Scalar Implicatures vs. Presuppositions – The view from Acquisition

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This paper reports an experimental investigation of presuppositions and scalar implicatures in language acquisition. Recent proposals (Chemla 2009; Romoli 2012, 2014) posit the same mechanisms for generating both types of inferences, in contrast to the traditional view. We used a Covered Box picture selection task to compare the interpretations assigned by two groups of children (4/5 and 7 year olds) and by adults, in response to sentences with presuppositions and ones with either 'direct' or 'indirect' scalar implicatures. The main finding was that the behavior of children and adults differed across inference types. This asymmetry is consistent with the traditional perspective, but poses a challenge for the more recent uniform accounts. We discuss how the latter could be amended to account for these findings, and also relate the findings to previous results on presupposition processing. Finally, we discuss an unexpected difference found between direct and indirect scalar implicatures.

Keywords: Presuppositions, Scalar Implicatures, Pragmatics, Child Language Acquisition.

1 Introduction

As the sentences in (1a)-(3a) illustrate, scalar implicatures like those in (1b) and (2b), and presuppositions such as (3b) are central features of the overall meaning that is conveyed when speakers make certain utterances.

(1)
   a. Some of the giraffes have scarves
   b. Not all of the giraffes have scarves

(2)
   a. Not all of the giraffes have scarves
   b. Some of the giraffes have scarves

(3)
   a. The bear didn't win the race
   b. The bear participated in the race

Traditionally, the inferences involved in computing the scalar implicatures in (1b) and (2b) and those involved in computing the presupposition in (3b) have been analyzed differently; scalar implicatures are standardly treated as arising from reasoning about the speaker's intentions (Grice 1975; and much subsequent work), whereas presuppositions are typically analyzed as appropriateness conditions to be satisfied in the conversational context (Stalnaker 1974; Karttunen 1974; Heim 1982; among others). While there are many different theories that depart more or less radically from the two standard approaches, most of these theories agree that scalar implicatures and presuppositions are qualitatively distinct.

Recently, several theorists have argued that at least some presuppositions may be more closely aligned to implicatures, and they have proposed theories of presuppositions that are based on mechanisms traditionally associated with scalar implicatures (Simons 2001; Abusch 2002, 2010; Chemla 2010; Romoli 2014). Throughout this paper these theories will be referred to as the 'Presupposition as Implicature' approach. The Presupposition as Implicature approach predicts that, everything being equal, certain presuppositions and scalar implicatures should behave uniformly. This prediction has been investigated in adult sentence processing studies by Chemla and Bott (2013), and Romoli and Schwarz (2015), with their results at least *prima facie* challenging the predictions made by this approach.[1]

Following the logic of these previous studies, the present investigation tested the predictions of the Presupposition as Implicature approach by comparing the way adults and children interpret scalar implicatures and presuppositions under negation. The main finding is that presuppositions and scalar implicatures evoked different patterns of behavior from children and adults. This finding presents a challenge to the Presupposition as Implicature approach, but fits naturally with the more traditional perspective on these kinds of inferences. As we discuss, however, one need not entirely abandon the Presupposition as Implicature approach in the face of these results, but it is necessary to supplement the approach with extra assumptions to account for the asymmetry in the patterns of responses by children and by adults.

[1] Schwarz, Romoli and Bill (2014) show that, despite these initial interpretations, it is not clear that these processing results do actually support making a distinction between presuppositions and scalar implicatures.

The paper is organized as follows: Section 1.1 compares the traditional approach on presuppositions and implicatures to the Presupposition as Implicature approach. Section 2.1 outlines the method we used to investigate the possibility that presuppositions are scalar implicatures. Section 2.2 reports the results of this investigation and, finally, Section 3 discusses how the findings of the present study bear on these different accounts of presuppositions and scalar implicatures.

1.1 Presuppositions and Scalar Implicatures

The traditional conception of presuppositions and scalar implicatures contends that these inferences are fundamentally different. This stands in contrast to the Presupposition as Implicature approach. In the following two sections, we briefly sketch how presuppositions and scalar implicatures are analyzed within these different perspectives. First, we present the traditional perspective that scalar implicatures and presuppositions are generated by distinct mechanisms. Then we turn to the Presupposition as Implicature approach, and show how this approach ties these inferences together. In both cases, we just give the gist of the idea, without going into detail; what is relevant for the present study is the different predictions that the two approaches make about scalar implicatures versus presuppositions.

1.1.1 The Traditional Perspective

In this section, we will give a brief sketch of how presuppositions and scalar implicatures can be analyzed. As a concrete example, we focus on traditional ways of accounting for these inferences, but it should be noted that we are lumping together all accounts, old or new, as taking the 'traditional perspective' as long as they treat presuppositions and scalar implicatures as different.[2]

One way of distinguishing presuppositions from scalar implicatures, is to view them as definedness conditions on the admissible conversational contexts for sentences expressing the presupposition. The gist of the idea is that a sentence like (4a) is only felicitous in a context in which the presupposition in (4b) has already been established in the conversational contexts, and is thereby mutually known to the discourse participants (Stalnaker 1974; Karttunen 1974; Heim 1982, 1983).[3]

(4)

a. The bear won the race.
b. The bear participated in the race.

An additional assumption is that some mechanism accounts for the so-called

[2] Notice that accounts like Schlenker's (2008), who essentially treat presuppositions as manner implicatures, would also fit in the 'traditional perspective' in that they do not equate presuppositions with scalar implicatures. An interesting way of testing the prediction of Schlenker's theory would be to look at children and adults' behavior with manner implicatures in comparison to presuppositions. We leave this for future research.

[3] See also Beaver and Geurts (2012), Schwarz (2015), and Romoli and Sauerland (to appear), for an introduction to presuppositions.

'projection' behavior of presuppositions in more complex sentence. This mechanism is needed to explain how the presupposition of a sentence like (4a) is inherited by more complex sentences containing (4a), such as (5). In other words, both sentence (4a) and its negation (5) have the same presupposition - that the bear participated in the race. In traditional terminology, the presupposition of (4a) in (4b) 'projects' from under the scope of negation in (5).[4]

(5) The bear didn't win the race.

According to this perspective, presuppositions are necessarily associated with sentences containing presupposition triggers. In order to reconcile this perspective with cases of apparent suspension of presuppositions, as in (6), an additional mechanism is invoked to locally 'accommodate,' and thereby suspend, the presupposition in the scope of negation (Heim 1983; von Fintel 2008). This gives rise to the meaning paraphrased in (7), which is compatible with the continuation in (6), according to which the bear didn't participate in the race.

