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Children's Knowledge of Free Choice Inferences and Scalar Implicatures

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Abstract

This article presents experimental results showing that 4- and 5-year-old children are capable of drawing free choice inferences from disjunctive statements and from statements containing free choice indefinites, despite not being able to compute inferences of exclusivity for disjunctive statements, or other scalar implicatures. The findings appear to challenge accounts that attempt to unify the two kinds of inferences (Kratzer & Shimoyama 2002; Alonso Ovalle 2005; Fox 2007; Klinedinst 2007; Chemla 2010; van Rooij 2010; Franke 2011; Chierchia 2013). We discuss, however, the compatibility of the child data with a recent approach in the experimental literature, which attributes children's failures to compute scalar implicatures to a difficulty with alternatives (Chierchia *et al.* 2001; Gualmini *et al.* 2001; Reinhart 2006; Barner *et al.* 2011; Singh *et al.* 2013). Based on the results of two experiments, we propose an explanation for children's selective success on scalar inferences, according to which scalar inferences are generally unproblematic for children, unless they necessitate lexical retrieval of the required alternatives.

1 INTRODUCTION

A long-standing puzzle in the semantics/pragmatics literature is to explain why disjunctive statements such as (1a) license conjunctive inferences such as (1b).[1]

[1] See Kamp (1973), Zimmerman (2000), Geurts (2005), Fox (2007), Klinedinst (2007), Barker (2010), Chemla (2010), Chierchia (2013), among many others.

(1) a. Jack may have sushi or pasta.
b. $\rightsquigarrow$ *Jack may have sushi and Jack may have pasta*

The fact that we infer (1b) from (1a) is surprising, because in all standard modal logics a sentence of the form $\Diamond(p \vee q)$ does not entail the corresponding sentence $\Diamond p \wedge \Diamond q$. Moreover, a plain disjunctive sentence like (2a) never conveys the corresponding conjunctive inference in (2b); in fact, it typically conveys its negation, as we will see.

(2) a. Jack had sushi or pasta.
b. $\not\rightsquigarrow$ *Jack had sushi and pasta*

The question, then, is why the addition of an existential modal to a disjunctive statement suffices to engender an inference to the corresponding conjunctive sentence, as illustrated in (1). Inferences like (1b) are traditionally called 'free choice inferences', the intuition being that sentence (1a) grants Jack free choice between the two options.

One successful approach in the literature derives free choice inferences as a kind of scalar implicature (Kratzer & Shimoyama 2002; Alonso Ovalle 2005; Fox 2007; Klinedinst 2007; Chemla 2010; van Rooij 2010; Franke 2011; Chierchia 2013). We refer to this as the scalar implicature or uniformity account. By grouping free choice and scalar implicature phenomena together, this account gives rise to the prediction that similar behavioral profiles should be observed across the two linguistic phenomena, both in acquisition and processing.[2] Chemla & Bott (2014) assessed this uniformity prediction in studies of language processing with adults, where scalar implicatures and free choice inferences are expected to manifest similar processing profiles. However, different performance profiles by adults were observed for the computation of free choice inferences as compared to scalar implicatures. Taken at face value, these results represent a challenge to the uniformity account.[3]

Following the example of Chemla & Bott (2014), the present study explores the uniformity account in language acquisition. The uniformity

[2] As an anonymous reviewer rightly points out, existing theories of free choice inferences do not in and of themselves make any specific predictions about processing or acquisition. The idea, however, is that unless we add additional assumptions about processing or acquisition that would give rise to differences in behavioral profiles, we can expect that the two phenomena should give rise to similar behavioral profiles, given they are of the same nature. In other words, on a uniformity-based approach, additional assumptions (i.e. about acquisition and/or processing) would be needed to explain any observed differences in the behavioral profiles of the two phenomena.

[3] Other accounts in the literature invoke different analyses for each kind of inference (Zimmerman 2000; Geurts 2005; Barker 2010). In this article, we focus on investigating in detail the predictions of the uniformity account and how the latter is constrained by our results. We leave for future research an exploration of other approaches to free choice.

account predicts that, all else being equal, children should display similar acquisition profiles in the development of the ability to compute free choice inferences and scalar implicatures. In line with the processing result by Chemla & Bott (2014), the findings from our first experiment also fail to meet the expectations of the uniformity account. As we suggest in the discussion, however, the results are consistent with recent proposals in the developmental literature concerning children's knowledge of alternatives (see Chierchia *et al.* 2001; Gualmini *et al.* 2001; Reinhart 2006; Barner *et al.* 2011; Singh *et al.* 2013; Chemla & Bott 2014). Building on these recent proposals, we formulate a hypothesis about the observed behavioral differences. We then identify a precise prediction of this hypothesis, and test this prediction in a second experiment. The results of Experiment 2 lead us to a more general formulation of our hypothesis concerning children's knowledge of alternatives, wherein we identify the source of the problem as a difficulty with lexical retrieval.

The remainder of this article is organized as follows. We briefly introduce free choice inferences and scalar implicatures, and their relationship. Focusing in particular on the approach that treats free choice inferences as a kind of scalar implicature, we sketch, as an example, one variant of this approach and discuss its predictions for child language acquisition. In Section 2, we present our first experiment and discuss the implications of the results, in particular tying them to recent suggestions in the developmental literature regarding children's knowledge of alternatives. Section 3 presents a second experiment designed to test a prediction of the alternatives-based explanation of children's performance with scalar implicatures. In Section 4, we discuss the implications of our findings. Section 5 concludes the article.

1.1 *What are free choice inferences and scalar implicatures?*

Consider sentences (3a) and (3b). Example (3a) contains a plain disjunction, and example (3b) contains an existential modal. When we hear these sentences we typically draw the corresponding inferences in (4a) and (4b), respectively.

(3) a. Jack had sushi or pasta.
b. Jack may have sushi.

(4) a. Jack didn't have both sushi and pasta.
b. Jack doesn't have to have sushi.

We will call the inference in (4a) the 'exclusivity' inference and we will call the inference in (4b) the 'not-required-to' inference.

Next consider sentence (5), which combines an existential modal and disjunction.

(5) Jack may have sushi or pasta.

Notice that an exclusivity inference is generally derived from (5), namely that Jack may not have both sushi and pasta. Moreover, we also typically generate the conjunctive inference in (6).

(6) Jack may have sushi and Jack may have pasta.

This conjunctive inference is surprising because, as we have seen, from a plain disjunction like (3a) (*Jack had sushi or pasta*) we never conclude the corresponding conjunction (7a) (*Jack had sushi and Jack had pasta*). In fact, we typically conclude the negation of (7a), namely (7b).

(7) a. Jack had sushi and Jack had pasta.
    b. Jack did not have both sushi and pasta.

Clearly, the existential modal is responsible, at least in part, for the conjunctive inference from (5) to (6). The puzzle is to understand why the free choice inference in (6) arises when we combine an existential modal with disjunction.[4]

One characteristic of all three of the inferences under consideration is that they are suspendable. For instance, it is clear from the continuation in (8) that Jack does not have to have sushi. Similarly, we can suspend the exclusivity inference of the first statement in (9), by adding a continuation that makes it clear that it is possible that Jack had both sushi and pasta.

