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Hope for Syntactic Bootstrapping

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1. Introduction

Attitude verbs, like *think*, *want* and *hope*, describe the contents of other people's minds, which are not directly observable. In such cases, information other than the physical context of use will be required to learn their meaning. The syntactic bootstrapping hypothesis (Landau & Gleitman 1985, Gleitman 1990) holds that the syntactic context provides one relevant source of information which children can use in identifying verb meanings. Attitude verbs represent the paradigm case for such learning because (a) the physical contexts in which they are used provide so little evidence about their meanings (Gleitman 1990, Gillette et al. 1999), and (b) their syntactic distributions are highly restricted (Landau & Gleitman 1985). Only attitude verbs take clausal complements and so the presence of a clausal complement is good evidence that a verb comes from that class. Attitude verbs are acquired later than many action verbs. This observation provides initial evidence for the syntactic bootstrapping hypothesis. If attitude verbs depend on the syntax of clausal embedding to be learned, we can expect the acquisition of clausal embedding to function as a bottleneck on their acquisition.

This perspective is further strengthened by mounting evidence that infants are surprisingly aware of the mental states of others (Onishi & Baillargeon 2005, Southgate et al. 2007, Surian et al. 2007, Kovács et al. 2010, Knudsen & Liszkowski 2012, Buttleman et al. 2009, He et al. 2017). From the first months of life, infants give privileged status to human agents, and are sensitive to the goals and perspectives of their conversation partners. They attribute goal-directedness to agents from as young as 5 months (Woodward 1998), and seem to track beliefs from as early as 7 months (Kovacs et al. 2010). This sensitivity to other minds also helps children in language acquisition. Children can track eye-gaze and use it to learn new words by 16 months (Baldwin 1991, Bloom 2000). In their second year, infants can use their knowledge of existing words to infer that a novel noun refers to a novel object (Markman & Wachtel 1988, Clark 1990, Mervis & Bertrand 1994, Diesendruck & Markson 2001, Halberda 2003). By age 2, children are adult-like in their interpretation of indexical pronouns, which shift reference based on conversational roles (Moyer et al. 2014). Given the salience of psychological states in infant reasoning and their efficacy in shaping word learning, linking psychological concepts with words may be no more difficult than linking object and event concepts with words, despite the lack of physical evidence in the world. If, due to this richness of the learners' representations of other minds, this linking is indeed straightforward, there should be no *conceptual* barrier to learning attitude verbs. Consequently, the view that syntax presents the barrier to acquisition is strengthened (Gleitman & Snedeker 2004).

While attitudes provide the strongest argument for the plausibility of syntactic bootstrapping, evidence for it is thin on the ground. Most of the evidence for syntactic bootstrapping has focused on simple action verbs (Fisher et al. 2009, Lidz et al. 2003, Naigles 1990, Naigles 1996, Scott 2009, Pinker 1989, Yuan & Fisher 2009), or on whether attitude verbs as a class can be differentiated from other classes of verbs (Fisher et al. 1991, Gleitman 1990, Gleitman et al. 2005, Landau & Gleitman 1985, Lidz et al. 2003, but see Papafragou et al. 2011).

Some attitude verbs seem to be acquired easily. Children start producing *want* to express desires as young as 18 months (Bartsch & Wellman 1995). They further seem to understand *want* sentences by around age 3 (Bartsch & Wellman 1995, Harrigan et al. 2018, Repacholi & Gopnik 1997, Wellman & Banerjee 1991, Wellman & Bartsch 1988, Wellman & Wooley 1990), even when the desired outcome conflicts with reality or with the child's own desires (Moore et al. 1995, Rakoczy et al. 2007, Rakoczy 2010, Harrigan 2015, Harrigan et al. 2018). This suggests that the concept of desire is readily available to very young children, that they are proficient at tracking others' minds, *and* that their sophisticated cognitive capacities allow them to link the word *want* to the desire concept with relative ease.