(6) The bear didn't win the race ... he didn't even participate!
(7) It's not true that (the bear participated and won)
(≈ the bear didn't participate or didn't win)

Scalar implicatures are analyzed differently on the traditional approach, which goes back to Grice (1975) and Horn (1972). On this approach, scalar implicatures arise from the hearer's reasoning about the speaker's communicative intentions. In particular, the inference (8b) that is drawn from the statement in (8a) arises from the hearer's reasoning about what the speaker did say and what the speaker did not say.

(8)
a. Some of the giraffes have a scarf
b. Not all of the giraffes have a scarf

In brief, the hearer notes that the speaker said (8a), rather than the more informative sentence (9). Assuming that (9) is relevant to the purposes of the conversation, and that speakers are committed to conveying the most informative relevant information at their disposal, the hearer infers that the speaker's reason for not saying (9) is that the speaker believes (9) to be false. Therefore, the hearer derives the inference (8b). We will refer to this type of scalar implicature as a 'direct' scalar implicature (DSI), following terminology introduced in Chierchia (2004).

(9) All of the giraffes have a scarf

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[4] The projection behavior is not limited to negation, but is a general pattern involving all sorts of complex embeddings. For instance, the presupposition of (4a) is inherited also by conditional sentences containing (4a) in their antecedent, questions, or modal sentences embedding (4a): all of (1)-(3) give rise to the inference that the bear participated in the race.

(1) If the bear won the race, he will celebrate.
(2) Did the bear win the race?
(3) The bear might have won the race.

Following a parallel line of reasoning, the hearer derives the implicature in (10b) from the speaker's utterance in (10a). The hearer observes that the speaker said (10a), rather than the relevant and more informative (11). Therefore, the hearer infers that (11) is false (= (10b)). This type of scalar implicature will be referred to as an 'indirect' scalar implicature (ISI).[5]

(10)
a. Not all of the giraffes have a scarf
b. Some of the giraffes have a scarf

(11) It is not the case that some of the giraffes have a scarf
(≈ None of the giraffes have scarves)

This brief reconstruction of the traditional account of presuppositions and scalar implicatures, while quite general and glossing over many intricacies, will suffice for our purposes. Again, what is important here is to give a sense of how presuppositions and scalar implicatures have been treated as distinct linguistic phenomena. In this sense, any theory that does not treat the presupposition of triggers like *win* as a scalar implicature is to be grouped within the rubric of the traditional perspective on scalar implicatures and presuppositions. We now turn to the more recent accounts of these inferences from the Presupposition as Implicature approach.

1.1.2 The Presupposition as Scalar Implicature Perspective

The Presupposition as Implicature approach brings presuppositions and scalar implicatures closer together. Within this general approach, some accounts treat certain presuppositions, such as the presupposition associated with the verb *win* (12b), as scalar implicatures of a sort (Simons 2001; Abusch 2002, 2010; Chemla 2010; Romoli 2012, 2014).[6]

(12)
a. The bear won the race
b. The bear participated in the race

One argument for this approach comes from the observation that the presuppositions that are associated with certain verbs like *win* differ in certain respects from the presuppositions associated with other linguistic expressions. One difference concerns the ease with which the different kinds of presuppositions can be suspended in certain contexts and another difference concerns their behavior in quantificational sentences (see Abusch (2010) and Romoli (2014) for discussion). To illustrate the former, it is reasonably easy to suspend the presupposition triggered by *win* in (13) (vis., the inference that the bear participated). It suffices for the speaker to explicitly state his

[5] The distinction between DSIs and ISIs can be roughly defined as follows: a DSI involves the interpretation of a weak scalar term in an upward entailing context, whereas an ISI involves a strong scalar term in a downward entailing contexts, such as the scope of negation.

[6] Notice that among the mentioned accounts, that by Abusch (2002, 2010) is perhaps less associated with the expectation of similarity between presuppositions and *scalar* implicatures, as she invokes an implicature-based mechanism for (some) presuppositions, that is slightly different from that involved in the computation of scalar implicatures.

ignorance about the presupposition. It is more difficult (perhaps impossible) to suspend the presupposition triggered by the *it*-cleft in (14) (vis., the inference that someone stole the honey). In view of this contrast, the presuppositions triggered in a sentence like (13) are labeled 'soft presuppositions', and the presuppositions triggered in sentences like (14) are labeled 'hard presuppositions' (Abusch 2002, 2010).

(13) I don't know if the bear participated in the race in the end ... but if he won, he will celebrate with his friends
(14) I don't know if anybody stole the honey ... #but if it was the bear who stole the honey, he should give it back

If we accept the proposed distinction between different 'classes' of presuppositions, the obvious question is how such a difference arises. Theorists from the Presupposition as Implicature approach have attempted to answer this question by suggesting that these inferences have in fact been miscategorized. The approach suggests that soft presuppositions should be treated as a kind of scalar implicature, rather than as a presupposition. The basic idea, from Chemla (2009), is that the inference (12b) is derived from (12a) following the same line of reasoning as the traditional approach to scalar implicatures. We will illustrate this by considering again how the presupposition of *win* gives rise to the same inference (16), both in a positive sentence like (15a) and in its negative counterpart in (15b).

(15)
a. The bear won the race
b. The bear didn't win the race
(16) The bear participated in the race

According to the traditional account, as we have seen, the sentence (15a) is associated with the presupposition in (16), which then projects from under negation in (15b). The Presupposition as Implicature approach offers a different explanation. On this account, (16) is simply an entailment associated with (15a). This is supported by the fact that asserting (15a) and negating (16) sounds contradictory, as attested by (17).[7]

(17) #The bear won the race but in fact he didn't participate in the race

Second, (16) can be derived as a scalar implicature from (15b) in a fashion parallel to the reasoning above. The hearer notes that the speaker said (15b) rather than the relevant and more informative sentence (18). Therefore, the hearer infers that the speaker believes the latter to be false, which is equivalent to (16).

