Mapping Projective Content: An investigation of *too* in English

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1 Introduction

In this paper, I investigate the form-meaning MAPPING PROBLEM in child language acquisition (Clark, 1993, p.43) for a class of meanings (IMPLICATIONS) called PROJECTIVE CONTENT and the words or constructions associated with them commonly referred to as TRIGGERS (Tonhauser et al., 2013). Since triggers are conventionally associated with projective content, I ask how children successfully limit the hypothesis space of concepts to learn their conventional form-meaning mappings, like any other item in the lexicon. However, unlike other lexical items, triggers are associated with the property of PROJECTION: their semantic contribution is unaffected by certain entailment canceling operators such as negation.

Mapping projective content raises several important questions: How do children know which lexical items should be associated with projection and

which ones should not? How frequently do we find triggers in entailment canceling environments in child directed speech? Is projection learnable from children's linguistic input or is it necessary to posit innate biases to account for the learnability of projection? Is it possible that they rely on certain a priori constraints for this task as well (Markman, 1990) or do they rely on socio-pragmatic cues (Clark, 2009)? For example, do children use a constraint that gives a default status to non-projective mapping or do they, alternatively, use some cues in the semantics or pragmatics of triggers to learn projection from the context? Do they ever make mapping errors where a trigger is analyzed as non-projective or a non-projective lexical item is mapped as projective?

In this paper I try to formulate these questions more rigorously and test some of them experimentally using a forced choice paradigm. A full investigation of the theoretical issues raised here is beyond the scope of this paper. However, I hope to show that these questions are on the right track. The structure of the paper is as follows: In the remainder of this section, I introduce the theoretical assumptions behind projection and the mapping problem, and explain how the mapping problem applies to the triggers of projective content. In section 2, I introduce an experiment that addresses some of the theoretical issues raised in section 1 and report its results. Section 3 contains a general discussion and concluding remarks.

1.1 Projective Content

Projective content consists of a class of implications, commonly identified as presuppositions or conventional implicatures. These stand in contrast to "at-issue" meaning, also known as "ordinary entailment" or "what-is-said". The main property of projective content is PROJECTION: they survive the linguistic environments that normally cancel the implications of contents in their scope. In (1), for example, adopted from Chierchia and McConnell-Ginet (1990), (1a) has two main implications: (i) that there is a unique queen of France and (ii) that someone lives in Ithaca. In (1b)-(1e) where the sentence S in (1a) is embedded under various entailment canceling operators $(\neg, ?, \diamond, \rightarrow)$, we do not get the second implication that "someone lives in Ithaca" anymore. This at-issue implication is targeted by the operators mentioned. However, (1b)-(1e) still imply that "there is a unique queen of France". This implication is therefore **projective**.

(1)   Chierchia and McConnell-Ginet (1990)

    a. The present queen of France lives in Ithaca. (S)

    b. It is not the case that the present queen of France lives in Ithaca. $(\neg S)$

    c. Does the present queen of France live in Ithaca? $(?S)$

    d. Maybe the present queen of France lives in Ithaca. $(\diamond S)$

    e. If the present queen of France lives in Ithaca, she has probably met Nelly. $(S \rightarrow q)$

Projective content is associated with a class of words or constructions called TRIGGERS. For example, in 1 the implication that there is a unique queen of France is associated with the English definite determiner *the*. Replacing *the* with the indefinite determiner *a* results in sentences where both implications i and ii are targeted by the entailment-canceling operators and the implication that there is a unique queen of France no longer projects.

Beaver and Guerts (2013) provide a list of (presupposition) triggers that includes factive verbs (e.g. *know*, *realise*, etc.), definite determiners and demonstratives (e.g. *the*, *this*, etc.), pronouns, proper names, quantifiers (e.g. *both*, *all*, etc.), additive particles (e.g. *too*, *also*, etc.), aspectual verbs (e.g. *stop*, *continue*, etc.), manner adverbs (e.g. *quickly*), and temporal clauses headed by *before*, *after*, *since*, etc. Potts (2014) adds some (conventional implicature) triggers to this list such as some connectives (e.g. *but*, *so*, *therefore*, *nevertheless*, etc.), subordinating conjunctions (e.g. *although*, *even though*, *despite*), implicative verbs (e.g. *manage*, *fail*, etc.), swears, parentheticals (e.g. nonrestrictive relative clauses, nominal appositives), etc.

This is already a notable list of lexical items which share the common property of projection. Since these forms are conventionally associated with their corresponding projective meanings, we expect them to be stored in the lexicon of a language. Like any other item in the lexicon, children have to learn the form-meaning mapping for them. In 1.2 below, I introduce this mapping problem in more detail.

1.2 The mapping problem

An essential part of learning a first language for a child is establishing form-meaning mappings. The problem of identifying the conventional meanings for each linguistic form is often called "the mapping problem" in the acquisition literature (Clark, 1993, p.43). Quine (1960) introduced the same problem in the context of "indeterminacy of reference" using the well-known *gavagai* thought experiment. Below I present a definition of this problem. Let's assume that in a linguistic community of language L, there are established mappings between forms in the lexicon of L and their corresponding meanings. The mapping problem is therefore defined as:

Definition 1. THE MAPPING PROBLEM: Given a form f in the lexicon of L, and a countably infinite set M of possible meanings, what algorithm(s) can a learner of L use to find a member of M which corresponds to the meaning of form f according to the conventions of the linguistic community?

It is clear that children succeed in solving the mapping problem. The question is exactly what algorithms do they use to do it. Most proposals for solving the mapping problem focus on limiting the set M of possible concepts to a manageable subset. The constraints approach (Markman, 1990) proposes a priori constraints to exclude certain concepts from the hypothesis set M. For example, the TAXONOMIC constraint removes thematic categories (e.g. cow-and-milk) and the WHOLE-OBJECT constraint removes concepts that correspond to object parts. Socio-pragmatic accounts emphasize

the role of context in the process of acquisition (Clark, 2009). PHYSICAL CO-PRESENCE, for example, can limit the hypothesis space to the concepts relevant to here-and-now while JOINT ATTENTION with the speaker can isolate a single member (e.g. a particular cat) of a category (e.g. cat). In 1.3 below, I explain how projective content and the triggers associated with projective content are subject to the mapping problem as well.

1.3 The mapping problem for triggers

Clark (1993) explains that the comprehensive solution to the mapping problem involves three main tasks: i. Isolating the linguistic form f ii. Isolating a meaning; and iii. Mapping the meaning to the form. Since triggers are part of our lexicon, they are also subject to the mapping problem in language acquisition. In other words, how do children map the forms of the triggers to their conventional meaning? This amounts to asking how children accomplish the three tasks in the mapping problem: i. how they isolate the trigger forms, ii. how they pick the conventional meaning out of the hypothesis space M, and iii. how they map the triggers to their meanings.

Here I am not concerned with the first task and I cannot see how this step would be any different for triggers than other lexical item. Triggers do not differ in form (phonetics or phonology) significantly from other words in the lexicon. For second task, we can ask how children rule out alternatives in the hypothesis space to arrive at the intended meaning for each trigger; especially that their meanings are often highly abstract and complicated. However, I

believe the more interesting question with regard to the mapping of triggers is related to the third task: How do children know that the meaning of a trigger should be mapped as "projective" and not "at-issue"? In other words, how do they know that this class must be associated with the property of projection?

Let me elaborate with an example. According to the standard view (e.g. Karttunen and Peters (1979)), a sentence such as "Mary lives in London too" (2) has at-issue content "Mary lives in London" (2a) and presuppositional content "someone else lives in London" (2b). In (2c), I show both implications together and mark the presuppositional content with Beaver (1992)'s partial function $\partial()$ to get a logical form that matches our intuition about what "Mary lives in London too" means. The presupposition in (2b) is contributed by the trigger *too*.