(8) Jack may have sushi. In fact, he might even have to have it.

(9) Jack had sushi or pasta. In fact, he might even have had both.

[4] The phenomenon extends beyond sentences with deontic modals, which grant permission. Such an inference can also arise in sentences such as (i), which express epistemic modality.

(i) a. Jack might be in Sydney or in Paris.
    b. ⇝ *Jack might be in Sydney and might be in Paris*

Free choice inferences also arise with existential quantifiers and some generic sentences (see Fox (2007), Klinedinst (2007), and Nickel (2011) for discussion).

(ii) a. (This course is very hard.) Some students take three semesters to complete it or do not finish it at all. (Fox 2007)
     b. ⇝ *Some students take three semesters and some students do not finish it at all*

(iii) a. Elephants live in Asia or in Africa. (Nickel 2011)
      b. ⇝ *Elephants live in Asia and elephants live in Africa*

Finally, we can also suspend the free choice inference in the original example in (1a), as in (10). Here the speaker is not saying that Jack has free choice between sushi and pasta; rather, Jack can only have one of the two, and the speaker simply does not remember which one.[5]

(10) Jack may have sushi or pasta. I don't remember which.

In the present article we focus on the inferences in (11b) and (12b), which are generally regarded as scalar implicatures, and free choice inferences like the one in (13b). In particular, we will examine the acquisition of such inferences in the context of the relationship between the two.

(11) a. Jack may have sushi.
b. $\rightsquigarrow$ *Jack doesn't have to have sushi*

(12) a. Jack had sushi or pasta.
b. $\rightsquigarrow$ *Jack didn't have both sushi and pasta*

(13) a. Jack may have sushi or pasta.
b. $\rightsquigarrow$ *Jack may have sushi and Jack may have pasta*

Before we turn to our first experiment, it will be instructive to briefly sketch how one can derive free choice inferences as scalar implicatures. Readers already familiar with theories of scalar implicatures may wish to skip ahead to Section 2.

1.2 *A scalar implicature-based approach to free choice disjunction*

This section offers an example of how free choice inferences can be derived as scalar implicatures. For the purposes of this demonstration, we will adopt a very simplified version of the type of theories proposed in Kratzer & Shimoyama (2002) and subsequent work. It should be understood that there are other scalar implicature-based accounts, some of them very different in implementation, including those presented in Fox (2007), Klinedinst (2007), Chemla (2010), van Rooij (2010), Franke (2011), and Chierchia (2013). Rather than going into a particular theory in detail, we will simply sketch the intuition that underlies the proposal in Kratzer & Shimoyama (2002).

[5] Of course, not every inference is suspendable in this way. For instance, a conjunctive sentence like (ia) gives rise to the inference in (ib). But one cannot go on and suspend it as in (ii).

(i) a. Jack had sushi and pasta.
b. Jack had sushi.

(ii) But in fact it might be that he didn't have sushi.

Let us begin with the idealized Gricean algorithm for computing scalar implicatures. The basic idea is that rational interactions between conversational participants are guided by general principles (see Grice 1975 and much subsequent work). In particular, the assumption is that upon hearing an utterance, the hearer will reason about what the speaker might have said instead, with various assumptions about what led the speaker to say what she said rather than something else. Among these assumptions, the one that is relevant here is the assumption that the speaker is being as informative as is required.[6] The fact that the speaker asserted what she asserted and not something more informative (among a set of restricted competitors) leads the hearer to conclude that the stronger competitors must be false.[7,8] In particular, the competitors that are rendered false are the ones that are not already entailed by the speaker's utterance. Consider the schematic rendering of this algorithm in (14).

(14) a. The speaker said A.
b. The speaker might have said B.
c. It's false that B.

For instance, when we hear a disjunctive statement such as (15a), we reason that the speaker could have instead uttered the corresponding conjunctive statement (15b), which would have been stronger; we are thus led to conclude that (15b) is false.

(15) a. Jack had sushi or pasta.
b. Jack had sushi and pasta.

How do we proceed from here to computing free choice inferences as scalar implicatures? Two further ingredients are required. First, we need to consider more competitors for disjunction (see Sauerland 2004). Importantly, we need to take into account all of the relevant alternatives as a whole; negating all stronger alternatives one after the other, for example, would be problematic.

Take the sentence in (15a) (*Jack had sushi or pasta*). This is compared not only to the alternative with *and* in (15b), but also to the disjuncts that it contains, namely those in (16a) and (16b).

[6] This is, roughly, what Grice called the 'Maxim of Quantity'.

[7] More precisely, the hearer will conclude that it is not true that the speaker believes that the stronger competitors are true, which, given other assumptions, can be strengthened to the speaker's believing that the stronger competitors are false, and even further to these stronger competitors actually being false. See Gamut (1991) for discussion.

[8] The assumption that we need to consider only a restricted set of competitors goes back to Horn (1972). For an elaborated theory of competitors, see Katzir (2007) and Fox & Katzir (2011).

(16) a. Jack had sushi.
b. Jack had pasta.

Although these alternatives are stronger than the assertion, if the algorithm in (14) were applied to these alternatives, the result would be the negation of the statements in (16) (*Jack didn't have sushi* and *Jack didn't have pasta*). Taken together, these negative statements would contradict the original assertion, *Jack had sushi or pasta*. Assuming that the speaker believes what she said, one would be led to conclude that the speaker is irrational, something one generally avoids.[9] Therefore, nothing happens to the alternatives in (16) on the present account. In other cases however, these additional alternatives become crucial, as we will see.

In addition to this broader range of competitors, the second ingredient of the new algorithm is a recursive step (see Kratzer & Shimoyama (2002); Alonso Ovalle (2005); Fox (2007), among others). The algorithm assumes the following shape. As before, when we hear an utterance, we reason about what the speaker might have said (taking into account a restricted set of competitors). So far, everything is as it was, that is as in the algorithm in (14). According to the new algorithm however, we also reason that if the speaker had uttered one of the competitors, that competitor would have come with its own inferences. In making comparisons between the assertion and its competitors then, not only do we consider the plain competitors, we also assess the assertion against each of the competitors enriched with its respective inferences. The conclusion we draw is that the competitors, along with their associated inferences, are false if they are stronger than the speaker's original assertion. The algorithm can be represented schematically as in (17).

(17) a. The speaker said A.
b. The speaker might have said B.
c. If the speaker had said B, B would have had C as an inference.
d. It's false that B and C.

To see how the algorithm works in practice, let us return to the example sentence (18a). According to the new algorithm, the target assertion is compared to each of the disjuncts that are contained in the assertion, namely (18b) and (1bc). As we saw, if these disjuncts were compared to

[9] Notice that it does not follow from the simple algorithm that we have sketched above why we do not negate only one of the two disjuncts. Minimally, we need to add the condition that we cannot conclude that a competitor is false if this leads to the conclusion that another competitor is true (see Sauerland (2004) and Fox (2007)).

the assertion using the older algorithm in (14), they would be negated on the threat of contradiction.

(18) a. Jack may have sushi or pasta.
b. Jack may have sushi.
c. Jack may have pasta.

