The Semantics and Pragmatics of Logical Connectives: Adults' and Children's Interpretations of *And* and *Or* in a Guessing Game

Masoud Jasbi
masoudj@stanford.edu
Department of Linguistics
Stanford University

Michael C. Frank
mcfrank@stanford.edu
Department of Psychology
Stanford University

Abstract

Logical connectives *and* and *or* have been a source of insight into the roles of semantics and pragmatics in children's linguistic development. Previous research has suggested that adults and children may differ in their interpretation of *or* in two ways. First, unlike adults, children may interpret *or* as *and*. Second, children interpret *or* as inclusive disjunction while adults interpret it as exclusive disjunction. We report the results of two experimental studies with truth value judgement tasks that agree with the latter but not the former claim. The results suggest that children do not interpret *or* as *and* but they do interpret it as inclusive disjunction more often than adults. We discuss our analysis of children's linguistic feedback in the experiment that suggests the difference in inclusive interpreation may be caused by truth value judgement tasks rather than differences between children and adults in pragmatic competence.

Keywords: semantics; pragmatics; disjunction; conjunction; language development.

Introduction

An airport sign reads "*If you see something, say something.*" Taken literally, this is a trivial request, but readers infer an interpretation that goes far beyond the literal meanings of the words. How much of what we interpret is due to literal meaning (semantics) and how much due to our general-purpose inferential abilities (pragmatics)? In this paper, we address this question by investigating adult and children's interpretation of logical words *and* and *or*.

Despite their simple appearance, *and* and *or* have been a major source of insight into the contributions of semantics and pragmatics to language interpretation. The meaning of *and* has always been unambiguously associaated with logical conjunction. A conjunction is true when each individual conjunct is true. The meaning of *or*, however, has proven hard to capture. It has two possible interpretations: **inclusive** or logical disjunction and **exclusive** disjunction. An **inclusive** disjunction is true when either disjunct or both are true. On the other hand, an exclusive disjunction is true when only one of the disjuncts is true – not both. Until Grice (1975), it was generally assumed that *or* is ambiguous between an inclusive meaning and an exclusive one.

Grice (1975) argued against this ambiguity account. He maintained that the core meaning of *or* is inclusive disjunction. The exclusive interpretation of it is derived from the inclusive meaning via pragmatic reasoning. For example, "*there is a cat or a dog in the picture*" implies that not both animals are in the picture. This is called the *exclusivity implicature*. Grice argued that this implicature is derived via reasoning on what the speaker of the sentence could have said. If the speaker meant to communicate that both animals are in the picture, s/he could have used the connective *and*. He chose *or* instead, so he did not mean to communicate that both animals are in the picture. In the Gricean account, the exclusivity implicature is not part of *or*'s meaning, but rather the result of our reasoning on why the speaker chose *or* instead of *and*.

The advent of Gricean pragmatics changed the landscape of research on children's development of *and* and *or* interpretations. The focus shifted to the differences between adults and children in semantic vs. pragmatic aspects of interpretation. In a series of influential studies, Stephen Crain and his colleagues argued that unlike adults who have an implicature-rich exclusive interpretation of *or*, children as young as three years old, interpret the meaning of *or* in its logical and inclusive sense. (Chierchia, Crain, Guasti, Gualmini, & Meroni, 2001; Crain, 2008, 2012; Notley, Zhou, Jensen, & Crain, 2012) They argued that children develop the semantics of *or* before its pragmatics: they interpret *or* as inclusive disjunction but fail to enrich it with the exclusivity implicature the way adults do. Therefore, the main difference between children and adults is that children interpret *or* as inclusive, but adults interpret it as exclusive.

Recent investigations have added a new level of complexity to this line of research. Tieu et al. (2016) and Singh et al. (2016) argued that a substantial number of children in their studies (30-40% of the samples) interpreted *or* like a conjunction. In other words, these children do not differentiate between *and* and *or*. Based on previous studies that show children undertsand the meaning of *or*, they argue that this conjunctive interpretation of *or* is due to a non-adult-like pragmatic reasoning. Children interpret *A or B* as *A or B, but not only A and no only B*, resulting in *A and B*.