(18) The bear didn't participate in the race

If this approach is correct, then presuppositions of soft triggers such as *win* are essentially (indirect) scalar implicatures. On this account, verbs like *win* are completely parallel to strong scalar terms like *all*, which give rise to parallel

[7] Traditional accounts also commonly assume that (16) is an entailment of (15a), though this isn't necessarily extended to all presupposition triggers (see Sudo (2012) for discussion). Note that (17) might be acceptable in some special sense of 'winning' in certain contexts - such as technical victories, assigned without the race ever actually taking place.

inferences in the scope of negation. Based on the unified treatment of (soft) presuppositions and indirect scalar implicatures, the Presupposition as Implicature approach leads us to expect that, all else being equal, both kinds of inferences should evoke similar patterns of responses from participants. In the next section, we present a brief review of previous research on the acquisition of presuppositions and scalar implicatures. Then, in the following section, we present the current experiment, which was designed to compare and evaluate the predictions of the traditional account and those of the Presupposition as Implicature approach. This was done by directly comparing the interpretations that adults and children derive of sentences containing presuppositions with their interpretations of sentences containing scalar implicatures.

1.2 Previous Research on the Acquisition of Presuppositions and Scalar Implicatures

Considerable research has focused on children's acquisition of DSIs. Although the specific rates at which adults and children respond to scalar implicatures vary widely in the literature, one consistent pattern has emerged; children have proven to be less likely than adults to respond to sentences based on a scalar implicature interpretation (Noveck 2001; Papafragou and Musolino 2003; Huang and Snedeker 2009; Foppolo et al. 2012; among many others[8]).[9] For example, consider sentence (19), in a context in which all giraffes have a scarf, as depicted in (20). In this situation, children tend to accept (19) as an accurate description of the context in (20), whereas adults tend to reject it.

(19) Some giraffes have a scarf

(20) 

There are fewer empirical investigations of the acquisition of ISIs. However, the work that has been done appears to display a similar pattern, with children being more likely than adults to give responses based on the literal meaning of the target sentences (Musolino and Lidz 2006; Katsos et al. 2011). For example, in a context in which no giraffe has a scarf, as depicted in (22), children tend to accept (21) as an accurate description of the scene, whereas adults tend to reject it.

(21) Not all giraffes have a scarf

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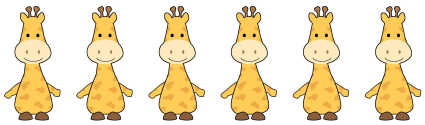
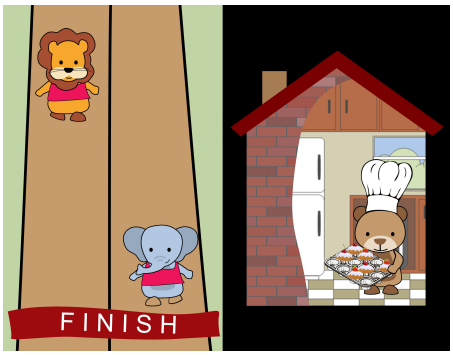
[8] See also Chemla and Singh (2014) for a critical review.

[9] We remain neutral as to the source of this different behavior. While it is commonly attributed to children's inability to generate SIs, it could also be due to a higher tolerance to pragmatic infringements (Katsos and Bishop 2011: a.k.a 'Pragmatic Tolerance Hypothesis'), or to variation in the type of judgments (e.g., with regards to assessing informativity vs. truth). Although these are interesting questions, it is not necessary for our purposes to settle on a particular answer, so in the interest of terminological consistency we may occasionally describe certain responses as being indicative or not of 'SI-generation', even though we are aware of the possibility of alternative interpretations and ongoing discussion in this area.

(22) 

As for presuppositions, there has been quite a bit of work on children's understanding of certain presupposition triggers (e.g., the presuppositions associated with negation, definite descriptions, relative clauses, temporal terms, etc.). However, there is little, if any, previous work on children's understanding of the kinds of pre-supposition triggers under consideration in the present study (i.e., soft triggers like the presupposition of the verb *win*). However, if the Presupposition as Implicature approach is on the right track, we would expect participants to engage with these presuppositions in the same way as they engage with scalar implicatures. If so, we would expect children to be less likely than adults to generate these presuppositions. In other words, the expectation is that in a context in which the bear didn't participate (24), children should tend to accept the description in (23), while adults should tend to reject it.

(23) The bear didn't win the race

(24) 

2 Experiment

2.1 Method

2.1.1 Participants

Twenty monolingual English-speaking adults, and 30 monolingual English-speaking children, split into two age-groups (22 4/5 year olds, 16 7 year olds), participated in the study. Only those participants who passed at least 3 out of the 4 controls related to each of the 3 critical conditions (outlined below) were included in the analysis. We report the data from the 16 4/5 year olds (4;01–5;05, M=4;06), 14 7 year olds (7;00–7;12, M=7;04), and 20 adults who met these requirements.

2.1.2 Materials

As shown in Figure 1, each trial consisted of three pictures, namely a context picture and two test pictures. One of the test pictures was visible, and the other was covered. These pictures were pasted onto a large cardboard poster, which was then laminated. The whole poster was 600mm x 450mm in size, with each individual picture measuring 297mm x 210mm. The context picture was positioned at the middle top of

the poster. The visible test picture was placed at the bottom left of the poster, and the covered test picture was placed on the bottom right of the poster.[10]

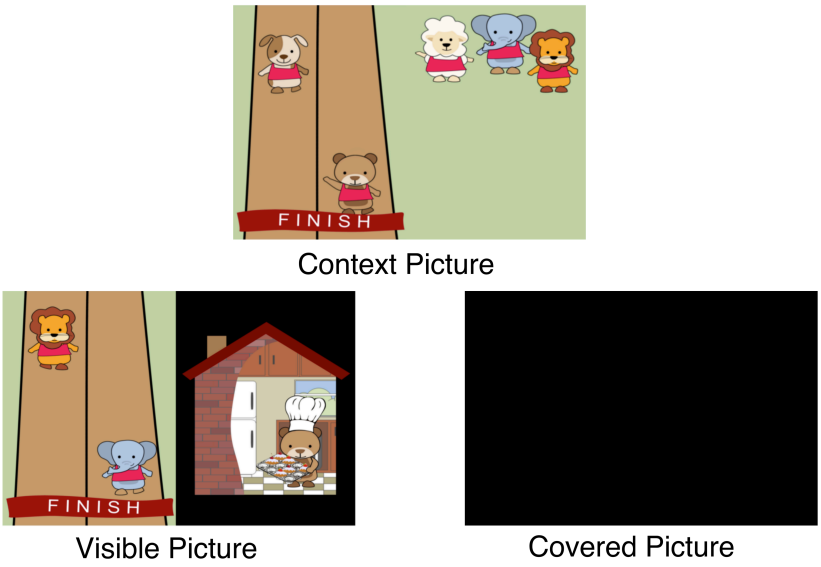


Figure 1: Example trial - Presupposition condition

Throughout the training trials the covered picture was revealed to the participants at the end of each trial. However, the participants were not shown the covered picture throughout the rest of the experiment, in order to ensure that participants' judgments would not be influenced by any interpretation options suggested by the covered picture.[11]