On the new algorithm however, these competitors are compared to the assertion only once they have been enriched with their associated inferences. What inferences are associated with (18b) and (18c)? If the question under discussion is what Jack can have, and if sushi and pasta are relevant to the discussion, then from competitor (19a) we would conclude (19b), and similarly from (20a) we would conclude (20b).

(19) a. Jack may have sushi.
b. Jack may not have pasta.

(20) a. Jack may have pasta.
b. Jack may not have sushi.

In (21), we have combined the competitors and their inferences. These are among the comparison set for the disjunctive sentence under consideration (*Jack may have sushi or pasta*).

(21) a. Jack may have sushi but not pasta.
b. Jack may have pasta but not sushi.

Notice that both of the competitors in (21a) and (21b) are stronger than the original assertion, so these wind up being negated by our algorithm. Therefore, we infer (22a) and (22b).

(22) a. It's false that Jack may have sushi but not pasta.
b. It's false that Jack may have pasta but not sushi.

In other words, allowance for one (i.e. *sushi*) goes hand in hand with allowance for the other (i.e. *pasta*). This is the last piece of the puzzle. From the assertion *Jack may have sushi or pasta*, the new algorithm allows us to infer (23).

(23) Jack may have sushi and Jack may have pasta.

Following the new algorithm, we are therefore able to derive free choice inferences as a type of recursive scalar implicature.

This concludes a sketch of one way that recent research has attempted to unify free choice inferences and scalar implicatures, based on the proposal initially put forth in Kratzer & Shimoyama (2002).

2 EXPERIMENT 1

As we described in the previous section, the uniformity approach unifies free choice inferences and scalar implicatures. This gives rise to a particular prediction for acquisition.[10] Unless we add further assumptions, we can expect that children will behave uniformly with respect to free choice inferences and scalar implicatures.[11] Experiment 1 was designed to test this prediction.[12]

2.1 *Method*

2.1.1 *Participants* Twenty-two Mandarin-speaking children (3;07 – 4;09, M = 4;03) participated in Experiment 1.

2.1.2 *Procedure* We used a Truth Value Judgment Task (Crain & Thornton 1998). In this task, one experimenter acts out a story using toy characters and props and a second experimenter plays the role of a puppet who describes what happened in the story. The child participant's task is to say whether the puppet's description of what happened in the story is right or wrong.

2.1.3 *Materials* The design of the experiment included two conditions, a free choice condition and a scalar implicature condition. Eight sentences were presented, four per condition. On one test trial, for example, Kung Fu Panda and Batman were engaged in a racing competition (see Figure 1). Before the competition, Mr. Owl, the judge of the competition, explained the rules, telling Kung Fu Panda that he was only allowed to push the green car, and telling Batman that he was only allowed to push the orange car. But as the game was about to start, Kung Fu Panda and Batman, being quite forgetful, asked the puppet to remind them of the rules. The puppet then produced the test sentence in (24).

[10] In the remainder of this article, we develop in greater detail the predictions of the uniformity approach, leaving to future work a more detailed investigation of the predictions made by an approach that treats free choice inferences and scalar implicatures as different in nature. On such an approach, any similarities or differences between the developmental profiles of the two phenomena remain mostly underspecified, and would rely on independent hypotheses. Because the two phenomena are independent, they could follow different acquisition paths or they could accidentally overlap.

[11] In fact, if the derivation of free choice inferences requires an additional element of recursivity that is absent in the case of classical scalar implicatures, one might expect the former to be more difficult than the latter.

[12] A description of Experiment 1 can also be found in Zhou *et al.* (2013).

Figure 1 A free choice disjunction trial.

(24) Gongfu xiongmao keyi tui lüse xiaoche huozhe juse xiaoche.
Kung.Fu Panda may push green car or orange car
'Kung Fu Panda may push the green car or the orange car.'

The logic of the design is as follows: the relevant rule stated by Mr. Owl was (25), which we can render schematically as in (26).

(25) Kung Fu Panda may push the green car but may not push the orange one.

(26) $\Diamond p \wedge \neg \Diamond q$

The puppet's statement, on the other hand, was (24). On its literal meaning, (24) can be rendered simply as in (27), which is compatible with the rule in (26); it is in fact entailed by (26). (27) is also compatible with (26) if we add to it its standard *not-both* implicature. We have seen, however, that from the disjunctive statement (27) we can compute the free choice inference in (28), and this is not compatible with Mr. Owl's rule as rendered in (26).

(27) $\Diamond (p \vee q)$

(28) $\Diamond p \wedge \Diamond q$

Therefore, if the child participants computed free choice inferences of the form in (28), they were expected to reject the puppet's statement. On the other hand, if they did not compute free choice inferences, they were expected to accept the puppet's disjunctive statement in (24) as an accurate description of Mr. Owl's rule.

The very same logic applied in the scalar implicature condition, which contained two types of trials. One tested the 'not-required-to' inference and the other tested the exclusivity inference. On two of the scalar implicature trials, the sentences contained the Mandarin modal verb *keyi* ('may'), as in (29). In the context associated with the test sentence (29), Mr. Owl states that Winnie the Pooh must eat a green pepper. In other words, the context validates an assertion of the form $\Box p$. The puppet's statement, on the other hand, is of the form $\Diamond p$. Again, Mr. Owl's rule is compatible with the literal meaning of the test sentence; it is not, however, compatible with its 'not-required-to' inference, $\neg\Box p$. Therefore, once again, if the child participants computed the 'not-required-to' implicature, they were expected to reject the puppet's statement; if they computed the literal meaning but not the implicature, however, then they were expected to accept the puppet's statement.

(29) Weinixiong keyi chi qingjiao.
Winnie-the-Pooh may eat green-pepper
'Winnie the Pooh may eat a green pepper.'

On the other type of scalar implicature control trials, the sentences contained the Mandarin disjunction *huozhe* ('or'), as in (30). As an example, on one trial, a red mermaid found both a white shell and a blue shell, which validates a statement of the form $p \wedge q$. The puppet's statement, however, was (30). Again the literal meaning $p \vee q$ is compatible with the events that unfolded in the story, but its exclusivity inference, $\neg(p \wedge q)$, is not. Once again, children were expected to reject the puppet's statement if they computed the exclusivity inference, but not if they computed only the literal meaning.

(30) Hongse meirenyu zhaodao-le baise beike huozhe lanse beike.
red mermaid find-ASP white shell or blue shell
'The red mermaid found a white shell or a blue shell.'

2.2 *Results*

The results of Experiment 1 are reported in Figure 2. As this figure indicates, children rejected the puppet's statement in the free choice condition 91% of the time (on 80 out of 88 trials). In contrast, the same children rejected the test sentences in the scalar implicature condition only 18% of the time (on 16 out of 88 trials). A Wilcoxon Signed Ranks Test, based on the average proportion of rejections by each participant in each condition, revealed a significant difference between conditions ($Z = 4.52$, $P < 0.001$).[13,14]

[13] A Wilcoxon Signed Ranks test was also conducted to determine whether the children exhibited differences in their responses to the two kinds of scalar implicatures (disjunction items v. modal items). The results indicated no differences in the rejection rates by the participants when responding to the disjunction items vs. the modal items ($Z = 0$, $P = 1$).