For *think*, however, we see a different trajectory. Many studies find that children have difficulty understanding *think* sentences well into their fourth year, when they report a false belief (de Villiers 2005, 2007, de Villiers & de Villiers 2000, de Villiers & Pyers 2002, Johnson & Maratsos 1977, Perner et al. 2003, Wellman et al. 2001, Wimmer & Perner 1983). Given the evidence for children's rich cognitive capacities and social sensitivity that make word learning, even for some attitude verbs, so easy, why should we see such difficulty with *think*?

A number of hypotheses address this *think*-*want* asymmetry in acquisition: some invoke differences in the concepts themselves (Perner et al. 2003, Perner et al. 2005, Perner & Ruffman 2005), others, differences in syntactic and semantic complexity between the verbs (de Villiers & de Villiers 2000, de Villiers 2007, de Villiers & de Villiers 2009). Our own view is that pragmatic differences in how these verbs are typically used mask children's early competence with *think* and the underlying belief concept (Hacquard 2014, Hacquard & Lidz 2018, Lewis et al. 2012, 2017). Regardless of the explanation, what these studies show is that children differentiate *want* from *think* early. This suggests that some aspect of a child's experience reveals that *think* and *want* belong to different semantic classes, even at a stage when they haven't fully mastered their meanings.

A good candidate for this triggering function is the difference in syntactic complements that these verbs select for, in accordance with the syntactic bootstrapping hypothesis. In English, belief verbs, like *think*, take finite complements, while desire verbs, like *want*, take nonfinite complements:

(1) John thinks that Mary is home.
(2) John wants Mary to be home.

Assuming that complement selection tracks a meaningful semantic distinction, and that learners are somehow privy to the link between syntactic complement and underlying semantic class, children can exploit it when learning novel attitude verbs. This should lead them to attribute desire-like meanings to verbs that take nonfinite complements, and belief-like meanings to verbs that take finite complements. This paper tests the viability of such a proposal.

In section 2, we briefly review the literature on the syntax and semantics of attitude reports, which argues for a principled link between the two, and spell out a syntactic bootstrapping account. In section 3, we present a series of experiments testing children's understanding of an unfamiliar attitude verb, *hope*, comparing it to their understanding of *think* and *want*. We exploit the fact that *hope* takes both finite and nonfinite complements. The syntactic bootstrapping hypothesis predicts that children will use syntax to figure out the meaning of unfamiliar attitude verbs, and in particular, that nonfinite complements should lead to desire-like interpretations (like *want*), while finite complements should lead to belief-like

interpretations (like *think*). This is exactly what we find. In experiments 1 and 2, we compare children's interpretation of *think* and *want* sentences in an experimental set-up that makes both beliefs and desires salient. We find that four-year-olds are adult-like with *want* and influenced by reality with *think*, reproducing past findings. Experiments 3 and 4 test children's comprehension of *hope*. We find that children are sensitive to syntactic frame, interpreting *hope* sentences differently depending on the complement: children are lured by reality with *hope* with a finite complement, as with *think*, but not with a nonfinite complement, as with *want*.

2. A syntactic bootstrapping hypothesis for attitude verbs: belief vs. desire

A syntactic bootstrapping account for attitude verbs minimally requires two things. First, the link between the semantics of different classes of attitudes and their syntactic distribution must be principled. Second, children must be sensitive to this link. In this section, we establish the link between belief and desire attitudes and their syntactic distribution, and present a syntactic bootstrapping proposal for attitudes. We first briefly review this *think-want* asymmetry in acquisition, and the different explanations from the literature.

2.1. think/want asymmetry in acquisition

Until at least age 4, children make consistent errors with *think* sentences used to report false beliefs (de Villiers 1995, de Villiers & de Villiers 2000, de Villiers & Pyers 2002, Johnson & Maratsos 1977, Sowalsky et al. 2009). In a context where John thinks that Mary is home, but she is really away, children typically reject a sentence like (3):

(3) John thinks that Mary is home.

Three year olds, however, show no difficulty with the corresponding *want* sentence, in a context where John wants Mary to be home, but she really is away:

(4) John wants Mary to be home.