(2) $[\text{Mary}]_f$ lives in London *too*.

   a. lives-in-london (Mary)

   b. $\exists x$ [x $\neq$ Mary $\wedge$ lives-in-london (x)]

   c. $\partial(\exists x$ [x $\neq$ Mary $\wedge$ lives-in-london (x)]$) \wedge$ lives-in-london (Mary)

   d. $\exists x$ [x $\neq$ Mary $\wedge$ lives-in-london (x)] $\wedge$ lives-in-london (Mary)

Now let's assume that the child correctly isolates the meaning of *too* - something close to (2b) - and maps the phonological form *too* to this meaning. Let us also assume that the child, following compositionality, assumes that the meaning of *too* should be conjoined to the proposition expressed by the VP it modifies, namely "Mary lives in London" in (2a). This would result in

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a logical form like the one presented in (2d). However, the resulting logical form would not match our intuitions about what (2) means as represented in (2c). The child also needs to assign a projective status (in this case also presuppositional) to the meaning that *too* contributes. Otherwise, the mapping will result in a non-projective version of *too* which can be targeted by entailment-canceling operators and does not match the use of *too* in adult language.

For many lexical items, we can imagine either a projective or a non-projective variant. Triggers show that the third task, namely mapping the form to the meaning is not simple or straightforward. The child needs to decide whether the content is going to be mapped as projective or non-projective (at-issue). Below I summarize the mapping problem of projective content:

Definition 2. THE MAPPING PROBLEM FOR PROJECTIVE CONTENT: Given a form f in the lexicon of L, and a meaning M associated with it, how can a learner of L determine whether f is projective or not ?

Notice that we can imagine a language in which *too* contributes its meaning (2b) as at-issue and results in (2d). In fact, we may be able to find pairs of words within or between languages, such that the encoded content only differ with respect to projection. In these pairs, the meanings contributed by the first member and the second member of the pair are very similar but the first member is projective (presuppositional). I think $\langle both, two \rangle$ and

$\langle again, twice \rangle$ in English are very close to such pairs. However, there are valid objections to their content being truly identical[1].

In general, it seems to be hard to find such pairs in English. I am not sure if this is due to the general difficulty of finding lexical items with exactly the same meaning or it reflects a universal tendency to not encode such trigger/non-trigger pairs within a language. If this universal tendency is true, then we might be able to find such pairs between different languages: the first item is from one language and the second from another. If even this second task proves to be difficult we may be facing a principle (let's assume a pragmatic one) that forbids the content of a trigger to be encoded as non-projective or at-issue. In other words, it is indeed the nature of the content that makes a projective mapping more likely. Cleo Condoravdi (p. c.) suggested that for *too* this might simply be high context-dependency. The content of *too* is something close to "in addition to a given (discourse) alternative". The meaning also depends heavily on the common knowledge of the discourse participants on what the relevant alternatives are. These could be pragmatic clues to assigning a projective status to the content of *too*. In the next section, I discuss two possible solutions to the problem of mapping projective content: one based on default mapping and another based on a

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[1]This was pointed out to me by Cleo Condoravdi and Paul Kiparsky. *two* has an "at least" reading while this is not true for *both*. If "both apples are red" it cannot be the case that there is more than two apples in the relevant context. In other words, *both* places an upper bound on the number of entities described by the NP it takes. *twice* differs from *again* in that it encodes the numeral *two*. If I say "I didn't jump twice" it is possible that I jumped once or not at all. However, if I say "I didn't jump again", it is not clear how many acts of jumping have occurred before.

pragmatic principle.

1.4 Mapping projective content and theories of form-meaning mapping

The discussion above raises a fundamental question: how do children know about the notion of projection at all? Notice that this is a different question from the one raised by the mapping problem of projective content. There we assumed that children know about projection but have to decide on the projective/non-projective mapping for a given lexical item. Here I ask how children know about projection in the first place?

I believe the answer lies in the notion of at-issue-ness (or non-projectivity). It is safe to assume that some notion of at-issue-ness appears in children very early in the course of development. At-issue-ness in conversation (in the linguistic sense) is tightly connected to the notion of goal-directed behavior (in the psychological sense). In other words, we can think of at-issue-ness in conversation as what lies at the center of the speaker's conversational goals. There is a lot of literature suggesting that the understanding of goals and goal-directed behavior of agents appears very early in development; even before the infant reaches their first year of life (c.f. Premack and Premack (1997); Csibra et al. (2003)). Therefore, we can assume that the child is coming to the task of form-meaning mapping equipped with the understanding that some information will be directly relevant to the conversational goals of

the speaker and some other will not; the latter may be presupposed or rather a commentary on the main point. Therefore, it is the child's awareness of at-issue-ness that gives rise to projection. This is indeed Simons et al. (2011)'s approach in giving a pragmatic explanation of projection. Let me flag this assumption explicitly here:

Assumption 1. The awareness of communicative goals and the division of information into what directly addresses these goals (at-issue information) and what is peripheral to the main goal develops very early in children.

Now given the assumption above, how do children solve the mapping problem for triggers? There could be two general approaches to the problem here: first, mapping using default assumptions and second mapping using a pragmatic principle.

First, children can use a default assumption to map all lexical items as non-projective and only revise this mapping for triggers when there is substantial evidence to do so. Since most of the lexicon of a language consists of non-triggers, a non-projective (at-issue) default mapping would get most of the mappings right. However, it would result in systematic mapping errors for triggers. It predicts that there will be a period of "mis-mapping" in which a trigger is treated as a non-projective (at-issue) lexical item, before its status is revised. For example in comprehension, the child may interpret someone pointing at an apple and asking "the apple?" (with a rising intonation) as a question on whether the object is an apple or not. Notice that in normal usage, such an interpretation is possible if the speaker says "an apple?"

and not "the apple?". A question like "the apple" could be about whether someone wants the apple or not but it cannot be about whether some entity is an apple or not. That is simply presupposed. In production, the child may start conversations with lexical triggers. For example, when there is an apple and a banana on the table, the child may start a conversation with "I want the apple, too" to mean "I want the apple and the banana". This is again a marked usage of "too" in adult conversation[2].

Alternatively, children can use a pragmatic principle to classify lexical items as projective vs. non-projective. This pragmatic principle could be something close to Assumption 1 introduced earlier. Children are aware of the conversational goals of the discourse participants and keep track of the content that addresses these goals. Lexical items that address these goals are mapped as at-issue. Lexical items that do not and provide background assumptions or parallel commentary are mapped as non-projective. This

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[2]Another logically possible default assumption is the "projective default" mapping. Using this assumption, the child maps all lexical items as projective at first and then revises them for non-triggers. I find it harder to motivate the projective default hypothesis for three reasons. First, it is hard to imagine what this constraint would even mean. Suppose a child knows only three lexical items: *you*, *love*, *chocolate*. These are all mapped as projective initially. S/he also understand the sentence "you love chocolate". Now if I ask "you love chocolate?" with a rising intonation marking the question, what is being targeted by the question exactly? Everything is assumed to be projective. This does not make much sense. Second, triggers constitute a minority of any language's vocabulary. It seems rather inefficient to start with such a general rule that needs to be overridden so frequently. Third, the concept of projection seems a complicated one by itself. I started this section with some thoughts on how could children become aware of the projective non-projective distinction. As I mentioned, a natural path could be through the awareness of conversational goals, this makes it more likely that children learn at-issue-ness and non-projectivity first. Of course one could argue that perhaps projection is an innate concept and the child does not need to learn it. Although this is possible, I do not find it probable and would rather keep the the explanation clear of a priori constraints as much as possible.

pragmatic account predicts that mapping projective content is done quite accurately with almost no errors. Therefore, existence of systematic mapping errors is the crucial difference between the two approaches sketched here. The at-issue default assumption will result in systematic mapping errors (projective as non-projective) in the acquisition of triggers while the pragmatic principle approach predicts no such errors. In the next section, I propose an experiment for the presupposition trigger *too* that aims at finding mapping errors in which the content of *too* is assumed to be non-projective. If we find a robust mis-mapping effect as children learn the meaning of *too*, then we can conclude that the non-projective default account is on the right track. Otherwise, the absence of projection errors would be consistent with the use of a pragmatic principle.

