# Assessing Truth and Knowledge:

# How Children Differ From Adults in Assessment of Truth Values and Speaker Knowledge

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Abstract

A speaker who is said to know "where to buy a good cup of coffee" should minimally be able to list at least one such place, and maybe even be able to identify every local place that sells good coffee (and know which places don't). What happens when the speaker knows the right places, but has false beliefs about the wrong ones? Previous research indicates that false beliefs seem to matter much less for children than for adults (Cremers, Tieu, & Chemla 2016). However, this research suffers from two faults. First, participants were asked to provide a binary judgment of what the speaker knew on the basis of the speaker's statement, but were never asked to evaluate the truth value of the speaker's actual statement (a conjunction of true and false propositions). It is therefore unclear whether children accept or reject such a truth-conditionally false statement. Second, the previous research was in French, which requires determiners. Thus, it is unclear whether the target plural definite descriptions biased participants towards certain responses. The current study, run with preschoolers and adults, paired truth-value judgment with assessment of speaker's knowledge using a ternary scale, manipulating false beliefs and presence/absence of definiteness. Results show that adults are more likely to accept the statement when there is a definite description present and when homogeneity is not obeyed. Homogeneity had a similar affect on child responses, but children treated bare plurals and definite descriptions the same. When the speaker's statement includes a false report, both age groups are likely to reject the statement, and subsequently assess the speaker's knowledge to be less than adequate. These findings demonstrate that children do not differ qualitatively from adults in overlooking false beliefs when assessing truth values and speaker knowledge.

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# 1. INTRODUCTION

Studying embedded questions enables us to better understand the meaning of questions and what the speaker knows. Weakly Exhaustive (WE) readings of embedded questions allow the speaker to hold a false belief and still regard the statement as true. One robust finding is that children are more permissible of WE readings than adults, even though both age groups appear to access this reading and stronger readings (Cremers, Tieu, & Chemla 2016, Moyer 2016). The current study investigates the role of the false belief in evaluation of truth values in order to discern the cause of children's divergence from adults. The goal is to understand if children do treat a false proposition differently than adults, and how this affects the answers they give to embedded questions. We use a Truth Value Judgment Task to separate children and adults' evaluation of the truth value from that of the speaker's knowledge. Next, participants evaluate the embedded question using a ternary scale. The study builds on previous work by manipulating homogeneity and definiteness of the plural object. We aim to show that children do not differ qualitatively from adults in evaluation of false information in a speaker's report. Consequently, this relates to what we know about children's Theory of Mind ability. If children can successfully assess speaker knowledge based on the speaker's report, then they can assess what the speaker knows.

## 1.1. The meaning of questions

Language is a sophisticated tool we use for the purposes of communication. We can put our language abilities to work and share information that we already know. We can also ask others about information that we wish to know. At any point in time, it is quite plausible that there is more information that we do not know than that which we do know. This may lead us to ponder the importance of being able to ask for new information. What would happen if you were unable

to ask someone where to get a meal, or what time your bus was coming? Clearly, asking questions is a vital part of our intellectual existence. And an essential aspect of linguistic interaction is answering questions.

What must a language user know in order to answer a question? Firstly, they must be able to understand the meaning of the question. Determining the meaning of a question differs from that of a declarative statement. Traditionally, the meaning of a declarative statement is constituted by its set of truth conditions – what is required for the given propositional content to be true; in other words, is the proposition true or false according to its compositional semantic meaning. When dealing with questions, on the other hand, the meaning of the utterance is determined by its answerhood conditions (Chemla 2014). The meaning of a question is all of the propositions that could be an answer. To know the meaning of a question, then, one must understand what would be an acceptable answer. A competent hearer must also be able to identify which is the true answer of a *set* of answers to a question. Language users must be able to discern what is the truth based on the set of possible worlds relevant in the conversational and linguistic context. This yields the ability to determine the truth value of a proposition. Once a language user can evaluate a proposition as true or false, they can then evaluate the set of answers to a question. They must also consider the knowledge of the speaker.

Let us consider an example of a typical question one might hear in every day life, and look at what it means to be able to give an answer:

(1) Who went to the debate?

The speaker wants to know, for every person who went to the debate, who was at the debate. Consider a world in which you went to the debate, and there you saw Jay and George, but did not see Hanna. Therefore, you know that the following propositions are true:

(2) Jay went to the debate.

(3) George went to the debate.

(4) Hanna did not go to the debate.

You can now tell your friend that Jay and George went to the debate. You understand the truth conditions of the possible answers, have assigned each a truth value, and therefore can understand the meaning of the question. Consequently, you provide a truthful answer. If you said that Hanna went to the debate, that answer would be false. If you said that Jay went to the debate and Hanna went to the debate, that is still false because it includes a false proposition. In the next section, we consider when it is acceptable to only provide one truthful proposition (Jay went to the debate) and when that is not enough of an answer. Next we discuss why, for the speaker to have full knowledge of who went to the debate, they must truthfully say who went to the debate and who did not (Jay and George went to the debate, and Hanna did not go to the debate).

### 1.2 Embedded questions

Considering that the meaning of a question is its answerhood conditions, a useful way to study questions involves embedded questions. An embedded question is a question that is embedded within a declarative sentence. For example, *Angela knows who went to the debate*, is a declarative sentence that embeds the question *who went to the debate*. Understanding the answerhood conditions to embedded questions, and how language users assign a sentence with an embedded question a truth value will enable us to better analyze the phenomena of answering a question.

A closer look at the multiple interpretations of embedded questions shows a variation of truth conditional meanings. A question like (5) has been proposed to have at least three different

interpretations, each with varying truth conditions: weakly exhaustive, intermediate exhaustive, strongly exhaustive. These interpretations are illustrated in an example below.

(5) Patrick knows who went to the debate.

a. Weakly exhaustive (WE):

   For each person who went to the debate, Patrick knows that they went to the debate.

b. Intermediate exhaustive (IE):

   For each person who went to the debate, Patrick knows that they went to the debate and Patrick has no false beliefs about who did not go to the debate.

c. Strongly exhaustive (SE):

   For each person who went to the debate, Patrick knows that they went to the debate, and for each person who did not go to the debate, Patrick knows that they did not go to the debate.

Consider a situation in which Jay and Amelia went to the debate, but George did not. The WE reading will be true if Patrick has full knowledge that Jay and Amelia were at the debate. It is not required that he know anything about whether or not George went to the debate. For the IE reading to be true, Patrick must again have only true beliefs about Jay and Amelia being at the debate, as well as have no false beliefs about the people who were not at the debate, i.e. George. A false belief is when an individual's beliefs about the world do not reflect reality. Even if Patrick were to admit he had no idea if George went to the debate or not, the IE reading would still be true. Lastly, Patrick must know that Jay and Amelia went to the debate and know that no one else went to the debate (George did not go to the debate) for the SE reading to come out true.

Notice that for the WE reading, Patrick could mistakenly believe that George went to the debate for the reading to be true. In other words, Patrick could hold a false belief about whether or not George was at the debate. How can an answer be judged true when not all its constituent propositions are true? Not surprisingly, adults judge these weakly exhaustive interpretations as false most of the time (Chemla, Tieu and Cremers, 2016, Cremers 2014, Moyer 2016). However, one robust finding is that children tend to accept WE interpretations as true more often than adults (Cremers, Tieu, & Chemla 2016, Moyer 2016). In later sections, we will discuss how previous research has concluded from this empirical data that children may be more likely than adults to regard a proposition as true even if it includes a speaker's false belief. We find motivation to be skeptical of this conclusion that children differ qualitatively from adults in their assessment of speaker knowledge, considering the semantics of embedded questions.

### 1.3 Theoretical background

As we have discussed, evaluating a proposition's truth value and the speaker's knowledge enables a language user to answer questions. Here we give an overview of the semantics of specifically embedded questions. The literature discusses the semantics of two main types of answers to embedded questions: mention-some (non-exhaustive) readings and exhaustive readings. A mention-some reading assigns the properties in the question to at least one thing (George 2013). An example of a mention-some answer is what you may expect to hear after asking someone where you can buy a cup of coffee. If they are being felicitous, they will respond by mentioning one place where you can buy coffee. According to Paul Grice (1989), this response is suited for the conversational circumstance because the speaker is following the Quantity Maxim and only providing as much information as is needed for the exchange, and no

more. Thus, fortunately for the addressee, they will not list every possible place you could ever buy coffee. In contrast, an exhaustive reading requires that for every thing that has property *p*, the agent knows that it has property *p*. The three currently accepted types of exhaustive readings differ in the knowledge requirements about which thing does not have property *p* (for example, being at a debate). We saw in the previous section, see (4), that in weakly exhaustive interpretations, Patrick had full knowledge of who went to the debate. In the intermediate exhaustive interpretation, he also had no false beliefs about who was not at the debate. Thirdly, the strongly exhaustive interpretation require that he also have full knowledge of who was not at the debate. One question under debate is which reading is the most basic interpretation of embedded questions: the strongly exhaustive reading or the weakly exhaustive reading.

A weakly exhaustive reading is the conjunction of all the possible true mention-some answers to a question (George 2013). Klinedinst and Rothschild (2011), Heim (1994) and Guerzoni (2007) are in favor of the WE reading as basic. Chemla (2014) also provides empirical evidence for WE as basic, further arguing that *know* gives rise to WE and not just the previously assumed SE readings. The WE reading is believed to be basic because the stronger exhaustifications can be derived from it. Cremers (2014) derives the IE and SE readings from the WE reading using a strengthening mechanism. A strengthening mechanism, such as exhaustification using an EXH-operator, serves to derive answers from an already existing set of possible answers. In this fashion, stronger, more exhaustive answers can be derived from weaker ones, but not the reverse (Chemla 2014, Heim 1994). This relates to the Gricean strengthening seen in implicature derivation.

Several researchers have recently incorporated IE readings into the theory in order to better predict the truth conditions of embedded questions. More recently, it has been shown that

an intermediate reading is also salient (a possible interpretation available) and thus accessible when interpreting embedded questions (Chemla 2014, Cremers 2016, Spector and Egre 2015, Klinedinst and Rothschild 2011). Both George (2011) and Spector and Egre (2015) question the existence of the WE reading.In fact, the theory proposed by Spector and Egre (2015) does not generate a WE reading at all. Their incorporation of the 'no false belief' constraint replaces the derivation of WE readings, therefore they argue that the WE is actually the IE reading. Possible answer sets will depend on the nature of the verb and exhaustivity requirements differ among verb classes. Specifically, factive verbs, such as *know* are thought to require strongly exhaustive readings only (Klinedinst and Rothschild 2011, George 2013, Spector and Egre 2015), whereas non-factive verbs, such as *tell* or *predict*, can take an intermediate exhaustive reading (Klinedinst and Rothschild 2011). Their theory argues for the existence of intermediate exhaustive readings of certain non-factive verbs, proposing that one can actually get a non-SE reading from certain embedded questions.

In his attempt to determine a parsimonious theory of which semantic readings exist in an answer set, George (2011) argues that SE readings are the only possible readings available and thus the most basic. In his theoretical argument, he highlights the importance of considering all possible worlds when determining true answer sets. He proposes that WE readings may be the result of SE readings "in combination with domain restriction effects," as well as particular mention-some readings. Using the negation test and judgement verbs such as "surprise," his analysis fails to sufficiently distinguish between a WE reading from SE or mention-some readings. Therefore, his work undermines the argument for the existence of WE readings, and further supports SE as the primitive reading.

It is intriguing that the weakest interpretation of an embedded question allows for the speaker to hold a false belief, because this means that the overall sentence is judged true even though it includes false information about reality. This runs contrary to the semantics of conjunction, given that the joining of a true subset with a false subset makes the entire proposition false. For this reason, the role of the false belief is important when studying the interpretations of embedded questions. As was previously mentioned, some research supports the idea that children are more tolerant of this weakly exhaustive reading of an embedded question, meaning that they are more tolerant of the false belief than adults are. Assuming that the weak reading is also available to adults, why is that adults tend to reject a weak interpretation when it includes a false belief? Adults are not willing to say that the speaker knows X if the proposition includes a false report at all. On the other hand, if rejecting a weak reading because it includes a false report is the adult-like interpretation, what are children doing differently that makes them accept the false report? It is possible that they are not sensitive to the false belief at all. Or perhaps, there is another explanation for why children appear to behave differently from adults.

