretation to sentences such as (16) and (17). Therefore, it was concluded that they analysed conjunction as taking scope over negation regardless of word order.

The Notley et al. study also included English-speaking children (ranging in age from 3;10 to 5;6), as well as a control group of English-speaking adults. An example sentence from the study is (18).

(18) The elephant didn’t eat both the carrot and the capsicum.

The English-speaking children’s responses differed from the English-speaking adults’ responses: children assigned a ‘neither’ interpretation to test sentences like (18), thus they were taken to have analysed conjunction as having a wider scope than negation (AND > NEG), whereas adults assigned a ‘not both’ interpretation to the test sentences, with negation taking scope over conjunction (NEG > AND).

An Alternative to the Disjunction Parameter

The review of previous research leads to some interesting conclusions. First, we have seen cross-linguistic variation in the interpretation of logical connectives in negative sentences. We attributed this variation to two lexical parameters. The values of these parameters reflect whether or not the logical connective is analysed as +PPI or –PPI. Most important is the finding that children acquiring one class of languages initially assign a different value to these lexical parameters than adults do. This observation suggests that children do not learn the meaning of logical connectives in these languages by observing how adults use these words. This finding is evidence against the kind of *meaning-is-use* account of the acquisition of logical expressions proposed by Dummett (1978) and by Quine (1992).

The differences observed in the linguistic behaviour by children and adults in interpreting negative sentences with disjunction, such as the English sentence *John didn't eat pasta or sushi*, have been attributed to a lexical parameter, the Disjunction Parameter. The two values of the parameter form a subset/superset relationship. This poses a potential problem of language learnability, which can be called a subset problem. As we have seen, it has been proposed that children avoid subset problems by initially assigning the subset value, –PPI, to the Disjunction Parameter. On this value, negation takes scope over disjunction in negative sentences. It follows that children acquiring English or German initially adopt the same setting of the parameter as adult speakers of these languages. By contrast, children acquiring Japanese, Mandarin and Turkish are expected to initially adopt a different parameter value than adults do, because adult speakers of these languages have switched to the superset value of the parameter, +PPI, at some point in the course of language development. The fact that children acquiring all languages initially adopt the subset value of the parameter ensures that they will encounter positive evidence to converge on a grammar that is equivalent to that of adult speakers, regardless of the value of the parameter in the local language.

There is another way, however, to account for the interpretations that children initially assign to negative sentences with disjunction. On the alternative account, children acquiring all languages initially analyse disjunction as a Positive Polarity Item. On this account, the initial hypothesis of children acquiring all languages is that disjunction takes scope over negation in simple negative sentences.

If disjunction is a Positive Polarity Item for children, as the alternative account contends, it clearly cannot generate a conjunctive entailment for children acquiring English or German. Nevertheless, the alternative account proposes that children produce the same pattern of linguistic behaviour as adult speakers of these languages, but for a different reason. So, negative sentences with disjunction generate conjunctive entailments for adults, whereas children assign the same interpretations without generating conjunctive entailments. On the alternative account, only the adult pattern of behaviour is explained as a consequence of the fact that adults analyse disjunction as +PPI. According to the alternative account, although disjunction takes scope over negation for children, this does not result in the same pattern of behaviour for children and adults. In both classes of languages, children's pattern of behaviour is attributed to a conjunctive inference. Children's conjunctive inference mirrors the conjunctive entailment that is generated by adult speakers of English or German. Moreover, children's conjunctive inference explains why children acquiring Japanese, Mandarin and Turkish produce a different pattern of responses than adult speakers of these languages.

The conjunctive inference that children license for negative sentences with disjunction is based on the same cognitive algorithm used by adult English speakers to license a conjunctive

inference in sentence (19), where disjunction is in the scope of a deontic modal verb phrase, *is allowed to*.

(19) John is allowed to eat pasta or sushi.

The deontic modal verb phrase, *is allowed to*, confers a conjunctive free choice interpretation to disjunction in (19), so (19) implies that John is allowed to eat pasta **and** John is allowed to eat sushi. The alternative account of children's linguistic behaviour contends that children acquiring all languages initially derive conjunctive inferences for ordinary sentences with disjunction, i.e., ones that lack a licensing expression. To understand the proposal, we will first sketch how the conjunctive inference is derived in sentences with a licensing expression, such as (19). Then, we will explain children's conjunctive inferences in sentences with disjunction, but without a licensing expression.

According to several recent approaches, conjunctive (free choice) inferences are derived in two steps (Alonso-ovalle 2006; Chemla 2009; Chierchia 2013; Fox 2007; Franke 2011; Klinedinst 2007; Kratzer and Shimoyama 2002; Rooij 2010). The first step is to formulate alternatives to the asserted sentence, such as (19), and to compare these alternatives to the speaker's original assertion. These alternatives are statements that the speaker could have made, but did not. The alternatives to (19) are two sentences, each containing only one of the disjuncts, i.e., *Jack is allowed to eat pasta* and *Jack is allowed to eat sushi*. At the first step in the derivation of a conjunctive inference, each of these alternative sentences is enhanced by adding to it an inference that it licenses. Consider the alternative *Jack is allowed to eat pasta*. Someone who utters this sentence will be taken to imply that Jack is only allowed to eat pasta, and isn't allowed to eat sushi. Similarly, the sentence *Jack is allowed to eat sushi* implies that Jack isn't allowed to eat pasta. When an alternative sentence is combined with the inferences it licenses, the result is called an enhanced alternative.

At the second step in the derivation of a conjoined inference, the original assertion is assessed against each of the enhanced alternatives that have been generated during the first step. The second step invokes the algorithm that generates scalar implicatures. According to this algorithm, any enhanced alternative that is stronger than the original assertion is negated. Both of the enhanced alternatives generated during the first step are stronger than the original statement (19), so they are both negated. At this point in the derivation, three propositions are operative: the original assertion and the negations of the two enhanced alternatives. The negations of the two enhanced alternatives are: *It's not the case that Jack is allowed to eat pasta and not sushi*, and *It's not the case that Jack is allowed to eat sushi and not pasta*. Each of the negated enhanced alternatives is logically equivalent to a conditional statement: *If Jack is allowed to eat pasta, then he is allowed to eat sushi*, and *If Jack is allowed to eat sushi, then he is allowed to eat pasta*. Taken together, the three remaining propositions assert, first, that Jack is allowed to eat pasta or sushi, and, second, if Jack is allowed to eat either one, then he is allowed to eat the other. Thus, the output of the algorithm is the conjunctive inference that Jack is allowed to eat pasta **and** Jack is allowed to eat sushi.

The alternative account of children's interpretation of negated disjunctions proposes that children invoke the same two-step algorithm when they encounter ordinary sentences with disjunction, i.e., ones with a licensing expression. Some researchers have interpreted the findings of their studies as evidence for this proposal (Singh et al. 2016; Tieu et al. 2017). According to these researchers, children license conjunctive inferences for ordinary disjunctive statements such as (20).

(20) John ate pasta or sushi.

Now let us return to negative sentences with disjunction, as in (21). The alternative account of children's response to negative sentences with disjunction contends that children analyse disjunction in (21) as having scope over negation. The upshot is that children analyse (21) to have the same meaning as the English cleft sentence in (22).

- (21) John didn't eat pasta or sushi.
 (22) It was pasta or sushi that John didn't eat.

For adult speakers of English, sentences (21) and (22) have different truth conditions. Adults interpret disjunction to be within the scope of negation in (21), so it generates a conjunctive entailment: *John didn't eat pasta and John didn't eat sushi*. On the other hand, disjunction is interpreted as taking scope over negation in (22), so it has 'disjunctive' truth conditions: *It was pasta that John didn't eat or it was sushi that John didn't eat*. On the account under consideration, children are expected to interpret sentences (21) and (22) on a par; both sentences are expected to generate a conjunctive inference, due to the fact that disjunction takes scope over negation in both cases. Thus, both sentences imply that it was pasta that John didn't eat and that it was sushi that John didn't eat. This explains why children exhibit the same pattern of linguistic behaviour as adult speakers of English and German. In languages like Japanese, Mandarin and Turkish, children's conjunctive inference would contrast with the interpretation assigned by adults. Adult speakers of these languages analyse disjunction as licensing 'disjunctive' truth conditions, because disjunction is interpreted outside the scope of negation. This is the interpretation that adult speakers of English assign to the cleft sentence (22). Moreover, adults will be likely to license an 'exclusivity' inference in response to such sentences. To the extent that adults license this inference, the pattern of responses by adults will contrast even more sharply with that of children, who license a conjunctive inference for the same sentences.