I would like to add here that the mapping problem of projective content also gives rise to a learnability problem: What kind of data and how much data is required for the child to learn the correct projective vs. non-projective mapping of the lexicon? Do children receive only positive evidence with respect to such mapping or both positive and negative evidence? A good start to investigate this learnability issue would be analysis of child directed speech and children's production with respect to triggers and the environments they appear in.

2 The Experimental Study

2.1 Method

2.1.1 Choice of the trigger

For my experimental investigation, I chose the additive adverb *too*. There are several properties of *too* that make it a good candidate for the study of triggers and projective content. First, its meaning is proposed to be completely projective (Karttunen and Peters, 1979; Beaver and Guerts, 2013). Some other triggers seem to contribute both projective and at-issue meaning. For example, the determiner *both* is analyzed to contribute a universal quantifier to the at-issue content of a sentence and presuppose that the cardinality of the restriction is 2 (Von Fintel, 1994). Second, the implication of *too* seems to be stronger than many other triggers. Tonhauser et al. (2013), for example, argue that *too* sets strong constraints on the context of the utterance while a factive verb like *know* does not. Finally the age of acquisition for this trigger seems to be relatively young.

2.1.2 Participants

40 children between 3;4 and 5;7 participated in this study (Mean age = 4;7). 36 completed the trials while four did not go through more than half of the trials and had to be excluded from the final analysis. Among the 36 participants, there were 20 girls and 16 boys. Figure 1 shows the exact age
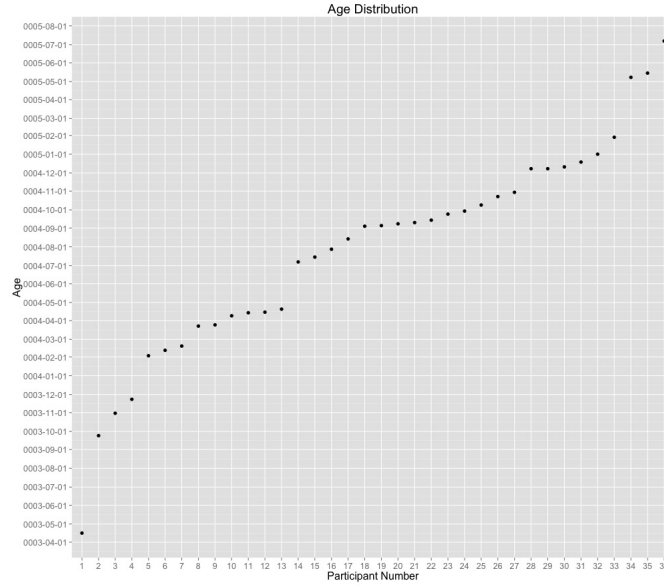
Figure 1: The distribution of the participants with respect to age in Y-M-D format.

distribution of the participants.

2.1.3 Materials

There were four round blue plastic chips: One with an elephant sticker on one side, one with a frog sticker, and the other two blank (figure 2). The backs of the chips were all identical and blank. One could not see what was on the other side by looking at the back of the chips. The experiment relied on a board game to keep the participants interested in the guessing game. Figure 3 shows the board game.

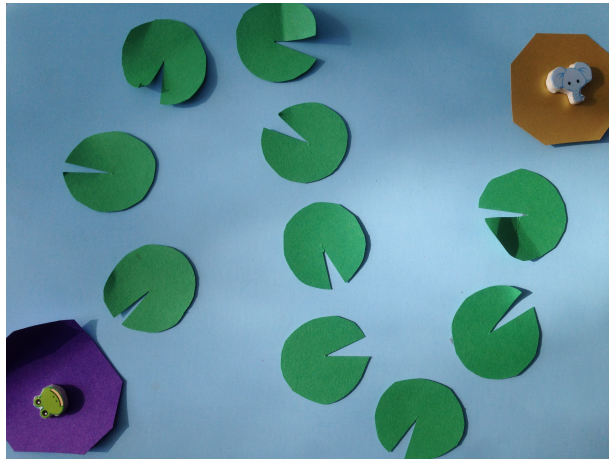Figure 2: The elephant, frog, and blank chips.

Figure 3: The board game.

2.1.4 Design and procedure

The current experiment was designed as a guessing game. The experimenter first laid the four chips face up on the table and asked the child what was on each chip he pointed at. The goal of this task was to see which labels the child was most comfortable with for the chips. The responses were almost always "elephant", "frog", and "nothing". If the child was not sure how to label the blank chips, the experimenter helped them with the label "nothing". Then the experimenter explained to the child that he was going to put the chips face-down and mix them up. As he did this, he made sure that it was impossible to track the chips. Then he chose two chips and put them between himself and the child but slightly closer to the child. The other two chips were at the corner of the table further away to the right. Considering the two chips in front of the experimenter and the child, there are four possible outcomes: elephant and frog, only elephant (i.e. elephant and a blank chip), only frog (i.e. frog and a blank chip), or nothing (i.e. two blank chips). I represent these outcomes as EF, E, F, and N respectively.

At this stage, the experimenter asked: "What do you think we have here? Can you guess what these are?". The experimenter looked and pointed at the chips to make the referents of "here" and "these" clear in the context. If the child was reluctant to guess, the experimenter started to enumerate the possible outcomes as if he is trying to guess himself (e.g. "maybe elephant and frog? or frog and nothing? etc.). After that he asked the participant what s/he thought. All participants were happy to make a guess at this point.

When the child made his/her guess, the experimenter flipped the chips to show the actual outcome. He also flipped the chips at the corner of the table to help the child see the full state of the game.

The experiment had four within-subject conditions: 1.Baseline 2.Without-trigger 3.With-trigger and 4.Conjunction. The baseline condition always appeared first but trials related to conditions 2-4 were randomized. There were 2 trials in the baseline condition, 7 in the without-trigger condition, 3 in the with-trigger condition, and 3 in the conjunction condition, resulting in a total number of 15 trials. The number of trials in different condition were uneven because they reflected the natural probability of the experimenter randomly sampling two chips out of four. If the experimenter is truly picking at random, the probability of EF, E, F, and N, would be 1/6, 1/3, 1/3, 1/6, respectively. An even distribution of trials among experimental conditions would have resulted in a distribution of outcomes that favored E and F outcomes disproportionately. A disproportionate distribution of the outcomes would have suggested that perhaps the experimenter is not truly picking at random. In order to not bias the children this way, the actual outcomes were presented randomly with a frequency close to the actual probability of each outcome: there were 3 EF, 4 E, 4 F, and 2 N outcomes. In what follows I describe each experimental condition in more detail.