[14] In order to determine whether there were any effects of age, we grouped the participants into two age groups: 11 children fell between the ages of 3;08 and 4;02, and 11 children were between 4;03 and 4;09. A Mann–Whitney U test (based on mean proportion of rejections in each condition)

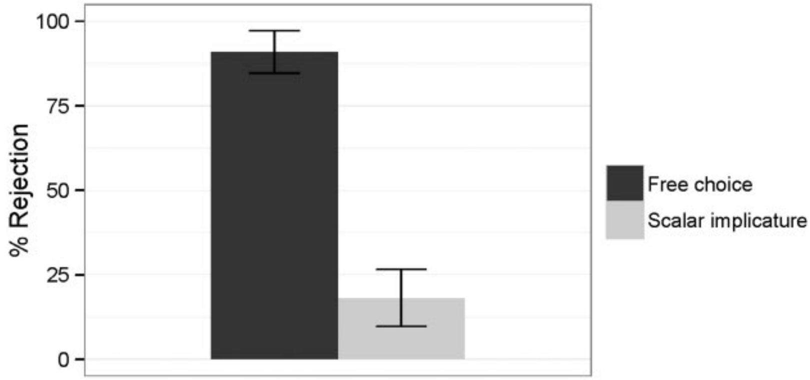

Figure 2 Rejection rate of the puppet's statement in the two conditions.

2.3 *Discussion*

In Experiment 1, children were found to compute free choice inferences but not scalar implicatures. The scalar implicature result is consistent with previous findings in the literature (Chierchia *et al.* 2001; Gualmini *et al.* 2001; Papafragou & Musolino 2003, among many others). The observation that children consistently computed free choice inferences, however, is a novel finding. Moreover, a comparison between the two conditions is potentially informative for the debate surrounding the relationship between free choice inferences and scalar implicatures.

The findings reveal that children's behavior with respect to free choice inferences and scalar implicatures is not uniform. On the face of it, such findings speak against the uniformity account. There is, however, a recent approach in the acquisition literature that we believe connects very nicely to our findings. In the remainder of this article, we will build on this approach and develop an alternative explanation for children's performance on Experiment 1. In other words, we will explore a response to the present findings without abandoning the uniformity account of free choice inferences and scalar implicatures. In particular, we formulate a hypothesis based on a suggestion in Chemla & Bott (2014) and elsewhere in the literature, namely that children have access to a restricted set of alternatives (see also Singh *et al.* (2013), Reinhart (2006) and Barner *et al.* (2011)).

conducted on each condition revealed no significant differences between older and younger children's rejection rates in either condition (Free Choice Condition: older children v. younger children, $Z = 1.45$, $P = 0.48$; Scalar Implicature Condition: older children v. younger children, $Z = 0$, $P = 1$). We thank an anonymous reviewer for raising this question.

2.3.1 *The restricted alternatives hypothesis* Our uniformity-based proposal has two main ingredients. One comes from the observation that scalar implicatures and free choice inferences are derived from different sets of alternatives. The second comes from the observation that explicit mention of alternatives appears to help children to compute the inferences that can be associated with these alternatives.

Let us start with the first observation. Notice that the alternatives from which we derived the 'not-required-to' inference are different from the alternatives used to compute the exclusivity inference. The alternatives from which we derived the not-required-to and the exclusivity inference in (31c) and (32c) from (31a) and (32a) were (31b) and (32b), respectively. To obtain these alternatives from the corresponding assertions, we needed to replace the modal and the connective, respectively.

(31) a. Jack **may** have sushi.
  b. Jack **has to** have sushi.
  c. $\rightsquigarrow$ *Jack doesn't have to have sushi*

(32) a. Jack had sushi **or** pasta.
  b. Jack had sushi **and** pasta.
  c. $\rightsquigarrow$ *Jack didn't have sushi and pasta*

To derive the free choice inference in (33d) from (33a), on the other hand, we only needed the alternatives corresponding to the individual disjuncts.[15] In other words, the alternatives that we need for free choice inferences are substrings of the assertion, while those of the scalar implicatures are not.

(33) a. Jack may have sushi or pasta.
  b. Jack may have sushi.
  c. Jack may have pasta.
  d. $\rightsquigarrow$ *Jack may have sushi and Jack may have pasta*

The second ingredient of the restricted alternatives hypothesis is the observation that mentioning alternatives helps children to compute the corresponding inferences (Chierchia *et al.* 2001; Gualmini *et al.* 2001; Reinhart 2006). In most previous studies, children were presented with disjunctive sentences in contexts that made the corresponding conjunctions true. In other words, when the context validated that Jack had sushi and pasta, the puppet would utter (34) and children (unlike adults) tended to accept this sentence in this context (e.g.

[15] This is true in particular in Fox's (2007) theory, but most scalar implicature-based accounts have this same property.

Gualmini *et al.* 2001). This has been taken as evidence that young children do not compute scalar implicatures from sentences such as (34). On the other hand, if in the same context children are presented with both (34) and (35), by different puppets, children show a preference for (36). One possible interpretation of this pattern, following Gualmini *et al.* (2001), is that when children are explicitly provided with the alternatives, they are able to compute the corresponding inferences.[16]

(34) Jack had sushi or pasta.

(35) Jack had sushi and pasta.

Finally, let us add the simple observation that if alternatives are contained in the assertion, they are necessarily 'mentioned' in the assertion, so to speak. Now, putting together the two ingredients, we can formulate our hypothesis as in (36) (see Gualmini *et al.* (2001); Chierchia *et al.* (2001); Reinhart (2006); Barner *et al.* (2011); Chemla & Bott (2014); Singh *et al.* (2013)).

(36) **Restricted alternatives hypothesis:** Children compute inferences arising from alternatives which are substrings of the assertion.

Schematically, the restricted alternatives hypothesis in (36) can account for the findings of Experiment 1 in the following way. The alternatives of free choice inferences are mentioned in the assertion, in the sense just explained, while those of other scalar implicatures are not. Mentioning the alternatives helps children to compute their corresponding inferences. Therefore, we expect a difference in children's performance on free choice inferences versus scalar implicatures; in particular we expect the difference in performance to favor free choice inferences over scalar implicatures. In sum, the restricted alternatives hypothesis provides a natural way of accounting for our results, without abandoning the uniformity account.

Consider now two predictions that arise from the hypothesis as stated in (36). The first is that children should be able to compute other kinds of inferences that similarly arise from alternatives mentioned in the assertion. The second is that if we can find free choice inferences that do not arise from alternatives that are mentioned in the assertion, then we expect that children will fail at these latter kinds of free choice

[16] An alternative interpretation of these data might be found in Singh *et al.* (2013), which offers a different version of the restricted alternatives hypothesis. Both versions are compatible with our results.

inferences, just as they do in the case of exclusivity and 'not-required-to' implicatures. Experiment 2 will put this second prediction to the test.

2.3.2 *Testing the restricted alternatives hypothesis* To sum up the discussion in the previous section, we have suggested that the reason the children we tested on Experiment 1 succeeded on the free choice condition was that the alternatives required to compute the relevant free choice inferences were provided explicitly as substrings of the test sentences. Thus, children performed well because the alternatives were explicitly mentioned in the test sentences. This account makes the immediate prediction that if the alternatives were not provided explicitly as substrings of the assertion, children might fail to compute free choice inferences, as they often do in the case of scalar implicatures. As it happens, however, this prediction cannot be tested with free choice disjunctions, as these will always involve providing children with the alternatives as substrings of the assertion, given that the alternatives correspond to the disjuncts.