Evidence in support of the proposal that children license a conjunctive inference for ordinary disjunctive statements has been offered in two recent studies, Singh et al. (2016) and Tieu et al. (2017). In these studies, some of the child participants were found to consistently reject sentences with disjunction in circumstances in which only one of the disjuncts was true, but to accept such sentences in circumstances in which both disjuncts were true. This pattern of responses was obtained in the Singh et al. study, for example, for sentences with a universally quantified subject NP, such as (23). There were also control sentences with conjunction replacing disjunction, as in (24).

- (23) Every boy is holding an apple or a banana.
 (24) Every boy is holding an apple and a banana.

On each test trial, the participants were shown a picture, which was accompanied by a statement produced by a puppet named Fuzzy. The participants' task was to judge whether or not Fuzzy's statement was a true description of the picture. In one condition, sentences (23) and (24) accompanied a picture in which three boys were holding both an apple and a banana. This was referred to as the "Every-both" condition, as depicted in Fig. 1 Panel a. In another condition, sentences (23) and (24) accompanied a picture in which two boys were holding apples, and one was holding a banana. This was referred to as the "Every-one" condition, as in Fig. 1 Panel b.

There were 56 child participants in the Singh et al. study. However, nearly half of the child participants (25 = 46%) were excluded from the data analysis. These participants failed to respond at above-chance levels to the control sentences with conjunction, such as (24). More than half of the excluded participants (25% of the 56) accepted the control sentences

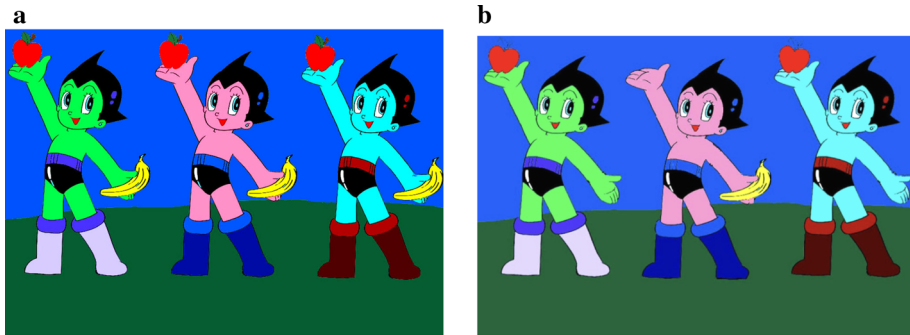


Fig. 1 Sample of pictures for critical items in the Singh et al. (2016) study. Reprinted by permission from publisher Springer Nature. © Springer Science + Business Media Dordrecht 2016. **a** “Every-both” condition. **b** “Every-one” condition

with conjunction at least half of the time in the “Every-one” condition, where only one of the conjuncts was true. There was also a control group of adult participants who were presented with the same materials. Although the adults did not fail the control sentences, their pattern of responses was unexpected. The adult controls accepted the test sentences with disjunction, as in (23), in both the “Every-both” condition and in the “Every-one” condition. In short, the adult participants “resisted” deriving scalar inferences for sentences with disjunction, for unknown reasons. In the end, the data from 31 child participants were analysed (37.5% of the original 56 child participants). The responses of these children were offered by Singh et al. as evidence that disjunction licenses a conjunctive inference in sentences like (23). These children accepted these sentences 75% of the time in the “Every-both” condition and rejected them 54% of the time in the “Every-one” condition, a statistically significant difference. The pattern of responses by these children resembles the conjunctive inferences that adult English-speakers produce in interpreting sentences with a deontic modal verb, as in (25). For adults, sentence (25) implies that every boy is allowed to eat an apple and every boy is allowed to eat a banana.

(25) Every boy is allowed to eat an apple or a banana.

As noted earlier, children’s conjunctive inferences in responding to sentences like (23) is conjectured by Singh et al. to be derived using the cognitive algorithm that adults use in deriving conjunctive inferences for sentences like (25). The conjunctive inference by children is engendered for sentences like (23) because, unlike adults, children do not access the scalar alternative with conjunction, as in (24). In the absence of the scalar alternative, the cognitive algorithm that yields conjunctive inferences becomes operative for children in sentences with disjunction, as in (23). On this account, then, the source of children’s failure to compute ‘exclusivity’ inferences for plain disjunctive statements also underpins children’s derivations of conjunctive inferences for sentences with disjunction.

Before extending the account offered by Singh et al. to children’s interpretations of disjunction in negative sentences, e.g., *John did not eat pasta or sushi*, three observations are worth making. It is worth noting, first, that the main finding by Singh et al. is out of step with previous research, in two ways. First the proportion of child participants in the Singh et al. study, who licensed conjunctive inferences is considerably lower (37.5%) than that reported in studies of children’s interpretation of negated sentences with disjunction. In these studies, children rejected the test sentences over 90% of the time in circumstances in which only one

disjunct was true. This would amount to an unexplained increase of over 50% in children's application of the algorithm for licensing conjunctive inferences in sentences with negation, as compared to ones with a universal quantifier.

The alternative account of children's responses is also inconsistent with the findings of both production and comprehension studies of children's knowledge of the meaning of disjunction. For example, a review of 240 transcriptions of audio-taped exchanges between 2- and 5-year-old children and their parents was undertaken by Morris (2008), using the CHILDES Database. Morris reports 465 uses of 'or' out of a total of 100,626 conversational turns. The main findings were that both English-speaking children and adults rarely used disjunction in circumstances that were uniquely consistent with an inclusive-*or* interpretation, and inconsistent with an exclusive-*or* interpretation. For children, utterances in which disjunction could uniquely be analysed as inclusive-*or* were produced less than 10% of the time, and adults used 'or' in circumstances that were uniquely consistent with this interpretation only slightly more often than 10% of the time. The vast majority of the time, both children and adults produced sentences with disjunction in circumstances in which only one disjunct was true. Although this finding is consistent with the conclusion (from comprehension studies)—that children initially analyse disjunction as inclusive-*or*—this finding is difficult to reconcile with an account that supposes that children generate conjunctive inferences for ordinary statements with disjunction. Turning to comprehension studies, several previous studies fail to report any evidence of children requiring both disjuncts to be true in response to disjunctive statements with a pre-subject universal quantifier, as in the Singh et al. study (Boster and Crain 1993; Pagliarini et al. 2018; Su and Crain 2013).

Let's now turn to a theoretical reason to refrain from extending the Singh et al. account to explain children's responses to negative sentences with disjunction. The theoretical issue has to do with language learnability in the absence of negative evidence. On the lexical parameter account, children initially analyse disjunction as –PPI. This ensures that they will encounter abundant evidence that disjunction is a +PPI in languages like Japanese, Mandarin and Turkish. More critical, however, is the following observation. Once children no longer assign a conjunctive inference to statements with disjunction that lack a licensing expression, children acquiring languages such as Japanese, Mandarin and Turkish would converge on the adult grammar of those languages. However, at the same stage of development, children acquiring languages such as English or German would confront the learnability dilemma that the lexical parameter was designed to obviate. At the point at which children no longer generated a conjunctive inference in statements with disjunction (without a licensor), they would still analyse disjunction as +PPI. At this stage of acquisition, then, children acquiring languages like English or German would generate a superset of the sentence/meaning pairs that adults generate for negative statements with disjunction. In the absence of negative evidence, it is difficult to see how children could converge on the adult grammar of these languages.

The Present Study

The experimental studies reviewed in the previous sections found that children behaved uniformly across languages in the interpretation of negative sentences with disjunction or with conjunction, despite different morphosyntactic expressions, word order, and case. The present series of studies adds new evidence from Italian, which differs in a significant way from the languages that have been investigated previously. The difference is that Italian is a Negative Concord language, in contrast to all of the other languages that have been

investigated previously. In a Negative Concord language, two negative elements do not cancel each other out, but combine to yield a single semantic negation, as shown in sentence (26) (Zejlstra 2004:3). Sentence (26) means that Maria ate nothing.