The Baseline Block This condition was designed as a pre-test to assess any biases that children may have for particular outcomes. It also helped
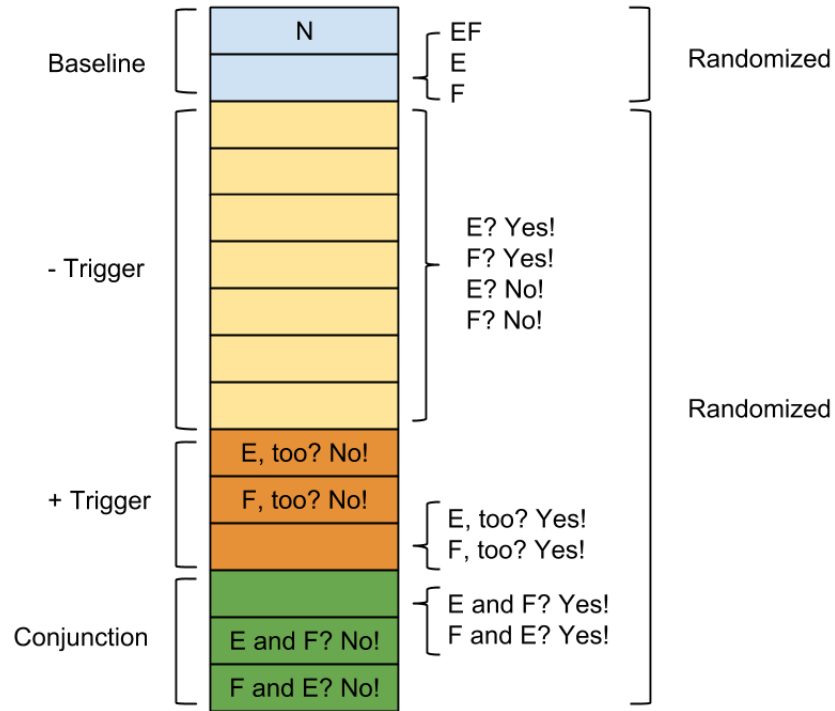
Figure 4: The experiment design: Each cell represents a trial. E/F are short for elephant/frog. The baseline block shows the randomization for outcomes while the other blocks show the distribution and randomization pattern of the questions asked by the experimenter.

the children understand the possible outcomes better and become used to guessing before going on to conditions 2-4.

The baseline condition always appeared as the first block of the experiment. It contained two trials. In each trial the experimenter chose two chips and the child had to guess what they were. The outcome of one trial was randomly chosen from EF, E, and F and the outcome of the other trial was consistently N (i.e two blank chips). This was to raise children's awareness of the N outcome which might otherwize be visually less salient. The order of the trials were randomized.

In order to keep the children interested in the guessing game, the experimenter introduced a simple board game at the end of the baseline condition. As figure 3 shows, the board was rectangular and blue, with two smaller squares, one golden and one purple, at opposite corners of the board. On the golden square, there was a small elephant figurine and on the purple one, a small frog figurine. The experimenter explained to the child that the golden square is the elephant house and the purple one the frog house. Ten green lily pads made a pathway between the two houses. The experimenter explained that the frog wants to go to the elephant's birthday party and and that every time that they made a guess in the guessing game, the frog could jump one lily pad to get closer to the elephant house. When the frog reached the elephant house, the experimenter explained that the frog needs to go back home after the party. This procedure motivated the participants to complete the experimental trials.

The Experimental Block   After the introduction of the board game, the experimenter moved to the experimental block which contained conditions 2-4. In the experimental block, the experimenter told the child that he is going to take a peek at the chips before the child makes his/her guess. Then he peeked at the chip on his right. Peeking was done in a way that the child could not see what was on the other side of the chips. Then he uttered a question as if it was something he was wondering and he was curious to know its answer. The list below shows the questions asked by the experimenter in each experimental condition:

- Without-trigger: "Do we have an elephant (frog)?"

- With-trigger: "Do we have an elephant (frog) *too*?"

- Conjunction: "Do we have an elephant and a frog (a frog and an elephant)?

Then the experimenter peeked at the second chip and said "Yes" or "No" to indicate that he found the answer to his own question based on what he saw. Then he asked the child: "What do you think we have here? Can you guess?" In the without-trigger and the with-trigger conditions, the appearance of the word "frog" or "elephant" in the experimenter's question was randomized and counterbalanced. In the conjunction condition, the first argument of the conjunct matched the first chip the experimenter looked at. For example, if the first chip was a frog the experimenter asked "Do we have

a frog and an elephant?" and not the other way round. The with-trigger and conjunction conditions did not contain any trial in which the experimenter saw a blank chip first. In the without-trigger condition, the first chip was blank half of the times. When asking the question in the with-trigger condition, the experimenter stressed the word *too* while in the conjunction condition, the whole phrase "an elephant and a frog" was stressed.

2.2   Discussion of the Design

Figure 5 below shows the following for each condition: the questions asked after peeking at the first chip, the answers given after peeking at the second one, and the viable guesses after the participants updated their knowledge state with the content of the question-answer pair. I have abstracted over the choice of frog or elephant with X and Y: X is the one mentioned explicitly by the experimenter and Y is the salient alternative. In the conjunction condition, since both elephant and frog were mentioned in the question, X and Y simply indicate the order.

Condition	Question	Answer	Guesses
Without-trigger	"Do we have an X?"	"Yes"	XY or X
Without-trigger	"Do we have an X?"	"No"	Y or N
With-trigger	"Do we have an X *too*?"	"Yes"	XY
With-trigger	"Do we have an X *too*?"	"No"	Y
Conjunction	"Do we have an X and a Y?	"Yes"	XY
Conjunction	"Do we have an X and a Y?	"No"	XN, (YN) ,(N)

Figure 5: Question-answer pairs and the corresponding viable guesses for each experimental condition. Parentheses around a guess suggest that such an outcome could be ruled out by some sort of pragmatic reasoning.

In the without-trigger condition, the experimenter's answer helps the participant narrow down the possible outcomes to two options with certainty. Nevertheless, none of the two remaining outcomes (e.g. Y or N) could be ruled out based on what the experimenter said. However, the participant could use the following pragmatic reasoning to zero-in on a final guess: "*The experimenter asked whether there was an X. He could have asked whether there was a Y. Probably he chose X over Y because he has already seen a Y on the first chip.*"

If the participant follows this line of reasoning, the experimenter's question could contextually imply that the first chip was the contextually salient alternative Y as shown in (3).

(3) "Do we have an X?" $\rightsquigarrow$ There is a Y.

This predicts that we should see more Y guesses than N guesses in the without-trigger condition. However, this implication is weak, uncertain, and defeasible. Maybe the experimenter picked the elephant randomly or likes elephants more than frogs. What the experimenter actually said does not convey any information about the presence of a Y chip in the without-trigger condition. Therefore, while the existence of such an implication may result in higher Y guesses, I expect the effect to be weak.

However, in the with-trigger condition, the experimenter's question and the corresponding answer remove uncertainty with respect to the outcome. The implication that there is a frog is a commitment of what the experimenter explicitly said (4). Using the presupposition trigger *too* implies that the alternative, namely the frog, is (also) present. This is an implication of what the experimenter said and no longer a contextual implication as shown with $\Rightarrow$ in (4).

(4)   "Do we have an elephant too?" $\Rightarrow$ There is (already) a frog.

The negative or positive answer to the question removes the uncertainty with respect to the presence or absence of the elephant. Therefore, in the with-trigger condition, there should be a robust effect of the semantic contribution of *too* translated into significantly more Y guesses than N guesses, compared to the rates in the without-trigger condition.