The traditional explanation for this asymmetry from the developmental psychology literature is that it reflects an asymmetry in their grasp of the underlying concepts. Children are said to acquire the *desire* concept early, while the *belief* concept awaits the development of full theory of mind, around age 4 (Perner et al. 2003, Perner et al. 2005, Perner & Ruffman 2005, a.o.). The relative delay of the belief concept could also be due to less exposure to explicit reference to belief *vs.* desire, or greater processing demands for beliefs than for desires (see Moore et al. 2005, Rakoczy et al. 2007, Rakoczy 2010). For de Villiers and colleagues (de Villiers & de Villiers 2000, de Villiers 2007, de Villiers & de Villiers 2009), the development of the belief concept is enabled by the grammatical development of the type of complement that verbs like *think* or *say* select for, namely finite complements, which can be true or false. Mastering this kind of structure, in which a false sentence can be embedded under a true one, gives children the conceptual scaffolding to represent false belief.

That children independently struggle with the belief concept until age 4 is supported by hundreds of explicit false belief tasks (for a meta-analysis, see Wellman et al. 2001). However, numerous infant studies in the last fifteen years cast doubt on the conceptual hypothesis, by showing that infants as young as 7 months show surprise when protagonists act in ways that are inconsistent with their beliefs, whether these beliefs are true or false (Onishi & Baillargeon 2005,

Southgate et al. 2007, Kovacs et al. 2010, a.o.). While the exact nature of the disconnect between infants' performance on such implicit false belief tasks, and that of older children on explicit tasks is under debate, a growing number of researchers take the former to truly reflect children's conceptual competence, and blame factors other than conceptual deficiency to explain older children's consistent failures, such as additional task demands (Hansen 2010, Rubio-Fernandez & Geurts 2012, Helming et al. 2014).

For the remainder of this paper, we bracket the analysis of children's difficulty with *think*, but instead rely on this difficulty as diagnostic for children's interpretation of a verb as a belief verb. The interested reader is referred to Lewis et al. (2012, 2017) and Hacquard & Lidz (2018) for explanation of this difficulty.

2.2. think/want asymmetry in syntax/semantics

Attitude verbs have been argued to fall into two main semantic classes: Bolinger's (1968) "*representationals"* (*think, say*), which express judgments of truth, and "preferentials" (*want, wish*), which express preferences. The formal linguistic literature argues extensively that this split in representationality is tracked by syntactic selection in different languages. In Romance languages, representationals select for complements in the indicative mood, preferentials for complements in the subjunctive mood, as shown in (5) and (6) for French (Bolinger 1968, Hooper 1975, Farkas 1985, Giannakidou 1997, Villalta 2008).

(5) Jean veut que Marie vienne.
Jean wants that Marie come-SUBJ.
'*Jean wants Marie to come*.'

(6) Jean pense que Marie vient.
Jean thinks that Marie comes-IND.
'*Jean thinks that Marie is coming*.'

In English, representationality is also tracked syntactically: representationals typically take finite complements, preferentials nonfinite complements, as we saw in (1) and (2)[1]. In German, the split is tracked by word order. Typically, embedded clauses in German are verb final. However, representationals, but not preferentials, allow the verb to appear in second position (Truckenbrodt 2006, Scheffler 2008):

(7) Maria denkt, dass Peter heute kommt. Maria denkt, Peter kommt heute.
Maria thinks that Peter today comes Maria thinks Peter comes today
'*Mary thinks that Peter is coming today.*'

(8) Maria will, dass Peter heute kommt. *Maria will, Peter kommt heute.
Maria wants that Peter today comes Maria wants Peter comes today
'*Mary wants Peter to come today.'*

[1]Bolinger (1968) argues that the syntactic feature in English that correlates with mood selection in Romance is complement preposing. Representationals allow preposing (*John is home, I think*), preferentials do not *(#John to be home, I want*). Here we focus on finiteness, which also tracks representationality (see White et al. 2012, 2018).