This is where the use of free choice indefinites such as English *any* can provide a useful testing ground. This is because free choice indefinites have been analyzed as giving rise to scalar implicatures on a par with free choice disjunction (cf. Krifka 1995; Chierchia 2006, 2013). Chierchia (2013), in particular, has endorsed a unified account of free choice inferences arising from free choice indefinites and those arising from disjunction. What is crucial for our purposes is that in these scalar implicature-based accounts, free choice inferences from indefinites do not arise from alternatives that are substrings of the assertion. That is, in contrast to the case of free choice disjunction, the relevant alternatives in the case of free choice indefinites are not explicitly uttered as substrings of the assertion. This key difference allows us to test our current formulation of the restricted alternatives hypothesis: if the property of being substrings of the test sentences is the critical factor that allows children to compute inferences off of the relevant alternatives, we should expect them not to compute free choice inferences from free choice indefinites.

We designed a second experiment to test this prediction. Before we turn to Experiment 2, however, we briefly sketch how the scalar implicature account of free choice inferences can naturally be extended to free choice indefinites.

2.3.3 *Extending the scalar implicature-based account to free choice indefinites* In this section, we will sketch Chierchia's (2013) account of free choice indefinites as an example of a scalar implicature-based account. As we did in Section 1.3, here again we will only sketch the idea behind the proposal.[17] Chierchia's approach to free choice indefinites like *any* involves three ingredients. First, Chierchia analyzes the literal meaning of *any* simply as that of an existential quantifier, much like *a*. As a quantifier, *any* is relativized to some pragmatically determined domain of quantification. If a sentence such as (37) were grammatical, it would mean that there is one thing that Jack had from a contextually specified domain of drinks (e.g. tea and coffee). Notice that this meaning of (37), where the subscript D represents the domain of quantification, is equivalent to a disjunctive statement over the members of D, as shown in (38).

(37) *Jack had any_{D} drink.

(38) Jack had coffee or tea.

Chierchia's theory is also designed to account for the ungrammaticality of (37). But the licensing of *any* is not relevant for our purposes, so we will put that aside and concentrate instead on cases where *any* gives rise to free choice inferences. To see how these come about, we need to introduce the second ingredient of Chierchia's theory, which lies in the nature of the relevant alternatives. The idea is that a sentence containing *any* like (37) is associated with alternatives that are identical to the sentence itself, but wherein the domain of quantification of the free choice indefinite is replaced with one of its possible subdomains. In other words, the alternatives of *any* are its contextually defined (sub)domain alternatives, that is, more restricted domains of quantification available in the context. In particular, given the assumption that D contains coffee and tea, the alternatives of (37) are (39) (where D′ and D″ represent the two subdomains of D).[18]

(39) $$\left\{\begin{array}{l}\text{Jack had any}_{\text{D}}\text{ drink(= Jack had coffee or tea)}\\ \text{Jack had any}_{\text{D}'}\text{ drink(= Jack had coffee)}\\ \text{Jack had any}_{\text{D}''}\text{ drink(= Jack had tea)}\end{array}\right\}$$

[17] For the sake of presentation, we will also simplify Chierchia's approach and we will actually sketch his theory of the German indefinite *irgendein* rather than English *any*. This is because Chierchia's treatment of the former is completely parallel to disjunction. The treatment of *any*, on the other hand, involves some further assumptions about alternatives. As these are not relevant for our purposes, we will disregard them here and refer the reader to Chierchia (2013) for details.

[18] In a nutshell, the ungrammaticality of (37) on this approach is explained as follows. An indefinite like *any* obligatorily triggers the application of the scalar implicature algorithm. In the case of a simple sentence like (37), the algorithm will negate the alternatives in (39), namely *Jack had coffee* and *Jack had tea*. This, however, gives rise to a contradiction: Jack had either coffee or tea but he did not have coffee and he did not have tea. The idea according to Chierchia (2013) and others is that this contradiction is the source of the ungrammaticality of sentences like (37).

As one can see, this is completely parallel to disjunction. And this parallelism remains in cases where *any* is embedded under an existential modal, as in (40). In this case again, in the very same way as its corresponding disjunction, the alternatives are those in (40).

(40) Jack may have any$_D$ drink. =
Jack may have coffee or tea.

(41) {Jack may have coffee or tea
Jack may have coffee
Jack may have tea}

The third and final ingredient is that these domain alternatives must be strengthened with their respective scalar implicatures, as in the case of the free choice disjunctions we saw in Section 1.3. Just as we considered the strengthened alternatives in the case of disjunction, here too we compare the assertion to the alternatives enriched with their own inferences. In other words, the alternatives that we consider are not those in (41), but rather those in (42):

(42) {Jack may have coffee and may not have tea
Jack may have tea and may not have coffee
Jack may have coffee or tea}

We now apply the scalar implicature algorithm in the same way as we did with disjunction. The negation of the excludable alternatives in (42), together with the assertion in (43), give rise to the free choice inference in (43d), which conveys that Jack has free choice of the two subdomain alternatives.

(43) a. Jack may have any$_D$ drink (=Jack may have tea or coffee)
b. It's not the case that Jack may only have tea.
c. It's not the case that Jack may only have coffee.
d. Jack may have tea and Jack may have coffee.

In sum, Chierchia (2013) provides a unified account of the free choice inferences in (44) and (45), based on Fox (2007).[19]

(44) Jack may have coffee or tea.
⇝ *Jack may have coffee and Jack may have tea*

[19] In fact, as an anonymous reviewer points out, Chierchia's approach to free choice inferences from free choice indefinites makes the clear prediction that, everything else being equal, the free choice interpretation of *any* should be acquired simultaneously with free choice construals of disjunction, as they are the same in nature. In addition to testing the restricted alternatives hypothesis then, we can also expect Experiment 2 to shed light on this timing prediction made by Chierchia's approach.

(45) (Jack may have any$_{D}$ drink. (where D includes coffee and tea)
$\rightsquigarrow$ *Jack may have coffee and Jack may have tea*

Importantly, for our purposes, the alternatives required to compute the free choice inference in (45) are not explicitly provided as substrings of the assertion in the same way as in the case of (44). That is, a sentence like *Jack may have any drink* does not explicitly provide the subdomain alternatives as substrings of the assertion.[20] If the formulation of the restricted alternatives hypothesis given above is on the right track, we expect children not to be successful at computing free choice inferences from *any*, despite their success with free choice disjunction on Experiment 1. We turn now to Experiment 2, designed to put this prediction to the test.

3 EXPERIMENT 2

3.1 *Method*

We used a modified version of the Truth Value Judgment Task to investigate children's comprehension of free choice *any* in deontic modal statements.

3.1.1 *Participants* Sixteen English-speaking children from the Sydney area were tested at Macquarie University, Australia. One child failed the control items and was excluded from the analysis. We report here the data from the 15 remaining children (4;01 – 6;08, M = 5;01). Note that the average age of children tested in Experiment 2 was greater than the average age in Experiment 1. We rely here, however, on previous literature that has reported difficulties with scalar implicatures in 5-year-olds.[21]

All children were acquiring English as a first language, according to the information provided on parental permission forms. Families were paid $20 for participating.