If children truly understand the conventional meaning of *too*, they should rely on different patterns of guesses in the without-trigger and the with-

trigger conditions. Asking the question with *too* should result in more guesses identifying the alternative not mentioned in the question.

Finally, in the conjunction condition, a "yes" answer removes all uncertainty and makes it clear that EF is the correct guess. But, a "no" answer leaves the participant with three possible outcomes: E, F, and N. Since the experimenter first looks at the first chip and then asks the question "do we have an elephant and a frog?", it is possible to remove N based on the fact that he would have known the answer if the first chip was blank. The fact that he asked a question with conjunction implies that the first chip was not blank.

Now there are two possible outcomes: E and F. The participant could use the order of E and F in the experimenter's question to zero-in on a single answer: *the experimenter mentioned the elephant first in the conjunct so perhaps he saw it on the first chip.* Therefore, the experimenter's question in the conjunction condition could contextually imply that there is an elephant (5).

(5)   "Do we have an elephant and a frog?" ⤳ There is an elephant.

It is important to notice that the reasoning above is uncertain and the implication in the conjunction condition is relatively weak and defeasible. Maybe the experimenter asked that question even though he knew the answer before looking at the second chip. Or perhaps he is fond of using an opposite order, putting what he has seen in the second position in the conjunct. Such

pragmatic uncertainties should translate into a more varied pattern of guesses in the conjunction condition.

Now with respect to the mapping problem sketched in section 1, let's investigate what a non-projective (at-issue) variant of *too* would look like in the experimental setting presented above. Let's first assume that what *too* contributes semantically is basically the presupposition that the predicate (e.g. having something) is true with respect to some salient alternative (e.g. frog) not mentioned explicitly.

(6)   a. $?[\partial(\exists x[x \neq \text{FROG} \wedge \text{HAVE}(\text{SP}, x)]) \wedge \text{HAVE}(\text{SP}, \text{FROG})]$

    b. $?[\exists x[x \neq \text{FROG} \wedge \text{HAVE}(\text{SP}, x) \wedge \text{HAVE}(\text{SP}, \text{FROG})]$

    c. $?[\text{HAVE}(\text{SP}, \text{ELEPHANT}) \wedge \text{HAVE}(\text{SP}, \text{FROG})]$

(6a) is the translation of "Do we have a frog too?" to a logical language (SP stands for the speaker). The property of projection assigned to the contribution of *too* (marked with ∂) guarantees that the content of *too* is not targeted by the question operator ? but simply presupposed. (6c) shows an at-issue variant where the content of *too* is targeted by the question. Notice that in the context of the experimental setting, having something that is not a frog amounts to having an elephant. Therefore, (6b) and (6c) are logically equivalent in the context of this experiment. Now if some children fail to map the conventional meaning of *too* as projective, we expect to see the results in the with-trigger condition to look similar to the conjunction condition. In the next section I discuss the results of the experiment sketched above.

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2.3   Results

Using the median age, the participants were divided into two age groups: Group 1 = 3;4 - 4;9 (n=18) and Group 2 = 4;9 -5;7 (n=18). First, I review the results in the baseline condition. There were a total of 74 guesses (two per participant and one participant provided two extra guesses). Figure 6 shows the distribution of guesses among the two age groups. In Group 1, a mixed effects multinomial logistic regression showed a significant preference for "EF" over "E" ($t = -2.05$, $p < 0.05$) and a preference for "EF" over "F" that only approached significance ($t = -1.82$, $p = 0.07$). There was no significant preference for "EF" over "N" ($t = -1.38$, $p = 0.17$). However, these differences were not significant in Group 2. Across all participants, "EF" was guessed significantly more than "F" ($t = -2.2861, p = 0.02$) but not significantly more than "E" ($t = -1.9507, p = 0.05$). There was no significant difference between the number of times "EF" or "N" were guessed in the baseline condition overall ($t = -1.4625, p = 0.14$).

Figure 7 below shows the short forms that I will use in this section to refer to the experimental subconditions and the number of trials in each. Figures 8 and 9 show the distribution of the guesses in the six subconditions for Groups 1 and 2.

In the figures for both age groups, there is a sharp distinction between the results of the conjunction condition (X&Y?) and the other two conditions ("X?" and "X,too?"). In both age groups, children unanimously guessed EF in the "X&Y? Yes!" trials. In fact many participants remarked that
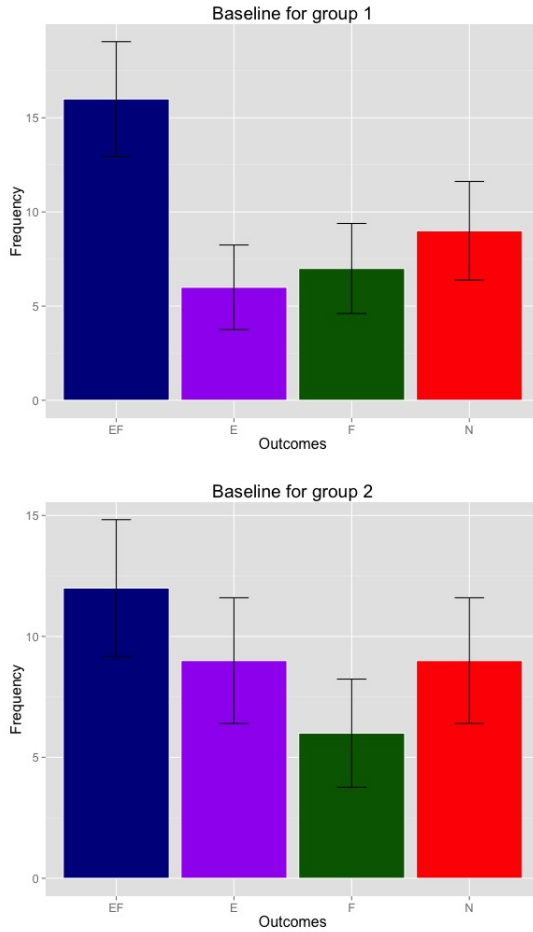
Figure 6: Basline distribution of guesses among the younger (group 1) and older (group 2) participants.

Condition	Question	Answer	Short Form	# trials
−Trigger	"Do we have an X?"	"Yes"	X? Yes!	71
−Trigger	"Do we have an X?"	"No"	X? No!	180
+Trigger	"Do we have an X *too*?"	"Yes"	X,too? Yes!	35
+Trigger	"Do we have an X *too*?"	"No"	X,too? No!	72
Conjunction	"Do we have an X and a Y?	"Yes"	X&Y? Yes!	36
Conjunction	"Do we have an X and a Y?	"No"	X&Y? No!	72