2.1.3 Procedure

The task was a variant of the 'Covered Box' paradigm used in Huang et al. (2013) to investigate similar phenomena. In each trial, the participant was presented with a short description of the context picture. This was done to 'set the scene' and make the use of negation felicitous. This short description was followed by a test sentence that purportedly described only one of the two test pictures (visible or covered). The participant's task was to judge which of the two test pictures was described by the test sentence, and then to provide a short justification for their decision.[12] An audio

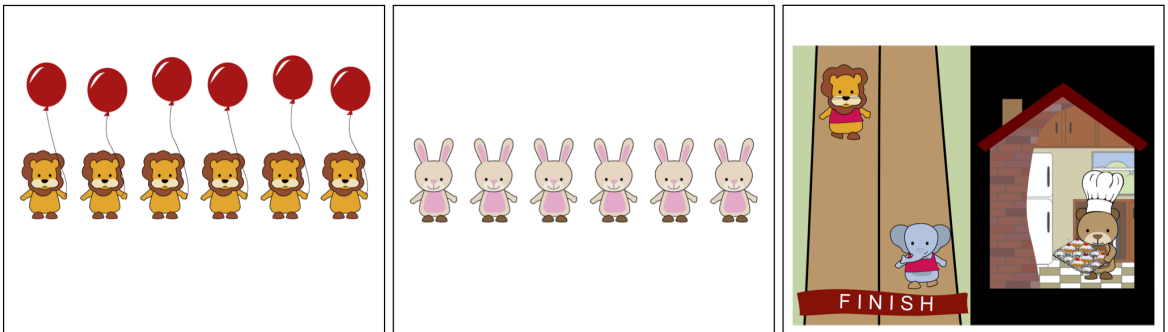
[10] The covered test picture consisted of a black piece of laminated paper stuck to the poster by tabs of fabric hook and loop fastener (a.k.a 'Velcro').

[11] In fact, unbeknown to participants, for the non-training part of the session, there was no actual picture underneath the 'Covered Picture'.

[12] This paradigm is quite similar to the Truth Value Judgment Task paradigm (Crain and Thornton 1998); however, it arguably differs in a couple of important ways. First, by presenting the option of the 'unknown' interpretation, participants are encouraged to actively consider alternative interpretations, which might better suit the test sentence. Second, by requiring participants to choose between two pictures, rather than judging the 'truth-value' of a sentence, the possibility of participants accepting the test sentences out of politeness or confusion is reduced.

recorder was used to record these judgments and related justifications.

In total, the study compared 3 different linguistic contexts corresponding to the three inferences under investigation (DSI, ISI, and P). Each of these contexts was tested on 4 critical trials and 4 control trials. The critical trials tested whether participants were generating the relevant inferences from the test sentences. The control trials tested participants' general capacity to understand the test sentences.



(a) DSI: "Some of the lions got balloons"

(b) ISI: "Not all of the rabbits brought balls"

(c) P: "The bear didn't win the race"

Figure 2: Examples of the visible test pictures and test sentences for each condition.

As illustrated in Figure 2, the visible test pictures in the critical trials, while consistent with the literal meaning of the test sentence, were incompatible with the additional inference of interest. For example, picture (b) is incompatible with the implicature that some of the rabbits brought balls, and picture (c), where the bear is at home baking cookies, is incompatible with the (global) inference that he participated in the race. Therefore, selection of the covered picture was interpreted as evidence of the associated inference being generated.

The control trials were designed so that participants were required to select the visible picture twice, and the covered picture twice. In the latter case, the picture was incompatible with the literal meaning (e.g., by using a sentence such as *Some rabbits brought balls* with a picture like (b)). In the former case, the images were compatible both with the literal meaning and the additional inference. Note that these overt picture controls were only presented after all the critical trials for that condition had been presented. This was done to avoid influencing participants' choices on the critical trials through exposure to a picture suggesting an interpretation consistent with the relevant inference.

The trials for each of the conditions (DSI, ISI, and P) were presented separately in their own sub-parts of the overall experimental session. The order in which the three conditions were presented was counterbalanced, and the trials in each condition were presented in a pseudo-random order (see previous paragraph).

Trial Outline Each individual trial followed the same steps, as outlined below:[13]

[13] The examples presented are from one of the trials in the ISI condition. The visible picture for this trial is shown in Figure 2(b).

1. The participant (with the help of the experimenter, if required) identified the different animals in the picture, (to ensure familiarity).

2. The experimenter presented a short preamble introducing the animals and the setting (e.g., "Today a group of penguins and a group of rabbits went to the park").

3. The experimenter gave a short description of the context picture (e.g., "All of the penguins brought balls").

4. The experimenter presented the test sentence (e.g., "But not all of the rabbits brought balls"). The test sentence was presented a second time (e.g., "So remember, not all of the rabbits brought balls"), to ensure that the participant heard it accurately.

5. The participant was asked to identify which of the test pictures (visible or covered) the test sentence was referring to (e.g., "Which group of rabbits do you think I'm talking about?").

6. Finally, the participant was asked to give a justification for their judgment (e.g., "Why do you think I'm talking about that picture?").

2.2 Results

The proportions of Covered Picture choices by age group and condition are graphed in Figure 3. As discussed above, choosing the Covered Picture is indicative of the associated inference being generated. Statistical analyses using logistic regression mixed effect models revealed significant interactions between inference type and age group. Due to space limitations, our report of detailed statistical analyses focuses on comparisons between the group of 4/5 year olds and the group of adults. Table 1 lists estimated β 's, standard errors, Wald's *z* and *p*-values from the *lmer*-output.