[20] Emmanuel Chemla points out that *Jack had any$_{D'}$ drink* could be seen as being contained within *Jack had any$_{D}$ drink*. The alternatives *tea* and *coffee*, however, would not be phonological substrings of the assertion, and thus would not be 'explicit' in the same sense as the alternatives in (44). The restricted alternatives hypothesis as stated in (36) would still predict a difference in children's performance on the two kinds of sentences.

[21] In fact, a non-adult-like preference for so-called 'logical' interpretations of scalar terms has been reported in children as old as 7 and 9 years of age (see e.g. Smith (1980); Braine & Rumain (1981); Noveck (2001)). A future experiment that could more directly address the age gap, and which would constitute an ideal next step in this project, involves a within-subject design that would allow us to examine all three kinds of inferences in the same children: scalar implicatures, free choice inferences from disjunctions, and free choice inferences from free choice indefinites.

3.1.2 *Procedure* The truth value judgment task was carried out by a single experimenter using a laptop computer. The experimenter told stories using cartoon pictures and animations assembled out of clipart images and displayed in PowerPoint. Pre-recorded video clips of a puppet created the pretense that the puppet was participating in the task live via webcam. Participants were told that the puppet sometimes did not pay close attention to stories. They were given a scorecard to fill out in order to help the puppet to learn how to pay closer attention. At the end of each story, the puppet was either asked to recall something from the story or to describe something that had happened in the story. Participants were asked to judge whether the puppet's statement was 'right', in which case s/he was instructed to put a stamp under the 'happy face' column of the report card. If the puppet was 'wrong', the participant was instructed to put a stamp under the 'sad face' column of the scorecard. Follow-up justifications were elicited from the children to ascertain their reasons for providing *yes* or *no* responses. All children were tested individually. Sessions were video-recorded for subsequent coding and analysis.

3.1.3 *Materials* We once again designed stories that made free choice statements felicitous. The critical test stories revolved around a series of cartoon children and their babysitter Mr. Cat. It was established that Mr. Cat was in charge of setting rules for the children to follow. Each story context clearly provided different possible (sub)domains of quantification. On the critical test trials, Mr. Cat would state a rule indicating that the cartoon character could interact with one of the possible subdomains in some particular way, for example *Lucy is allowed to hold the big rabbits*. Then the puppet was asked to recall the puppet's rule, and would utter a free choice statement, for example *Lucy was allowed to hold any rabbit.* Depending on whether participants accepted the free choice statement, we could infer whether they were computing merely the literal meaning (the disjunctive assertion *Lucy was allowed to hold the big rabbits or the medium rabbits or the small rabbits*) or the free choice inference (the conjunctive inference *Lucy was allowed to hold the big rabbits and Lucy was allowed to hold the medium rabbits and Lucy was allowed to hold the small rabbits*). As in Experiment 1, the literal meaning, but not the free choice inference, was compatible with Mr. Cat's rule, so if the child provided a *no*-response, we could infer that they had calculated the free choice inference.

Each child received two training items, followed by four test items and six control items, which were presented in pseudo-randomized and counterbalanced order. The four test trials varied in the dimension of the subdomain alternatives (size, colour, texture and kind of animal).

Figure 3 Final image accompanying the puppet's utterance of the test sentence *Lucy was allowed to hold any rabbit.*

See (46) for an example test item and Figure 3 for the accompanying final image.

(46) Today Lucy is visiting a rabbit farm. There are big rabbits, medium rabbits, and little baby rabbits! Will Lucy get to hold the rabbits? Let's see what Mr. Cat says. Remember, he knows all the rules! Mr. Cat says, "Lucy, you may hold the big rabbits, but you may not hold the medium rabbits and you may not hold the small rabbits, because they're still growing."
EXPERIMENTER: Hey Baba, can you tell us something about the story?
PUPPET: Hmm... Lucy was allowed to hold any rabbit!
(*Target*: NO)

In this test story, the domain of quantification consisted of a set of six rabbits, which varied along the contextual dimension of size, that is, there were two big rabbits, two medium rabbits, and two small rabbits. The largest domain of quantification in the context was the one containing all six rabbits. Possible subdomain alternatives in this context included: {big rabbits}, {big rabbits, medium rabbits}, {small rabbits, big rabbits}, {medium rabbits}, etc. In particular, Mr. Cat's rule was that Lucy was only allowed to hold the big rabbits, since the medium and small ones were still growing and rather fragile.[22] Next, a puppet appeared on the screen

[22] An anonymous abstract reviewer raised the concern that the Condition of Plausible Dissent has not been satisfied on such a trial. The concern is that if Mr. Cat's rule makes reference only to the objects that Lucy is allowed to carry out the action with, the child may consider that the same rule

and was asked to recall something about the story. He would then answer with a free choice statement, and participants were asked to decide if the puppet's statement was right or wrong. If participants computed only the literal meaning of the puppet's statement (47a), they were expected to accept the statement, as it was compatible with Mr. Cat's rule; if they computed the free choice inference (47b), they were expected to reject the sentence.

(47) a. Lucy was allowed to hold the big rabbits, the medium rabbits, or the small rabbits.
b. $\rightsquigarrow$ *Lucy was allowed to hold the big rabbits and Lucy was allowed to hold the medium rabbits and Lucy was allowed to hold the small rabbits*

The four critical test sentences are provided in (48). All of the puppet's lines were pre-recorded with neutral intonation, and in particular without stress on *any*. Having the critical test sentences presented via video files ensured consistency in stimuli across participants.

(48) a. Emily was allowed to feed any animal.
b. Billy was allowed to push any truck.
c. Lucy was allowed to hold any rabbit.
d. Mary was allowed to touch any star.

In addition to the four test stories, each child also saw six control stories. Control items consisted of: (i) sentences containing only the deontic modal *is allowed to* to ensure full comprehension of the modal without the free choice indefinite; (ii) sentences containing the NPI *any* under negation;[23,24] and (iii) sentences containing free choice

can apply to the other objects, but has merely been omitted by Mr. Cat (rather than holding as prohibitions against carrying out the action with the other objects). This is not the case, however. In every test story, not only does Mr. Cat explicitly prohibit characters from carrying out the action with the other (subsets of) objects, he also provides an explanation for the prohibition. In the rabbit story, for example, Mr. Cat says that Lucy is not allowed to hold the medium or small rabbits because they are still growing. Every story was consistent in this respect, satisfying the Condition of Plausible Dissent.

[23] Ordinarily, one might include control sentences containing just the free choice indefinite without the modal, but this was impossible, as *any* would be unlicensed in the resulting episodic sentence. Rather than introduce the complication of subtrigging (e.g. *Lucy held any rabbit that was close by*), we chose to test children's comprehension of the NPI *any* as it is instantiated in negative sentences. This allowed us to isolate *any* from the modal.