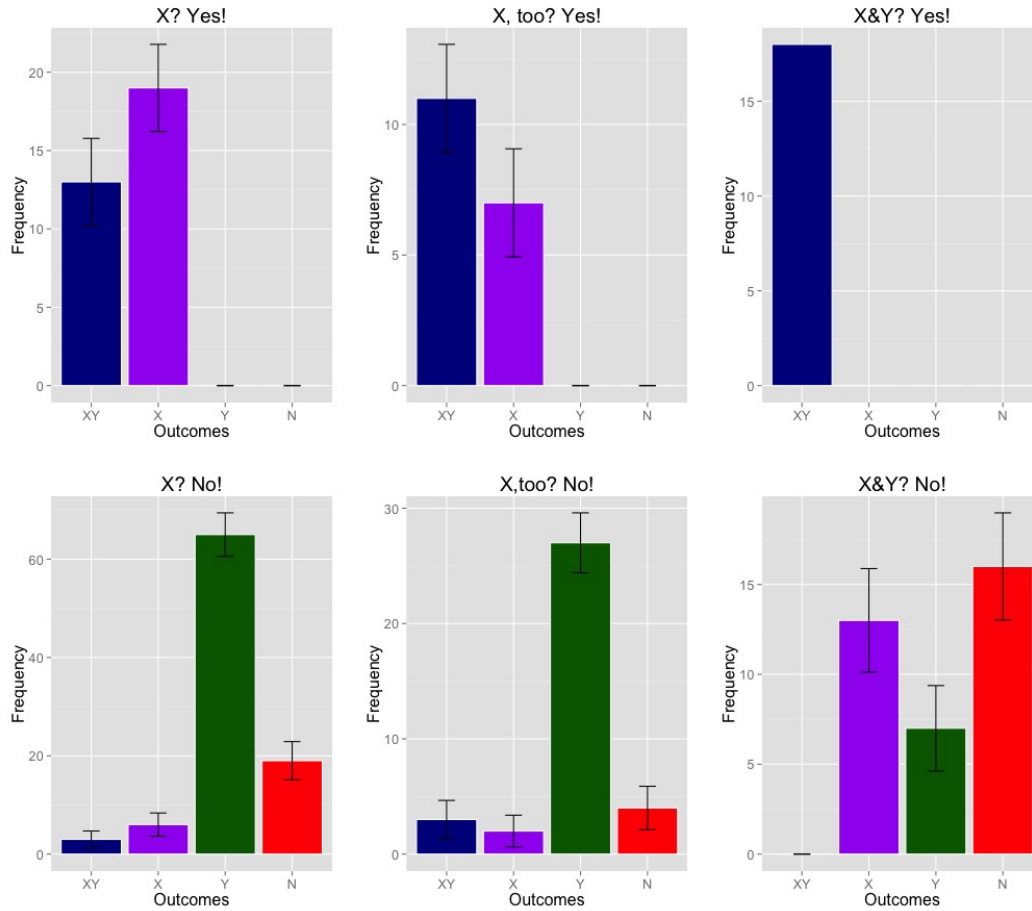Figure 7: The short forms for the six experimental subconditions and the number of trials in each subcondition

Figure 8: Distribution of guesses among the younger participants (Group 1) for the six subconditions.
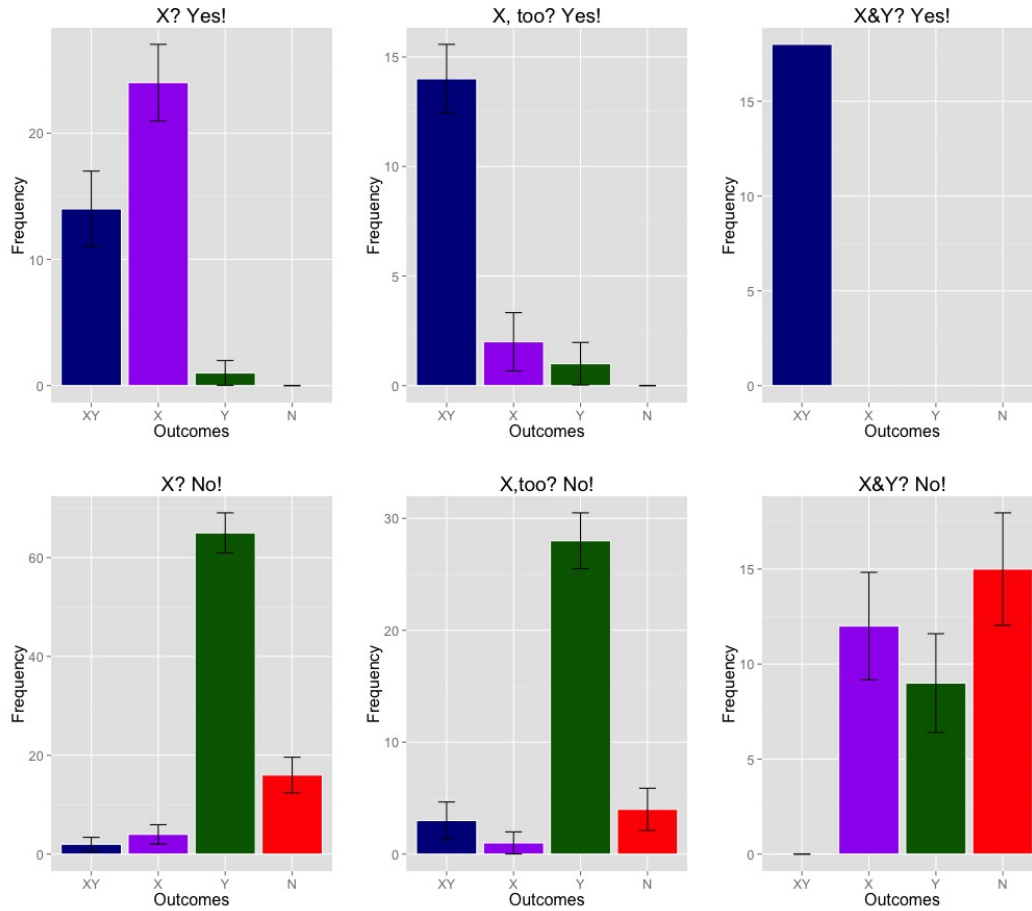
Figure 9: Distribution of guesses among the older participants (Group 2) for the six subconditions.

the experimenter told them the answer and found the trial very easy. In the "X&Y? No!" trials, participants succeeded in removing the EF outcome with certainty in both age groups but there was no significant preference for any particular outcome. Children showed a surprisingly high number of N guesses in the "X&Y? No!" trials compared to the other trials. Collapsing the age groups, the number of N guesses were significantly more than the Y guesses ($t = 2.1486, p < 0.05$) but not X guesses ($t = 1.3940, p = 0.16$). This is a relatively surprising finding and I discuss some possible interpretations in the next section.

In the without-trigger (X?) and the with-trigger (X,too?) conditions, both age groups display very similar guessing patterns except for a strong interaction of age group with the "X,too? Yes!" trials. The younger participants did not guess between XY and X above chance level ($t = 0.9348, p = 0.35$). This parallels their responses in the "X? Yes!" trials in which the trigger *too* was absent. They showed no significant preference for XY or X there either: the younger group ($t = -1.0543, p = 0.29$). However, the older group showed a significant preference for XY over X in "X, too? Yes!" trials ($t = 2.5742, p < 0.05$), but no such preference in "X? Yes!" trials where the trigger was absent ($t = -1.6027, p = 0.1$).

The responses in the "X? No!" trials and the "X, too? No!" trials were almost identical in both age groups. The younger children showed a highly significant preference for Y over N in both the "X? No!" trials ($t = 4.72, p < 0.001$) and the "X, too? No!" trials ($t = 3.56, p < 0.001$). The situation is the

same with the older age group ($t = 5.0230, p < 0.001$ and $t = 3.64, p < 0.001$ respectively). There was no significant difference between the number of N guesses in "X? No!" and "X, too? No!" trials for either age group.