Thus, in English, Romance and German, syntactic distribution may serve as a cue as to whether a given attitude verb falls into the representational or the preferential class, though the cue differs across languages. This may at first blush seem to be problematic for a bootstrapping learning strategy, as learners cannot anticipate the particular features specific to their language. However, although the specific features associated with both semantic classes differ cross-linguistically, they seem to converge at an abstract level (Hacquard & Lidz 2018): the complements of representationals, but not preferentials, allow syntactic features found in declarative main clauses in that language, the clause type typically used for assertions: indicative mood for Romance, finiteness for English, Verb Second for German. Thus, at the right level of abstraction, syntax tracks representationality in ways that might be useful to the learner.

2.3. A syntactic bootstrapping hypothesis for attitudes

Syntax could play a crucial role in helping learners map attitude verbs into two main semantic classes: *representationals* (judgment of truth) take complements with syntactic hallmarks of declarative clauses, *preferentials* (desire) do not: their complements instead resemble imperative clauses. The acquisition trajectory could look as follows (for details, see Hacquard & Lidz 2018): by seeing a verb with syntactic hallmarks of declarative clauses in its complement, a learner infers that this verb must express a judgment of truth. In contrast, the lack of declarative syntax in complements of verbs like *want* leads learners to assume that the verb expresses a preference.

Hacquard & Lidz (2018) further argue that assigning a verb like *think* to the representational class leads to false belief errors, because of a further link between the representational class and the type of indirect speech acts this class naturally triggers, namely, indirect assertions. When children hear a verb with a complement with declarative syntax (the clause type typically reserved for assertions), they assume that the speaker is indirectly asserting the complement clause, and they reject it, if they know the complement to be false (for experimental evidence in support of this view, see Lewis et al. 2012, 2017).

This syntactic bootstrapping hypothesis makes the following predictions. Upon hearing an unfamiliar attitude verb, children will exploit the syntactic frame in which it appears: with a finite complement, they will assume a representational (belief) meaning. This will lead to reality-based errors. With a nonfinite complement, they will assume a preferential (desire) meaning, and hence no reality-based errors. We test these predictions next.

3. Testing the syntactic bootstrapping hypothesis for attitude verbs: *think, want, hope*

Syntactic bootstrapping provides a plausible explanation for how children first categorize *think* and *want*: their syntactic distribution might alert the learner that they belong to two separate semantic classes, representational vs. preferential. To demonstrate the validity of this hypothesis, we need to show that children are sensitive to syntax when learning a novel attitude verb. Both *think* and *want* are very clear examples—syntactically and semantically—of the representational and preferential subclasses. *Want* expresses only a desire, *think* expresses only a belief. Furthermore, their syntactic distributions are exactly complementary. We focus here on the less straightforward verb *hope.*

Hope shares semantic and syntactic properties with both. Syntactically, we observe distributional facts that are consistent with both classes. *Hope* can take both nonfinite (9) and finite (10) complements:

(9) John hopes (for Mary) to be home.

(10) John hopes that Mary is home.

Hope also shares meaning components with both classes. *Hope* has an obvious desire component: it always expresses a preference, regardless of syntactic frame. In the above sentences, the *hoper* desires the content of the embedded clause. *Hope* also seems to have a belief component (Portner 1992, Scheffler 2008, Anand & Hacquard 2013): the complement has to be a doxastic possibility for the subject. In a scenario where Mary is away, and John knows this, John can still *want* her to be home, but it is infelicitous to say that he *hopes* that she is home (11)-(12). Thus, *think* expresses a commitment to truth, *hope* expresses a commitment to the possibility of truth, *want* expresses neither.

(11) John knows Mary is away, but he wants her to be home.
(12) #John knows that Mary is away, but he hopes she's home.

These facts suggest that syntactic distribution might track semantic features, even in the case of *hope*: *hope* can take both finite and nonfinite complements, and both belief and desire meaning components are present. For our syntactic bootstrapping hypothesis to hold, the learner must be able to use the syntax to get to the semantics. We will now see why *hope* is an ideal case to investigate this.