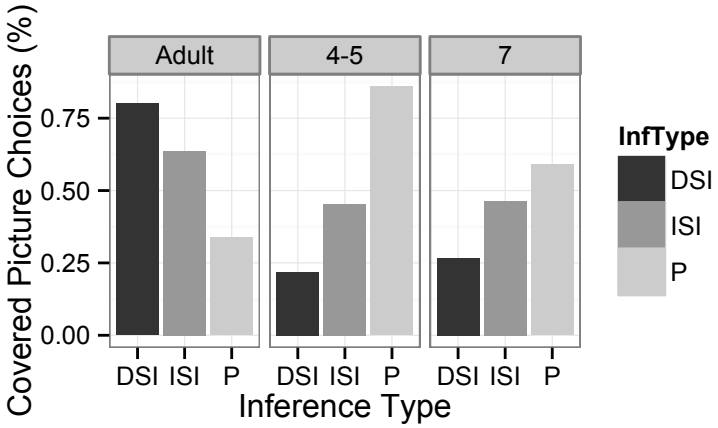


Figure 3: Results for adults and children across all conditions.

Table 1: Interactions and post-hoc comparisons for covered test picture choice proportions, comparing 4/5 year olds and adults.

		β	*SE*	Wald's z	$p <$
Interactions:	P vs. DSI	-8.09	0.84	-9.62	.001
	P vs. ISI	-5.03	0.73	-6.94	.001
	DSI vs. ISI	-3.05	0.69	-4.40	.001
Post-hoc Comparisons:					
4/5:	P vs. DSI	4.68	0.66	7.10	.001
	P vs. ISI	3.02	0.58	5.19	.001
	DSI vs. ISI	1.66	0.49	3.36	.001
Adults:	P vs. DSI	3.40	0.52	6.53	.001
	P vs. ISI	2.01	0.43	4.66	.001
	DSI vs. ISI	-1.39	0.49	-2.85	.01
P	Adults vs. 4/5	3.86	0.84	4.62	.001
DSI	Adults vs. 4/5	4.23	0.84	5.06	.001
ISI	Adults vs. 4/5	1.18	0.77	1.53	0.15

As can be seen in Table 1, there were significant 2 × 2 interactions ($p<0.001$) for adults versus 4/5 year olds on all pairs of factor levels: P vs. ISI, P vs. DSI, and DSI vs. ISI comparisons. As can be seen in Figure 3, the P vs. ISI interaction was driven by adults being significantly more likely to select the Covered Picture in the ISI condition than in the P condition while children were significantly more likely to select the Covered Picture in the P condition, compared to the ISI condition. The same pattern produced the interaction in the DSI vs. P comparison. The final interaction between the ISI and DSI conditions was caused by adults being significantly more likely to choose the Covered Picture in the DSI condition, compared to ISI condition, while children were significantly more likely to choose the Covered Picture in the ISI condition, compared to the DSI condition.

The 7 year olds were numerically in-between the adults and 4/5-year olds, but only differed significantly from 4/5-year olds in one respect: they had fewer Covered Picture choices in the presupposition condition ($\beta = -2.15$, $SE = 0.89$, Wald's $z = 2.42$, $p < .05$), which in turn also led to significant 2×2 interactions between these groups and the P vs. DSI and ISI conditions. Just like the 4/5-year olds, they had significantly more Covered Picture choices in the presupposition condition and in the ISI condition than in the DSI condition ($\beta = 2.02$, $SE = 0.50$, Wald's $z = 4.02$, $p < .001$ and $\beta = 1.28$, $SE = 0.49$, Wald's $z = 2.61$, $p < .01$), but only a marginally significant difference between the former two ($\beta = 0.74$, $SE = 0.45$, Wald's $z = 1.65$, $p < .1$). Compared to adults, they had significantly more Covered Picture choices in the P condition ($\beta = 1.71$, $SE = 0.79$, Wald's $z = 2.16$, $p < .05$) and significantly fewer Covered Picture choices in the DSI condition ($\beta = 3.72$, $SE = 0.85$, Wald's $z = 4.39$, $p < .001$), but comparable rates of Covered Picture choices in the ISI condition. The interaction patterns between 7-year olds and adults were the same as for 4/5-year olds.

Table 2: Example justifications produced by participants for both visible and covered test picture judgments. Justifications are in reference to the visible pictures.

Group	Condition	Example Justification
Child(4/5&7)	DSI	Visible: "Because they got balloons" Covered: "Because this group of lions all have balloons"
Adult	DSI	Visible: "Because they have balloons" Covered: "Because all of the lions have balloons"
Child(4/5&7)	ISI	Visible: "Because they don't have balls" Covered: "Because there, none of them have balls"
Adult	ISI	Visible: "Because they don't have balls with them" Covered: "Because in that picture, none of them brought balls"
Child(4/5)	P	Visible: "Because the bear is baking cookies" Covered: "Because the bear isn't in the race"
Child(7)	P	Visible: "Because the bear's not in it" Covered: "Because there is no bear in the second race"
Adults	P	Visible: "Because he wasn't in the race, so he couldn't have won it" Covered: "Because the bear wasn't even racing"

In addition to providing critical picture judgments, participants also provided justifications for their decisions. Some examples of these justifications are provided in Table 2. In the DSI and ISI conditions, the judgments for both groups of children (4/5 year olds and 7 year olds) were very similar (see Figure 3), therefore, only one example justification has been provided to represent both child groups in those conditions.

3 Discussion

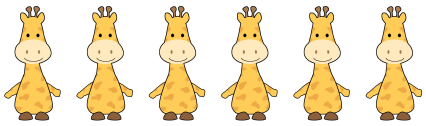
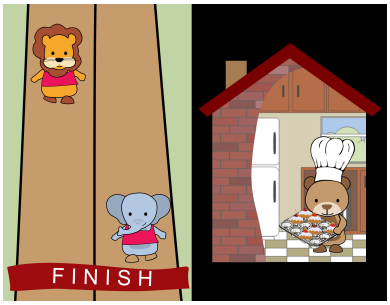
The results reported above appear to be inconsistent with the predictions of the Presupposition as Implicature approach. According to that approach, presuppositions are analyzed as indirect scalar implicatures, so participants' responses should be parallel across all three conditions (DSI, ISI, and P), or at least across the ISI and P conditions. In fact, the results from the present study appear more consistent with the traditional view, according to which these inferences are derived by different mechanisms. Despite this apparent inconsistency with the Presupposition as Implicature approach, it is possible to supplement the approach in a way that reconciles it with the results for the present study. We will flesh out such a possibility for a particular version of this approach — the one advanced in Romoli (2014) — but other ways of modifying the Presupposition as Implicature approach are conceivable as well.