The current paper seeks to fill two gaps in the current literature. First, for theoretical reasons, previous research has focused on children's interpretation of *and* and *or* in complex sentences – for example with with other logical words such as quantifiers *every* and *none*. In this paper we test children and adults' understanding of *and* and *or* in simple existential sentences like "*There is a cat or a dog*." Second, previous research has tested children and adults using the binary truth value judgement task (Crain & Thornton, 1998). In such tasks participants are asked whether a puppet's statement is right or wrong. In this study, we allow participants to make use of three options: wrong, kinda right, and right. Katsos & Bishop (2011) showed that ternary judgment tasks are better

suited for assessing children's pragmatic competence.

In this paper we address two main questions. First, do children (and adults) interpret *or* similar to *and*? Second, do they understand *or* as inclusive disjunction, or exclusive disjunction? We conduct two experiments to answer these questions. Experiment 1 tests the adults' performance and sets the benchmark for children's perfomrance in the task. Experiment 2 investigates children's interpretaitons. The results of our experiments suggest that the answer to the first question is **no** for both adults and children. For the second question, the results suggest that adults are more inclined to interpret *or* as exclusive than inclusive. On the other hand, children show judgements compatible with inclusive disjunction. We bring an analysis of children's linguistic feedback that hints at exclusive interpretations not captured by the truth value judgement task. We discuss this methodological concern and possible ways of addressing it.

Experiment 1

The goal of this study was to examin adults' interpretation of the connectives *and* and *or* as a benchmark for children's interpretations. We designed the study as a card game in which participants saw a picture card, read a description about the card, and had to evaluaate the description. The descriptions contained the conjunction word *and* and the disjunction word *or*. This study found that adults interpret *and* and *or* differently and that adults are more likely to interpret *or* as exclusive than inclusive.

Methods

Participants We recruited 52 English speaking adult participants online. The task took about 5 minutes on average to complete.

Materials and Design We used Amazon's Mechanical Turk (MTurk) for recruitment and the online platform Qualtrics for data collection and survey design.

The study included six cards with cartoon images of a cat, a dog, and an elephant. There were two types of cards. The cards with only one animal on them and the ones with two animals. We also used three types of descriptions as guesses for these cards: simple (e.g. *There is a cat.*), conjunctive (e.g. *There is a cat and a dog*), and disjunctive (e.g. *There is a cat or a dog*). Pairing the card-types with the guesses results in 6 types of card-guess scenarios (One Animal-Conjunctive, Two Animals-Disjunctive, etc.). In each scenario, the animal labels used in the guess and the animal images on the card may have no overlap (e.g. Image: dog, Guess: *There is a cat or an elephant*), a partial overlap (e.g. Image: Cat, Guess: *There is a cat or an elephant*), or a total overlap (e.g. Image: cat and elephant, Guess: *There is a cat or an elephant*). The number of animals on the card, the type of guess, and the overlap beetween the guess and the card results in 12 different trial types. The experiment also included a blindfolded cartoon character Bob.

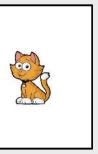
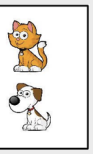
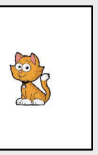
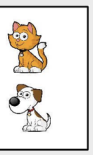
Guess		One Animal (1T)	Two Animals (2T)
AND	There is a cat and a dog.		
OR	There is a cat or a dog.		

Figure 1: Critical trials with example cards.

Procedure Participants read the consent form on Mturk and clicked on the study link to participate in the study. The link started a survey on Qualtrics with three phases: introduction, instruction, and test. In the introduction, participants saw the six cards and read that they will play a guessing game with these cards. They were then introduced to the blindfolded cartoon character Bob. They were told that in each round of the game, they will see a card and Bob is going to guess what animal is on that card. We emphasized that Bob cannot see the cards. We asked particpants to judge whether Bob's guess is *wrong*, *kinda right*, or *right*. In the instruction phase, participants saw an example trial where a card with the image of a dog was shown and the following was written above Bob's head: *Bob: There is a cat on the card*. All participants correctly responsed with *wrong* and proceeded to the next phase.