## 1.4 Developmental language background

### 1.4.1 Relevant studies

In this section we discuss exactly the methods that are used to investigate how children interpret and answer embedded questions. We know that a weakly exhaustive reading of an embedded question permits the speaker to have a false belief, while the intermediate and strongly exhaustive readings do not allow for any false beliefs. Yet, children under the age of six tend to be more accepting of weakly exhaustive readings of embedded questions, while adults are more likely to only accept intermediate and strongly exhaustive readings (Cremers, Tieu, & Chemla

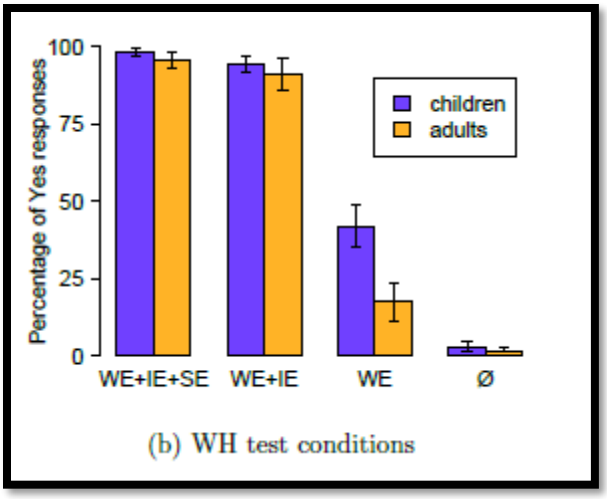
2016, Cremers 2014). Here we consider the experimental scenarios that give rise to these patterns of behavior.

In a recent study by Alexandre Cremers, Lyn Tieu and Emmanuel Chemla, they investigate children's interpretations of embedded questions and how they compare with adults. They employ a truth value judgement task, and the experiment is conducted in French. They test 35 children acquiring the language between the ages of 4;03 and 6;04 and 23 adult native speakers as controls. Participants are shown a cartoon image with 2 sets of toy objects located in two different locations on a laptop computer. A character named Zap also watches along. Next, Zap is asked to put on a blindfold and then recall aloud the location of each set of objects in the image. An example of the screen participants saw is included below (see Figure 1). Zap makes a statement such as, "*The trucks are in the box. The boats are also in the box*," or, "*The trucks are in the box. The boats, I don't know*." Children are then asked a question regarding Zap's knowledge such as, "*Does Zap know which toys are in the box?*" The four WH test conditions include a baseline condition (false control) where Zap is wrong about both sets of objects, a Weakly Exhaustive (WE) condition where Zap is right about one set and wrong about the second, an Intermediate Exhaustive (WE+IE) condition where Zap is right about the location of the first set of objects and does not know about the second, yet has no false beliefs about the second set. Finally, in the Strongly Exhaustive (WE+IE+SE) condition Zap knows where both sets of objects are, and all participants are expected to give a *yes* response (true control).

Figure 1. Visual stimuli used in Cremers, Tieu, & Chemla (2016) during experimental task. There are always two sets of objects and the character Zap makes statements regarding the location of each. Retrieved from Cremers, A., Tieu, L., & Chemla, E. (2016).

Overall, Cremers, Tieu, & Chemla (2016) showed that children between the ages of 4 and 6 accept weakly exhaustive readings of embedded questions significantly more often than do adults ($p = .005$), while also being sensitive to the range of interpretations of embedded questions. Children did not differ from adults in amount of WE+IE readings ($p = .9$). The percentages are illustrated below (see Figure 2). The study confirms previous findings that 5 year old children are more accepting of weakly exhaustive readings of embedded questions. Importantly, they provided evidence that both children and adults are able to access WE, IE and SE readings, with both groups performing similarly in the WE+IE condition. However, children gave significantly more *yes* responses in the WE condition than adults, mirroring the findings of previous studies (Moyer 2016, Noveck 2001, Papafragou & Musolino 2003, Katsos & Bishop 2011). Interestingly, fourteen out of the 35 children gave spontaneous 'both yes and no' responses, ten on the WE targets and four on the WE+IE targets. This indicates children may be sensitive to the false proposition.

Figure 2. Graph used in Cremers, Tieu, & Chemla (2016) to show results from all WH test conditions. Retrieved from Cremers, A., Tieu, L., & Chemla, E. (2016).




(b) WH test conditions

They propose a novel explanation for the discrepancy between child and adult interpretations of embedded questions based on children's treatment of scalar implicatures. They proposes that children are more accepting of weakly exhaustive readings for the same reason they are more accepting of weaker scalar terms: mainly, because children are less able to derive the necessary implicature. They do not address how children may be evaluating the false proposition in the first place, and how this effects children's answers to the embedded question.

A similar study uses evidence from four year olds to investigate how children assess speaker knowledge (Moyer 2016). They utilize a modified Truth Value Judgement Task with embedded questions. Participants view a computer screen along with a puppet. In the procedure, two girls are looking for objects in a store and a third character, Johnny, offers to help. In each trial, the girls indicate what they need and Johnny then consults three separate boxes. The target objects are in one or more of the boxes, and Johnny looks for them in some combination. At the end, one of the girls asks Johnny "*Where can we find X?"* and Johnny's responses are compatible with either true mention-some readings or mention some/WE readings (including a

false report). They manipulate definiteness of the plural object between subjects. The puppet delivers the target embedded question statement, and participants answered either *yes* or *no*.

Their results show that children respond similarly to adults to the statements compatible with SE/IE/WE readings as well as the true mention some statements. Again, the difference in response patterns arise in the condition that include a speaker's false report. When Johnny made a false report, children accepted the statement 43.9% without the definite description and 34.5% with a definite description. In comparison, adults only accepted a statement with a false report 27.5% without the definite description and 17.5% with the definite description. Their analysis highlights that children were significantly more likely than adults to accept a true mention some statement when the speaker only had partial knowledge (81.9% acceptance rate from children and 70.0% acceptance from adults). Interestingly, children also accepted true mention some statements when the speaker had full knowledge significantly more than adults. In addition, the presence or absence of definite descriptions produced no significant effect on child responses. They conclude that assessment of speaker knowledge arose from a combination of answer exhaustivity, the truth value of the speaker's report, and the speaker's direct perceptual evidence.

### 1.4.2 Evaluating previous research

Here we incorporate a truth table to evaluate the explanations for the previous research by Cremers, Tieu, & Chemla (2016) and Morgan (2016). In the previous work, every experimental trial included a proposition with conjunction. For example, the character Zap would say, "*The trucks are in the box, and the boats are in the box*." The fact that children are more likely than adults to evaluate a proposition such as this one as true in an experimental task, even if it includes a speaker's false belief, motivates us to consider how children deal with true and false

information when it is together in the same proposition, and how this may be different from adults. Evaluation of the speaker's knowledge depended on the speaker's report and the context. The task for the participant was to evaluate each proper subset of his statements and then make a judgement about his overall knowledge based on the conjunction of these two subsets. Thus, it is essential we understand how children and adults treat conjunction, and determine if they treat it the same or differently. Were children more tolerant of the speaker's false belief because they were actually ignoring it in the speaker's report? Evaluating the conjunction of these statements allows us to determine the cause of divergence in behavior between children and adults. Children may either be treating a false proposition differently or evaluating speaker knowledge differently from adults.

In logic, the truth conditions of conjunction are such that when one proposition is true and the other false, the conjoined proposition in its entirety is false.

Table 1. Truth table for *and*.

| | | | |
|---|---|---|---|
| 1 | ^ | 1 | 1 |
| 1 | ^ | 0 | 0 |
| 0 | ^ | 1 | 0 |
| 0 | ^ | 0 | 0 |

If Lucy went to the salon and Mary went to the market, then it is, of course, true that *Lucy went to the salon, and Mary went to the market.* If in fact only Lucy had gone to the salon and Mary did not go to the market, then it is false that *Lucy went to the salon, and Mary went to the*

*market*, given the logic of *and*. Accordingly, if Lucy did not go to the salon and Mary did not go to the market, then the proposition that *Lucy went to the salon, and Mary went to the market* is again false. In the case of conjunction, the entire proposition is true only when both the first and the second conjoined propositions are true.

When the character Zap makes a report that reflect a true belief and a false belief, his report is the conjunction of a true proposition and a false proposition. Adults should know that this conjunction is false (given their implicit command of propositional logic), and currently there is no definitive understanding of how children would evaluate conjunction in the context of an embedded question. Are children's answers being guided by a different semantics of conjunction than are adults? Cremers, Tieu, & Chemla (2016) does not address if children respond differently from adults when evaluating the truth value of a proposition with conjunction, but this is highly relevant. There is a need for more empirical data showing how children assign a truth value to a proposition with both true and false information conjoined. Empirical data would prove useful in understanding if children judge these statements differently from adults would perhaps explain why they appear to judge embedded questions differently.

Cremers, Tieu, & Chemla (2016) explain their findings by making a connection between children's frequent acceptance of weakly exhaustive readings with their acceptance of weak interpretations of conversational pragmatic inferences. Drawing from findings of experimental investigations of scalar implicatures, they argue that scalar implicatures are directly applicable to the process needed to access the stronger alternative to a weak reading of an embedded question. More specifically, they propose that the "lexical retrieval of *believe* as an alternative to *know* is entirely parallel with retrieving *all* as an alternative to *some*" (26 Cremers, Tieu, & Chemla 2016). Children, they argue, are not able to access the scalar alternative required to perform the

implicatures as well as adults. However, it is not clear if children are unable to access the stronger reading in the first place, or if they are indeed accessing each interpretation but evaluating the truth value of the false proposition differently. The study's methodology utilizes the conjunction of false propositions with true propositions, and there remain open question about how children evaluate conjunction in the first place. Cremers, Tieu, & Chemla (2016) only asks children to evaluate the speaker's knowledge, but this evaluation is based on their assessment of the speaker's report (which is consistently a statement with conjunction).

Indeed, previous research has shown that children are often more accepting of weaker scalar terms than are adults, but that is not the complete picture (Noveck 2001, Papafragou & Musolino 2003, Katsos & Bishop 2011, Guasti et al., 2005). It remains unclear if this parallel behavior is related in language development, yet research has produced more insight; children may not be incapable of deriving these implicatures but less sensitive to "subtle aspects of the semantic-pragmatic interface" (Papafragou & Musolino 2003). In fact, recent work has provided evidence that children are deriving scalar implicatures, yet their performance is more subject to contextual factors than adults, such as cognitive expectations (Papafragou & Musolino 2003, Guasti et al. 2005, Katsos & Bishop 2011, Skordos & Papafragou 2016, Syrett et al. in press). Children are more likely to perform more like adults when they were provided with increased training before experimental sessions, increased contextual support, or salient alternatives. Overall, this line of research suggests children have the same cognitive capabilities as adults when it comes to deriving implicature, yet are not mature in their ability to recognize when to put these capabilities into action. This supports an alternate explanation for children's greater acceptance of WE readings of embedded questions, mainly that children treat them more logically whereas adults treat WE readings more pragmatically.

In addition, it has been shown that children between the ages of four and six, the age of child participants in the Cremers, Tieu, & Chemla (2016) study, have Theory of Mind ability (Leslie, Friedman, & German, 2004, Wimmer, & Perner 1983). Theory of Mind is essential for successful social interaction because it allows us to attribute thoughts and goals to others, and understand that they may be different from our own or from reality. By the age of four, children can successfully complete a Sally-Ann Task. In this task, participants are introduced to two characters who call attention to an object in the room. The object is seen and then covered. Then, one character leaves the room, and in their absence the second character moves the object so it is no longer where it first was, but is also still covered. At this point, the first character returns and participants must indicate where the first character believes the object to be. Participants must be able to comprehend that the first character has their own mental state and believes the object to be in the first location, even though they the participant knows the object has been moved. We know that four year olds can successfully indicate where the first character believes the object to be. This is important because it shows children at this age have the cognitive mechanisms required to comprehend the mental states of others. Therefore, it is reasonable to question a conclusion that children do not recognize when a speaker gives a false report.

Cremers, Tieu, & Chemla (2016) explains children's tolerance of weaker readings as being a result of their difficulty computing the necessary scalar implicatures to derive the stronger alternatives. They emphasize that this may be due to children's inability to retrieve lexical alternatives, specifically *believe* as the stronger alternative to *know*. The study focuses solely on children and adults' semantic interpretation of an embedded question regarding the location of two homogenous groups, yet fail to consider how participants are assessing the truth value of such sentences.

The current study is intended to investigate this gap in the literature for the purpose of understanding why children are more accepting of weaker interpretations of embedded questions, with a focus on the role of the false belief. My work builds on the study by Cremers, Tieu, & Chemla (2016) by taking a step back and asking participants to assign the proposition a truth value before they are even prompted to answer the embedded question. Using this addition, we dig deeper into children and adults' semantic understanding of an embedded question. It will allow us to first look at how children assign a truth value to a proposition with conjunction. We predict that children may in fact respond in an adult-like manner by recognizing the conjunction of true and false information to be overall false. If children do behave in an adult-like manner when assigning a truth value, then they must be interpreting an embedded question in a more similar fashion to adults than previously proposed. It would mean that they understand when a speaker is reporting a false belief, and they are accessing the same compositional semantic meaning of the statement. It rules out the explanation that children are more accepting of false information than adults, and inquires as to what makes children simply answer embedded questions differently.