- (26) Maria *(non) ha mangiato niente.
 Maria neg has eaten n-thing.
 ‘Maria didn’t eat anything’.

Negative Concord languages can be contrasted with Double Negation languages such as English. In the latter class of languages, the two negation markers cancel each other out, thus yielding an affirmative interpretation, as in the example (27).

- (27) Maria didn’t eat nothing.
 ‘There is something that Maria ate’.

In Italian, the n-word *niente* is licensed by the preverbal negative marker. If the negative marker *non* is removed, the sentence becomes ungrammatical.⁵ The same is true for sentence (28), in which recursive *né* is an n-word, and requires an obligatory negative marker:

- (28) Maria *(non) ha mangiato né il pollo né il salmone.
 Maria neg had eaten nor the chicken nor the salmon.
 ‘Maria ate neither the chicken nor the salmon’.

Italian children who hear an adult produce sentence (28) in a context in which Maria ate neither the chicken nor the salmon can use this as evidence that speakers of the local language use (28) to express the meaning $\neg A \wedge \neg B$ instead of a sentence such as *Maria non ha mangiato il pollo o il salmone*. In Italian, this latter sentence is usually used to convey the meaning $\neg A \vee \neg B$. Notice that $\neg A \wedge \neg B$ is equivalent to $\neg(A \vee B)$ according to De Morgan’s laws. These observations raise the interesting possibility that Italian-speaking children encounter abundant evidence for resetting the Disjunction Parameter earlier than children acquiring other languages. The present series of experimental studies was designed to investigate the possibility that in Italian, children converge on the adult grammar earlier than children acquiring other languages, due to constructions such as (28) that unambiguously express the $\neg A \wedge \neg B$ meaning.

Experiment 1

The present study seeks to determine, first, whether disjunction and conjunction are +PPI for Italian-speaking adults, as our intuitions suggest. Having established that, the second aim of the study is to investigate whether Italian-speaking children generate interpretations that are consistent with the SSP. If so, children acquiring Italian are expected to differ from adults in interpreting simple negative sentences with disjunction, such that children initially assign the NEG > OR interpretation, whereas adults assign the OR > NEG interpretation. On the other hand, children acquiring Italian are expected to make the same scope assignments as adults do in response to simple negative sentences with conjunction. Both children and adults are expected to assign the stronger ‘neither’ interpretation, with conjunction taking scope over negation (AND > NEG).

⁵ In Romance languages, Negative concord is always obligatory in sentences containing n-words. However, in Bavarian, West Flemish and some Dutch Negative concord varieties the negative marker may be absent in sentences containing an n-word (Zejlstra 2004).

Method

Participants

The child participants were 27 monolingual Italian-speaking children ranging in age from 3;5 to 6;0, with an average age of 4;6 ($SD = 1.3$; 13 females, 14 males). The child participants were recruited from two day-care centres in Milan. A control group of 13 Italian-speaking adults also participated. The adults ranged in age from 22;5 to 34;4, with an average age of 26;5 ($SD = 3.3$; 9 females, 4 males). The adult participants were students at the University of Milano-Bicocca. None of the participants had a history of speech, language or hearing impairment. Ethical approval according to standards of the Helsinki Declaration (World Medical Association 2013) was obtained from the board of the University of Milano-Bicocca (prot. 20974/13). Before the testing session, informed consent was signed by child participants' parents and by the adult participants themselves.

Procedure

The experiment adopted the Uncertainty Mode of the TVJT (Crain and Thornton 1998) following the procedures used by Goro (2007) and Goro and Akiba (2004a, b). The first part of the experiment consisted of vignettes that were acted out by one of two experimenters using a paper-crafted story book. A puppet was manipulated by the second experimenter. The puppet watched the story book along with the child participant.

There were twelve stories, each involving a different animal. Each animal appearing in the centre of the page was invited to eat two vegetables: a carrot and a green pepper (Fig. 2, Panel a). The participant was told that it was an eating game and that not all animals liked vegetables. Then, the participant was instructed to award a medal to each of the animals, depending on how many vegetables the animal had eaten. If the animal ate both vegetables, the participant was instructed to award the animal a golden medal sticker. We will call this the *Golden Medal condition*. If the animal ate only one of the vegetables, the child was instructed to give it the silver medal sticker. We will call this the *Silver Medal condition* (Fig. 2, Panels b, c). If the animal did not eat either of the vegetables, the participant was instructed to give the animal a sad face sticker. We call this the *Sad Face condition*. Whenever an animal failed to eat a vegetable, it was either placed in a fridge, to eat later, or in a rubbish bin. After the reward system was introduced to the participant, the experimenter proceeded to go through the story book, one animal at a time. There was a total of twelve animals. Four were rewarded with a golden medal; four were rewarded with a silver medal; and four received a sad face.

After all the twelve animal stories were told, all of the vegetables were removed from the fridges and from the bins, but the sticker rewards remained on the animals. Then, the experimenter went through the story book a second time. The experiment asked the puppet to tell the participant what happened in each story, beginning with the first animal and then proceeding through the rest of the animals in turn. On each trial, the puppet said that he could not remember exactly what the animal had eaten, but he could guess what it had eaten based on the reward the animal had been given. For our purposes, the critical trials were the *Silver Medal condition*. The silver medal sticker indicated to the participant that the animal had eaten only one of the two vegetables. However, because there had been twelve preceding stories, it was unlikely that the participant could remember which vegetable the animal had eaten, and which it had put in the fridge or in the rubbish bin. At this point, the participant judged whether the sentence produced by the puppet was right or wrong. If the participant

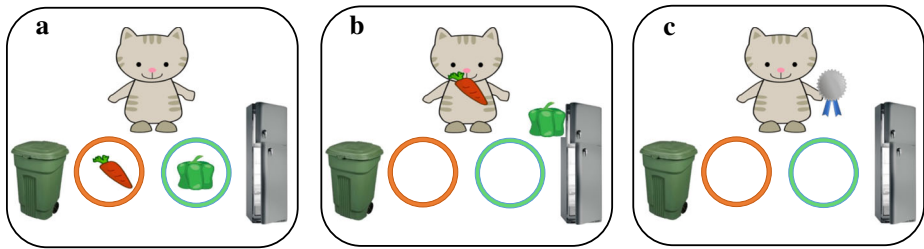


Fig. 2 Example of a story. Panel **a** depicts an animal and a choice of two vegetables. Panel **b** depicts the animal's decision to eat one of the vegetables, but to put the other one in the fridge. Panel **c** depicts the *Silver Medal condition*, with the vegetables removed. The silver medal remains, and serves as the basis for the participant's judgment about the Truth/Falsity of the puppet's test sentence

judged that the puppet was wrong, the participant was asked to tell the puppet what had really happened in the story.

To ensure that the child participants understood the reward system, a training session with three items preceded the main testing session. The main session lasted approximately 15–20 min. The child participants were tested individually in a quiet room at their day-care centre. Adult participants were tested at the university. Children's responses and the justifications for their rejections of the puppet's test sentences were audio-recorded for later transcription.

Materials

The materials were adapted from the study reported in Goro (2007). There were two kinds of test sentences: negative sentences with disjunction, as in (29), and negative sentences with conjunction, as in (30). Each participant was presented with 4 negative sentences with disjunction (2 in the *Silver Medal condition* and 2 in the *Sad face condition*) and with 4 negative sentences with conjunction (2 in each condition).

(29) Il gatto non ha mangiato la carota o il peperone.

'The cat didn't eat the carrot or the pepper'.

(30) Il topo non ha mangiato la carota e il peperone.

'The mouse didn't eat the carrot and the pepper'.

Experimental items were presented in pseudo-random order and interspersed with the filler trials.

There were 2 true filler trials and 2 false filler trials. On the filler trials, the animal was rewarded with a golden medal. An example of a true filler is (31), and an example of a false filler is (32).

(31) Il leone ha mangiato tutto.

'The lion ate everything'.

(32) Il cane non ha mangiato niente.

'The dog ate nothing'.

A detailed description of the materials is presented in “Appendix A”. Each test sentence was preceded by a lead-in sentence that mentioned the reward the animal had received. The lead-in used in the *Silver Medal condition* is (33).