In the test phase, participants saw one trial per trial type for the total of 12 trials. Within each trial type, the specific card-guess scenario was chosen at random. The order of tryial types was also randomized for each participant. At the end of the study, participants received a 4 digit code to enter into Mturk and recieve $0.4 as compensation for their participation.

Results

Here we focus on the results of the critical trial types. You can see the example scenarios of these trial types in Figure 1. These scenarios include conjunctive and disjunctive guesses with some overlap between the guessed animals and the animal(s) on the cards[1]. Figure 2 shows the results for these critical trials. The columns mark the number of animals on the cards and the rows the type of guess, namely conjunctive vs. disjunctive. The number of animals in the critical trials of this study corresponds to the number of true conjunct/disjuncts: one animal is 1 conjunct/disjunct true (1T)

[1]Participants judged the trials with no overlap as *wrong* consistently.

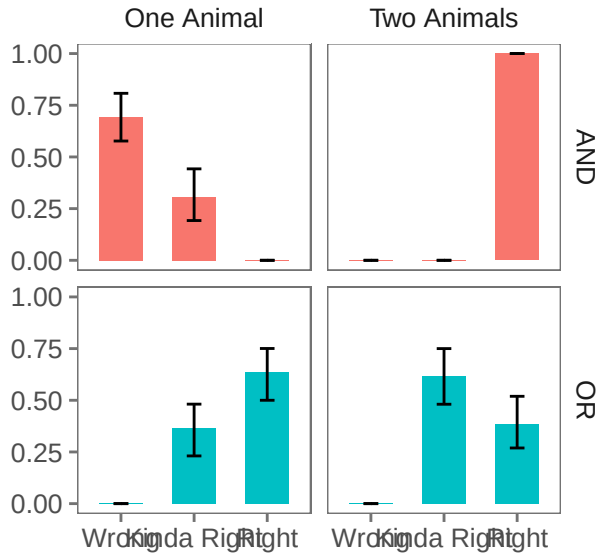


Figure 2: Results for Adults' Conjunction and Disjunction Trials. Error bars represent 95% confidence intervals.

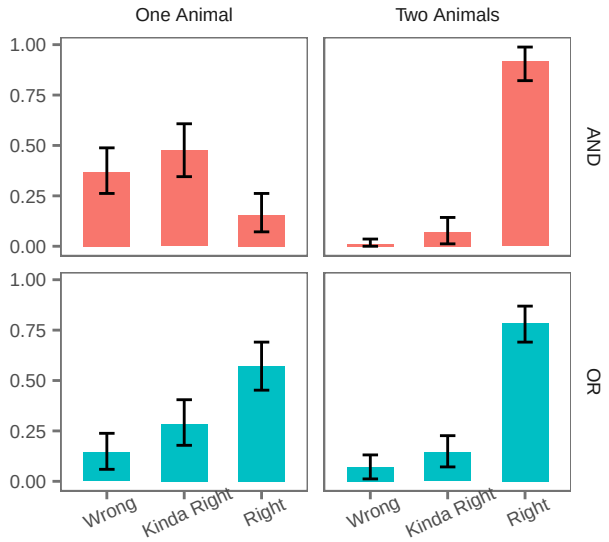


Figure 3: Results for Children's Conjunction and Disjunction Trials. Error bars represent 95% confidence intervals.

and two animals, two conjunct/disjuncts true (2T) (Tieu et al., 2016). Comparing the rows allows us to know whether adults interpret *and* and *or* differently. The column comparison shows whether *or* is interpreted as inclusive or exclusive.