3.1 Accounting for the results within a traditional perspective

The traditional perspective treats scalar implicatures and presuppositions as two different classes of inference, based on distinct mechanisms. The traditional account, therefore, is compatible with an asymmetry in participants' processing of each kind of inference. In particular, a scalar implicature is derived over-and-above the basic

meaning of a sentence that contains a scalar term, through an extra process (e.g., Gricean enrichment (Grice 1975)). In the case of presuppositions, on the other hand, the traditional account takes the associated inference to be part of the basic meaning, which can be 'cancelled', but only through some extra process (e.g., local accommodation (Heim 1983)). We will refer to the basic meaning of these sentences the 'Base Meaning', and we will use the term 'Derived Meaning' to designate the meaning that is produced through some extra process (whether Gricean enrichment or local accommodation). Adopting this terminology, Table 3 summarizes the status of the relevant inferences.

Table 3: An interpretation of our results from the traditional perspective

	Base Meaning (Child)	**Derived Meaning (Adult)**
DSI/ISI	[-inference]  Not all of the giraffes have scarves	[+inference]  Not all (*but some*) of the giraffes have scarves
P	[+inference]  The bear didn't win (*but participated in*) the race	[-inference]  The bear didn't win the race

As is evident from Table 3, the traditional view can account for the interaction we observed in the response by adults and children in the DSI/ISI and P conditions in the following way. Across conditions, on this account, children tend to access the base meaning of these sentences, whereas adults tend to access the derived meaning. This kind of pattern is consistent with the idea that these inferences are different phenomena, generated by distinct mechanisms. The traditional approach still needs to provide an explanation of children's non-adult behavior, however, given that this approach does not claim any consistency in the way these inferences are generated, it is free to posit different explanations for children's responses to scalar implicatures and presuppositions. For instance, it has been suggested that children's inability to access the derived meanings of scalar implicatures could be due to processing

difficulties involved in comparing what the speaker said with the alternative utterances the speaker might have said.[14] On the other hand, the source of the problem for presuppositions could lie in the processing cost associated with suspending the presuppositional inference (Chemla and Bott 2013; Romoli and Schwarz 2014). At any rate, by treating presuppositions and scalar implicatures differently, it is straightforward to interpret our results with the traditional approach. We now turn to the Presupposition as Implicature approach, to discuss how it could be modified to account for the observed asymmetry between presuppositions and scalar implicatures in both children and adults.

3.2 Constraining the Presupposition as Implicature Approach

As mentioned, the results of the present experiment displayed a difference in the inference generation of participants, across inference conditions (DSI, ISI, and P). This is a problem for the Presupposition as Implicature approach's prediction of a uniform response pattern across these inferences. However, if these differences in our results can be explained by invoking different ancillary mechanisms, then it may be possible to explain them, while retaining the Presupposition as Implicature approach's central idea that these inferences are all generated through reasoning over scalar alternatives. And in fact, it would appear that there already exists versions of the Presupposition as Implicature approach in the literature that provide just such a description of these inferences. For example, the version of the Presupposition as Implicature approach presented in Romoli (2014) makes certain distinctions regarding the mechanisms through which these inferences (scalar implicatures and soft presuppositions) can be suspended, which could be held responsible for the differences in the patterns of responses across conditions that were observed in the present study.

According to Romoli (2014), certain (soft) presuppositions (such as the presupposition of *win*) and scalar implicatures are generated via the same mechanisms (outlined in Section 1.1.2). However, the way that these respective inferences are suspended is not the same. For scalar implicatures, the most straightforward way of suspending the inference is to assume that the mechanism for generating the inference is not involved in the first place.[15] This can happen in two types of circumstances. First, it could be a situation where the speaker explicitly states that they are ignorant regarding the truth-value of the inference. For example, the basic meanings of the sentences (25a) and (25b) do not carry the inference that the speaker thinks not-all/some of the giraffes are wearing scarves, respectively.

(25)

a. I don't know if all of the giraffes are wearing scarves, but some of them are

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[14] There are different versions of this idea: in one version the difficulty is thought to be due to a processing cost that would be associated with holding the alternatives in memory. A different interpretation suggests that children have not acquired yet the relevant knowledge of alternatives altogether. See Barner et al. (2011), Reinhart (2006), Zhou et al. (2013) and Tieu et al. (to appear) for discussion.

[15] See section 3.4 for discussion of the potential additional possibility of local application of a scalar mechanism, parallel to what we describe for presuppositions below. See also Magri (2010), (2011) for a different perspective on cancellation/suspension of scalar implicatures through domain restriction.

b. I don't know if any of the giraffes are wearing scarves, but not all of them are.

The second type of circumstance in which scalar implicatures can be suspended is when the context makes it clear that the alternatives (which, as shown in Section 1.1, are integral to the derivation of scalar implicatures) are not relevant, such as in reply (26b) to the question (26a).[16]

(26)
a. Q: Are any of the giraffes wearing scarves?
b. A: Some of the giraffes are wearing scarves

For the case of soft presupposition triggers, on the other hand, Romoli (2014) proposes that the mechanism giving rise to the inferences is necessarily involved in the interpretation process (i.e., they are considered as 'obligatory scalar implicatures'), regardless of speaker ignorance or contextual relevance. Cases involving negation (and other operators) where the relevant inference is absent at the global level are then construed as involving a local application of the mechanism. This is, indeed, rather parallel to the notion of 'local accommodation' in traditional accounts that we alluded to in the previous section. Let us therefore begin by describing the traditional approach's version of this mechanism. In the traditional approach, presuppositions are also always computed. In order to reconcile this idea with the existence of interpretations like (27), repeated from above, where the presuppositional inference appears to be absent at the global level, the traditional approach posits what we could characterize as a local application of the mechanism generating presuppositions.[17]

(27) The bear didn't win the race...he didn't even participate!

We can characterize this idea in general terms: Call the algorithm or mechanism through which presuppositions arise $\mathscr{P}$. When $\mathscr{P}$ is applied to a sentence, it returns that sentence meaning and its presupposition(s). Now, if you apply $\mathscr{P}$ globally to a sentence as in (28a), you will obtain a meaning paraphrasable with (28b). When, on the other hand, $\mathscr{P}$ is applied locally, in the scope of operators like negation as in (29a), we obtain the meaning in (29b), which is compatible with a context in which the (global) presupposition is false, i.e., the bear didn't participate, and can therefore explain the reading of the sentence in (27).

(28)
a. $\mathscr{P}$[The bear didn't win the race]
b. The bear participated in the race and didn't win

(29)
a. not[$\mathscr{P}$[The bear won the race]]
b. It is not the case that the bear participated in the race and won the race

[16] We are assuming here a way of thinking about relevance as whatever answers the explicit or implicit question under discussion. See Roberts (1996) and much subsequent work.