Based on the significant difference between the age groups with respect to their answer to the "X, too? Yes" trials, children were divided according to their responses: those that answered these trials with X (n=11) and those that answered with XY (n=25). Figures 10 and 11 show the distributions for these groups. These groups differed significantly with respect to their answers to the "X? Yes" trials. The group that answered with X, showed a signifiant preference for X over XY in the "X? Yes" trials where there was no trigger ($t = 5.27, p < 0.001$). This was not the case for the group that guessed XY ($t = 0.34, p = 0.73$). The groups differed in no other respect for any measures in the experimental conditions.
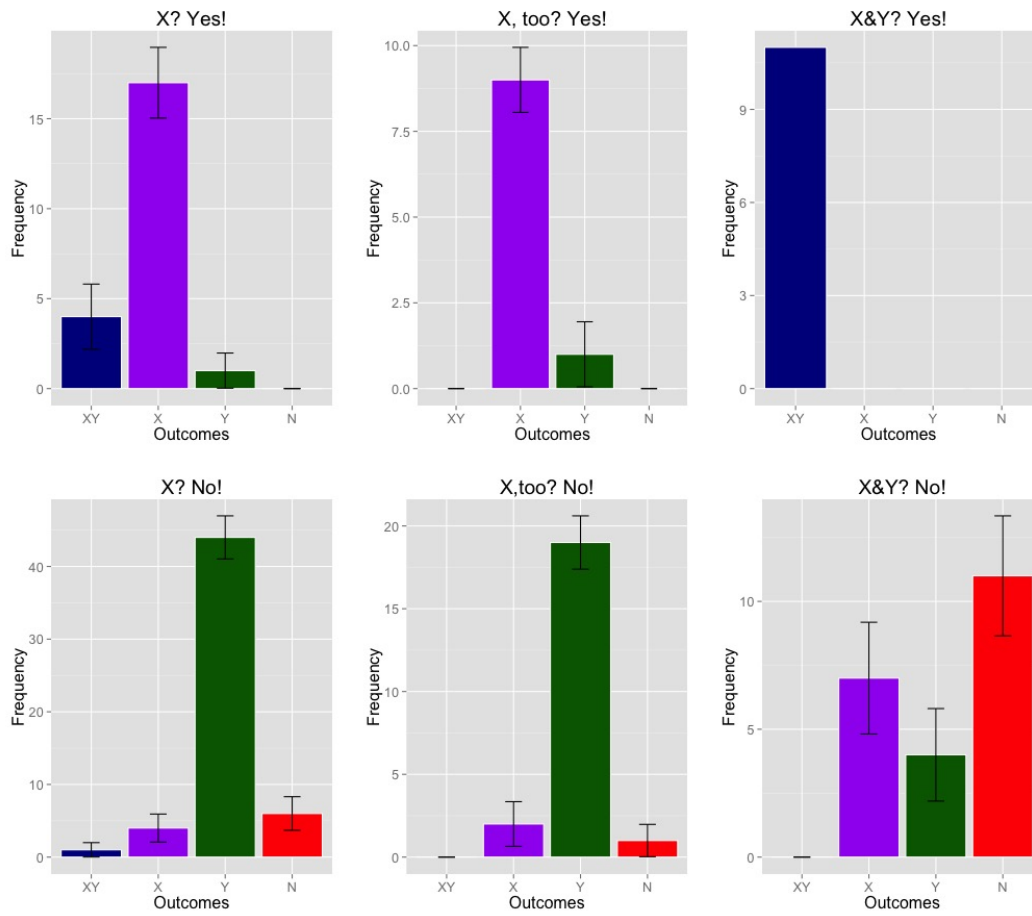
Figure 10: Distribution of guesses among the group that answer "X, too? Yes" with "X".
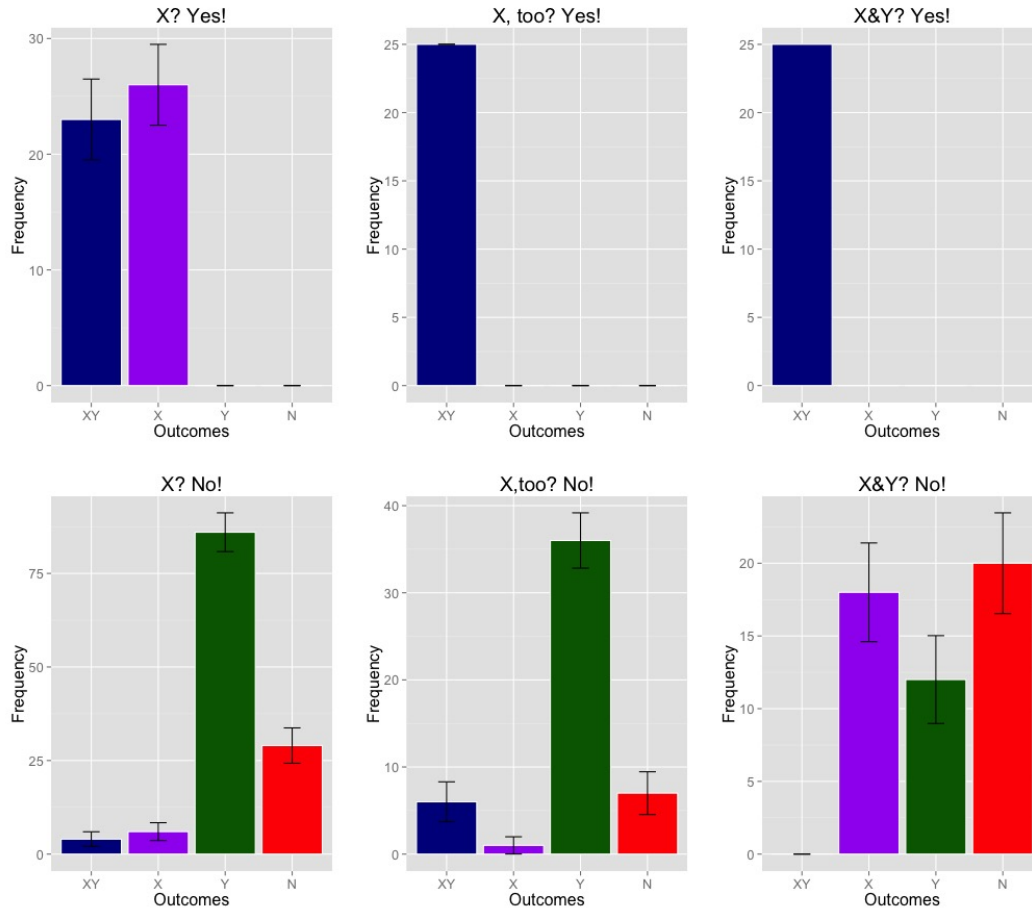
Figure 11: Distribution of guesses among the group that answer "X, too? Yes" with "XY".

2.4 Summary

There are four main patterns present in the results reported in this study: first, a difference between the conjunction condition and the with- and without-trigger conditions; second, a developmental pattern with respect to the inter-

pretation of the trigger *too*; third a pragmatic strengthening pattern for the negative responses in the with- and without-trigger conditions; and fourth a pragmatic strengthening for the group that did not take the semantic contribution of "too" into account in the "X, too? Yes!" trials.

Children's responses showed a clear difference between the with- and without-trigger conditions and the conjunction condition. This difference is most evident in the negative trials. A negative response to an "X&Y?" question is evaluated very differently from a negative response to an "X?" question or an "X?too" question. In the latter conditions, a negative response to X is evaluated as an implication that the salient alternative Y is present. But, a negative response to "X&Y?" is met with uncertainty when choosing among alternatives to XY. I had hypothesized that since the question "X&Y?" was asked after the experimenter had looked at the first chip, this could imply that the first chip was X. However, the results suggest that this implication was not robustly present. On the contrary, the results suggest a preference for N guesses in "X&Y? No!" trials. In fact, when the outcome of the game was not N in these trials, several children objected that the experimenter had lied to them. In other words, they thought that a "No" to the question "Do we have a frog and an elephant?" means there is no frog and no elephant. This suggests that some children do not fully follow De Morgan's laws with respect to linguistic conjunction early in development. It would be interesting to investigate children's understanding of De Morgan's laws with the same paradigm introduced here.