A further point to consider is the following. The original experiment by Cremers, Tieu, & Chemla (2016) was conducted in French, a language that requires descriptions before nouns and does not allow for bare plurals (*toys* v. *the toys*). English allows for both, and therefore permits a comparison of the interpretation of embedded questions that include definite descriptions with those that have bare plurals. A definite description presupposes the existence of the predicate and presupposes it is unique (Heim 1991), and plural definite descriptions pick out the maximal element of the set (Caponigro 2012). Cremers, Tieu, & Chemla (2016) investigated how children and adults treat groups that are all homogenous in their properties.

In a case with plural predicates, the truth value of a proposition is neither true not false when the group described is mixed in the assigned properties (Kriz 2015). The ambiguity of the truth value in sentences with mixed information is a result of the principle of homogeneity (Kriz & Chemla 2015, Kriz 2015). Due to the phenomena of non-maximality, a plural predicate can be judged as true even if there exist some exceptions within the group. Crucially, the exceptions must be irrelevant to the at issue information of the exchange (Kriz 2015). For example, imagine passing by a college dormitory with a friend and noticing an unusually large gathering of students in one room. You ask your friend what everyone is doing together, and they reply, "That room is the study lounge and inside *the students are studying*." Now, it is probable that there are a few individual students in the study lounge who are not studying, but distracting themselves online. However, for the purposes of this exchange, the addressee will accommodate the speaker's proposition that all of the students in the study lounge are studying. This is because what the students are doing is not at issue, and the addressee is able to tolerate the exceptions to the principle of homogeneity. Tolerance of the exceptions, distinct from the at issue information, constitute non-maximality. If half of the information being true yields an overall false classification, how much of the information must be true for the entire utterance to be accepted as true?

Kriz (2015) argues that non-maximal readings can be derived as conversational implicatures, more specifically quality implicatures. Implicature is something that the speaker might reasonably mean by making a particular utterance, but it is inferred and not explicitly expressed (Grice 1975). The quality maxim requires a speaker to be maximally informative without being untruthful in their contribution (Grice 1975). Interestingly, some researchers have reasoned that there exists a scale on which quality is assigned depending on the context. Kriz

argues for the idea of "sufficient truth," meaning that what is actually maximally informative in a conversation is information that is simply true enough for the purposes of the exchange. In turn, this gives rise to quality implicatures at the pragmatic interface. Thus, in an experimental setting, when the subset is not so clearly false, there ensues a pull towards acceptance due to the property of non-maximality in the interpretation of homogeneity. In other words, the proposition is more likely to be judged as true.

For example, imagine if the group of five girls were split up, with three in the playroom and two in the art room. Again, the boys are all also in the playroom. If the speaker asserts that *the boys are in the playroom and the girls are too,* we might predict the property of non-maximality will encourage the addressee to judge the proposition as true because there are exceptions, but they are not important for the purposes of the exchange. This will be essential to understand how children and adults assign these ambiguous propositions a truth value, before they even assess the speaker's knowledge.

The principle of homogeneity is an important factor to study in the role of the false belief, because it is possible that children's interpretations and resulting acceptance of WE readings of embedded questions may be influenced by non-maximality. Perhaps the information children hear in a proposition with true and false information is "true enough." Recently, homogeneity has been shown to be a distinct phenomenon from scalar implicature (Tieu, Kriz, & Chemla, under review). They investigated homogeneity effects on plural definite descriptions in French. Based on children's performance in their tasks, they proposed three distinct groups of children: children who interpret plural definite descriptions existentially and do not compute any implicatures, children who access homogenous interpretations but do not compute implicatures, and finally, children who access homogenous interpretations and also compute the implicatures

(Tieu et al., under review). It is therefore possible that at least some of the children in their earlier study disregarded the false information in the speaker's report, and thought the statement was 'true enough' for the speaker to know X. The current research therefore probes this possibility further not only by asking participants to provide a judgment about the conjunction of true and false propositions, but also by manipulating the truth values of the proposition by making part of the statement false in some instances, and in other instances making it only 'partially true'. In addition, the current research manipulates the definiteness of the subject, something that was not possible in the earlier research, which was in French, a language that requires a definite description to appear before the noun and does not allow bare plurals.

Given the above, we therefore predict the following. When presented with a true and false conjunction (reflecting a true belief and a false belief), adults will reject the statement and say it is false. However, the truth value assigned may change when the speaker instead delivers an assertion about a group that is mixed in its properties, and the proposition is only true of a proper subset of the group. It is then up to the addressee to determine what amount of true information is sufficient for the purposes of the conversation. In this case, adults may perhaps be significantly more likely to say that the statement is true (enough). If children are guided by adult-like propositional logic in their semantics, they will assign the true and false conjunction statement a truth value of false. When homogeneity is violated, it is an open question what children will do. Considering that children may acquire the concept of homogeneity before implicature, they too should be more likely to say such a proposition is true (enough). For both age groups, we predict that the percentage of 'true' answers in the non-homogenous cases should *increase* when the subject is a bare plural, and *decrease* when the subject is a definite

description, since the definite description should pick out the maximal element, and the property should apply to *all* members of the set (Caponigro 2012).

Finally, returning to the assessment of the speaker's knowledge, participants in Cremers, Tieu, & Chemla (2016) were only able to respond using a binary scale: Did Zap know where the toys were, or did he not? I introduce an additional experimental twist to derive a more fine-grained understanding of participants' assessment of speaker knowledge. Rather than asking participants to respond to the question of whether a speaker knows something, providing solely a *yes* or *no* response, I use a ternary scale, allowing for the possibility of graded knowledge. In this way, by asking for the truth value of the conjoined proposition and the subsequent assessment of speaker knowledge based on this statement, we can separate the assessment of the speaker's knowledge in an embedded question from the binary truth value of a proposition. I will argue that these two assessments are distinct in both adult and child language; the cognitive process of judging a proposition as false is distinct from a hearer's assessment of what they believe the speaker to know.

### 1.5 The current study

The purpose of my thesis is three-fold. Firstly, I am interested in how children treat conjunction, and particularly how they treat a statement that is both true and false. This issue is directly relevant to how they assess speaker knowledge on the basis of a speaker's statement that is a conjunction of a true and false proposition. Next, my work will target the property of homogeneity in plural predication and how homogenous groups with mixed properties will alter assessment of both truth values and the speaker's knowledge. Finally, my experiment looks at both definite description and bare plurals in the construction of embedded questions. Thus, I

introduce several novel variables that build on contributions originally made by Cremers, Tieu, & Chemla (2016) to the work on embedded questions in language development.

My work aims to provide more information as to why children are more accepting of weakly exhaustive readings of embedded questions than adults by first asking participants to assign a proposition a truth value to the speaker's statement, then asking them to assess the speaker's knowledge based on this statement, employing a ternary scale to allow for graded knowledge: doesn't know, kind of knows, definitely knows. Finally, I manipulate homogeneity and definiteness to probe what has to hold of the relevant property for the statement to be 'true enough.' These alterations from the work produced by Cremers, Tieu, & Chemla (2016) attempt to show that it is not due to children's inability to access the stronger lexical alternative and derive the necessary scalar implicature. Instead, I hypothesize that children are indeed sensitive to the scalar alternatives available in an embedded question. Children can derive the implicature, yet they require more linguistic and contextual support to access the pragmatic interpretation and thus evaluate a weak reading as false.

My thesis will ultimately address why children are more accepting of weakly exhaustive readings of embedded questions and how homogeneity and the compositional semantic meaning of conjunction guide our judgements of answerhood conditions and assigning a proposition a truth value. These findings will have implications not only for our knowledge of children's developing semantic representations, but also for the connection between language and cognition, since assessment of another speaker's knowledge requires being able to represent the mental state of another individual. This work is therefore directly connected to research on children's developing theory of mind.

## 2. EXPERIMENT

The purpose of this Experiment was to investigate the source of a pattern of results observed in Cremers, Tieu, & Chemla (2016): namely, that children acknowledge that a speaker knows X based on the speaker's having delivered a statement about X that combines a true and a false report (belief). To that end, we designed a dual-methodology task that combined a binary judgment task probing participants' assessment of the truth value of the speaker's conjoined true and false statement with ternary judgment task probing participant's assessment of what the speaker knows, on the basis of this conjunction.

We further manipulated two other factors in the speaker's conjoined statement: first, whether the subject of the two conjuncts featured a plural definite description or a bare plural, and second, whether the second conjunct was not false, but was either incomplete or failed to adhere to the principle of homogeneity. Doing so allowed us to investigate in a more fine-grained way how children assess the truth value of the speaker's statement and in turn, what the speaker's knowledge is, based on the statement s/he uses to describe the situation.

### 2.1 Participants

77 adult native speakers of English (age range 18-47 years) participated. 3 of these 77 adults were excluded for reasons of non-native status (assessed through a demographic pre-screening). All participants were undergraduate students enrolled in a Linguistics or Cognitive Science course at Rutgers University–New Brunswick, and were compensated with course credit for their participation. 48 children (range: 3;04,03 to 6;03,05, Mean: 4;06, 26 males, 22 females) participated. 3 additional children were excluded for reasons of a response bias (n=1), inattentiveness (n=1), or to maintain an even mean age between conditions (n= 1). Ages and

gender distribution were comparable across the four conditions. There were 12 children run in each of the four between-subject conditions. The mean age for the first condition (subject type definite description x embedded *wh*-phrase *who*) was 4;08, and for the second condition (subject type definite description x embedded *wh*-phrase *which*) the mean age was 5;01. For the third condition (subject type bare plurals x embedded *wh*-phrase *who*), the mean age was 4;04. In the fourth condition (subject type bare plurals x embedded *wh*-phrase *which*), the mean age was 4;01.

### 2.2 Materials and Procedure

There were two experimental methodologies employed: a Truth Value Judgment Task (TVJT, Crain & McKee 1985) and a Question-Answer Task (QAT). The TVJT asked participants to provide a binary judgment about the truth value of a proposition expressed by a speaker's utterance, while the QAT asked participants to assess the speakers' knowledge based on this statement, using a ternary scale.

The experiment proceeded as follows. An experimenter presented a series of stories (trials) to the participant using Powerpoint slides and animation.[1] The experimenter narrated each story according to a script (provided in the Appendix). In each scenario, there were two distinct groups of individuals (animals or children) in the foreground, and two locations placed above them, so as to appear in the background. In each story, the individuals from each group made a

[1] Children were invited to participate one at a time. Adults participated one or two at a time in the same room, but were separated from each other. Children provided verbal answers, while adults provided answers using a response sheet on a clipboard.

decision one by one about which location to go to. At the end of the story, all of the individuals were in one of the two locations. After each story, an animated character on the screen (Woody, used for adults) or a puppet (Mr. Rabbit, used for children, manipulated either by the same experimenter or a second one) delivered a target statement. This statement was a conjunction of two propositions, as in (6) and (7).

(6) [(The) boys went to the art room] and [(the) girls went to the art room, too.]

(7) [(The) red dinosaurs went to the bookstore] and [(the) green dinosaurs went to the bookstore, too.]

Participants were asked to assess the truth value of this target conjunction statement using a binary judgment. Adults circled *yes* or *no* on their response sheet, while children rewarded the puppet with either a smiley or frowny/sad face, which appeared on a scorecard in front of them.

Table 2. Binary scale accompanying conjoined statement. Children pointed to one of the two faces award the puppet. Adults circled either YES or NO.

|  |  |
|---|---|
| YES | NO |

This part of the task allowed us to assess children's sensitivity to the presence of a false or infelicitous proposition when providing a truth value. The subjects of the two conjuncts were manipulated so that they were either a plural definite description (e.g., *the boys, the red dinosaurs*) or a bare plural (e.g., *boys, red dinosaurs*), as indicated in (6) and (7). This manipulation allowed us to investigate whether children's sensitivity to issues of homogeneity

are tied to definite descriptions in particular, since the type of subject was also manipulated (definite description v. bare plural) – a manipulation that was not possible in Cremers, Tieu, & Chemla (2016) or Tieu et al. (under review), since their experiment was in French, which does not allow bare plurals.