- (33) Mmm, il gatto ha una medaglia di argento.
 ‘Mmm, the cat has a silver medal’.

Predictions

If negative sentences with disjunction yield a ‘not both’ interpretation in Italian, where disjunction takes scope over negation (OR > NEG), this will be taken as evidence that the Italian word for disjunction, *o*, is analyzed as +PPI. On this interpretation, the test sentence (29) would be judged to be true if the cat ate the carrot but not the pepper, or the reverse. The experimental hypothesis is that disjunction takes scope over negation for adult speakers of Italian, so the adult participants are expected to accept (29) in the *Silver Medal condition*. From a logical point of view, adult participants might also accept (29) in the *Sad face condition*, since disjunction words in human languages are assigned the truth conditions associated with inclusive-*or*, as in classical logic (see Crain 2012; Crain and Khlentzos 2010). To see this, we note that the wide scope reading of OR in (29) is logically true in circumstances in which the cat did not eat either vegetable. That is, the English paraphrase of the Italian sentence in (29) is logically equivalent to a cleft sentence, in which disjunction has scope over negation in the surface syntax, as in (34).

- (34) It is the carrot or the pepper that the cat did not eat.

Assuming that disjunction is inclusive-*or*, then (34) is true if the cat failed to eat both the carrot and the pepper. However, disjunction in sentence (34) licenses an ‘exclusivity’ inference. This inference follows from Grice’s Maxim of Quantity. If the speaker intended to convey the message that the cat had failed to eat both vegetables, then the speaker would have used a sentence that conveys this message directly. In English, the alternative sentence would be a cleft sentence with AND rather than OR: *It is the carrot and the pepper that the cat did not eat*. Because the speaker chose to use the weaker statement, with disjunction, the hearer infers that the speaker was not in a position to assert the stronger statement, with conjunction. Therefore, the hearer infers that the puppet’s intended message was: *It is the carrot or the pepper, but not both, that the cat did not eat*. On this interpretation, (29) would be judged to be false in the *Sad face condition* (for further discussion, see Geçkin et al. 2016).

Therefore, we will rely on the participants’ responses in the *Silver Medal condition* to evaluate the experimental hypotheses. If Italian-speaking children, like their Mandarin- and Japanese-speaking counterparts, are guided by the SSP, they are predicted to differ from adults in the *Silver Medal condition*. Child participants are expected to reject test sentences like (29) in the *Silver Medal condition*, because children are expected to take negation to have scope over disjunction. In other words, the SSP predicts that Italian-speaking children will initially generate a conjunctive entailment in response to negative sentences with disjunction, just as English-speaking children and adults do. According to the SSP, children should initially adopt the subset value of the Disjunction parameter, on which the disjunction word *o* is –PPI, yielding the scope assignment with negation taking wide scope, NEG > OR. By contrast, adults are expected to accept the test sentences in the *Silver Medal condition*. Because the animal has eaten only one of the vegetables, the inference of exclusivity is

satisfied in the condition, so there is no reason for adults to reject the test sentences in the *Silver Medal condition*. The *Silver Medal condition* therefore is critical to evaluate the SSP: Italian-speaking adults are predicted to accept (29) in this condition, whereas children are predicted to reject it.

Turning to negative sentences with conjunction, our native speaker intuitions tell us that these sentences yield a ‘neither’ interpretation in Italian, such that the word for conjunction, *e*, is +PPI. If so, then sentence (30) should only be judged to be true in circumstances in which the cat did not eat the carrot and did not eat the pepper. Adult Italian speakers are predicted, therefore, to accept sentences like (30) in the *Sad face condition*, and to reject them in the *Silver Medal condition*. The SSP predicts that Italian children will assign the same interpretation as adult Italian speakers, since the +PPI value of the Conjunction Parameter is the subset value.

Results

Eight of the child participants were excluded from the analysis. Five of these children were excluded because they always responded ‘yes’ in the main session of the experiment; two children did not understand the system of rewards, and one child did not respond to the questions. Therefore, the analyses we report represent the data from 19 children and 13 adults. The participants included in the analysis responded correctly 100% of the time to filler items (i.e., the *Golden Medal condition*).

Test Sentences with Conjunction

We begin by presenting the findings from participants’ responses to negative sentences with conjunction, because the pattern of behaviour is straightforward for both children and adults. As expected on the experimental hypothesis, the responses to negative sentences with conjunction in the *Silver Medal condition* were the same for the child and adult participants (Fig. 3). Children rejected test sentences like (30) 95% of the time (36/38 items) and adults rejected them 92% of the time (24/26). In the *Sad face condition*, both children and adults accepted these sentences 100% of the time.

Test Sentences with Disjunction

The crucial experimental items were sentences like (29) in the *Silver Medal condition*. The results are reported in Fig. 4. In this condition, Italian-speaking children rejected negative sentences with disjunction 39.5% of the time (15/38 trials). A typical justification for these rejections is given in (35).

(35) Puppet: Il gattino ha una medaglia d’argento. Il gattino non ha mangiato la carota o il peperone.

‘The cat has a silver medal. The cat didn’t eat the carrot or the green pepper’.

Child: No, perché il gattino ha mangiato una cosa sola.

‘No, because the cat ate only one thing’.

Italian-speaking adults always accepted test sentences like (29) in the *Silver Medal condition*. A Mann–Whitney *U* test revealed a significant difference in the response patterns of the two groups ($Z = -3.63$, $p < .001$) with a medium-to-large effect size ($r = -.45$).

It is even more revealing to look at the individual responses by the child participants. An analysis by individual participants reveals that 6 children consistently rejected the test

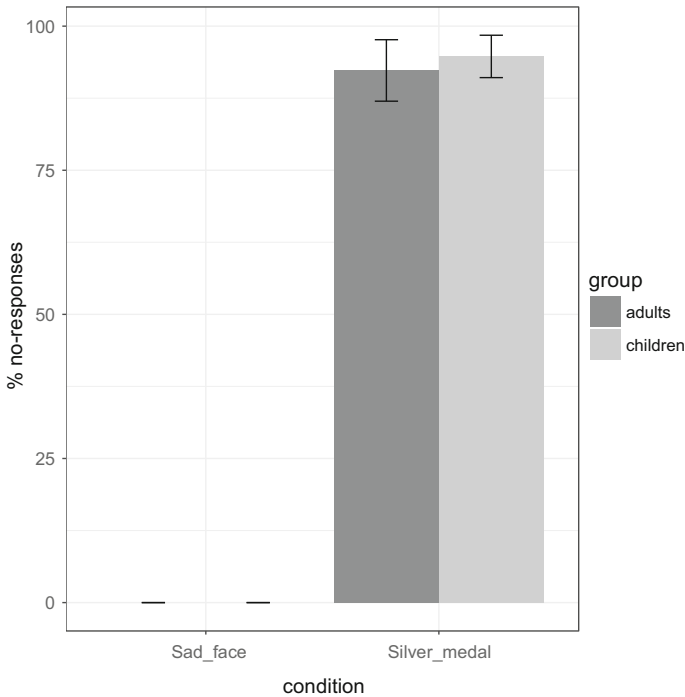


Fig. 3 Percentages of rejections by group in the *Silver Medal* and *Sad face* conditions for negative sentences with conjunction. Vertical bars represent standard error

sentences in the *Silver Medal* condition, as predicted by the SSP (average age = 4;75, SD = 0;66). However, 10 of the child participants consistently accepted these sentences, so these 10 children produced adult-like responses (average age = 5;33, SD = 0;33). The remaining 3 children produced mixed responses (average age = 5;19, SD = .32).

We conducted a further analysis on the data from the two groups of child participants that produced consistent responses, to see if age was a determining factor. The analysis revealed a significant effect of response-type by age $t(15) = -2.38, p < .01$. The mean of the age of the child participants who conformed to the SSP was significantly lower than those of the child participants who gave an adult-like response.

We also analysed the responses by group to the test sentences in the *Sad face* condition. The results are reported in Fig. 4. The child participants rejected the test sentences in this condition 34% of the time (13/38 trials), whereas adults rejected them 100% of the time. Again, the different patterns of responses by children and adults was significant using a Mann–Whitney U test ($Z = 5.26, p < .001$) with a medium-to-large effect size ($r = .66$).