Think and *want* are quite common in the input. Looking in the CHILDES database (MacWhinney 2000), we found that *want* occurs 22,012 and *think* 10,187 times per million utterances. Thus children may possibly get some help from the situational contexts in figuring out their meanings. *Hope* is much less frequent, occurring at a rate of 364 times per million utterances. It is thus unlikely that children have had enough exposure to know its meaning by age 4. Do children understand that *hope* has a desire component and a belief component? And is this understanding influenced by the kind of syntactic frame it appears in?

We now present a series of experiments testing children's comprehension of *want*, *think,* and *hope*. Previous research shows that children have difficulty with *think* but not *want*, in particular when the complement is false. Thus, in contexts in which the shape under consideration is not a heart, children would typically reject (13), but accept (14).

(13) Froggy thinks that it's a heart.
(14) Froggy wants it to be a heart.

Our experimental set-up makes both beliefs and desires salient, which are sometimes in line with reality or counter to it. Our goals with experiments 1 and 2 are to (i) reproduce the *think/want* asymmetry within a single experimental paradigm, (ii) establish patterns of responses to desire (*want*) and belief (*think*) verbs, which we use to compare their responses to *hope*, in experiments 3 and 4. In experiments 3 and 4, we test children's comprehension of *hope* and manipulate complement type (finite (15) or nonfinite (16)), to see if it influences interpretation.

(15) Froggy hopes that it's a heart.
(16) Froggy hopes to get a heart.

We predict that children's responses to *hope* sentences should be influenced by syntactic frame: with a nonfinite complement (16), children should give *want*-like responses: they

shouldn't be lured by reality, and thus accept such sentences even when the shape is actually a star. With a finite complement (15), children should give *think*-like responses: they should be lured by reality, and reject such sentences when the shape is actually a star.

3.1. Experiment 1

While many studies have made claims about children's understanding of *want* vs. *think*, few directly compare them. Perner et al. (2003) looked at interpretation of both verbs using different stories that were not exactly matched. In experiment 1, we test *want* and *think* in a single task that makes both beliefs and desires salient.

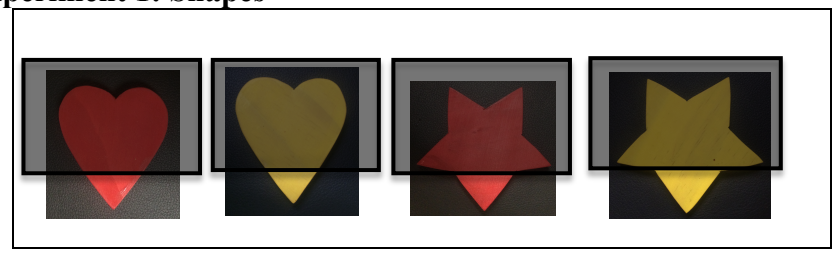
3.1.1. Experiment 1: Subjects

Participants were 48 children aged 4,0 to 5,0 (mean=4,6). 6 additional children were excluded from the task, 4 due to getting too many controls incorrect, 1 due to parental report of hearing below 80% English, 1 due to experimenter error. Children were recruited from the greater Washington DC area, and tested in the Project on Children's Language Learning lab at the University of Maryland.

3.1.2. Experiment 1: Design and Materials

To manipulate verb (*want* vs. *think*), we set up a game in which both the beliefs and desires of a character are relevant. The child plays with a puppet, *Froggy*. The child and one experimenter are behind an occluder, while Froggy is on the other side. In front of the child is a box with 40 wooden shapes. The shapes, which are hearts and stars, are either red or yellow. Color is predictive of shape: 15 of the hearts are red and 5 are yellow, and 15 of the stars are yellow and 5 are red. In the game, the child and the experimenter pull shapes out of the box to show Froggy, and every time the shape is a heart, the child gives Froggy a sticker. We establish that Froggy likes getting stickers, therefore his desire on every trial is that a heart be pulled out. On each trial, before Froggy sees what the shape is, the child and the experimenter show him a "clue," which is ambiguous in shape. There is an opening in the occluder that is the right shape for a point—either the point of the heart or one of the points of the star (figure 1).