The adult responses differ in both dimensions. First, the response patterns in the conjunctive and disjunctive trials are different. For conjunction, the responses are on the extremes of *right* and *wrong* while for disjunction, they distribute on *kinda right* and *right*. This pattern suggests that adults interpret *and* and *or* differently. Second, the responses are different between the trials where one disjunct/conjuct is true (1T) - and those that both disjuncts/conjuncts are true (2T). This difference is greater for conjunction than disjuction. Adults showed a small preference for the use of disjunction when only one disjunct is true rather than when both are true. This pattern suggests a small preference for an exclusive interpretation in the context of this experiment.

Individual Responses Tieu et al. (2016) and Singh et al. (2016) categorized participants as a function of their responses to the disjunctive trials. Here we perform a smiliar analysis on our disjunctive trials. Table 1 summarises the results. None of the participants considered a disjunctive guess *wrong* when one or both of the animals were on the card. However, participants divided into four different groups when interpreting disjunctive guesses for the one-animal and two-animal scenarios.

The majority of participants (23 out of 52) considered the disjunctive guess *right* when one animal was on the card (1T), but *kinda right* with two animals (2T). This pattern is consistent with an interpretation of "or" with an exclusivity implicature. The use of disjunction when both disjuncts are true is not *wrong* but it is nevertheless infelicitous and not completely *right*. For these participants, *kinda right* captures the violation of such a pragmatic expectation.

The other 29 participants were divided almost equally into the three remaining groups. 10 participants rated disjunctive guesses as *right* in both scenarios where one or two animals were on the card. This pattern is consistent with an inclusive interpretation of *or* with no exclusivity implicature. 9 other participants rated disjunctive guesses as only *kinda right* in both one-animal and two-animal trials. In other words, disjunctive guesses were dispreferred regardless of the outcome. This response pattern is consistent with the violation of another pragmatic expectation in the context of a guessing game: the guesser must choose the most specific guess possible. Under this expectation, guesses that cover several possible outcomes are punished. A disjunctive guess never picks a specific outcome and for these participants, *kinda right* captures the violation of this specificity expectation.

Finally, 9 participants reported a disjunctive guess as *right* when both animals were on the card, but only *kinda right* when only one of the animals was on the card. In other words, these participants preferred the guess when both disjuncts where true rather than only one. It is possible that these participants expected a right guess to be one that brings up a relevant number of animals. When only one animal is on the card, bringing up a second animal violates this expectation. When two animals are on the card, bringing up both animals satisfies this expectation even though the right linguistic connective was not used. For these participants, the choice of the linguistic connective (*and* vs. *or*) did not play an important role in their judgements.

If these speculations are on the right track, we expect participants to show different response profiles based on how they interpret the goal of the guessing game and ultimately the meaning of *right* in the context of the guessing game. We

will discuss this issue further in the last section of this paper.

Discussion

In this study, we tested adult interpretations of the connective words *and* and *or* in the context of a guessing game. Adult participants interpreted these words differently and depending on how many disjuncts/conjuncts were satisfied. Overall, a guess with *and* was considered right if both conjuncts were true and wrong if only one was true. A guess with *or* was not wrong in either case, yet adults were more likely to consider it as right when only one of the disjuncts was true. Grouping inviduals based on their responses, we also found that some participants dispreferred disjunctive guesses whether one or both disjuncts were true, some considered them better when both disjucts where true, and some others considered them right in either case.

The results are consistent with the dominent view on the division of labor between semantics and pragmatics in the interpretation of connective words. The semantics of *and* is captured by logical conjunction and *or* by inclusive disjunction. *And* is true when both conjuncts are true and false when only one is true. *Or* is true in both cases but not the best option as a connective when both disjuncts are true. In Experiment 2 we examine preschool children's interpretation of these connectives in the conext of the same guessing game.

Experiment 2

Methods

Participants We recruited 42 English speaking children from the Bing Nursery School at Stanford University. Children were between 3;02 and 5;02 years old (Mean = 4;04).