Discussion

The negative test sentences with conjunction evoked the same pattern of responses by child and adult participants. For both groups, conjunction appeared to take scope over negation (AND > NEG), despite having the opposite word order in the surface syntax. This finding therefore confirmed the experimental hypothesis that conjunction is a +PPI in Italian, for

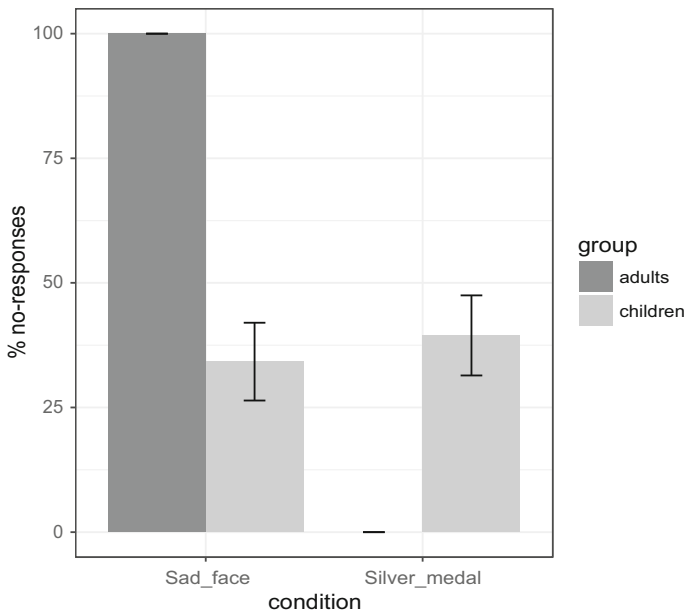


Fig. 4 Percentage of rejections by group in the *Silver Medal* and *Sad face* conditions for negative sentences with disjunction. Vertical bars represent standard error

both children and adults. Moreover, the responses of the child participants clearly showed that they were able to compute the inverse scope interpretation of the test sentences.

As for the test sentences with disjunction, the Italian-speaking adult participants interpreted negative sentences with disjunction as meaning ‘not both’, as they consistently accepted the test sentences in the *Silver Medal* condition. This finding therefore confirmed the experimental hypothesis that disjunction is a +PPI in Italian. Contrary to the prediction of the SSP, however, the Italian-speaking child participants only rejected the test sentences with disjunction in the *Silver Medal* condition 39.5% of the time. To put this finding in perspective, we wish to note that the Japanese-speaking child participants in the Goro and Akiba study rejected the corresponding Japanese test sentences 75% of the time in the *Silver Medal* condition.

A closer look at the child data in the present study revealed that Italian-speaking children divided into two main groups according to their pattern of responses: one group of children consistently assigned a ‘neither’ interpretation to simple negative sentences with disjunction, in keeping with the SSP. Another group of children consistently assigned a ‘not both’ interpretation, just as the adult participants did. Three children displayed a mixed pattern of responses. Interestingly, child participants who consistently assigned a ‘neither’ interpretation were significantly younger than the child participants who gave an adult-like response. The pattern of responses by this group of children, however, is out of line with the findings of much previous research. For example, in Goro’s study, only 4 of the 30 child participants produced adult-like responses (these four children were 4;11, 5;5, 5;10, and 6;2). The different pattern of responses by the child participants in the *Silver Medal* condition and in the *Sad face* condition can be taken as evidence that the majority of child participants distinguished between the Italian conjunction word *e* and the disjunction word *o*. However, it is possible that the presence of both words in the same experiment may have influenced the interpre-

tation assigned by some child participants. In this regard, it is worth noting that the word for disjunction, *o*, and the word for conjunction, *e*, have similar phonological realizations; because both are one-syllable words, they are possibly confusable for children unless they are paying close attention to the puppet's test utterances. In order to eliminate this potentially confounding factor from Experiment 1, we conducted a second experiment. Experiment 2 consisted only of test sentences with disjunction.

Experiment 2

Experiment 2 was a replication of Experiment 1, but the negative sentences with conjunction were removed from the experiment, leaving only sentences with disjunction.

Method

Participants

The child participants were 21 Italian monolingual children who ranged in age from 4;10 to 5;7; with an average age of 5;2 (SD 0;23, 15 females, 6 males). There were also 14 Italian-speaking adult participants. The adult control group ranged in age from 21;10 to 30;3, with an average age of 24;8, (SD 2;56, 6 females, 8 males). None of the participants in Experiment 2 had participated in Experiment 1. The child participants were recruited from a day-care centre in the province of Milan. The adult participants were students at the University of Milano-Bicocca. None of the participants had a history of speech, language or hearing delay or impairment. Ethics approval was obtained in accordance with the standards of the Helsinki Declaration (World Medical Association 2013) from the board of the University of Milano-Bicocca (prot. 20974/13). Before the testing session, informed consent was signed by the parents of the child participants, and by the adult participants themselves.

Procedure

The procedure was the same as Experiment 1.

Materials

In Experiment 2, only negative sentences with disjunction such as (29) (repeated here as 36) were included.

- (36) Il gatto non ha mangiato la carota o il peperone.
'The cat didn't eat the carrot or the pepper'.

Four test sentences were presented in the *Silver Medal condition* and four were presented in the *Sad face condition*. Experimental items were presented in pseudo-random order and interspersed with filler items. The warm-up trials and the filler sentences were similar to those of Experiment 1. A detailed description of the material is presented in "[Appendix B](#)".

Predictions

Adult participants were expected not to generate a conjunctive entailment for disjunction in the scope of negation, as in Experiment 1, because that experiment established that the

Italian disjunction word *o* is a +PPI. By contrast, the SSP predicts that the Italian-speaking child participants will generate a conjunctive entailment for the test sentences. Therefore, the experimental hypotheses were as before: the adult participants were expected to accept the test sentences in the *Silver Medal condition*, whereas the child participants were expected to reject them.

Results

The responses by three children were excluded from the analysis, because two children always responded ‘Yes’ in the main session of the experiment, and the third child did not understand the system of rewards. Therefore, the data analysis was based on responses by 18 children and 14 adults. These participants responded correctly 100% of the time to the filler sentences in the *Golden Medal condition*.

As in Experiment 1, the critical responses were those produced by participants regarding the *Silver Medal condition*. Results are reported in Fig. 5. The Italian-speaking child participants rejected the test sentences in this condition 45.84% of the time (33/72 trials). Typical justifications for rejections were as follows: *Perché ha mangiato una cosa* ‘Because he ate one thing’; *Perché ha mangiato solo una cosa, mentre lei ha detto che non ha mangiato niente* ‘Because he ate one thing, whereas she said she didn’t eat anything’.

Italian-speaking adults only rejected the test sentences 8.93% of the time (5/56) in the *Silver Medal condition*. A Mann–Whitney *U* test revealed a significant difference in the

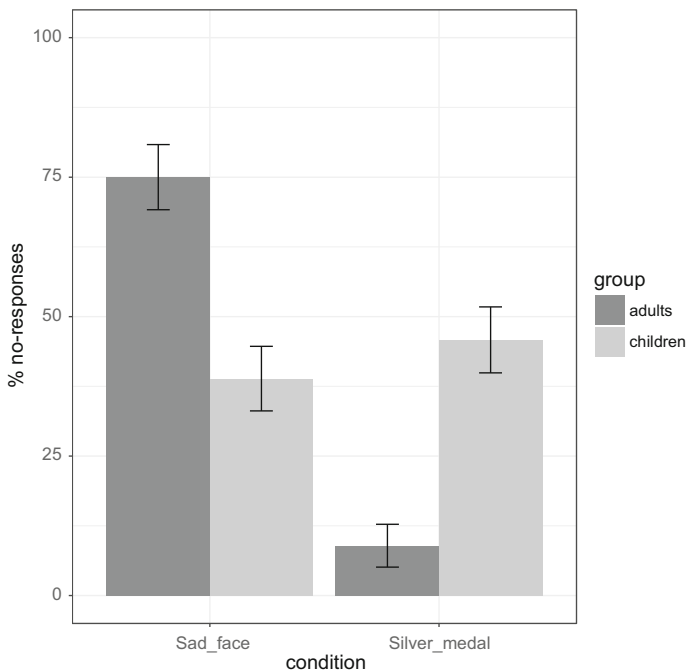


Fig. 5 Percentage of rejections by group in the *Silver Medal* and *Sad face* conditions for negative sentences with disjunction. Vertical bars represent standard error

response patterns by group ($Z = -4.51, p < .001$) with a medium-to-large effect size ($r = -.40$).