FIGURE 1: Experiment 1: Shapes



This way, on every trial, Froggy has both a *desire* about the shape—because he always wants the shape to be a heart, and a *belief*—because whenever it is red, he thinks it's a heart and when it's yellow he thinks it's a star. This set-up allows another puppet, *Booboo*, whom the child is told is "silly and wants to learn how to play the game, but often gets things mixed up," to utter test sentences either about what Froggy *wants* (17) or what he *thinks* (18).

(17) *Froggy wants it to be a heart/star!*

(18) *Froggy thinks that it's a heart/star!*

The child's job in the task is then to say whether Booboo is correct or incorrect.

In a 2x2x2x2 design, we tested verb as a between-subjects factor (*want* (n=24)*, think* (n=24)), and color (red vs. yellow), shape (heart vs. star) and mentioned shape (heart vs. star) as within-subjects factors. The child's response of *yes* or *no* was the dependent measure. On every trial, Froggy had both a belief and a desire about the next shape. His "belief" was dictated by the color of the clue. When color correctly predicted shape (red heart, yellow star conditions), his belief was true. When it did not (red star, yellow heart), his belief was false. Similarly, his desire for a heart was sometimes fulfilled (heart conditions), and sometimes unfulfilled (star conditions). This set-up allows for an ideal comparison of interpretation of *think* and *want* sentences —in both cases, the child is asked to reason about a mental state (belief or desire) which may conflict (false belief/unfulfilled desire) or be consistent with (true belief/fulfilled desire) reality. The goal is to see whether children have more difficulty with conflicting beliefs than desires, as in previous literature. In the study, the participant encounters every possible combination of realized and non-realized beliefs or desires. The experiment includes 4 items of each type, for a total of 32 test items per child. Table 1 shows all 16 conditions. "Mentioned" is the name of the shape mentioned in the test sentences (heart or star).

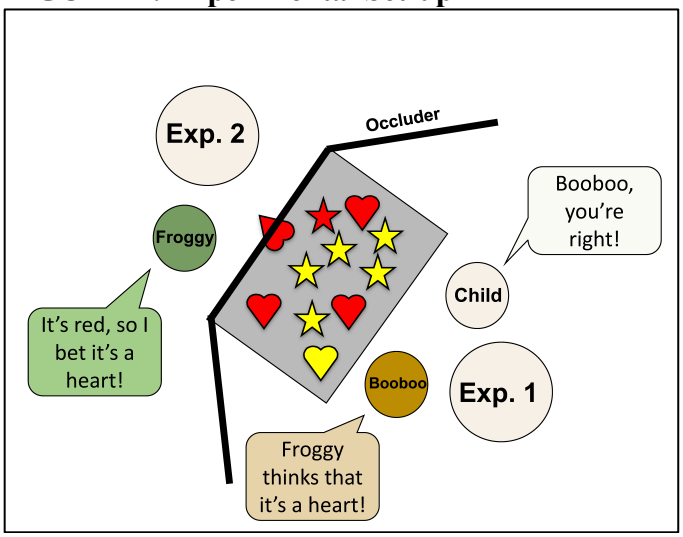
TABLE 1: Experiment 1: Conditions

Verb (between subjects)	Color (within subjects)	Shape (within subjects)	Mentioned (within subjects)
Think	Red	Heart	Heart
			Star
		Star	Heart
			Star
	Yellow	Heart	Heart
			Star
		Star	Heart
			Star
Want	Red	Heart	Heart
			Star
		Star	Heart
			Star
	Yellow	Heart	Heart
			Star
		Star	Heart
			Star

3.1.3. Experiment 1: Procedure

Each child was tested in a quiet room with two experimenters. One experimenter sat next to the child and gave the child instructions about the game. This experimenter controlled the silly puppet, "Booboo," and delivered the filler and test sentences. The other experimenter sat on the other side of the occluder, and played Froggy (see figure 2).

FIGURE 2: Experimental Set-up



The second experimenter also coded the child's responses. Permission was obtained from parents to video record each subject in case any responses were missed during online coding. The experiment began by the child being introduced to "Froggy":

> *"Hi, [child's name]. This is Froggy! We're going to play a game with Froggy today!"*

Next, the child completed several practice sections to ensure that they understood all the necessary elements of the game, including Froggy's desires and beliefs in this context. The practice sections are detailed below.