The target statement was constructed so that the events described by the first conjunct always preceded those described by the second conjunct, so that the conjunction adhered to Grice's Maxim of Manner. The first conjunct was always true. The second one was either false, or violated homogeneity, given the events of the story. For example, in (6), all of the boys went to the art room, but and none of the girls went to the art room; all of the girls went to the playroom to do gymnastics instead. Thus, a single predicate could apply to all of the girls in the group based on their location. In (7), all three of the red dinosaurs went to the bookstore, while three green dinosaurs went to the bookstore, and two went to the library instead.[2]

The experimenter then delivered a target question, asking the participant whether or not the character or puppet knew something based on this statement, as in (8).[3]

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[2] In order to satisfy the Conditions of Falsification and Deniability, which are central to the TVJT, there was always a moment of indecision before a character chose where to go. This, combined with the trial types in the test session made the locations unpredictable. In addition, when the individuals in the second group went to two different locations, the order was always mixed.

[3] Children often received a reminder about the puppet's original statement before the target question, given the time that elapsed between the puppet's statement, the choice of a happy or sad face, and the target question.

(8) Does [Mr. Rabbit/Woody] know [who/which children] went to the art room?

Participants were asked to assess the character or puppet's knowledge using a ternary scale, as shown in Table #, which was on the back of the scorecard with the smiley/frowny faces.

Table 3. Ternary scale accompanying question assessing speaker's knowledge. Children pointed to one of the three stars to award the puppet. Adults circled one of the three numbers.

|  |  |  |
|---|---|---|
| 1 | 2 | 3 |
| DEFINITELY DOESN'T KNOW | KIND OF KNOWS | DEFINITELY KNOWS |

Thus, for each trial, each participant responded to two items: a target statement delivered by a character or puppet, and a target question about that speaker's knowledge based on that statement, delivered by the experimenter. Participants received training on how to respond to both. Responses for each were analyzed for each age group. Children's experimental sessions were recorded using Photobooth, and answers were later transcribed, and checked for accuracy by at least two research assistants in the lab. Children were occasionally reminded throughout the session about how to use both sides of the scorecard.

The target question asked participants what the speaker who delivered the target statement knew, based on that statement.

(9) Does [Mr. Rabbit/Woody] know [who/which children] went to the art room?

The target question was a yes/no polar question featuring an embedded question. The *wh*-word was always headed by either *who* or *which*. This manipulation allowed us to investigate whether the explicit mention of a noun and the D-linking provided by the *which* phrase influenced participants' assessment of the speaker's knowledge based on the experimental scenario.

Figure 3. The final placement of children in the homogenous experimental trial for *"The boys went to the art room and the girls went to the art room, too."* This mirrored the scenes used for Cremers, Tieu, & Chemla (2016).


Figure 4. The final placement of the characters in the non-homogenous experimental trial for *"The red dinosaurs went to the book store and the green dinosaurs went to the bookstore, too."*


To summarize, there were two between-subject factors, yielding four between-subject conditions: subject type (plural definite description, bare plural) x embedded *wh*-phrase (*who*, *which N*). There was a within-subject condition: distribution of individuals in the second conjunct (homogenous/split, non-homogenous/mixed).

Participants were exposed to one training item before proceeding on to the actual test session. This item was designed to familiarize them with the trial structure and how to respond in the two judgment tasks. Children were required to pass this training item before moving on to the test session. There were 12 trials in the test session, of the following types (in pseudorandomized order): There was 1 true control item, in which the two groups of animals obeyed homogeneity and the character/puppet correctly stated both of their locations. This item varied by subject type (definite descriptions or bare plurals) and embedded *wh*-phrase type (who or which) depending on the condition being run. There were also 2 other true controls with a partitive used in definite description conditions. The character stated the animals/children location, saying *some (of the) N*

*chose to X*. One false control item was included, in which the character or puppet was incorrect about both groups locations. This item also differed by subject type (definite descriptions or bare plurals) and embedded *wh*-phrase type (who or which) depending on condition. Our test items included 4 true or false homogenous items. Here, the character or puppet made a correct statement about one group, and an incorrect statement about the second. In addition, there were 4 true non-homogenous test items, in which the character or puppet made a true statement about one group and a statement about the second that did not obey homogeneity. In this non-homogenous condition, one group is divided by location and the character/puppet is incorrect about 3 animals/children from the divided group, but correct about the remaining 2. They are also correct about the location of the group not divided All 8 test items used either definite descriptions or bare plural subjects, and either *who* or *which* for the embedded *wh*-phrase.

### 2.3 Predictions

*Binary Statement Task*

We predicted that when presented with a conjunction in which the first conjunct was true, and the second one was false, a majority of adults will reject the statement for both sentences with definite descriptions in the subject and with bare plurals in the subject. This would replicate the findings of Cremers, Tieu, & Chemla (2016). If children also are mostly rejecting such statements with conjunction it will show that they use logic in an adult-like manner when evaluating a truth value.

We predicted that when presented with a conjunction in which the first conjunct was true and maximally informative about a set of individuals, and the second one violated homogeneity, that the truth value might depend on the use of a definite description or a bare plural in the

subject positions. When the subject was a definite description, we predicted there to be high rejection rates because the definite description presupposes the existence and uniqueness of the group to which it refers. We predict this will make adults more likely to reject a statement that violates homogeneity. According to Tieu, Kriz, & Chemla, (under review), children should also reject a statement that violates homogeneity.

When the subject was a bare plural there is nothing that presupposes the groups existence or uniqueness, so with adults we predicted lower rates of rejection of a statement that violates homogeneity. Children's treatment of bare plurals was not addressed in Cremers, Tieu, & Chemla (2016) or Tieu et al. (under review).

*Ternary Question-Answer Task*

We predicted that when participants were asked whether the speaker knew P, the response would depend on the speaker's previous statement, and possibly also on the type of *wh* word featured in the embedded question.

When the participant had answered YES or ☺ to the speaker's statement, they should be less likely to respond that the speaker 'definitely doesn't know.' When the participant had answered NO or ☹ to the speaker's statement, they should be more likely to respond that the speaker 'definitely doesn't know.' In conditions that do not obey homogeneity, participants should be more likely to respond with 'kind of knows.'

When the embedded question began with *who*, we predicted less 'definitely doesn't know' responses. When the embedded question began with *which N*, we predicted more 'definitely doesn't know' responses.

## 2.4 Results

*Control Items*

Adults correctly accepted 97.2% of true control statements that obeyed homogeneity, and 98.6% of adults correctly accepted the two true control statements with a partitive used in definite description conditions. 94.4% of adults correctly rejected the false control statements.

100.00% of adults answered that the character 'definitely knows' for the true control question that obeyed homogeneity. For the true control question with a partitive used in definite description conditions, split, 31.0% answered 'definitely doesn't know,' 39.4% answered 'kind of knows,' and 29.6% answered that the character 'definitely knows.' For the true control question with a partitive used in definite description conditions, mixed, 29.6% answered 'definitely doesn't know,' 38.0% answered 'kind of knows,' and 32.4% answered 'definitely knows.' This is likely because the character was not being maximally informative in using the term *some*.

95.8% of children correctly accepted the true control statement that obeyed homogeneity. 69.4% of children accepted the true control with a partitive split, while 72.9% accepted the true control with a partitive mixed. These responses are similar to the adult controls in that there is not 100% acceptance because the character uses the term *some* and is not maximally informative. 85.4% of children correctly rejected the false control that obeyed homogeneity.

85.4% of children responded that the puppet 'definitely knows' for the true control item that obeyed homogeneity. For the true controls using a partitive split, 19.1% of children responded 'definitely doesn't know,' 12.8% responded 'kind of knows,' and 68.1% responded 'definitely knows.' Next, in the true control with a partitive mixed, 12.5% of children responded that the puppet 'definitely doesn't know,' 20.8% responded 'kind of knows,' and 66.7%

responded ‘definitely knows.’ Again, this distribution resembles adult responses. 62.5% of children said ‘definitely doesn’t know’ for the false control that obeyed homogeneity. 20.8% said ‘kind of knows,’ while 16.7% said ‘definitely knows.’

*Test Items*

We begin by reporting the results for the adults. As expected, adults rejected the conjoined statement true and false conjuncts in a majority of responses. We ran a Kruskal-Wallis test to show effect of homogeneity, age and subject type on responses to the target sentence evaluations. Homogeneity had a significant effect on responses across both age groups ($\chi^2(1)= 283.45$, $p <.001$). Homogeneity significantly effected adult responses ($\chi^2(1)= 265.45$, $p <.001$). The Adults rejected the statement 94.4% overall when the groups were homogenous in their properties. Adults rejected 94.4% of the statements about homogenous groups when a definite description was present, and 94.3% of statements about homogenous groups without the definite descriptions. This is indicative of a command of the propositional logic of conjunction, that when true and false information are conjoined, the entire proposition must be false in its entirety.

Adults rejected the character’s statement 28.5% overall when the groups were not homogenous. Subject type had a significant effect on responses across age groups ($\chi^2(1)= 7.2803$, $p = .007$). The presence or absence of a definite description (subject type) significantly effected adult responses ($\chi^2(1)= 16.769$, $p = 4.222e\text{-}05$). When the statement was about non-homogenous groups, adults rejected it 43.1% of the time with a definite desription, compared to 13.6% rejection when there was a bare plural.

A logistic regression analysis of the statement responses revealed there was a significant main effect of homogeneity, such that participants for both age groups were more likely to reject the statement when it obeyed homogeneity ($\beta = 5.5446$, $\alpha = -4.1728$, $SE = 0.4697$, $z = 11.805$,

$p < .001$). There was also a significant interaction between homogeneity and subject type. Participants for both age groups were most likely to reject the statement when it obeyed homogeneity and included a definite description ($\beta = 3.6212$, $\alpha = -2.7324$, $SE = 0.3155$, $z = 11.477$, $p < .001$). As predicted, adults were least likely to reject the statement when it did not obey homogeneity, and did not include definite descriptions.

A Fisher's Exact test shows there is a main effect of homogeneity on responses to the embedded question for adult participants. Overall in their evaluation of the embedded question about homogenous groups, 25.7% of adults responded that he 'definitely does not know.' Adults were significantly more likely to respond that the character 'definitely doesn't know' in the trials that obeyed homogeneity than trials that were non-homogenous ($p < .01$). However, given a ternary scale, a majority of adults (68.0%) responded that he 'kind of knows,' and 6.3% answered that he 'definitely knows' in this condition. This shows that when adults are not limited to a binary scale of judgment, they in fact show sensitivity to the speaker's partially correct knowledge or report. When a definite description was present, adults responded that he 'definitely does not know' 28.5% of the time. 68.8% of responses said that he 'kind of knows,' and only 2.8% said he 'definitely knows' in this condition.

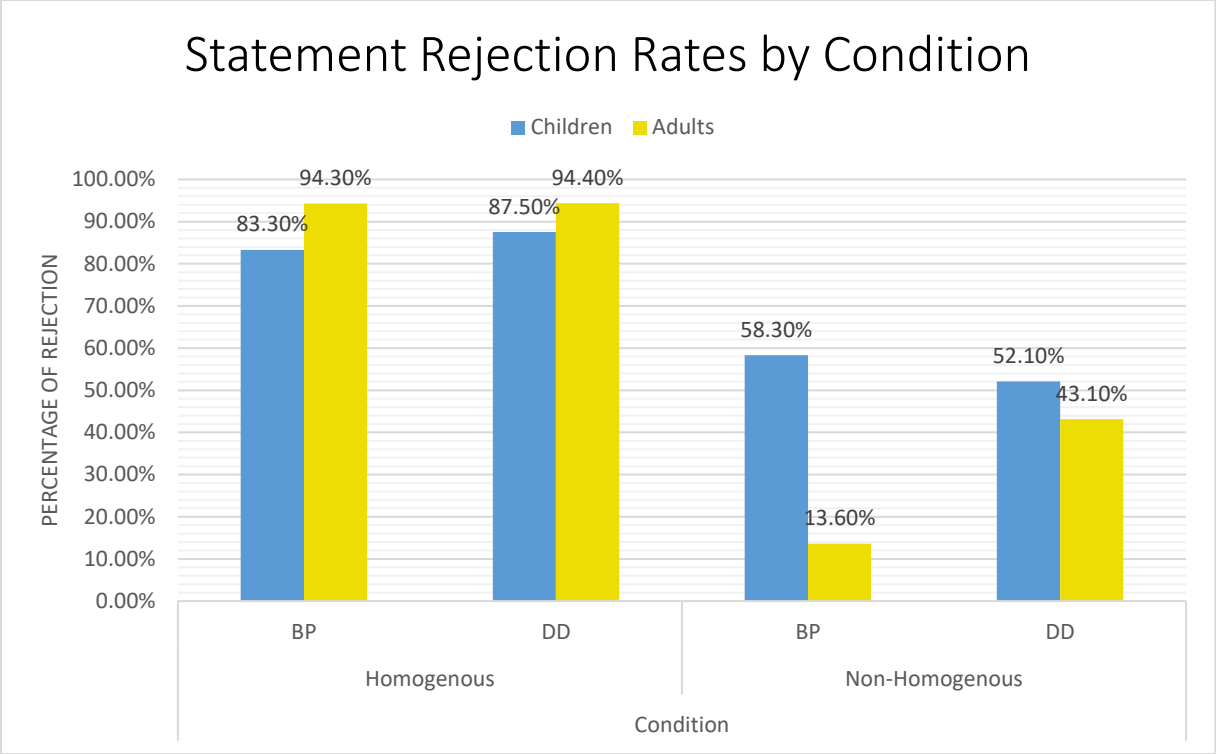
In answer to the target embedded questions with non-homogenous items, overall 4.6% of adults responded that he 'definitely does not know'. As in the condition with homogenous groups, the majority of adults (72.2%) answered that the speaker 'kind of knows', while adults answered he 'definitely knows' 23.2% of the time. With a definite description present, 4.2% of adults said the character 'definitely does not know.' 83.3% answered that he 'kind of knows,' and 12.5% answered that he 'definitely knows.' In comparison, in the condition without a definite description present, 5.0% of adults responded that he 'definitely does not know,' 60.7%

responded he ‘kind of knows,’ and 34.3% answered he ‘definitely knows.’ There was no difference for adults in the quantity of ‘definitely knows’ responses in the homogenous or nonhomogenous conditions ($p = .45$). The same was true for rates of ‘kind of knows’ responses ($p = .41$).