[17] This is not entirely accurate for all versions of the traditional approach, but this level of description will be enough for our illustrative purposes here.

(≈ Either the bear didn't participate in the race or he didn't win)

In a parallel fashion, Romoli (2014) suggests that soft presuppositions are obligatory scalar implicatures, which can only be suspended at the global level through a local application of the mechanism generating scalar implicatures. Call this mechanism $\mathscr{S}$, conceived of as a function applying to sentences and returning its meaning and its scalar implicature(s). If $\mathscr{S}$ is applied globally, as in (30a), the result includes the scalar implicature paraphrasable as (30b). If, on the other hand, $\mathscr{S}$ is applied locally, as in (31a), then there is no stronger alternative statement, and it is rendered vacuous, i.e., equivalent to not including $\mathscr{S}$ at all. Consequently, the resulting meaning does not include the inference, (27). One final aspect of this account that is relevant here is the idea that the default level at which $\mathscr{S}$ is applied is the global level, and that the local application is only used when forced; that is, when explicit information in the context contradicts the inference that would be derived through the global application.[18]

(30)

a. $\mathscr{S}$[The bear didn't win the race]
b. The bear participated in the race and didn't win

(31)

a. not[$\mathscr{S}$[The bear won the race]]
b. Either the bear didn't win or he didn't participate

In sum, the version of the Presupposition as Implicature approach outlined by Romoli (2014), while treating soft presuppositions like indirect scalar implicatures, makes some extra assumptions about the ways they can be suspended. These assumptions recreate some asymmetry between these two inferences, which opens the window towards understanding differences in participants' ability to suspend inferences across our conditions. Section 3.2.1 and Section 3.2.2, go into more detail on how this version of the Presupposition as Implicature approach might account for our specific set of results.

3.2.1 Explaining Adults' behavior

The version of the Presupposition as Implicature approach articulated in Romoli (2014), supplemented with the extra assumptions about the mechanism for suspending soft presuppositions, could account for the difference we found in adult responses between the DSI/ISI and P conditions in the following way. As discussed, soft presuppositions, such as those presented in the P condition, are derived through the comparison of alternatives. However, the effect of considering these alternatives depends on the site at which the scalar implicature mechanism is applied. Romoli (2014) assumes that the default site for applying $\mathscr{S}$ is the global level, and that this is only likely to change in the light of explicit contextual information, which is in contradiction to the inference that a global application of $\mathscr{S}$ would yield. In the case

[18] This is again parallel to what the traditional perspective assumes about global and local application of the presupposition generating mechanism. Romoli (2014) tries to derive this by appealing to a principle of maximize strength.

of the present experiment, only the interpretation derived through local application of $\mathscr{S}$ (E.g. (32)) was consistent with the visible target picture (see Figure 2). The explicit presentation of such a picture may have encouraged adults to actively consider an interpretation compatible with this, resulting in the local application of $\mathscr{S}$. This would account for the high rates of adults suspending the inference in the P condition.

(32) The bear didn't win the race...in fact he didn't even participate

The question at this point is why adults did not display a similar tendency to suspend inferences in the scalar implicature conditions. This may seem especially pressing since, according to Romoli (2014), there are two processes through which scalar implicatures can be suspended. But recall that both of these processes are distinct from the process through-which soft presuppositions are suspended. In particular, scalar implicatures are suspended either because the speaker is known to be ignorant about the truth-value of the inference, or because the context is such that the alternatives are not regarded as relevant. Let us first examine suspension through speaker-ignorance. In the case of the current experiment, the speaker (i.e., the experimenter) was established to be knowledgeable regarding the contents of both the visible and the covered test pictures. Therefore, (provided the participant understood this aspect of the experiment) it would not have been possible for the scalar implicature to have been suspended on the basis of speaker-ignorance. Now let us turn to the second possible process of suspension, that of contextual relevance. The sentences were presented in an experimental context, wherein the participants were attempting to identify which test picture the experimenter was referring to, on the basis of the test sentence. In such a context, considering the alternative sentences that the speaker might have uttered is obviously relevant. Therefore, this suspension option was arguably not viable for participants, either. And if neither one of these suspension-options were available to adult participants, we expect high rates of inference interpretations in the DSI/ISI conditions, at-least relative to the P condition, which is precisely what was found. It is thus possible for a version of the Presuppositions as Implicatures approach like that presented by Romoli (2014) to account for the adult behavior in our experiment. In the next section, we will explore how Romoli (2014)'s account might explain the behavior of children in the present experiment.

3.2.2 Explaining Children's behavior

The response behavior of the children in the experiment also differed significantly in the DSI/ISI conditions relative to the P condition. However, the pattern was the exact opposite of that found for adults: children were significantly more likely to suspend the inference in the DSI/ISI conditions than in the P condition. Therefore, the explanation of this part of the results has to be different from that of the adult data. Nonetheless, accounting for the child results, whilst retaining the structure of inference generation and suspension laid out by Romoli (2014), is possible, if we adopt just one additional assumption, namely that children are less sensitive to contextual cues than adults.

First, let us apply this idea of contextual insensitivity to children's low rate of inference interpretations in the DSI/ISI conditions. As discussed, Romoli (2014) assumes two possible ways for suspending a scalar implicature: through speaker ignorance, or through lack of contextual relevance of the alternatives. The only way to

determine that these suspension options are not available is through an examination of the context. For adults, it seemed reasonable to assume that they took neither option to be available in the given context. But if children are relatively insensitive to the kinds of contextual cues available to adults, then they may not see any reason against suspending the inference in the DSI/ISI conditions, which would account for the high rate of target picture choices.

Turning to presuppositions, children were also found to display the opposite pattern from adults, with significantly more inference interpretations of the test sentences. A Presupposition as Implicature account along the lines of Romoli (2014), paired with the assumption of context insensitivity can also account for this pattern of results in the following way. Romoli (2014) proposes that soft presuppositions are obligatory scalar implicatures. Therefore, as long as subjects are aware of the alternatives, they are forced to conduct the relevant comparisons, and derive the inference, regardless of any contextual properties. In fact, in this case, the only way that this inference can be suspended is through the local application of the scalar implicature mechanism, which only occurs if forced by explicit contextual motivation. Without the full ability to access the relevant contextual considerations, there is no pressure to overcome the default and choose this option. Therefore, children would be more likely to stick to the global application of $\mathscr{S}$ and generate the presuppositional inference, which is in line with our results.