[24] The purpose of these NPI trials was to control for the possibility that children might interpret *any* as a universal like *every* or *all* (e.g. as in *Lucy was allowed to hold every rabbit*). Testing *every*-sentences in the same free choice contexts would not help to tease apart children's comprehension of *any* and *every*, as presumably the target response in the case of *every* would also be *no* (assuming that children might interpret the sentence as, *Every rabbit x is such that Lucy can hold x*). Children's justifications for their rejections would also fail to tease apart the two interpretations, as these justifications would be the same for free choice *any* and for *every* (e.g. it is false that *Lucy was allowed to hold any/every rabbit*, since *Lucy was only allowed to hold the big rabbits*). This is where the NPI

any where the target response was *yes*, to ensure that children could plausibly give a *yes*-response to a free choice statement where appropriate.[25] While the four free choice test trials and modal and NPI controls were randomized, the two free choice control trials were presented last, so as not to contaminate the children's interpretations of the critical test trials.[26]

The control trials allowed us to make sure participants were on task, and enabled us to assess children's knowledge of the relevant components of the critical test sentences. The modal and NPI control trials could be associated with *yes*- or *no*-targets, and were selected on the basis of the child's responses on the test trials. This allowed us to balance the overall number of *yes*- and *no*-responses. Any child who did not answer correctly on at least three of the four control trials was excluded from data analysis. The modal control sentences are provided in (49), the NPI controls in (50), and the free choice controls in (51).

(49) *Modal controls*
   a. Sally was allowed to have an apple. (*Target*: YES)
      Sally was allowed to have chocolate. (*Target*: NO)
   b. Billy was allowed to read a book. (*Target*: YES)
      Billy was allowed to swim. (*Target*: NO)

(50) *NPI controls*
   a. Emily didn't feed any donkeys. (*Target*: YES)
      Emily didn't feed any giraffes. (*Target*: NO)
   b. Sally didn't find any triangles. (*Target*: YES)
      Sally didn't find any diamonds. (*Target*: NO)

(51) *Free choice controls*
   a. Lucy was allowed to order any pizza. (*Target*: YES)
   b. Mary was allowed to have any flavor ice cream. (*Target*: YES)

controls proved useful. For example, in one of the NPI control stories, Emily fed one giraffe, so the sentence *Emily didn't feed any giraffes* should yield a *no*-response, whereas the answer would be *yes* to the sentence *Emily didn't feed every giraffe*. Thus children's target-like responses on these trials could be taken as an indication that their grammar distinguished *any* from *every*. We note, however, the additional possibility that children may interpret free choice *any* as universal but NPI *any* as existential (thanks to Nathan Klinedinst for pointing this out); our current controls cannot rule out this possibility.

[25] In other words, we wanted to rule out the possibility that a child (with a non-adult-like grammar) might simply reject any sentence containing free choice *any*, thereby giving the appearance of target-like performance on the critical test trials.

[26] Since the purpose of the free choice control trials was to ensure that children could respond positively to a felicitous free choice statement, situating these trials after all the critical test trials (with a *no*-target) arguably stacked the deck against us; if there were any contamination effect at all, we would expect the *no*-answers to spill over into the free choice control trials. If the children successfully accepted these controls, however, then we could be assured that they were not simply employing a reject-all strategy in their responses to free choice statements.

3.2 *Results*

Children's accuracy on the different trial types is summarized in Figure 4. Children were target-like on the free choice and modal control trials. They accepted all free choice control trials, and accepted and rejected the modal control trials accordingly. They also performed well on the NPI control trials, with an accuracy rate of 87%. Finally, children were also target-like on the free choice test trials, rejecting these free choice statements 95% of the time.[27]

The follow-up justifications provided by the child participants allowed us to ascertain their reasons for accepting or rejecting the target statements. Justifications for rejecting the free choice statements sometimes made explicit reference to the subdomain alternatives that were and were not 'allowed', according to Mr. Cat's rule. Children's construction of domain alternatives was also attested by their frequent use of the focus operator *only*, for example 'Lucy was only allowed to hold the big rabbits.' Some examples of justifications are provided below.

(52) [FC-CHI-03, age 4;09]
CHILD: 'Cause he wasn't paying attention. [. . .] Mr. Cat said Billy, he's only allowed to feed the pigs.

(53) [FC-CHI-05, age 5;03]
CHILD: She was only allowed to feed the pigs. [. . .] He said Sal- he said Emily's allowed to f- allowed to feed any animal. [. . .] That's silly.

(54) [FC-CHI-06, age 5;09]
CHILD: He was being silly! [. . .] Billy wasn't allowed to touch any truck. [. . .] Um, he's only allowed to um push the um yellow trucks.

Summarizing the data, 4- and 5-year-old children appear quite adult-like in their ability to compute free choice inferences from free choice *any* in deontic modal statements.

4 DISCUSSION

Our two experiments reveal that 4- and 5-year-old children are capable of computing free choice inferences from free choice disjunctions in

[27] There was no significant difference between mean accuracy on the NPI control condition and mean accuracy on the free choice test condition ($t(27) = -1.08$, $P = 0.29$).

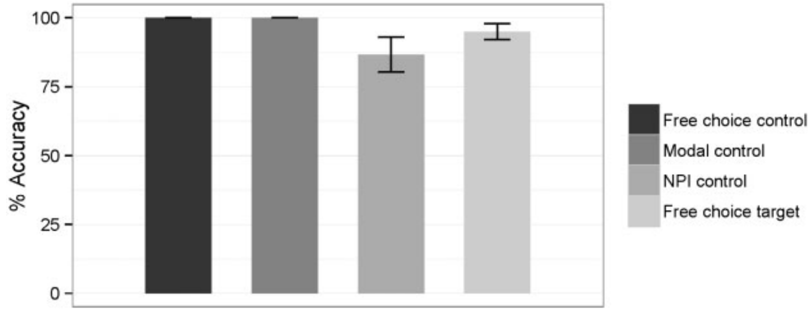

Figure 4 Children's performance on free choice indefinite control and test conditions ($n = 15$).

Mandarin and from the free choice indefinite *any* in English. Yet free choice inferences have been argued to be derived as scalar implicatures, a type of inference with which children in the same age range have been known to have persistent difficulties. Recall our proposed explanation for children's success on free choice inferences from disjunction: we suggested that the reason children succeeded on Experiment 1 was that the alternatives required to compute the relevant free choice inferences were provided explicitly as substrings of the test sentences. Thus, children performed well because the alternatives were explicitly restricted to substrings of the test sentences themselves. This hypothesis gave rise to the prediction that if the alternatives were not provided explicitly as substrings of the assertion, children might fail to compute the free choice inferences.

In Experiment 2, we were able to test this prediction using the English free choice indefinite *any*, argued to involve the same kind of free choice inference as the disjunction we examined in Experiment 1. The free choice indefinite allowed us to test for children's ability to compute free choice inferences without explicitly providing the alternatives as substrings of the assertion. We have seen that children nevertheless succeeded on the free choice inferences. This finding suggests that the substring property of the alternatives cannot be the (only) factor responsible for children's success on free choice inferences. Putting Experiments 1 and 2 together then, we are lead to reformulate the alternatives-based hypothesis. In particular, we posit the reformulation in (55), a more general hypothesis based on the idea that children succeed on inferences that are based on alternatives that do not have to be retrieved from the lexicon (cf. also Singh *et al.* 2013).