Children also showed a clear developmental pattern with respect to taking the contribution of *too* into account while guessing the outcome of the game. On average, children between 3;4 and 4;9 did not use the meaning of *too* to pick the correct outcome in the "X, too? Yes!" trials systematically while children between 4;9 and 5;7 were almost always right in those trials. It is important to note that the younger group's failure in these trials does not necessarily mean that they do not understand the meaning of *too*. It is possible that they are simply not following the pragmatic steps necessary for a successful update to their knowledge state, to pick the relevant outcome. In order to make a successful guess like the older group, they need to retrieve the salient alternative in context, accommodate the presupposition that the alternative is already present, and then update this by assuming the presence of the entity mentioned by the experimenter in arriving at the EF guess. The younger children may know the meaning of *too* but fail to follow one of the pragmatic steps in the experimental game. Barner et al. (2011), for example, argue that the absence of scalar reasoning for ⟨*some, all*⟩ in young children is mainly due to their inability to generate the salient linguistic alternatives to *some* in context. One can similarly argue that for *too*, younger children knew the meaning but failed to find the salient alternative to what was mentioned. Young children may also be more reluctant to accommodate presuppositions.

The third significant finding of this study is the fact that all participants are at ceiling with respect to pragmatic reasoning on both "X? No!" (without-trigger) and "X,too? No!" (with-trigger) trials. In the introduction,

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I hypothesized that asking the question "Do we have X?" would pragmatically imply that the salient alternative Y is present. However, this implication is weak and could leave some uncertainty that would be resolved by the semantic contribution of *too*. The results here suggest that this pragmatic implication is strong enough for both age groups to completely mask the semantic contribution of *too*. In other words, the question-answer pair "X? No!" generated such a strong implicature that little or no gain came from the addition of *too* in the negative without-trigger trials. These results seem at odds with the accounts of children's pragmatic competence which argue that young children are "more logical" than adults and stick to the literal meaning of words (Noveck, 2001).

Finally, the distribution of guesses for the children who responded with "X" to the "X,too? Yes!" trials, shows that they also respond with "X" to the "X? Yes!" trials. In other words, some children (n=11,) did not use the semantic contribution of *too* in their reasoning and strengthened the meaning of "X? Yes!" to "Only X? Yes!". This pattern is suggestive of strong pragmatic reasoning in young children and again contrasts with an account that considers young children to be interpreting language based on literal meaning with little or no pragmatic inferences.

3   General Discussion

In this section, I review the results of this study with respect to how children map projective content. This experiment was designed to test the acquisition of the presupposition trigger *too* in two respects: 1. its semantic/pragmatic contribution to the utterance 2. the property of projection. In taking the meaning of *too* into account, children showed a developmental trajectory: the younger children did not differentiate between the trials where *too* was present and trials where it was not, while the older children used the meaning of *too* to arrive at the correct answer in trials with *too*.

With respect to projection, this study found no evidence of a period of systematic mapping errors in the acquisition of the presupposition trigger *too*. All the children differentiated between trials where the trigger was present and trials where the semantic contribution of *too* was explicitly mentioned by the experimenter in a conjunction. This is consistent with the hypothesis that children use a pragmatic principle to map projective content as described in section 1.4. However, it is also possible that this study did not find any period of systematic mapping errors due to one of the following three reasons:

First, non-projective meaning of *too* may differ from the meaning of a conjoined salient alternative to the element mentioned earlier by the speaker. In other words, the assumptions about the at-issue content of *too* may be incorrect. One solution to this is to use trigger/non-trigger pairs like $\langle again, twice \rangle$ and $\langle both, two \rangle$ in future studies. This solution is still subject to the same

criticism since it is possible that these are not true trigger/non-trigger pairs.

Second, while there may be some period of mis-mapping in the acquisition of projective content, the period between the initial mis-mapping and later correction could be very short and hard to detect with a small scale experiment like the one presented above. I hope to remedy this in two ways in future research. First, I could run a more comprehensive study of a group of triggers and see if I can find a robust stage of mis-mapping for any of them. Second, I could simplify the design of the experiments further to be able to recruit more participants and improve the odds of finding children going through a mis-mapping period as well as increasing statistical power.

Third, mis-mapping of projective content may occur in children younger than 3.5 years old. Children in this study were between 3;4 and 5;7 and at this stage, children may have already identified projection as a relevant property in mapping *too*. There are two ways that we can test whether triggers are acquired earlier in acquisition: First a corpus study could investigate early appearance of triggers and confirm the successful production of triggers in children younger than 3.5 years old. Second, a follow up experimental study could recruit younger children and use an implicit measure such as eye-tracking that suits studies with younger children.

I would like to add that it will be fruitful to run the same study reported here with adults and compare the results with what we have for children. There are two areas where there may be differences: the semantic effect of *too* which was absent with children for the with-trigger negative trials, and

the interpretation of the negated conjunction in the "X&Y? No!" trials. I would expect the results for adults to have a significantly lower number of N responses in the "X&Y? No!" trials. This is indeed the next step in the development of this project. Finally, in the introduction I raised the issue of learnability with respect to the property of projection. A comprehensive corpus study of a set of triggers and the entailment canceling environments in child directed speech could confirm the richness of the input for learning the property of projection.

References

Barner, D., Brooks, N., and Bale, A. (2011). Accessing the unsaid: The role of scalar alternatives in childrens pragmatic inference. *Cognition*, 118(1):84–93.

Beaver, D. and Guerts, B. (2013). Presupposition. In Zalta, E. N., editor, *The Stanford Encyclopedia of Philosophy*. Stanford University.

Beaver, D. I. (1992). *The kinematics of presupposition*. Institute for Logic, Language, Information, University of Amsterdam.

Chierchia, G. and McConnell-Ginet, S. (1990). *Meaning and Grammar: An Introduction to Semantics*. MIT Press, Cambridge, Mass.

Clark, E. V. (1993). *The Lexicon in Acquisition*. Cambridge University Press.

Clark, E. V. (2009). *First language acquisition*. Cambridge University Press.

Csibra, G., Bıró, S., Koós, O., and Gergely, G. (2003). One-year-old infants use teleological representations of actions productively. *Cognitive Science*, 27(1):111–133.

Karttunen, L. and Peters, S. (1979). Conventional implicature. In Oh, C.-K. and Dinneen, D. A., editors, *Syntax and Semantics*, volume 11. Academic Press.

Markman, E. M. (1990). Constraints children place on word meanings. *Cognitive Science*, 14(1):57–77.

Noveck, I. A. (2001). When children are more logical than adults: Experimental investigations of scalar implicature. *Cognition*, 78(2):165–188.

Potts, C. (2014). Presupposition and implicature. In Lappin, S. and Fox, C., editors, *The Handbook of Contemporary Semantic Theory*. Oxford: Wiley-Blackwell, 2nd edition.

Premack, D. and Premack, A. J. (1997). Infants attribute value±to the goal-directed actions of self-propelled objects. *Journal of cognitive neuroscience*, 9(6):848–856.

Quine, W. V. O. (1960). *Word and Object*. MIT press, 2013 edition.

Simons, M., Tonhauser, J., Beaver, D., and Roberts, C. (2011). What projects and why. In *Proceedings of SALT*, volume 20, pages 309–327.

Tonhauser, J., Beaver, D., Roberts, C., and Simons, M. (2013). Toward a taxonomy of projective content. *Language*, 89(1):66–109.

Von Fintel, K. (1994). *Restrictions on quantifier domains*. PhD thesis, University of Massachusetts.