Materials and Design We used the same set of cards and linguistic stimuli as the ones in Experiment 1. The study used 8 trial types and 2 trials per trial type for the total of 16 trials. The trials were balanced to include the same number of one-animal and two-animal cards, the same number of simple and connective guesses, and the same number of expected true vs. false judgements. However, we made a few changes to make the experiment more suitable for childrens. Instead of Bob, a puppet named Jazzy played the guessing game with the children. Jazzy had a sleeping mask on his eyes during the game. To introduce a three-valued scale, we placed a set of red circles, small blue stars, and big blue stars in front of the children. These tokens were used to reward the puppet after each guess. The use of tokens as rewards proved to be a more successful measure during piloting than hand gestures or only verbal feedback (e.g. *Jazzy you were right!*). One experimenter was involved in this study.

Procedure The experimenter and the puppet interacted with the children before the study. The experiment was carried out in a quiet room and the sessions were videotaped. There was a small table and two chairs in the room. Children sat on one side of the table and the experimenter and the puppet on the other side facing the child. The groups of circles, small stars, and big stars were placed in front of the child from left to right. A deck of six cards was in front of the experimenter. Similar to the previous study, participants sat through three phases: introduction, instruction, and test.

The goal of the introduction phase was to show the animal cards to children and make sure they recognize the animals and know their names. The experimenter showed the cards to the children and asked them to label the animals. All children recognized the animals and could label them as cat, dog, and elephant. In the instruction phase, children went through three example trials. The experimenter explained that he is going to play with the puppet first so that the child can learn the game. He removed the six introduction cards and placed a deck of three cards face-down on the table. From top to bottom (first to last), the cards had the following images: a cat, an elephant, a cat and a dog. He put the sleeping mask on Jazzy's eyes and explained that Jazzy is going to guess what is on these cards. He then picked the first card and asked the puppet: "*What do you think is on this card?*" Jazzy replied with "*There is a dog*". The experimenter showed the cat-card to the child and explained that when Jazzy is *not right* he gets a circle. He then asked the child to give the puppet a circle. Rewards were collected by the experimenter and placed under the table to not distract the child. The second trial followed the same pattern except that the puppet guessed *right* and the experimenter invited the child to give the puppet a big star. In the final trial, the puppet guessed that there is a cat on the card when the card had a cat and a dog on it. The experimenter said that the puppet was *a little right* and asked the child to give him a little star.

In the test phase, the experimenter removed the three instruction cards and placed a deck of 16 randomized cards on the table[2]. The experimenter explained that it is the child's turn to play with the puppet. The test phase followed the pattern described in the instruction phase.

Measurement In each trial, children were asked to give the puppet a circle if he is *wrong*, a small star if he is *a little right*, and a big star if he is *right*. During the analysis of the videos, children's linguistic feedback to the puppet after each guess were categorized into four types: 1. None, 2. Judgements, 3. Descriptions, and 4. Corrections. The first category referred to cases where children did not provide any linguistic feedback. Judgements referred to linguistic feedback such as *you are right!*, *yes*, *nope*, *you winned*. Such feedback only expressed judgements and mirrored the rewards. Descriptions were cases that the child simply mentioned what was on the card: *cat!*, *dog and elephant!*, *There is a cat and a dog!* etc. Finally, corrections referred to feedback that provided corrections to what the puppet had said. Examples include: *Just a cat!*, *Both!*, *The two are!*, *Only cat*, *cat AND dog* (with emphasis placed on *and*).

[2]The randomization code can be found in the github repository of this study

Results

Figure 3 shows the results. Similar to Experiment 1, comparison of the rows lets us know whether children differentiate *and* and *or*. Comparison of the columns in the disjunctive guesses informs us of exclusivity implicatures. Comparing the conjunction and disjunction trials (the figure rows), we see that children distinguish between *and* and *or* in cases where one animal is on the card but not when both are. Given that the one-animal cojunction trials (top left) and the one-animal disjunction trials (bottom left) differ in truth conditions, the difference in response patterns suggests that children at this age have a different semantic knowledge for *and* and *or*. The two-animal conjunction and two-animal disjunction trials (top right and bottom right) do not differ in truth values, and the responses also show no difference.