(55) **Restricted alternatives hypothesis (second version):** Children have the ability to compute inferences arising from alternatives whose construction does not require access to the lexicon.[28]

Consider first the cases where children have been shown to have difficulties: computing scalar implicatures from scalar quantifiers (e.g. *not all* from *some*), the exclusivity implicature from the plain disjunction, or the *not-required-to* implicature from the modal *may*. All of these have one thing in common, and that is that in order to compute the implicature when presented with the test sentence containing the weaker scalar term, the child must be able to retrieve the stronger alternative from the lexicon. When presented with a *some*-statement for example, the child has to be able to retrieve *all* from the lexicon in order to compute the *not-all* implicature.[29,30]

In contrast, consider the experimental conditions in which children have been shown to succeed at computing scalar inferences: scalar implicature conditions where the alternatives are made explicit in the discourse context, free choice conditions where the alternatives are explicitly provided as substrings of the assertion, and free choice conditions where the alternatives are made salient or explicitly restricted in the discourse context. What this latter set of inferences has in common is that for all of these, the child does not have to: (i) learn the co-scalar status of the alternatives, as they are either pragmatically or explicitly

[28] As Nathan Klinedinst points out to us, a more precise formulation might be the following: children have the ability to compute inferences — when the alternatives are explicitly mentioned, either in the discourse context or in the assertion. This formulation would make the prediction that even in cases where children have been shown to have difficulties, they should succeed if we explicitly mention the relevant alternatives. For example, we should expect children to be able to compute the *some-not-all* implicature when presented with the following: *Yesterday, all the giraffes were wearing a scarf. Today, some of the giraffes are wearing a scarf.* We leave an investigation of this to future research.

[29] More accurately, the child needs to be able to invoke the knowledge that there is some stronger alternative to *some*, even if she has not yet mapped this stronger meaning to the particular lexical item *all* (Emmanuel Chemla, p.c.).

[30] As pointed out to us by Jon Sprouse, difficulty with the lexical retrieval of an alternative in an experimental setting is distinct from the problem of not having yet learned the co-scalar status of an item and its alternative. Take the case of scalar quantifiers. The child must learn that *some* and *all* lie on the same quantifier scale. A failure to compute the implicature could arise either because the child has yet to learn the co-scalar status of *some* and *all*, or because the child is unable to retrieve *all* from the lexicon during the experiment. The experiments described in this article cannot tease these two possibilities apart. The fact that mentioning alternatives increases the rate of scalar implicature computation does not tell us where the difficulty lies. If the alternatives are explicitly provided, the children neither have to learn their co-scalar status nor perform lexical retrieval of alternatives. Given that Experiment 2 did not examine lexicalized alternatives, however, for example *some/all*, *may/must*, *or/and*, we do not comment further here on the issue of learning of co-scalar status, and instead focus our discussion on the difficulty of lexical retrieval (see Barner *et al.* (2011) for very relevant discussion).

provided; or (ii) retrieve the relevant alternatives from the lexicon, as, again, they are pragmatically or explicitly provided. Recall for example Gualmini *et al.*'s (2001) experiment, in which children accepted disjunctive sentences in conjunctive contexts; these same children performed more like adults once they were explicitly provided with the alternatives. In other words, what causes children difficulty is access to the alternatives required to compute the relevant inferences. Provide them with the relevant alternatives, and they begin to look more adult-like.[31] This alternatives-based explanation provides a way of accounting for our findings from Experiments 1 and 2. Assuming free choice inferences are a type of scalar inference, children succeed on these inferences in the case of free choice disjunction and free choice indefinites because in neither case are they required to retrieve the relevant alternatives from the mental lexicon.

Finally, moving beyond the two experiments described in this article, the restricted alternatives hypothesis gives rise to further interesting predictions that remain to be tested. As formulated, our hypothesis predicts that children should be able to compute scalar implicatures that arise from alternatives that do not require lexical access. One such implicature can be found in (56), where the derivation of (56b) involves the alternatives *Every student took syntax* and *Every student took semantics*, both of which are contained within the assertion.

(56) a. Every student took syntax or semantics.
b. $\rightsquigarrow$ *Some students took syntax and some students took semantics*

The restricted alternatives hypothesis predicts that children should be able to compute such an implicature. Yet another prediction, suggested to us by an anonymous reviewer, is that the free choice effect with plain indefinites, for example in (57a) and (57b), should be as easy to obtain as that arising from lexicalized free choice items such as *any*:

(57) a. Pick a card.
$\rightsquigarrow$ *Any card is a possibility*
b. You may have a flower.
$\rightsquigarrow$ *Any flower is a possibility*

It remains to be seen whether children are similarly able to compute such inferences.

[31] More precisely, what Gualmini *et al.*'s (2001) experiment reveals is that explicitly providing the relevant alternatives brings out children's sensitivity to the choice between a sentence and its alternatives; this does not necessarily mean that the children can compute the relevant scalar inference (thanks to Emmanuel Chemla for making this point more precise).

5 CONCLUSION

In this article, we presented experimental findings revealing that 4- and 5-year-old children can compute free choice inferences but not scalar implicatures. This is prima facie challenging for the approach that argues that they are the same phenomenon. The results could be reconciled, however, with recent observations in the acquisition literature that children often perform better on scalar implicatures when the required alternatives are mentioned explicitly. Building on this literature, we formulated what we called the *restricted alternatives hypothesis*, based on two ingredients: (i) the alternatives from which free choice inferences arise are contained within the assertion but those of scalar implicatures are not; (ii) mentioning alternatives helps children compute the corresponding inferences. One immediate prediction of this hypothesis was that children should have difficulty with free choice inferences that arise from alternatives that are not explicitly provided in the assertion. Our second experiment, designed to test children's ability to compute free choice inferences when the required alternatives are not explicitly provided as substrings of the assertion, revealed that children were nevertheless successful at computing the inference. This gave us cause to reformulate our hypothesis. We posit that a child's failure to compute a particular inference derives from a difficulty with the retrieval of the relevant alternatives from the lexicon. Crucially, in both of our experiments, children did not have to perform lexical retrieval of alternatives; in the case of disjunction, the alternatives were explicitly provided as substrings of the assertion, and in the case of the free choice indefinite, the subdomain alternatives were explicitly provided in the discourse context. Thus, children are able to succeed when they do not have to handle lexical alternatives.

We view the contribution of our study as twofold. On the one hand, it reveals that children can compute free choice inferences from disjunctive statements and statements containing *any*. Second, it provides an explanation for the observed adult-like performance based on independently proposed hypotheses in the literature, in a way that allows us to accommodate the findings within a unified account of free choice inferences and scalar implicatures.

More generally, the present study is an example of how experimental work on acquisition can constrain theoretical debate. Our experiments were designed to address a theoretical approach that groups free choice inferences and scalar implicatures together. The findings represented a challenge for this account, because children's behavior was not uniform across the two kinds of inferences.[32] We have formulated one possible response to the challenge posed by our findings, which on the one hand, maintains the uniformity account, and on the other hand, further develops independently raised hypotheses about children's knowledge of lexical alternatives.

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[32] Such findings could ultimately shed light on the nature of alternatives in the adult state, with children's differential behavior merely magnifying existing differences in the adult.

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