3.1.3.1. Practice Sections

Practice Section #1: Practice with distribution. The first warm-up directs the child's attention to the distribution of colors and shapes. The shapes are divided up on the table in front of the child.

> *"Froggy has a whole bunch of different shapes. Let's look at what shapes he has! Can you tell me about the shapes? Some of them are red! Can you tell me what kinds of red shapes we have?"*
> *[Child responds 'hearts and stars'.]*
> *"That's right! Hearts and stars! Do we have a lot of the red hearts or just a few? And what about red stars?"*

The point of this warm-up is for the child to notice the distribution of colors and shapes. We have them tell us about each type—lots of red hearts and yellow stars, few red stars and yellow hearts. This helps them develop the intuition that a red clue is more likely to be a heart and a yellow clue is more likely to be a star, and that Froggy's guesses will reflect this.

Practice Section #2: Child and Froggy guessing game. During the next warm-up section, we put all the shapes in the box, and the experimenter turns the occluder so that the child can no longer see the shapes. She then shows Froggy and the child clues—which are in the form of a point sticking through a slot in the occluder. The point is ambiguous—it could be a star or a heart.

Neither the child nor Froggy can see what the shape is. The child is told that they will guess what the shape is, then Froggy will guess, and then the experimenter will take the shape out so everyone can see. If the shape is a heart, the child gives Froggy a sticker. The shapes pulled out during this section reflect the distribution in the box. The point of this practice is for the child to experience seeing the ambiguous clues, so that they understand that from the other side of the occluder, it is impossible to tell. They sometimes have the experience of guessing incorrectly and then being surprised when the clue is taken out. This section also demonstrates to the child Froggy's default guesses— when the clue is red, Froggy guesses heart, when it's yellow, he guesses a star.

Practice Section #3: Froggy's default guess check. The next practice section ensures that children understand Froggy's belief (or default guess) for each clue type. The experimenter checks this by asking the following questions:

> *"So when Froggy sees a red clue, what kind of shape does he guess? Right, a heart! And when Froggy sees a yellow clue, what kind of shape does he guess? Right, a star!"*

Practice Section #4: Practice with Booboo. In the final warm-up section, children are introduced to the silly puppet, Booboo, who watches them play the game with Froggy. The child is told the following about Booboo:

> *"OK, one more thing! This is Froggy's friend, Booboo! Booboo really wants to learn how to play the game, but he's really silly and he always gets things mixed up! He always forgets what kind of shapes Froggy likes, and what kind of stuff Froggy guesses when he sees clues. But you're super good at that, right? So maybe you could help Booboo learn, could you do that? OK, good! So Booboo is going to watch us play, and sometimes he's going to try to tell us something about Froggy, but he might get it wrong, and your job is going to be to help him out and tell him whether he's right or wrong so he can learn how to play the game. How does that sound?"*

After Booboo is introduced, the child is told that we are going to show Booboo some clues, and see what he says about Froggy. Then Booboo is shown four clues—one of each type—and says sentences about what Froggy will guess, and whether he likes that shape or not. During the time that the clue is only visible to the child, Booboo says a sentence about what Froggy will guess given the color (20) and after the shape is taken out, Booboo says a sentence about whether Froggy likes that shape or not (21).

(19) *This one is red/yellow… so Froggy is going to guess heart/star!*
(20) *Oh! Froggy likes/doesn't like that kind!*

The child's job is to tell Booboo whether his statement is right or wrong. This gives the child a chance to observe that Booboo is bad at remembering Froggy's mental states, and practice telling him when he is right and wrong. This section also serves as a reminder of Froggy's desires and

beliefs. If children have any trouble correcting Booboo on this section, they are given help from the experimenter.

3.1.3.2. Test Sentences

After the warm-up sections are finished, the box of shapes and the occluder are turned so that the child can see which shape is under discussion. They are told that now they are going to be able to "peek" while we show Froggy some more clues, and Booboo is still going to say something about "what Froggy likes, or what he might guess." Then we begin showing Froggy clues, and uttering test sentences. The whole game takes about 25 minutes.