In the one-animal and two-animal trials (figure columns), children show different response patterns when the guess contains the conjunction word *and* (top right vs. top left) but not when *or* is used (bottom right vs. bottom left). Since the truth values of one-animal and two-animal trials differ for conjunctive guesses but not disjuncitive ones, the results suggest that children have different semantic knowledge for *and* and *or*. The similarity of the disjunctive guesses in one-animal and two-animal trials (bottom right vs. bottom left) can be interpreted as a lack of exclusivity implicatures in children. We will bring up a caveat to this interpretationin our analysis of children's linguistic feedback.

Figure 4 shows a side-by-side comparision of adults and children's responses to the guessing game. We see that adults and children mostly differ in their interpretation of disjunction when both disjuncts are true. We also see a difference in one-animal conjunctions trials (top left) where children show more *kinda right* judgments and fewer *wrong* ones than adults. We believe that this is due to children's general reluctance to judge the puppet's guess as *wrong*.

Statistical Modeling We used the R package {*rstan*} for Bayesian statistical modeling. We fitted an ordinal mixed-effects logistic model on children and adults' judgments. The response variable had three ordered levels: *wrong*, *kinda right*, and *right*. The trial types *One-Animals-OR*, *Two-Animals-OR*, *One-Animal-AND* constituted the fixed effects of the model with *Two-Animal-AND* set as the intercept. The model also included by-subject random intercepts. The priors over trial types and the random intercepts were set to $\mathcal{N}(0, 10)$. We also included a paramter C of a set of cutpoints on probit of the resonses with the prior $\mathcal{N}(0, 1)$. All four chains converged after a burn-in of 1500 and 3000 iterations.

Figure 4 shows the difference of coefficients for the trial types of Expiriments 1 and 2. OR.2-1 shows the comparison between the disjunctive trials: both disjuncts are true vs. only one disjunct is true (Figures 2 and 3, bottom left and right). On average, children are more likely to judge a disjunction as *right* if both disjuncts are true rather than one of them while adults tend towards *kinda right*. AND.2-1 shows the difference between the conjunctive trials: when both conjuncts are true vs. when only on eis true. Both children and adult

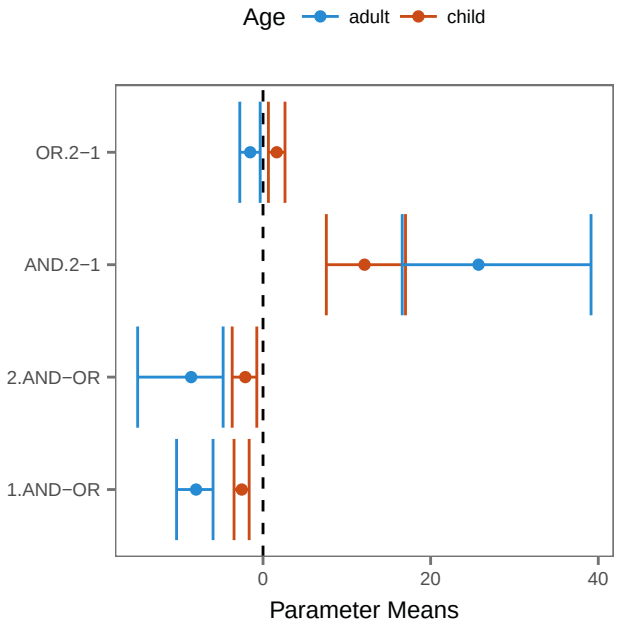


Figure 4: Comparison of estimated coefficients for trial types. Error bars represent 99% confidence intervals.

Individual Responses We searched for children that had the following response patterns: they responded with *wrong* when one disjunct was true but *kinda right* or *right* when both were true; as well as children that responded with *kinda right* when one disjuncts was true but *right* when both were true. We found 10 children with such response patterns. In Experiment 1 we found similar number of adults that showed some preference for a disjunctive guess when both disjuncts were true.