We also controlled for the type of embedded wh-phrase, but this measure produced no significant effects on responses for adults.

Next we report the results from the children. In the evaluation of the truth value of the character’s statement, children rejected it 85.4% of the time overall in the condition with homogenous groups. Homogeneity significantly effected children’s responses ($\chi^2(1)= 43.149$, $p <.001$). This was similar to adult rejection rates. When there was a definite description present, children rejected the statement 87.5% of the time, and 83.3% when there were bare plurals. Again, these responses were similar to adults.

Overall when the groups were non-homogenous, children rejected the character’s statement 55.2% of the time. In this condition, when there was a definite description, children rejected the statement 52.1% of the time. With the bare plurals, 58.3% of children rejected the statement. Overall, the presence or absence of a definite description (subject type) had no effect on children’s responses regardless of homogeneity ($\chi^2(1)=0.47609$, $p= 0.4902$). In this condition, the interaction effects of non-homogenous statements and definite descriptions were not significant for children ($\beta = 1.8465$, $\alpha = -3.4365$, $SE = 1.0045$, $p = .066$).




Graph 1. Results from the Truth Value Judgement Task.

There were also significant effect of homogeneity on children's responses to the embedded questions. When children evaluated the embedded question about homogenous groups, overall they answered 54.7% of the time that the character 'definitely does not know.' Overall, 26.0% of children responded that he 'kind of knows,' while only 18.8% responded that he 'definitely knows.' In the condition with definite descriptionss, children respond 55.2% of the time that he 'definitely does no know.' Children said that he 'kind of knows' 27.1% of the time, and 'definitely knows' 17.7% of the time. When there are only bare plurals, 54.2% of children responded that he 'definitely does not know.' 25.0% responded that he 'kind of knows,' and 19.8% responded that he 'definitely knows.' Regardless of subject type, children were significantly more likely to respond 'kind of knows' when the question obeyed homogeneity ($\chi^2(3)= 19.22$, $p = .0002$).

In the condition using non-homogenous groups, children overall responded that the character 'definitely does not know' 29.7% of the time. Overall, 30.7% of responses were that he 'kind of knows,' and 39.6% said that he 'definitely knows.' Child participants were close to being significantly more likely to respond 'definitely doesn't know' when the question did not obey homogeneity and a definite description was present ($\chi^2(3)= 7.48$, $p = .058$). When there was a definite description present, 27.1% of children responded that he 'definitely does not know.' In this condition, 37.5% of children responded that he 'kind of knows,' and 35.4% responded that he 'definitely knows.' Next, in the condition with bare plurals, 32.3% of children said that the character 'definitely does not know.' 24.0% of children said that he 'kind of knows,' while 43.8% said that he 'definitely knows.' There was not effect of homogeneity or subject type on children's rates of 'definitely knows' responses.

The type of embedded *wh*-phrase did not show any effect on children's responses. Children were asked to provide a justification for their answers in order to determine children's reasoning behind their responses.

(10) Justifications for *no* or *definitely doesn't know* responses to homogenous statements

a. Definite description + *who*
    a. "Penguins- you were right when you said the penguins going into igloo but you weren't right because the seals are going sliding down the hill." (41, 4;07, 11a)
b. Definite description + *which*
    i. Cause he thought that the dogs went to the tree too with the cats." (62,4;03, 9b)
c. Bare plural + *who*
    i. "No, the boys went to the art room and the girls went to the playroom" (07, 4;05, 5a)

d. Bare plural + *which*

    i. “Um, only boys went to there and girls went to there. Why did you thought that?” (18, 3;06, 5a)

(11) Justifications for *no* responses to non-homogenous statements

a. Definite description + *who*

    i. “Because two of the girls are gonna sit on the blue rug” (20, 5;02, 8a)

b. Definite description + *which*

    i. “Because some of the girls went in the red tent and some of the boys went in the red tent” (47, 5;09, 12a)

c. Bare plural + *who*

    i. “Two grasshoppers in the purple car and three grasshoppers in the yellow car and three ladybugs in the yellow car” (29, 4;06, 6a)

d. Bare plural + *which*

    i. “Because he didn’t know what all the kids did.” (13, 3;06, 8b)

(12) Justifications for *yes* or *kind of knows* responses to non-homogenous statements

a. Definite description + *who*

    ii. “Two of the girls and three of the girls in that one, so he’s right” (08, 4;10, 12a)

b. Definite description + *which*

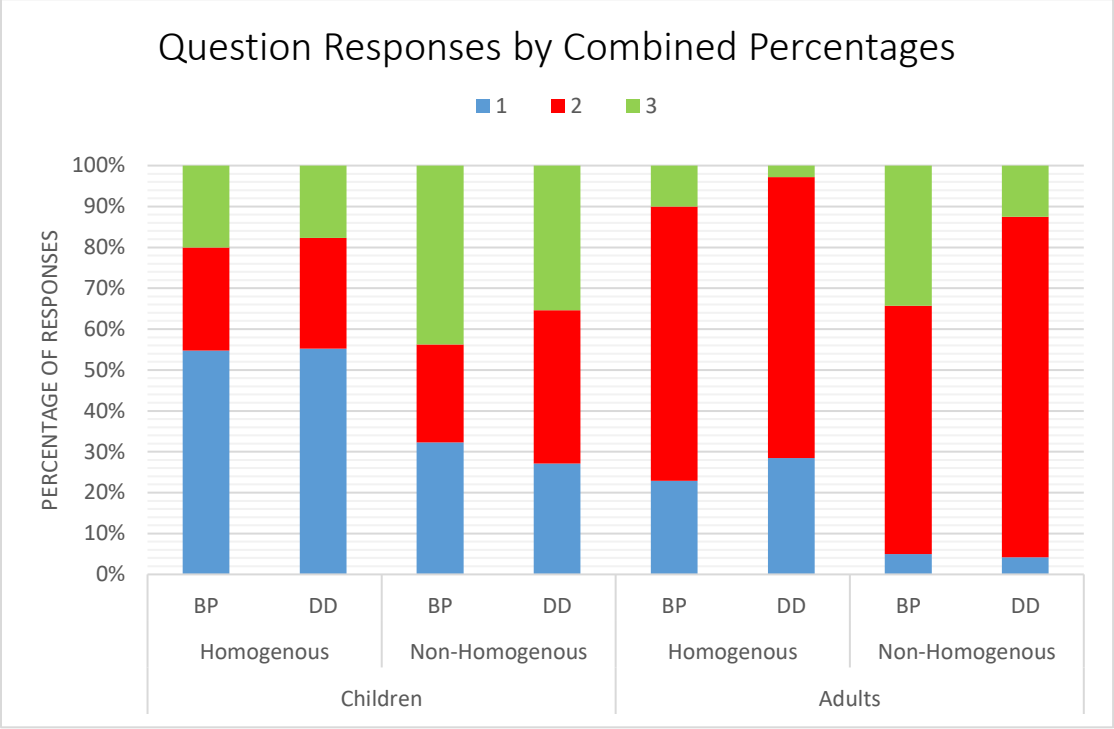
    i. “Because he got it a little bit right” (51, 6;03, 6b)

c. Bare plural + *who*

    i. “Because some girls went into the yellow tent and all of the boys went into the red tent and some of the girls went into the red tent” (07, 4;05, 12b)

d. Bare plural + *which*

i. "Because the girls and the boys sat on the blue one and there were girls and the girls sat on the red carpet." (25, 4;06, 8b)




Graph 2. Results from responses to the embedded question using a ternary scale.

## 2.5 Discussion

Overall, whether or not a statement obeyed homogeneity significantly effected response rates in children and adults. Both age groups overwhelmingly *rejected* statements that obeyed homogeneity. In these conditions, the character made a statement reflecting a false belief, and both adults and children therefore evaluated the truth value of the statement as false, reflecting a comparable command of the relevant propositional logic. As was expected, adults reject a majority of statements with a false report, regardless of subject type. Children also reject a majority of homogenous statements with a false report, regardless of subject type. This contrasts the findings of previous research by Cremers, Tieu, & Chemla (2016), in that children do not

judge the truth value of a statement with a false report differently from adults. Children seem to show the same underlying semantic understanding of conjunction.

Subject type significantly effected response rates for adults, but was not as significant as homogeneity. For adults, the subject type did not effect responses when the statements obeyed homogeneity, but the subject type *did* matter when the statement did *not* obey homogeneity. As theory of homogeneity would predict, adults rejected almost half of all statements about a group that was mixed in its properties (non-homogenous) when there was a definite description, and even less when there were was a bare plural. This indicates that adults used a non-maximal reading of homogeneity. They were more accepting of statements with bare plurals, likely because they did not access homogeneity when the character referred to bare plural predicates. A definite description is what requires homogeneity to be obeyed.

In contrast, the subject type was *not significant at all* in children. Like adults, children rejected most statements with a false belief, and reject about half the statements with a definite description that did not obey homogeneity. Unlike adults, however, children rejected the same quantity of nonhomogenous statements regardless if a definite description was present or not. Children were just as likely to reject the statement if it included a definite description or a bare plural. They treat plural predicates with definite descriptions in the same way they treat bare plural predicates. This indicates children are not accessing homogeneity when presented with definite descriptions.

Children's responses to embedded questions adds more depth to the conclusions presented in Cremers, Tieu, & Chemla (2016), namely that children are more accepting of weakly exhaustive readings of embedded questions, but are also sensitive to ambiguity. Cremers, Tieu, & Chemla (2016) reports that fourteen of the 35 children tested gave spontaneous 'both yes

and no' answers when the puppet made a statement with true information and a false belief. In the current study, we added a ternary scale to give participants a more concrete opportunity to evaluate a statement as neither completely true nor completely false. Indeed, children show the ability to judge a speaker's statement with a false belief as not completely true but also not completely false. They were significantly more likely to respond 'kind of knows' when the question obeyed homogeneity. Adults also answered 'kind of knows' in a majority of test conditions. This indicates children's judgement of the speaker's knowledge does not differ qualitatively from adults, and they acknowledge that the false belief is incorrect.

Furthermore, children more often than adults gave the puppet the smallest reward when his statement included a false belief, which emphasizes their understanding of the false information. Adults more often gave the intermediate reward. Interestingly, when the statement included a false belief, adults mostly rejected it as false, but still judged the speaker to 'kind of know' what he was talking about. These results suggest that the methodology used in Cremers, Tieu, & Chemla (2016) of binning the answers into yes/no categories removes the third option (2: kind of knows). Consequently, children lean more towards acceptance and adults more towards rejection. However, having a third category reveals that adults are tolerant of the false report to some extent. This suggests children and adults are not qualitatively different in their evaluation of embedded questions, because adults too are more accepting of partially false information. We are able to demonstrate this with the ternary scale.