Turning to the responses of individual child participants, children who rejected at least 3 of the 4 test sentences were classified as conforming to the SSP, and children who accepted at least 3 of the 4 test sentences were classified as being adult-like. Children who gave inconsistent responses across items were not classified in either of these categories and will be referred to as ‘mixed.’ The analysis revealed that 7 children conformed to the SSP. They had an average age of 5;27 ($SD = 0;18$). These 7 children rejected the test sentences in the *Silver Medal condition* on all 4 trials. Nine children were adult-like. Eight of these 9 children accepted the test sentences on all 4 trials, and one child accepted the test sentences on 3 of the 4 trials. This second group of child participants had an average age of 5;29 ($SD = 0;23$). Two children produced mixed responses. These child participants had an average age of 4;95 ($SD = .04$). In contrast to Experiment 1, here the age difference between the 7 children who conformed to the SSP and the 10 children who were adult-like was not significant 2, $t(14) = -.19, p = .85$.

In the *Sad face condition*, children as a whole rejected the test sentences 38.89% of the time (44/72 trials) and adults rejected them 75% of the time (42/56). The different pattern of responses by the two groups was significant (Mann–Whitney U test, $Z = 4.05, p < .001$) with a medium size effect ($r = .36$).

Discussion

The results of Experiment 2 replicated those of Experiment 1. Italian-speaking adults do not generate a conjunctive entailment for disjunction in the scope of negation, such that disjunction takes scope over negation (OR > NEG). This finding confirms that disjunction is a Positive Polarity Item (+PPI) for Italian-speaking adults. The responses by the child participants in Experiment 2 were similar to those in Experiment 1. Seven children complied with the SSP, 10 children were adult-like, and three children produced mixed responses. The results of Experiment 2 demonstrate that the pattern of behavior by the child participants in Experiment 1 was not an artifact caused by including both sentences with the Italian words for disjunction, *o*, as well as the word for conjunction, *e*. This factor can be ruled out, therefore, as the source of the finding that Italian-speaking children behaved differently from children acquiring other languages. Still, both experiments uncovered a group of children who consistently complied with the SSP, and there was a significant age effect in Experiment 1, such that the mean age of the children who complied with the SPS was significantly lower than the adult-like children. The findings, therefore, encourage us to hypothesize that some linguistic property that distinguishes Italian from the other languages that have been studied previously leads children to abandon the initial non-adult setting of the Disjunction Parameter earlier in Italian than in the other languages.

Because the Disjunction Parameter governs the analysis of polarity-sensitive items in sentences with negation, a reasonable first guess as to the property that invites earlier parameter resetting in Italian has to do with negation. More specifically, we hypothesized that the earlier convergence on the adult parameter setting by Italian-speaking children is due to the fact that Italian is a negative concord language. In Italian, the conjunction of two negated expressions is conveyed using the form “NEG... *né...né*”, without the disjunction word, *o*. This sentence structure unambiguously expressed the strong ‘neither’ interpretation, at least for adult speakers. Experiment 3 investigates the possibility that children acquiring Italian also assign the strong ‘neither’ interpretation to sentences of the form “NEG... *né... né*.”

As far as we know, this is the first experimental investigation of this structure in Italian child language.

Experiment 3

The aim of Experiment 3 is to determine whether Italian-speaking children assign the ‘neither’ meaning to sentences of the form “NEG.. *né... né*”.

Method

Participants

Twelve monolingual Italian-speaking children were tested. The child participants ranged in age from 4;0 to 5;9, with an average age of 4;86 (SD 0;52; 6 females, 6 males). None of the participants in Experiment 3 had participated in Experiment 1 or 2. Children were recruited from a day-care centre in the province of Milan. None of the children had a history of speech, language or hearing delay or impairment. Ethics approval was obtained in accordance with the standards of the Helsinki Declaration (World Medical Association 2013) from the board of the University of Milano-Bicocca (prot. 20974/13). Before the testing session, informed consent was signed by the parents of the child participants.

Procedure

The procedure was the same as Experiments 1 and 2.

Material

Experiment 3 presented negative sentences with *né... né* such as (37). A detailed description of the materials is presented in “[Appendix C](#)”.

- (37) Il gatto non ha mangiato né la carota né il peperone.
 The cat not had eaten not the carrot not the pepper.
 ‘The cat ate neither the carrot nor the pepper’.

As in Experiment 2, test sentences were presented in the *Silver Medal condition*, where the animal had eaten the carrot, but not the pepper, or the reverse, and in the *Sad face condition*, where the animal had eaten neither the carrot nor the pepper. Therefore, each test session included 8 *NEG né... né* sentences, with 4 presented in the *Silver Medal condition* and 4 in the *Sad face condition*. Experimental sentences were presented in pseudo-random order and interspersed with filler trials.

There were three warm-up items and 4 fillers (3 true and 1 false) in the *Golden Medal condition*. Both filler sentences and test sentences were preceded by a lead-in sentence, as in Experiments 1 and 2.

Predictions

The experimental hypothesis is that Italian speaking children assign the adult-like ‘neither’ interpretation to *NEG né... né* sentences. Therefore, the child participants are expected to

consistently reject the test sentences in the *Silver Medal condition*, and to consistently accept them in the *Sad Face condition*.

Results

Children responded correctly 94.4% of the time to the true filler items. Two child participants each responded incorrectly to one true filler item. All of the child participants always responded correctly to the false filler items. Therefore, all of the child participants were included in the data analysis. Here, the crucial experimental conditions are the *Silver Medal condition* and the *Sad Face condition*. If children assigned the ‘neither’ interpretation to *NEG né... né* sentences, they were expected to reject the test sentences in the *Silver Medal condition* and to accept them in the *Sad face condition*. Results are reported in Fig. 6. In keeping with the experimental hypotheses, the child participants rejected the test sentences in the *Silver Medal condition* 87.50% of the time (42/48 items) and accepted them 97.91% of the time in the *Sad Face condition* (47/48). A Mann–Whitney *U* test revealed a significant difference in the response pattern by the child participants in these conditions ($Z = 8.37$, $p < .001$), and this difference had a large effect size ($r = .85$).

Discussion

The results of Experiment 3 showed that 4- to 5-year-old Italian-speaking children robustly assigned the adult-like ‘neither’ interpretation to sentences of the form “NEG.. *né...né*”. It is worth speculating, therefore, on how this sentence structure could foster the early resetting

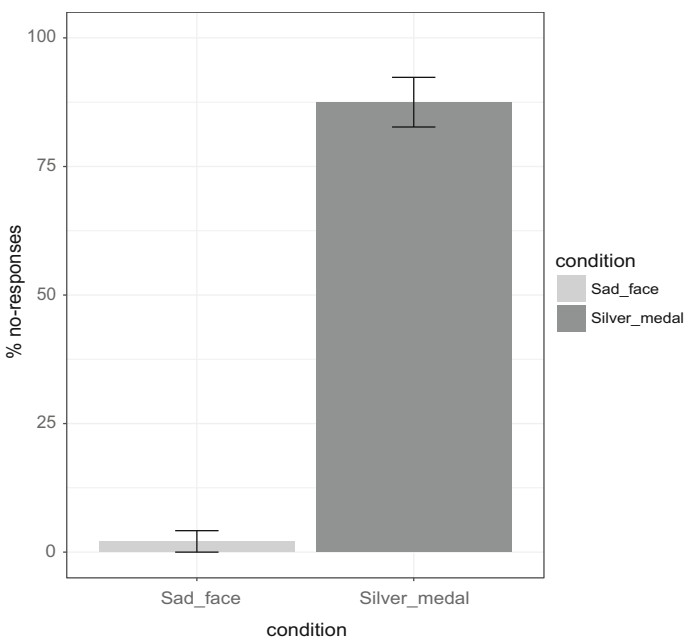


Fig. 6 Percentages of rejections in the *Silver Medal* and *Sad Face* conditions for *NEG né... né* sentences. Vertical bars represent standard error

of the Disjunction parameter for children acquiring Italian, a negative concord language, as compared to children acquiring double-negation languages, as in previous research.