While our results can be reconciled with Romoli (2014)'s version of the Presupposition as Implicature approach, with the assumption about children's contextual insensitivity, we should also note that there are other, more established, accounts for why children might suspend scalar implicatures at a higher rate than adults as well. For example, Barner et al. (2011) explain a similar set of scalar implicature results by suggesting that children might not be aware of the scalar relationship between the relevant expressions at play. Alternatively, Reinhart (2006) and others suggest that such response patterns might be due to a lack in children's processing capabilities, leading to a failure in retrieval of alternatives from the lexicon, or in holding them in working memory for scalar implicature computation. Finally, Katsos and Bishop (2011) suggest that children do in fact compute scalar implicature inferences just as readily as adults, however, they are more willing to give responses based on literal interpretations due to a higher level of tolerance (compared to adults) for violations of the scalar implicature inference. All of these approaches provide possible interpretations for the results in the DSI and ISI conditions, but it is not clear how they would account for the difference between the DSI/ISI and P conditions, if they were combined with some version of the Presupposition as Implicature approach. For example, why would children be able to derive and compare the relevant alternatives in the P condition, but not in the DSI/ISI conditions? Or why would children be tolerant to inferences derived in the ISI/DSI conditions, but not in the P condition? Therefore, as far as we can see, if one assumes the Presupposition as Implicature approach, the most straightforward way of accounting for the child results is to assume that they have access to both literal and scalar interpretations, but differ from adults in that they are less sensitive to contextual considerations. This amended version of the Presupposition as Implicature approach would be consistent with the child response patterns in the present experiment.

In summary, the Presupposition as Implicature approach in its most basic form is not directly consistent with our results. However, we have discussed possible supplementary assumptions for one particular version of this approach, which make it possible to account for the asymmetry between scalar implicatures and presuppositions in our data. While the experimental results do not provide fully conclusive evidence for deciding between the two accounts under consideration (Traditional vs. Presupposition as Implicature), their main theoretical contribution is to place constraints on the assumptions and specific details of the Presupposition as Implicature approach.

3.3 Relation to Processing Results on Presuppositions

In the P condition, we found a significant difference between the responses given by adults versus children, with children being less likely than adults to suspend the relevant inference in this condition. This result appears to link in nicely with recent results from the literature on how presuppositions are processed in studies of adult sentence comprehension (Chemla and Bott 2013; Romoli and Schwarz 2014). These studies found that responses based on a suspended-presupposition interpretation of a sentence was more costly, in terms of the time it took to give a response, than responding based on an interpretation that included the inference. Given that adults appear to experience this extra processing difficulty related to suspending presuppositions, and that children's processing capabilities are (presumably) not fully developed, it is only natural that children would be less proficient than adults at carrying out this process. Our finding of children being significantly less likely than adults to suspend the inference in the P condition, would thus seem to complement previous processing results on local interpretations of presuppositions rather nicely.

3.4 A note on ISI vs. DSI

An interesting aspect of our results that we have not discussed yet is the interaction between the DSI and ISI conditions when comparing adults versus children, which — to the best of our knowledge — is not expected based on any theoretical account of scalar implicatures. If this result is robust (and we have seen parallel patterns for the adult side of the results in other related studies, e.g., as reported in Schwarz et al. (2014)), we need to account for these differences between inferences. Since we are dealing with an interaction (rather than a main effect), any attempt to provide such an explanation would be unable to appeal to something 'simple,' like the presence of negation, to separate them theoretically. On the other hand, such an explanation may not be necessary at all, according to recent adult processing work on these inferences, which yielded mixed results and some arguments against interpreting similar apparent behavioral differences as indicative of differences in theoretical status (Romoli and Schwarz 2014; Cremers and Chemla 2013; Schwarz et al. 2014).

While we must leave a more comprehensive investigation of the comparison between ISIs and DSIs for future research, we would like to propose a possible avenue for explaining this initial result, invoking similar mechanisms to those already discussed. While DSIs and ISIs are on par with respect to the situations in which a literal interpretation without a scalar inference naturally arises (see section 3.2), there is a potential difference between them in terms of how such an interpretation can come about in technical terms. Again assuming a scalar operator $\mathscr{O}$, there actually are two possible ways for ISI-sentences to receive a literal interpretation: first, the

operator can be omitted altogether (as already mentioned). But secondly, it could be inserted locally, under negation as in (33b), where it's effect is vacuous, thus rendering a no-inference interpretation as well.

(33)

a. Not all giraffes have a scarf
b. Not[∅[all giraffes have a scarf]]

In the case of DSIs, on the other hand, only the omission option is open, since there is no operator relative to which a local interpretation could be construed. If we assume, now, that adults' behavior sometimes results from one strategy and sometimes from the other for ISIs, we would expect more literal interpretations for ISIs, as witnessed in our data. Children, on the other hand, do not generally seem to have access to such local operator construals, as seen in their low rate of inference suspension in the P condition, a process which involves parallel operator configurations. Thus, it is expected that they get literal interpretations for ISI-sentences relatively less often.[19] This is only a first sketch of a possible direction for thinking about the difference we found between ISIs and DSIs. We leave further exploration of this idea for future work.

3.5 Conclusion

We set out to test the claims of the Presupposition as Implicature approach, as they pertained to direct scalar implicatures, indirect scalar implicatures, and presuppositions. This approach was contrasted with a more traditional perspective on how these inferences are generated. Our results appear to favor the more traditional perspective, which derives presuppositions and scalar implicatures via different mechanisms. However, an appropriately supplemented Presupposition as Implicature account can be reconciled with the present data. Our discussion of this possibility presents potential additional assumptions, which may be necessary for future implementations of this approach. Further research on these inferences (perhaps using language processing measures like reaction time or eye tracking) may help to unravel the factors that contributed to the differences that were observed between the different age groups and inference-types, and further inform the overall theoretical picture. In particular with respect to presuppositions, our results seem very much in line with recent work on adult processing, and a more in-depth integration of processing and acquisition results seems highly desirable. Given the present state of affairs, both the traditional and Presupposition as Implicature approaches seem viable; however, we saw that the latter has to be supplemented with further assumptions, to account for the asymmetry we found between presuppositions and scalar implicatures.

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[19] Note that this still leaves open why they get them less often for ISIs than for DSIs, but an overall interaction pattern is expected between adults and children based on this line of thought.

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