## 3. GENERAL DISCUSSION

We argue in this study that children's understanding of speaker knowledge does not differ qualitatively from adults. Building on previous research that indicates children younger than 5

years of age are more accepting of weakly exhaustive readings of embedded questions, we used a truth value judgement task and added a ternary scale in the evaluation of embedded questions to collect more empirical data on this subject. In addition, conducting the experiment in English allowed for the manipulation of definite descriptions or bare plurals. This was not possible in previous experiments conducted in French (Cremers, Tieu, & Chemla 2016, Tieu et al., under review). Our findings indicate that children do not treat bare plurals differently from definite descriptions, whereas adults do. Definite descriptions require homogeneity and bare plurals do not. Children therefore are not relying on homogeneity or non-maximality to evaluate the speaker's knowledge. We propose that children may be relying more on informativeness to evaluate an embedded question that does not obey homogeneity. Therefore, we suggest that children are not assigning an existential interpretation of definite descriptions, as proposed by Tieu et al. (under review) in their study that only had definite descriptions, and no bare plurals.

This study took a step back from evaluations of embedded questions to look at how children and adults judge the truth value of a statement with a false belief. Both when homogeneity was obeyed and when it was not, children patterned like adults in their evaluation of this truth value.

The ternary scale (*definitely does not know*, *kind of knows*, or *definitely knows*) freed participants from constraints that a binary scale (*yes* or *no*) might impose when interpreting an embedded question. Previous reports show that when there is a false belief combined with true information, adults will reject the speaker's knowledge as completely false on a binary scale (Chemla 2014, Cremers, Tieu, Chemla 2016). Interestingly, when given a ternary scale, adults more often answered that the speaker 'kind of knows' what he is talking about, even when there was a false belief. When forced to choose between true or false, adults will say the speaker is

false but they still acknowledge the true information in the utterance. Semantically, they will still reject the statement as completely false, but pragmatically adults appear to interpret this conjunction as underinformative rather than completely false. Adults responded in this way despite being shown to be capable of accessing the strongly exhaustive interpretation of embedded questions (Cremers, Tieu, & Chemla 2016, Tieu et al., under review). For this reason, we propose that children are in fact more like adults qualitatively when interpreting an embedded question both semantically and pragmatically. Children may be able to access the stronger interpretation of an embedded question.

Cremers, Tieu, & Chemla (2016) proposes that children's difficulty accessing the stronger readings is due to difficulty retrieving the necessary lexical alternatives. Also, they argue children who are more accepting of weaker interpretations are unable to access the lexical alternative to *know*, mainly *believe*, as well as the lexical alternative to *all*, mainly *some*. This would predict that children are unable to understand that the character has made a false report because he *believes* the location of *x* to be *y*, and instead children only understand that he *knows* the locations of *x* to be *y* simply because he stated it. However, our child response justifications tell a different story (see (11)). Children were able to track the location of each animal or child in the experimental trials, and could correctly accept true controls and reject false controls.

Tieu et al. (under review) argues that a subgroup of young children do not compute implicature at all, therefore they must assign an existential interpretation to definite plural predicates to accommodate for the non-maximal use of homogeneity. This predicts that children should be just as accepting of a statement about a homogenous group as a non-homogenous group given there is a definite description used. If children were in fact interpreting definite descriptions existentially, children should be significantly more accepting of non-homogenous

statements with definite descriptions than those with bare plurals. Our data shows that there is no significant difference between these variables. Young children are perhaps not interpreting definite descriptions based on homogeneity but rather on informativeness.

Children's demonstrated ability to reject false beliefs and evaluate speaker knowledge on a ternary scale suggest Theory of Mind ability in 3-6 year olds. In order to correctly reject a statement with conjunction as adults do, children must understand another person holds their own theory of mind. They must understand it is possible for others to hold beliefs that do not correspond with reality, and be able to recognize this discrepancy based on their own perceptual evidence and distinguish it from their own theory of mind. Children's high rejection rates of statements with false beliefs show they understand theory of mind. Our study shows that not only can children assess the truth value of a speaker's statement in an adult-like manner, they can also use that statement or report as a reflection of the speaker's knowledge. Subsequently, this shows children's ability to assess what the speaker knows.

Finally, I take some space here to reflect on the limitations of the current study Children were told that Mr. Rabbit was still learning how to say things correctly and sometimes said things incorrectly. Pragmatically, children therefore may have misinterpreted the intended task to be to reject any incorrect information the character said. In the test items, what he said was never maximally informative. It is possible children thought that he did not say what had happened the way they would have said it, so they were more likely to reject the sentence in the truth value judgment task. For example, when one of the groups is split in their locations, the puppet says, "Red dinosaurs went to the bookstore, and green dinosaurs went to the bookstore too." To be maximally informative, one would have to say, "All of the red dinosaurs went to the bookstore, 3 green dinosaurs went to the bookstore, and 2 green dinosaurs went to the library." Some children

and perhaps adults may have focused on the exceptions to what was true about the statement, rather than focusing on what he said correctly. This would cause rejection rates for non-homogenous conditions to be more similar to homogenous conditions. Another limitation was that the average age from the definite description condition was about 10 months older than the average in the bare plural condition. This was simply a logistic problem related to access to a preschool population and scheduling study sessions during the academic year.

## 4. CONCLUSION

Our findings provide novel evidence that children pattern with adults when assigning a truth value to a statement with a false belief. They also behave in an adult-like manner when evaluating a statement that does not obey homogeneity, however they are just as likely to reject these statements if there is a bare plural or a definite description. We propose that children treat bare plurals the same as definite descriptions because they are not depending on homogeneity to evaluate a speaker's knowledge the way adults do. Instead, they evaluate the informativeness of the speaker's utterance. Children and adults behave more similarly in the evaluation of an embedded question when given a ternary scale to evaluate the speaker's knowledge. When the question includes a false belief, children show more sensitivity to the false information, while adults show more acknowledgement of the true information. Overall, these findings indicate that children do not differ qualitatively from adults in their evaluation of the truth value or speaker knowledge when there is a false belief. This has implications for our knowledge of children's developing semantic representations, and also for the connection between language and cognition because evaluating a speaker's knowledge requires the ability to represent other's mental states.

## 5. REFERENCES

Caponigro, I., Pearl, L., Brooks, N., & Barner, D. (2012). Acquiring the meaning of free relative clauses and plural definite descriptions. *Journal of Semantics*, 29, 261-293.

Cremers, A., Tieu, L., & Chemla, E. (2016). Children's exhaustive readings of questions. *Language Acquisition*. 1-22. http://dx.doi.org/10.1080/10489223.2016.1176173

Cremers, A., & Chemla, E. (2014). A psycholinguistic study of the exhaustive readings of embedded questions. *Journal of Semantics.* 33(1): 49-85.

George, B. (2013). Which judgements show weak exhaustivity (And which don't?). *Natural Language Semantics*. 21: 401-427.

Grice, P. (1989). Studies in the way of words. Cambridge, MA. Harvard University Press.

Heim, I. (1994). Interrogative semantics and Karttunen's semantics for *know*. In Rhonna Buchalla and Anita Mittwoch (Eds), *Proceedings of the Israeli Association for Theoretical Linguistics*. Hebrew University of Jerusalem.

Heim, I. (1991). Articles and definiteness. In A. von Stechow & D. Wunderlich (Eds.), *Semantics: An international handbook of contemporary research*.

Horn, L. R. (1972). *On the Semantic Properties of Logical Operators in English*. Ph.D. thesis, UCLA, Los Angeles.

Huang, Y. T. & Snedeker, J. (2009). Semantic meaning and pragmatic interpretation in five-year-olds: Evidence from real time spoken language comprehension. *Developmental Psychology*, 45, 1723-1739.

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

Klinedinst, N., & Rothschild, D. (2011). Exhaustivity in questions with non-factives.

*Semantics and Pragmatics* 4(2). 1-23.

Kriz, M. (2015). Homogeneity, Non-Maximality and *all*. *Journal of Semantics,* 33, 493–539.

Kriz, M. & Chemla, E. (2015). Two methods to find truth-value gaps and their application to the projection problem of homogeneity. *Natural Language Semantics*, 23, 205–248.

Leslie, A. M., Friedman, O., & German, T. P. (2004). Core Mechanisms in "Theory of Mind". *TRENDS in Cognitive Sciences,* 12, 528-533.

Moyer, M. (2016). Issues in the semantics and pragmatics of question embedding: an experimental investigation. Ms., Rutgers, The State University of New Jersey - New Brunswick.

Noveck, I. (2001). When children are more logical than adults: experimental investigations of scalar implicatures. *Cognition*, 78(8), 165-188.

Papafragou, A. & Musolino, J. (2003). Scalar implicatures: experiments at the semantics-pragmatics interface. *Cognition,* 86, 253-282.

Skordos, D. & Papafragou, A. (2014). Scalar inferences in 5-year-olds: The role of alternatives. *Proceedings from the 38th Annual Boston University Conference on Language Development*. Somerville, MA. Cascadilla Press.

Spector, B. & Egre, P. (2015). A uniform semantics for embedded interrogatives: *An* answer, not necessarily *the* answer. *Synthese*.

Syrett, K., Austin, J., Sanchez, L., Germak, C., Lingwall, A., Perez-Cortes, S., Arias-Amaya, A., & Baker, H. (2016). The influence of conversational context and the developing lexicon on the calculation of scalar implicatures: Insights from Spanish-English bilingual children. *Linguistic Approaches to Bilingualism.* Online first.

Tieu, L., Kriz, M., & Chemla, E. (under review). Children's acquisition of homogeneity in plural definite descriptions. *Semantics and Pragmatics*, 1-45.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, 13, 103–128.

## 6. APPENDICES

### 6. 1 Scripts

(11) Scripts for the homogenous test conditions, followed by character or puppet's statements, and experimenter's questions

1. *Some bunny rabbits and some squirrels are in the forest looking for a place to huddle up, since they think it's going to rain soon. They see a nice hollow log and a cave.*

RABBIT 1: It is definitely going to rain! I'm going to take shelter in this nice hollow log.

RABBIT 2: That log is a good choice! I'm going there, too!

RABBIT 3: Wait, there's a cave over here that could be perfect. But the log is even better. I'll choose that!

RABBIT 4: Hmm, I don't know which place to choose. I suppose I'll just go to the log.

*[All the rabbits go into the log.]*

SQURR'L 1: Oh no, rain is on its way! Hurry, hurry, I'm going to the cave.

SQURR'L 2: Is the cave better than the log? Well, I don't know, but I'm also going in the cave.

SQURR'L 3: The log looks nice and dry, and really warm. But I bet the cave is even better. I'm going there.

SQURR'L 4: Oh, I think I just felt a drop of rain! I have to choose quickly. I choose…the cave!

*[All the squirrels go into the cave.]*

*Woody enters.*

WOODY: Ooh, it looks like a storm is on the way! I hope the bunny rabbits and squirrels took cover somewhere. Wait, I spot a log and a cave. I think I know what happened.

a. Definite description x *who* condition

   i. The rabbits went into the log, and the squirrels went into the log, too. Am I right? Does Woody know who went into the log?

b. Definite description x *which* condition

   i. The rabbits went into the log, and the squirrels went into the log, too. Am I right? Does Woody know which animals went into the log?

c. Bare plural x *who* condition

   i. Rabbits went into the log, and squirrels went into the log, too. Am I right? Does Woody know who went into the log?

d. Bare plural x *which* condition

   i. Rabbits went into the log, and squirrels went into the log, too. Am I right? Does Woody know which animals went into the log?

2. *Some penguins and some friendly seals are playing in the snow together. They decide they'd like to do something different. They have two options: sliding down an icy hill, or telling stories in an igloo.*

PENG 1: I love sliding down hills, but I've never gone to an igloo before! I'm going there!

PENG 2: Hmm, it seems like a nice day for a slide, but it's also fun to tell stories with friends. I think I'll go to the igloo.

PENG 3: Storytime! Storytime! I choose the igloo.

PENG 4: Well, this is a hard choice, but I'm joining my friends in the igloo.

*[All the penguins go to the igloo.]*

SEAL 1: Storytime is fun, but I love a good slide down a hill! I choose that!

SEAL 2: Ooh, I can't wait to go sliding down the hill!

SEAL 3: I love igloos, and I love storytime! But I love sliding even more! I choose the hill!

SEAL 4: Hooray for snow! I choose sliding down a hill!

*[All the seals go to the hill.]*

*Woody enters.*

WOODY: Hey, what a great day to play with friends. Where did my penguin and seal friends go? Oh, I think I know what happened.

a. Definite description x *who* condition

    i. The penguins went to the igloo, and the seals went to the igloo, too. Am I right? Does Woody know who went to the igloo?

b. Definite description x *which* condition

    i. The penguins went to the igloo, and the seals went to the igloo, too. Am I right? Does Woody know which animals went to the igloo?

c. Bare plural x *who* condition

    i. Penguins went to the igloo, and seals went to the igloo, too. Am I right?

Does Woody know who went to the igloo?

d. Bare plural x *which* condition

i. Penguins went to the igloo, and seals went to the igloo, too. Am I right?

Does Woody know which animals went to the igloo?