General Discussion

The present study first sought to determine whether the Italian disjunction *o* (English *or*) and the Italian conjunction *e* (English *and*) are Positive Polarity Items (+PPI) for adult speakers of Italian. The values of the words on the relevant lexical parameters translate into scope assignments on which disjunction takes scope over negation (OR>NEG) and conjunction takes scope over negation (AND>NEG). Our data unequivocally confirm that Italian disjunction *o* and conjunction *e* are indeed +PPI (Szabolcsi 2002, 2004). Further, the study investigated which values of the relevant parameters Italian-speaking children assign to disjunction and conjunction. The Semantic Subset Principle (SSP) predicts that Italian-speaking children, as in other languages, will initially analyse disjunction as –PPI, which is the subset value of the Disjunction parameter. The SSP also dictates that Italian-speaking children will initially analyse conjunction as +PPI, just as adults do, because this is the subset value of the Conjunction parameter.

The findings of Experiment 1 were in line with these predictions for the Conjunction parameter. Both the child and adult participants displayed the same pattern of responses for negative sentences with conjunction. Both groups interpreted conjunction taking scope over negation (AND>NEG). The findings from Experiments 1 and 2 were less clear cut for the negative test sentences with disjunction. According to the SSP, children were expected to initially differ from adults in scope assignments. Children were expected to reject the test sentences in the *Silver Medal condition*, but to accept them in the *Sad Face condition*. By contrast, the adult participants were expected to display the reverse pattern, i.e., to accept the test sentences with disjunction in the *Silver Medal* context and to reject them in the *Sad Face* context, influenced by a pragmatic ‘exclusivity’ inference. The results from the adult participants were confirmed. The Italian disjunction word, *o*, proved to be a Positive Polarity Item and, as such, was consistently interpreted as having wide scope. By contrast, the findings from the experimental investigations of Italian-speaking children did not directly validate the experimental hypotheses. Despite the fact that child participants significantly differed from adult participants in the silver medal context, the rate of rejection of negative sentences with disjunction by the child participants in that context was not as high as expected, if compared with the findings from previous studies. Italian-speaking children rejected the negative sentences with disjunction in the silver medal context 39.5% of the time (Experiment 1). In the Goro and Akiba study with Japanese-speaking children, the rejection rate was 75% in this condition. However, the individual participant analysis of Experiment 1 showed that the mean age of the 6 Italian-speaking children who consistently generated a conjunctive entailment of disjunction in the scope of negation (as predicted by the SSP) was significantly different from those who gave an adult-like response. Children who complied with the SSP were younger than those who gave an adult-like response.

Because of the bi-modal responses by the child participants, we speculated that the concurrent presences of negative sentences with disjunction *o* and ones with conjunction *e* might have influenced children’s performance, due to their similar phonological realizations. Therefore, we designed a second experiment, which was a replication of Experiment 1. However, in Experiment 2 only negative sentences with disjunction were included, on the grounds that negative sentences with conjunctions might have influenced children’s interpretation of

o statements. The findings of Experiment 2 were similar to those of Experiment 1: seven children adopted the –PPI value for *o*, thus confirming the SSP; nine children were already adult-like; two children reported mixed results. In Experiment 2, the age of the children who consistently generated a conjunctive entailment of disjunction in the scope of negation did not differ from those who gave an adult-like response. In the light of these results, we could exclude the hypothesis that the results of Experiment 1 were due to a methodological bias. So, why do Italian children converge earlier to the relevant value of the parameter? We propose the following acquisition scenario.

Italian is a non-hybrid negative concord language in which a specific linguistic expression is used to express the conjunction of two negated expressions (not A and not B), which is illustrated in (38); this is the structure of the test sentences in Experiment 3.

- (38) Il gatto **non** ha mangiato **né** la carota **né** il peperone.
 The cat not did eat neg the carrot neg the pepper.

In sentence (38), the negation *non* resides in the same clause as the pair of n-words *né... né*. Moreover, these negative markers *né... né* cannot be used unless they are in the scope of negation. That is, sentence (39) is completely unacceptable for Italian speakers.

- (39) *Il gatto ha mangiato **né** la carota **né** il peperone.
 The cat did eat neg the carrot neg the pepper.

The fact that *né... né* must be licensed by negation means that Italian has a form for expressing the ‘neither’ interpretation that is not available in the other languages that have been investigated previously and that is licensed by negation. On the contrary, the English disjunction word, *or*, can be used in positive sentences, as in (40), and it can take scope over negation in negative sentences, as in (41a). Neither of these possibilities is available for the Italian negative markers, *né... né*, as in (39) and (41b):

- (40) The cat ate the carrot or the pepper.
 (41) a. It is either the carrot or the pepper that the cat did not eat.
 b. *E’ **né** la carota **né** il peperone che il gatto non ha mangiato.

Thus, the child learner of Italian can observe the co-occurrence restrictions that govern the use of the words for disjunction and conjunctions, which stand in contrast to negative concord linguistic expressions, including *né... né*. *Né... né* is a connective that is truly restricted to the scope of negation, whereas the words for disjunction and conjunction can be used in positive sentences, and they can be used in sentences in which they are outside the scope of negation. Therefore, for Italian-speaking children, the presence of an unambiguous ‘neither’ expression, such as the one in (39), would virtually block the ‘neither’ interpretation of disjunction in the scope of negation, cueing that disjunction with negation should be interpreted as ‘not both’. This mechanism should lead Italian-speaking children to converge earlier to the adult grammar than Japanese children.

This proposal is tenable if Italian-speaking children know the interpretation of sentences such as the one in (39) at that same age. As we documented in Experiment 3, 4-year-old children acquiring Italian know that sentences such as (39) express the ‘neither’ interpretation. Experiment 3 found that all of the child participants accepted (39) in the *Sad Face condition* and they rejected it in the *Silver Medal condition*. In both conditions, children’s performance was nearly at ceiling. With this knowledge under their belts, it is not surprising to find that children use the fact that the disjunction word, *o*, lacks the strict restrictions that govern the

use of the negative markers, *né... né*. If this account is on the right track, then we should expect children acquiring other negative concord languages, in which OR is a +PPI, to acquire the adult value of the Disjunction Parameter at an earlier stage of development than the children tested in previous studies.⁶ These languages include Hungarian, as illustrated in (42a), French in (42b), Spanish in (42c), and Catalan in (42d), among many others.

- (42) a. János nem ette meg sem az almát, sem a banánt. (Hungarian)
 János NEG had eaten not the apple, not the banana.
- b. Jean n' a mangé ni la pomme ni la banane. (French)
 Jean NEG had eaten not the apple not the banana.
- c. Juan no ha comido ni la manzana ni el plátano. (Spanish)
 Juan NEG had eaten not the apple not the banana.
- d. Em Juan no ha menjat ni la poma ni el plàtano. (Catalan)
 The Jean NEG had eaten not the apple not the banana.

It is worth noting that Japanese has a linguistic structure that is superficially similar to the Italian negative markers, *né... né*. This is illustrated in the negative sentence in (43).

- (43) John-wa supeingo **mo** furansugo **mo** hanasa-**nai**.
 John-TOP Spanish both French and speak-NEG.
 'John doesn't speak Spanish AND doesn't speak French'.

Sentence (43) indicates that when the pair of particles, *mo... mo*, appear in the scope of negation, the 'neither' interpretation is computed; so, sentence (43) entails that John didn't speak Spanish and that John didn't speak French. There is a crucial difference, however, between Japanese *mo... mo* and Italian *né... né*. Whereas *né... né* must be licensed by negation in Italian, along with all postverbal negative words, this is not the case in Japanese, where *mo... mo* can also appear in positive sentences such as (44).

- (44) John-wa supeingo **mo** furansugo **mo** hanasu.
 John-TOP Spanish both French and speak.
 'John speaks both Spanish and French'.

The critical cross-linguistic property, we conjecture, is the combination of negative concord structures and structures used to express statements with disjunction.