Linguistic Feedback We performed chi-squared goodness-of-fit tests to compare the feedback distributions in each condition. We found that in conjunction trials, children's linguistic feedback is not equally distributed when there is one animal vs. two animals on the card ($\chi(3, N = 83) = 201.65$, $p < .05$). Children's feedback is also not equally distributed when there is only one animal on the card and the puppet uses *and* vs. *or* ($\chi(3, N = 83) = 62.16$, $p < .05$). However, a chi-squared test did not find any significant difference between the trials where *or* was used and there was one animals vs. two animals on the card ($\chi(9, N = 4) = 12$, $p < .05$). Finally, we found a signifcant difference between the distribution of feedback between the trials with *and* vs. *or* when both animals were on the card ($\chi(3, N = 84) = 184.98$, $p < .05$).

We also categorized children's linguistic feedback to the puppet. Figure 5 shows the results. We excluded the *None* feedback (e.i. the child did not say anything) since a similar rate of such responses was present in each trial type. Children's linguistic feedback fell into three patterns: 1. the one-animal conjunctive and two-animal disjunctive (top left and

bottom right) trials show higher proportion of *Corrections* than the other trial types. These are trials that the guesses are either false or infelicitous. The higher number of corrective feedback in these two trial types hints at children's sensitivity to both semantic and pragmatic violations. 2. The one-animal disjunctive trials (bottom left) showed the highest proportion of *Descriptions*. These are trials that the guess is correct but not specific enough; leaves two possibilities open. 3. The two-animal conjunctive trials (top right) show the highest proportion of *Judgements* such as *you are right!*. This is not surprising given that in these trials represent the most optimal guessing scenario.

Our analysis of children's linguistic feedback in the context of the guessing game suggests that children are sensitive to the pragmatics of the game. More specifically, they produce more corrections to the puppet's disjunctive guess when both disjuncts are true. Such feedback suggests that children are sensitive to the exclusivity implicature that the use of *or* carries. The comparison of children's rewards to the puppet in the truth value judgment task and their linguistic feedback raises an important methodological issue. Truth value judgment tasks alone may not be sufficient for assessing children's pragmatic competence. In general discussion, we discuss how we intend to address this issue in our future work.

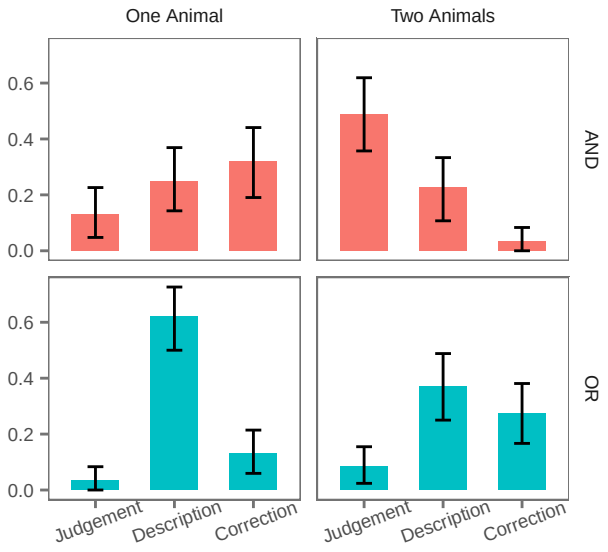


Figure 5: Children's Linguistic Feedback to Conjunction and Disjunction Trials. Error bars represent 95% confidence intervals.

Discussion

This study did not find any evidence for the hypothesis that a large group of children interpret the disjunction word *or* similar to its conjunctive counterpart *and*. To the countrary, both children's judgements and their linguistic feedback suggested that they differentiate these two connective words. More specifically, children's jugements mirrored those of adults in conditions with different truth values. We took this as a sign of children's adult like semantics for *and* and *or*. However, children's judgements differed from adults in disjunctive guesses when both disjuncts were true. Children showed no signs of an exclusivity implicature in such trials. These results can be interpreted to show that children differ from adults in the pragmatics of disjunction words.