3. *One afternoon some boys and girls were all playing together. Unfortunately, it began to rain, so they knew they couldn't have recess outdoors. But everyone was excited to find something to do on this rainy day, and they had two good choices: doing some fun projects in the art room, doing some gymnastics in the playroom.*

BOY 1: Ooh, I love art projects! I'm going to go to the art room.

BOY 2: I love gymnastics, but I think I'll do some art, too.

BOY 3: My somersault could really use some improvement, but I would love to do some painting. I'll go in the art room.

BOY 4: Hmm, this is a tough choice. I love gymnastics, but I also love art. I guess I'll go to the art room to build a sculpture.

*[All the boys end up in the art room.]*

GIRL 1: I do love art, but I think I'll practice my gymnastics today.

GIRL 2: Tumbling is so much fun! I'll go to the playroom to do some gymnastics.

GIRL 3: I know you all want to do gymnastics, but I love art! It's so much fun. Oh wait, maybe I can practice my handstands. I'll join you for gymnastics.

GIRL 4: Gymnastics it is! I'm going to the playroom!

*[All the girls end up in the playroom doing gymnastics.]*

*Woody enters.*

WOODY: Hey, where did all the kids go? Oh, yeah, I remember—they were thinking about a rainy day activity to do, and which room to go in. I think I know what happened.

a. Definite description x *who* condition

i. The boys went to the art room, and the girls went to the art room, too. Am I right? Does Woody know who went to the art room?

b. Definite description x *which* condition

i. The boys went to the art room, and the girls went to the art room, too. Am I right? Does Woody know which children went to the art room?

c. Bare plural x *who* condition

i. Boys went to the art room, and girls went to the art room, too. Am I right? Does Woody know who went to the art room?

d. Bare plural x *which* condition

i. Boys went to the art room, and girls went to the art room, too. Am I right? Does Woody know which children went to the art room?

4. *It's a beautiful summer day, and some cats and dogs are in the backyard playing hide and seek with Woody. It is Woody's turn to close his eyes and count to ten, while the rest of the friends run and hide.*

*The cats choose where to hide first.*

CAT 1: The tree is a great place to hide! I'll hide there.

CAT 2: The rock would be good, but I'll choose the tree.

CAT 3: He'll never find me in the tree! I'm hiding there!

CAT 4: The tree is getting crowded. I should choose the rock. But wait, there's more space for me! Tree, here I come!

*[All the cats end up in the tree.]*

*Now it's the dogs' turn!*

DOG 1: The rock is the best hiding place. I'm hiding there.

DOG 2: Hmm, rock or tree? I can't decide! I'll just pick the rock.

DOG 3: I wonder if there is even any more space around the rock. There is!

DOG 4: Boy, this is hard! Where to hide? I'll pick the…rock!

*[All the dogs end up behind the rock.]*

*Woody finishes counting, and opens his eyes. ("Ready or not here I come!")*

WOODY: Ooh, all of my little animal friends have found some good places to hide, but I have a good idea where they might be based on where they've hidden before! I think I know what happened.

a. Definite description x *who* condition

   i. The cats hid in the tree, and the dogs hid in the tree, too. Am I right?

   Does Woody know who hid in the tree?

b. Definite description x *which* condition

   i. The cats hid in the tree, and the dogs hid in the tree, too. Am I right?

   Does Woody know which animals hid in the tree?

c. Bare plural x *who* condition

   i. Cats hid in the tree, and dogs hid in the tree, too. Am I right?

Does Woody know who hid in the tree?

d. Bare plural x *which* condition

i. Cats hid in the tree, and dogs hid in the tree, too. Am I right?

Does Woody know which animals hid in the tree?

(14) Scripts for the non-homogenous test items, followed by character or puppet's statements, and experimenter's questions

1. *Some dinosaurs are very excited about reading, so they're making a special trip into town to pick out a book. There are some good bookstores and a good library in town. When they arrive, they have to decide which to go to.*

RED 1: I love getting a brand new book. I'm heading to the bookstore!

RED 2: That bookstore looks awesome! I'm heading there!

RED 3: Ooh, tough choice, but I'm heading to the bookstore. I can't wait to get a new book and start reading!

*[All the red dinosaurs end up at the bookstore.]*

GREEN 1: Oh no! I can't decide! Maybe I should go to the library. But that bookstore DOES look like a really good one. And I bet they have mystery books! I'll go there.

GREEN 2: That does look like a good bookstore, but I love a good public library. I can't wait to check out their fiction section!

GREEN 3: Ooh, who knew this would be so hard? I don't know what to do. I'll just go to the bookstore.

GREEN 4: Bookstore? No way! The library is such a special place. I'm going there.

GREEN 5: Oh no! I'm last to decide. Hmm, let me think. I know! I'll go to the bookstore and see what kind of great books they have there!

*[The green dinosaurs split between the bookstore and the library.]*

*Woody arrives and wonders where the dinosaurs went.*

WOODY: Hey, where did those big dinosaurs go? Oh, wait, they just learned how to read recently, right? And I know there are some good places in town! I think I know what happened.

a. Definite description x *who* condition

   i. The red dinosaurs went to the bookstore, and the green dinosaurs went to the bookstore, too. Am I right?

      Does Woody know who went to the bookstore?

b. Definite description x *which* condition

   i. The red dinosaurs went to the bookstore, and the green dinosaurs went to the bookstore, too. Am I right?

      Does Woody know which animals went to the bookstore?

c. Bare plural x *who* condition

   i. Red dinosaurs went to the bookstore, and green dinosaurs went to the bookstore, too. Am I right?

      Does Woody know who went to the bookstore?

d. Bare plural x *which* condition

   i. Red dinosaurs went to the bookstore, and green dinosaurs went to the bookstore, too. Am I right?

Does Woody know which animals went to the bookstore?

2. *One Saturday night, some bugs decided to get together for a night out in the city. There are so many of them, they need to call two cars! So now they have to decide which cars to go in.*

L'BUG 1: Well, yellow is my favorite color so I will pick the yellow car.

L'BUG 2: I love yellow cars, so I will go in this one too!

L'BUG 3: The yellow car looks more comfortable so I will also go in the yellow one.

*[All the ladybugs end up in the yellow car.]*

GR'HOP 1: I am going to go in the purple car since I can have first pick at my seat!

GR'HOP 2: The yellow car looks super comfy, so I am going to pick the yellow one!

GR'HOP 3: Wow, the purple car has so much leg room! I will go in that one.

GR'HOP 4: Both cars look very comfortable. Hmm, I suppose I will take the yellow car.

GR'HOP 5: I definitely love yellow cars, so I will chose the yellow one!

*[The grasshoppers are split between the purple and yellow cars.]*

*Woody enters, looking for the bugs, and he spots the two cars.*

WOODY: I am looking for my bug friends. I bet they got into these cars to head to the city for a fun night out! I think I know what happened.

a. Definite description x *who* condition

i. The ladybugs got into the yellow car, and the grasshoppers got into the yellow car, too. Am I right?

Does Woody know who got into the yellow car?

b. Definite description x *which* condition

i. The ladybugs got into the yellow car, and the grasshoppers got into the yellow car, too. Am I right?

Does Woody know which animals got into the yellow car?

c. Bare plural x *who* condition

i. Ladybugs got into the yellow car, and grasshoppers got into the yellow car, too. Am I right?

Does Woody know who got into the yellow car?

d. Bare plural x *which* condition

i. Ladybugs got into the yellow car, and grasshoppers got into the yellow car, too. Am I right?

Does Woody know which animals got into the yellow car?

3. *The local elementary school is going to go on a fun trip into the woods to explore the plants that live there. They're going to eat their lunch in tents, and the children have to choose which tent to eat their lunch in.*

BOY 1: I love red, so I'll choose the red tent!

BOY 2: I love red, too! So I'll also choose the red tent.

BOY 3: Ooh, I love yellow! But red is great, too. I'll choose the red tent.

*[All the boys end up in the red tent.]*

GIRL 1: Hmm, I've never eaten lunch in a red tent before. I'll do that.

GIRL 2: The yellow tent looks like fun. I'm going there.

GIRL 3: Hey, I think I'll join you all in the red tent!

GIRL 4: It seems like the red tent is a popular place. But I'm choosing the yellow tent.

GIRL 5: Lunch in the yellow tent for me!

*[The girls are split between the red and yellow tents.]*

*Woody arrives in the woods looking for the children, then remembers it's lunch time.*

WOODY: Hey, where are all the kids? Oh, wait, it's lunchtime. I bet they went to the tents to eat their lunch. I think I know what happened!

a. Definite description x *who* condition

   i. The boys went into the red tent, and the girls went into the red tent, too. Am I right?

   Does Woody know who went into the red tent?

b. Definite description x *which* condition

   i. The boys went into the red tent, and the girls went into the red tent, too. Am I right?

   Does Woody know which children went into the red tent?

c. Bare plural x *who* condition

   i. Boys went into the red tent, and girls went into the red tent, too. Am I right?

   Does Woody know who went into the red tent?

d. Bare plural x *which* condition

   i. Boys went into the red tent, and girls went into the red tent, too. Am I right?

   Does Woody know which children went into the red tent?

4. *During story time at the local public library, the librarian tells all of the children to find a place on one of the rugs. She has two rugs: a red one and a blue rug. The children walk over to the rugs and decide where to sit for storytime.*

BOY 1: I'm going to sit on the blue rug!

BOY 2: Me, too! Blue rug it is.

BOY 3: Hmm, the red rug looks comfy, but I think I'll choose the blue rug.

*[All the boys end up on the blue rug.]*

GIRL 1: I don't know where to sit! The red rug looks nice and soft. I think I'll sit there.

GIRL 2: Ooh, I'm going to sit on the blue rug. I'll be able to hear the story from there.

GIRL 3: Red or blue? Ooh, what a tough choice. I think I'll sit on the red rug.

GIRL 4: Blue is my favorite colors, so blue rug for me!

GIRL 5: Oh no! I don't know which rug to choose! I'll just choose…red!

*[The girls are split between the blue and red rugs.]*

*Woody comes into the library, but stays in the back, so he doesn't disturb anyone who is reading. He is excited about storytime.*

WOODY: You know, I remember that the boys and girls were coming in to the library for storytime today. I love storytime! And I remember that the children have to choose rugs to sit on. I think I know what happened.

a. Definite description x *who* condition

    i. The boys sat on the blue rug, and the girls sat on the blue rug, too. Am I right? Does Woody know who sat on the blue rug?

b. Definite description x *which* condition

i. The boys sat on the blue rug, and the girls sat on the blue rug, too. Am I right? Does Woody know which children sat on the blue rug?

c. Bare plural x *who* condition

i. Boys sat on the blue rug, and girls sat on the blue rug, too. Am I right? Does Woody know who sat on the blue rug?

d. Bare plural x *which* condition

i. Boys sat on the blue rug, and girls sat on the blue rug, too. Am I right? Does Woody know which children sat on the blue rug?

(15) False control script, followed by character or puppet's statements and experimenter's questions for each condition

1. *Some pigs and cows have just had a lot of fun playing at the park. Now they're all really hungry, and are planning to stop somewhere and get something to eat. They begin walking home and come across two restaurants: a pizzeria and a sandwich shop.*

*The pigs are the first to make their decision.*

PIG 1: Wow! This pizzeria looks like it has delicious food and I'm super hungry! I think I'm gonna go to the pizzeria.

PIG 2: I agree, the pizzeria smells good! I will go there too.

PIG 3: Ooh, the sandwich shop is tempting, but the pizzeria looks great! I'll go there.

PIG 4: I could try the sandwich shop, but the pizzeria DOES smell good! I will join you there!

*[All the pigs end up at the pizzeria.]*

*The cows then come over to look at both restaurants.*

COW 1: Mmm, the sandwich shop looks like it serves delicious food. I'm gonna go to the sandwich shop.

COW 2: Hmm, we have some good options for where to eat. I think I'm gonna eat at the sandwich shop.

COW 3: The sandwich shop looks like it serves very good food but so does the pizzeria. I think I'm gonna join them at the sandwich shop.

COW 4: I just can't decide! They both look like good places to eat. Hmm, what should I do? I think I'll choose the sandwich shop, too!

*[All the cows end up at the sandwich shop.]*

*Woody comes onto the scene.*

WOODY: Oh no I lost the pigs and the cows at the park but I know they were hungry, and were heading to get a bite to eat. Hmm, let me think. I think I know what happened!

a. Definite description x *who* condition

   i. The pigs dined at the sandwich shop and the cows dined at the pizzeria. Am I right?

   Does Woody know who dined at the pizzeria?

b. Definite description x *which* condition

   i. The pigs dined at the sandwich shop and the cows dined at the pizzeria. Am I right?