It is important to recall that the findings of Experiments 1 and 2 are compatible with an acquisition scenario on which Italian-speaking children initially adopt the subset value of the Disjunction Parameter. Indeed, some child participants in both experiments behave as predicted by the SSP and, despite the relatively small number of child participants, there was a significant effect of age in Experiment 1, such that the children who consistently appeared to comply with the SSP turned out to be significantly younger than those who consistently assigned adult-like responses. It is reasonable to suppose, therefore, that the "adult-like children" initially adopted the subset value of the Disjunction parameter, but reset the parameter to the adult value. Although we found no age effect in Experiment 2, the

⁶ For negative concord languages that have the – PPI of the disjunction parameter, e.g. Romanian, the presence of an equivalent structure to the Italian *né... né* is irrelevant, as these children do not have to change the default value of the parameter. One may wonder why in those languages, OR is – PPI, as there is an alternative way to express the conjunction of two negated expressions. We do not have an answer to this question, which is outside the scope of this work. We merely state that our claim is that if OR is +PPI in a negative concord language, there is an expression which overtly informs the child of the lexical value of OR.

range in the ages of the child participants was not large in either experiment. We anticipate that significant age effects may be found, especially if we extend the age of the child participants to include younger children.

Conclusion

The findings of the present study established, first, that OR and AND take wide scope in negative sentences in Italian. As for AND, this scope assignment with respect to negation entails that a negative sentence with conjunction in Italian is true only when both conjuncts are false, unlike the corresponding sentences in English. A second finding was that Italian-speaking children and adults interpret negative conjunctive sentences in the same way. As for OR, we established that several of the Italian-speaking child participants differed from adults, rejecting negative sentences with disjunction in the *Silver Medal condition*, where adults accepted them. The findings are consistent with the supposition that children initially assign the subset values of both the Conjunction and Disjunction Parameters. However, differently from previous studies in Japanese, Mandarin and Turkish, we found that a subset of the children behaves as adults and accepts not A or B when just one disjunct is false. We suggested that this earlier convergence with respect to other languages was promoted by the presence of negative concord in the system of disjunction. Since in negative concord languages negative words have to be licensed by a c-commanding negation, this fixes the scope of the negative words themselves.

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Authors' Contribution EP and SC conceived the project, EP and SC designed experiment 1, EP and MTG conceived and designed experiment 2 and 3, EP collected the data, EP analyzed the data, EP wrote and revised the paper and MTG and SC commented on the various versions of the manuscript.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix A: Experimental Materials—Experiment 1

Training material

Animal	Vegetable eaten	Reward
Rabbit	Both	Golden medal
Bear	None	Sad face
Zebra	One	Silver medal

Test material

Connectives	Animal	Vegetable eaten	Context	Sentence
NEG–Or	Hippo	One	Silver medal	L'ippopotamo non ha mangiato la carota o il peperone 'The hippo didn't eat either the carrot or the green pepper'
NEG–Or	Cat	One	Silver medal	Il gattino non ha mangiato la carota o il peperone 'The cat didn't eat either the carrot or the green pepper'
NEG–Or	Pig	None	Sad face	Il maialino non ha mangiato la carota o il peperone 'The pig didn't eat the carrot or the green pepper'
NEG–Or	Elephant	None	Sad face	L'elefantino non ha mangiato la carota o il peperone 'The elephant didn't eat either the carrot or the green pepper'
NEG–And	Donkey	None	sad face	L'asinello non ha mangiato la carota e il peperone 'The donkey didn't eat both the carrot and the green pepper'
NEG–And	Mouse	None	Sad face	Il topolino non ha mangiato la carota e il peperone 'The mouse didn't eat both the carrot and the green pepper'
NEG–And	Frog	One	Silver medal	La rana non ha mangiato la carota e il peperone 'The frog didn't eat both the carrot and the green pepper'
NEG–And	Giraffe	One	Silver medal	La giraffa non ha mangiato la carota e il peperone 'The giraffe didn't eat both the carrot and the green pepper'

Filler material

Animal	Vegetable eaten	Reward	Sentence
Lion	Both	Golden Medal	Il leone ha mangiato tutto 'The lion ate everything'
Tiger	Both	Golden Medal	La tigre ha mangiato tutto 'The tiger ate everything'
Monkey	Both	Golden Medal	La scimmietta non ha mangiato niente 'The monkey didn't eat anything'
Dog	Both	Golden Medal	Il cagnolino non ha mangiato niente 'The dog didn't eat anything'

Appendix B: Experimental Materials—Experiment 2

Training material

Animal	Vegetable eaten	Reward
Rabbit	Both	Golden medal
Bear	None	Sad face
Zebra	One	Silver medal

Test material

Connectives	Animal	Vegetable eaten	Reward	Sentence
NEG–Or	Hippo	One	Silver Medal	L'ippopotamo non ha mangiato la carota o il peperone 'The hippo didn't eat either the carrot or the green pepper'
NEG–Or	Cat	One	Silver medal	Il gattino non ha mangiato la carota o il peperone 'The cat didn't eat either the carrot or the green pepper'
NEG–Or	Frog	One	Silver medal	La rana non ha mangiato la carota o il peperone 'The frog didn't eat either the carrot or the green pepper'
NEG–Or	Giraffe	One	Silver medal	La giraffa non ha mangiato la carota o il peperone 'The giraffe didn't eat either the carrot or the green pepper'
NEG–Or	Pig	None	Sad face	Il maialino non ha mangiato la carota o il peperone 'The pig didn't eat either the carrot or the green pepper'
NEG–Or	Elephant	None	Sad face	L'elefantino non ha mangiato la carota o il peperone 'The elephant didn't eat either the carrot or the green pepper'
NEG–Or	Donkey	None	Sad face	L'asinello non ha mangiato la carota o il peperone 'The donkey didn't eat either the carrot or the green pepper'
NEG–Or	Mouse	None	Sad face	Il topolino non ha mangiato la carota o il peperone 'The mouse didn't eat either the carrot or the green pepper'

 Filler material

Animal	Vegetable eaten	Reward	Sentence
Lion	Both	Golden medal	Il leone ha mangiato tutto 'The lion ate everything'
Tiger	Both	Golden medal	La tigre ha mangiato tutto 'The tiger ate everything'
Monkey	Both	Golden medal	La scimmietta non ha mangiato niente 'The monkey didn't eat anything'
Dog	Both	Golden medal	Il cagnolino non ha mangiato niente 'The dog didn't eat anything'

Appendix C: Experimental Materials—Experiment 3

 Training material

Animal	Vegetable eaten	Reward
Rabbit	Both	Golden medal
Bear	None	Sad face
Zebra	One	Silver medal

Test material

Connectives	Animal	Vegetable eaten	Reward	Sentence
NEG–né... né	Hippo	One	Silver medal	L'ippopotamo non ha mangiato né la carota né il peperone 'The hippo ate neither the carrot nor the green pepper'
NEG–né... né	Cat	One	Silver medal	Il gattino non ha mangiato né la carota né il peperone 'The cat ate neither the carrot nor the green pepper'
NEG–né... né	Frog	One	Silver medal	La rana non ha mangiato né la carota né il peperone 'The frog ate neither the carrot nor the green pepper'
NEG–né... né	Giraffe	One	Silver medal	La giraffa non ha mangiato né la carota né il peperone 'The giraffe ate neither the carrot nor the green pepper'
NEG–né... né	Pig	None	Sad face	Il maialino non ha mangiato né la carota né il peperone 'The pig ate neither the carrot nor the green pepper'
NEG–né... né	Elephant	None	Sad face	L'elefantino non ha mangiato né la carota né il peperone 'The elephant ate neither the carrot nor the green pepper'
NEG–né... né	Donkey	None	Sad face	L'asinello non ha mangiato né la carota né il peperone 'The donkey ate neither the carrot nor the green pepper'
NEG–né... né	Mouse	None	Sad face	Il topolino non ha mangiato né la carota né il peperone 'The mouse ate neither the carrot nor the green pepper'

Filler material

Animal	Vegetable eaten	Reward	Sentence
Lion	Both	Golden medal	Il leone ha mangiato tutto 'The lion ate everything'
Tiger	Both	Golden medal	La tigre ha mangiato le due verdure 'The tiger ate the two vegetables'
Monkey	Both	Golden medal	La scimmietta non ha mangiato nessuna verdura 'The monkey didn't eat any vegetables'
Dog	Both	Golden medal	Il cagnolino ha mangiato tutto 'The dog ate everything'

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