The analysis of children's linguistic feedback points to a different possible interpretation of the results. Perhaps children do compute an exclusivity implicature at the adult rate but they express it differently. Adults choose to reflect the presence of the implicature in their judgements while children choose to give corrective linguistic feedback. In fact, adults in Experiment 1 had no way of offering linguistic feedback to the guessing character. Had they been able to, it is possible that they would have shown similar judgment responses to children.

General Discussion

We started our investigations with two questions: first, do adults and more importantly children interpret *and* and *or* differently? Second, do they interpret *or* as inclusive disjunction or exclusive disjunciton? In this paper, we presented two experimental studies to address these questions. Experiment 1 showed that adults interpreted *or* as a disjunction and differentiated it from *and*. Judgements of *or* were split between an inclusive and exclusive interpretation, with a slight advantage for the exclusive interpretation. Experiment 2 showed that three-to-five-year old children showed very similar patterns of interpretation in the guessing game excpet for disjunction when both disjuncts are true. Overall, children were more likely to interpret *or* as inclusive disjunction. Therefore, the results of our truth value judgement studies suggest that both adults and children differentiate *and* and *or*. Yet, adults are more likely to interpret *or* as exclusive while children interpret it as inclusive. These results are most compatible with the ones reported in Crain (2012).

At this point, we would like to discuss two issues raised by Experiments 1 and 2 that we would like to address in the future. First, the analysis of individual adult responses in experiment 1 showed that adults interpret *or* in many different ways, even though the majority stick to an exclusive interpretion. We suspect that this variation is due to participants' understanding of the goal of the game and ultimately what being *right* means in the context of the game. If this hypothesis is true, it should be possible to experimentally manipulate the goal of the game and assess the change in adult interpretations of *or*.

Second, in our analysis of children's linguistic feedback we saw signs of children's sensitivity to exclusivity implicatures that were not captured by the standard truth value judgement task. These results suggest that truth value judgement tasks may not be sufficient in assessing children's pragmatic competence and should be supplemented with other assessments such as elicitation of linguistic feedback to pragmatically in-

felicitious utterances. We would like to pursue this line of research in future work.

Acknowledgements

We would like to thank Eve V. Clark and Christopher Potts for their generous help and advice on this project. We would also like to thank the staff and children at Stanford's Bing Nursery School. This work was supported by NSF #1456077.

References

Chierchia, G., Crain, S., Guasti, M. T., Gualmini, A., & Meroni, L. (2001). The acquisition of disjunction: Evidence for a grammatical view of scalar implicatures. In *Proceedings of the 25th boston university conference on language development* (pp. 157–168). Cascadilla Press Somerville, MA.

Crain, S. (2008). The interpretation of disjunction in universal grammar. *Language and Speech*, *51*(1-2), 151–169.

Crain, S. (2012). *The emergence of meaning*. Cambridge University Press.

Crain, S., & Thornton, R. (1998). *Investigations in universal grammar: A guide to experiments on the acquisition of syntax and semantics*. MIT Press.

Grice, H. P. (1975). Logic and conversation. In P. Cole & J. Morgan (Eds.), *Syntax and semantics* (Vol. 3: Speech Acts, pp. 43–58). Academic Press.

Katsos, N., & Bishop, D. V. (2011). Pragmatic tolerance: Implications for the acquisition of informativeness and implicature. *Cognition*, *120*(1), 67–81.

Notley, A., Zhou, P., Jensen, B., & Crain, S. (2012). Children's interpretation of disjunction in the scope of "before": A comparison of english and mandarin. *Journal of Child Language*, *39*(03), 482–522.

Singh, R., Wexler, K., Astle-Rahim, A., Kamawar, D., & Fox, D. (2016). Children interpret disjunction as conjunction: Consequences for theories of implicature and child development. *Natural Language Semantics*, *24*(4), 305–352. http://doi.org/10.1007/s11050-016-9126-3

Tieu, L., Yatsushiro, K., Cremers, A., Romoli, J., Sauerland, U., & Chemla, E. (2016). On the role of alternatives in the acquisition of simple and complex disjunctions in french and japanese. *Journal of Semantics*.