   Does Woody know which animals dined at the pizzeria?

c. Bare plural x *who* condition

   i. Pigs dined at the sandwich shop and cows dined at the pizzeria. Am I right?

   Does Woody know who dined at the pizzeria?

d. Bare plural x *which* condition

i. Pigs dined at the sandwich shop and cows dined at the pizzeria. Am I right? Does Woody know which animals dined at the pizzeria?

(16) Script for the homogenous true control, followed by character or puppet's statement, and experimenter's questions

1. *Some butterflies are flying around the garden and decide to land on some flowers.*

*The blue butterflies choose their flowers first.*

BLUE 1: Ooh, what a lovely garden! I'm going to land on this beautiful tulip!

BLUE 2: I love daisies, but I love tulips even more! I'm going there!

BLUE 3: You're right! Tulips are lovely. I'm landing on the tulips.

BLUE 4: I just can't decide! The daisies are so cute! But the tulips are so pretty. I'll land on a tulip.

*[All the blue butterflies end up on a tulip.]*

*The yellow butterflies then choose their flowers.*

YELLOW 1: Those tulips are very pretty indeed! But daisies make me so happy. I'm landing there.

YELLOW 2: Daisies are such great flowers. I think I'll land on a daisy.

YELLOW 3: Hmm, tulip or daisy? Tulip or daisy? I choose…daisy!

YELLOW 4: Oh no, this is a hard decision. These are both beautiful flowers. I think I'll choose a daisy!

*[All yellow butterflies end up on a daisy.]*

*Woody comes onto the scene.*

WOODY: I love it when the butterflies fly around the garden! I bet they all chose their favorite flowers to land on. I think I know what happened!

a. Definite description x *who* condition

i. The blue butterflies landed on the tulips and the yellow butterflies landed on the daisies. Am I right?

Does Woody know who landed on the daisies?

b. Definite description x *which* condition

i. The blue butterflies landed on the tulips and the yellow butterflies landed on the daisies. Am I right?

Does Woody know which animals landed on the daisies?

c. Bare plural x *who* condition

i. Blue butterflies landed on the tulips and yellow butterflies landed on the daisies. Am I right?

Does Woody know who landed on the daisies?

d. Bare plural x *which* condition

i. Blue butterflies landed on the tulips and yellow butterflies landed on the daisies. Am I right?

Does Woody know which animals landed on the daisies?

(17) Character or puppet's statement followed by experimenter's questions, for the true controls with a partitive used in definite description

1. *Some birds are flying around looking for a nice place to rest. They spot two choices: a hole in a tree and a birdhouse.*

*The blue jays are the first to decide*

JAY 1: Ooh, the birdhouse looks beautiful! I will go there!

JAY 2: I love trees! What a nice cozy hole. I will go there.

JAY 3: This is a tough decision, but I think I will choose the birdhouse.

*[The bluejays are split between the birdhouse and the hole in the tree.]*

*The cardinals then come over to look at both options.*

CARD'L 1: What a lovely birdhouse! I can tell someone made it just for us! I will go there!

CARD'L 2: Yes, that is a very nice birdhouse! But it's getting cold, and I think the tree will keep me warm. I'll go to the hole in the tree.

CARD'L 3: It is chilly! But I think the birdhouse will keep me warm. I'll go there.

*[The cardinals are split between the birdhouse and the hole in the tree.]*

*Woody comes onto the scene.*

WOODY: Hey, where did all of the birds go? Oh, wait, there's a birdhouse and a lovely little hole in a tree. Those are great places to rest. I think they went there. And I think I know what happened!

a. Definite description with partitive x *who* condition

   i. Some of the birds chose to rest in the birdhouse, and some of the birds chose to rest in the hole in the tree. Am I right?

   Does Woody know who chose to rest in the birdhouse?

b. Definite description with partitive x *which* condition

   i. Some of the birds chose to rest in the birdhouse, and some of the birds chose to rest in the hole in the tree. Am I right?

Does Woody know which birds chose to rest in the birdhouse?

c. Bare plural x *who* condition

i. Some birds chose to rest in the birdhouse, and some birds chose to rest in the hole in the tree. Am I right?

Does Woody know who chose to rest in the birdhouse?

d. Bare plural x *which* condition

i. Some birds chose to rest in the birdhouse, and some birds chose to rest in the hole in the tree. Am I right?

Does Woody know which birds chose to rest in the birdhouse?

2. *Some farm animals have been out in the field all day, and they are so very hot! They decide they are going to do something to cool off. Their options are going to the pond, or sitting under a shady tree.*

*The ducks are the first to decide.*

DUCK 1: It is such a very hot day! The water in the pond will cool me off. I'm going there.

DUCK 2: Oh, that pond is still in the sun, so I'm going to go to the shady spot under the tree.

DUCK 3: I love a nice splash in the pond, but I love a nice nap under a big tree. Let's see. I think I'll choose the…tree.

*[The ducks are split between the pond and the tree.]*

*The sheep now have to decide.*

SHEEP 1: The tree looks so inviting, but the pond looks nice. Hmm, I think I'd like a drink of water at the pond. I'll go there.

SHEEP 2: I think I'll go rest under the tree.

SHEEP 3: Oh, I don't know what to do! They both look like such nice spots. But I love resting under a nice shady tree. I'll go there.

*[The sheep are split between the pond and the tree.]*

*Woody comes onto the scene.*

WOODY: Oh, what a hot day it is! I wonder where the sheep and the ducks went. Oh, there's a pond over there, and a nice big tree. I think I know what happened!

a. Definite description with partitive x *who* condition

   i. Some of the farm animals chose to rest under the tree, and some of the farm animals chose to go to the pond. Am I right?

   Does Woody know who went to rest under the tree?

b. Definite description with partitive x *which* condition

   i. Some of the farm animals chose to rest under the tree, and some of the farm animals chose to go to the pond. Am I right?

   Does Woody know which farm animals went to rest under the tree?

c. Bare plural x *who* condition

   i. Some farm animals chose to rest under the tree, and some farm animals chose to go to the pond. Am I right?

   Does Woody know who went to rest under the tree?

d. Bare plural x *which* condition

i. Some farm animals chose to rest under the tree, and some farm animals chose to go to the pond. Am I right?

Does Woody know which farm animals went to rest under the tree?

(18) Training session script, character or puppet's statement followed by experimenter's questions, for the training session

1. *Today some boys are practicing kicking soccer balls into the goal. Let's see how they do!*

BOY 1: I love playing soccer! I'm so good at this! Here I go! [He kicks it in.]

BOY 2: This is so much fun! Here I go! [He kicks it in.]

BOY 3: My turn! [He kicks it in.]

BOY 4: My turn! This looks easy! [He kicks it, but it doesn't go in.]

*Woody comes onto the scene.*

WOODY: Wow! These boys are practicing soccer. What fun! Let me see. I think I know what happened!

a. Every boy kicked a ball into a goal. Am I right?

Does Woody know who kicked a ball into a goal?

**6.2 Child Response Justifications**

(19) Child response justifications for homogenous test conditions, followed by participant number, age and trial number

e. Definite description x *who* condition

i. "No, he got squirrels in the cave and the bunny squirrels" (08, 4;10, 3a)

ii. “The girls went there and the boys went there. The girls didn’t go to the art room.” (19, 4;06, 5a)

iii. “Because the cats his in the tree and the dogs hid behind the rock” (39, 4;04, 9a)

iv. “Penguins- you were right when you said the penguins going into igloo but you weren’t right because the seals are going sliding down the hill.” (41, 4;07, 11a)

f. Definite description x *which* condition

i. “Because the squirrels choosed the cave and they choosed the log” (47, 5;09, 3a)

ii. “Because the boys went to the art room and the girls went to the playroom” (44, 4;05, 5a)

iii. “Cause he thought that the dogs went to the tree too with the cats.” (62, 4;03, 9b)

iv. “Because the seals went to the slide and the penguins wanted to read a story in the igloo” (51, 6;03, 11b)

g. Bare plural x *who* condition

i. “Because the rabbit go into the log and the squirrels go into the cave” (34, 4;03, 3a)

ii. “Noo the boys went to the art room and the girls went to the playroom” (07, 4;05, 5a)

iii. “All dogs behind the rock and all cats in the tree.” (29, 4;06, 9a)

iv. “Because the penguins went to the igloo and the seals went to the hill” (52, 4;03, 11a)

h. Bare plural x *which* condition

i. “Rabbits goed in the log and squirrels goed in the case.” (31, 4;05, 3a)

ii. “Um, only the boys went to there and girls went to there. Why did you thought that?” (18, 3;06, 5a)

iii. “No… those ones in the tree and those but the dogs went there and the cats went there” (14, 3;05, 9a)

iv. “No, cause penguins go in there and those go in there.” (38, 4;00, 11a)

(20) Child response justifications for non-homogenous test conditions, followed by participant number, age and trial number

i. Definite description x *who* condition

i. “No, I think half of them the green guys went to the bookstore with the red guys and two guys went to the library” (08, 4;10, 2a)

ii. “Well actually, Mr. Rabbit, some grasshoppers went in the yellow car too, and they only went into the purple car.” (41, 4;07, 6a)

iii. “Because two of the girls are gonna sit on the blue rug” (20, 5;02, 8a)

iv. “Two of the girls and three of the girls in that one, so he’s right” (08, 4;10, 12a)

j. Definite description x *which* condition

i. “Cause they both went there” (62, 4;03, 2a)

ii. “Because he got it a little bit right” (51,6;03, 6b)

iii. “Because three of the girls went on the red rug and two of the girls went on that rug” (49, 5;01, 8a)

iv. “Because some of the girls went in the red tent and some of the boys went in the red tent” (47, 5;09, 12a)

k. Bare plural x *who* condition

i. “Because two of the green ones went ot the library” (16, 4;00, 2b)

ii. “Two grasshoppers in the purple car and three grasshoppers in the yellow car and three ladybugs in the yellow car” (29, 4;06, 6a)

iii. “No, some girls sat on the blue rug and some girls sat on the red rug” (07, 4;05, 8a)

iv. “Because some girls went into the yellow tent and all of the boys went into the red tent and some of the girls went into the red tent” (07, 4;05, 12b)

l. Bare plural x *which* condition

i. “They went to the bookstore, they went to the library, two went to the library.” 913, 3;06, 2a)

ii. “Because the red ones are in the yellow car and the green ones are in the yellow car but two green ones are in the purple car.” (25, 4;06, 6b)

iii. “Because the girls and the boys sat on the blue one and there were girls and the girls sat on the red carpet.” (25, 4;06, 8b)

iv. “Girls went, two girls went in the red tent and three girls goed in the lellow tent three boys goed in the red tent.” (31, 4;05, 12a)

(21) Child response justifications for homogenous true control, followed by participant number, age and trial number

a. Definite description x *who* condition

i. “He gets a big gold star because he knows what he's doing" (08, 4;10, 1b)

b. Definite description x *which* condition

i. “Because they landed on the tulips and they landed on the daisies.” (47, 5;09, 1a)

c. Bare plural x *which* condition

i. “Because the blue butterflies go on the purple the pink flowers.” (25, 4;06, 1b)

(22) Child response justifications for the true controls with a partitive used in definite descriptions, followed by participant number, age and trial number

a. Definite description x *who* condition
    i. "Because two went here and four went there" (26, 5;06, 7a)
    ii. “No because that one slept in there and that one slept in there” (19, 4;06, 10a)
b. Definite description x *which* condition
    i. “Because some of the birds went here and some of the birds went here” (49, 5;01, 10a)
c. Bare plural x *who* condition
    i. “A lamb went there and a chicken went there and two chickens went under the tree and two lambs went under the tree.” (29, 4;06, 7a)
    ii. “The blue birds were in the birdhouse and the red birds and the blue birds went to the tree and the red birds” (52, 4;03, 10a)
d. Bare plural x *which* condition
    i. “The ducks went to the pond and the lambs went to the pond too” (13, 3;06, 7b)
    ii. “Because the birds went in the tree and the birds went in the birdhouse.” (25, 4;06, 10b)

(23) Child response justification for homogenous false control, followed by participant number, age and trial number

a. Definite description x *who* condition
    i. “The pigs went to the pizza shop and the cowns went to the sandwich shop” (08, 4;10, 4a)
b. Definite description x *which* condition

i. “The pigs did... go to the pizza” (44, 4;05, 4a)

c. Bare plural x *who* condition

i. “He mixed it up” (16, 4;01, 4a)

d. Bare plural x *which* condition

i. “The pigs went to there, but the sandwich, but those went to here and there, but… but they didn’t wanna go there, but that’s not the shop they needed it didn’t want that shop they need wanted to go to that shop.” (18, 3;06, 4a)