3.1.4. Experiment 1: Results

Children's responses were coded online by the second experimenter. There are three possible response patterns given the experimental setup. Each pattern is described below, including the predicted responses in each condition consistent with each response pattern. One pattern is to interpret the sentence as describing Froggy's *desires*. Children behaving this way should assent to sentences that mention "heart," regardless of what shape and color the shape actually is, because Froggy always wants it to be a heart (table 2).

TABLE 2: Desire Responses

CONDITION (within subjects)	Mentioned Shape	Desire Response
RED HEART	Heart	Yes
	Star	No
RED STAR	Heart	Yes
	Star	No
YELLOW HEART	Heart	Yes
	Star	No
YELLOW STAR	Heart	Yes
	Star	No

The second pattern are responses based on Froggy's *beliefs*. Children should assent to sentences that mention a heart whenever the clue is red, and to sentences that mention a star whenever the clue is yellow (table 3).

TABLE 3: Belief Responses

CONDITION (within subjects)	Mentioned Shape	Belief Response
RED HEART	Heart	Yes
	Star	No

RED STAR	Heart	Yes
	Star	No
YELLOW HEART	Heart	No
	Star	Yes
YELLOW STAR	Heart	No
	Star	Yes

Finally, we may see responses based on *reality*. Children should assent to sentences in which mentioned shape and actual shape are the same, regardless of color, desire or belief (table 4).

TABLE 4: Reality Responses

CONDITION (within subjects)	Mentioned Shape	Reality Response
RED HEART	Heart	Yes
	Star	No
RED STAR	Heart	No
	Star	Yes
YELLOW HEART	Heart	Yes
	Star	No
YELLOW STAR	Heart	No
	Star	Yes

The adult-like responses are, of course, to respond based on the puppet's desire when the sentence is about what he *wants*, and based on belief when it is about what he *thinks*. Adults should never give reality-based responses. For children, however, we predict a different pattern. In the *think* condition, we expect reality-based responses if children show the same difficulty that they do in typical false belief tasks. In the *want* condition, we expect desire-based responses if children are adult-like, as in previous studies. Table 5 shows the predictions for all three response types, highlighting adult-like responses in each condition. The rightmost column shows the predictions for children's responses, highlighting the conditions in which we expect children to differ from the adult pattern.

TABLE 5: Predictions Based on Response Type

VERB (between subjects)	CONDITION (within subjects)	Mentioned Shape	Desire	Belief	Reality	Child Predictions

THINK	1. RED HEART	Heart	Yes	**Yes**	Yes	Yes
		Star	No	**No**	No	No
	2. RED STAR	Heart	Yes	**Yes**	No	**No**
		Star	No	**No**	Yes	**Yes**
	3. YELLOW HEART	Heart	Yes	**No**	Yes	**Yes**
		Star	No	**Yes**	No	**No**
	4. YELLOW STAR	Heart	Yes	**No**	No	No
		Star	No	**Yes**	Yes	Yes
WANT	5. RED HEART	Heart	**Yes**	Yes	Yes	Yes
		Star	**No**	No	No	No
	6. RED STAR	Heart	**Yes**	Yes	No	Yes
		Star	**No**	No	Yes	No
	7. YELLOW HEART	Heart	**Yes**	No	Yes	Yes
		Star	**No**	Yes	No	No
	8. YELLOW STAR	Heart	**Yes**	No	No	Yes
		Star	**No**	Yes	Yes	No

Children's responses were measured in percent *yes*-responses. Red heart items were counted as controls: because this is a case of realized belief and realized desire, we predict the same pattern of responses, whether based on desire, belief *or* reality. They should say *yes* when a heart is mentioned (21) and *no* when a star is mentioned (22), regardless of verb (see table 5).

(21) *Froggy wants it to be/thinks that it's a heart!*
(22) *Froggy wants it to be/thinks that it's a star!*

We excluded participants who got fewer than 6 out of the 8 red heart items correct. We excluded 4 children for this reason.

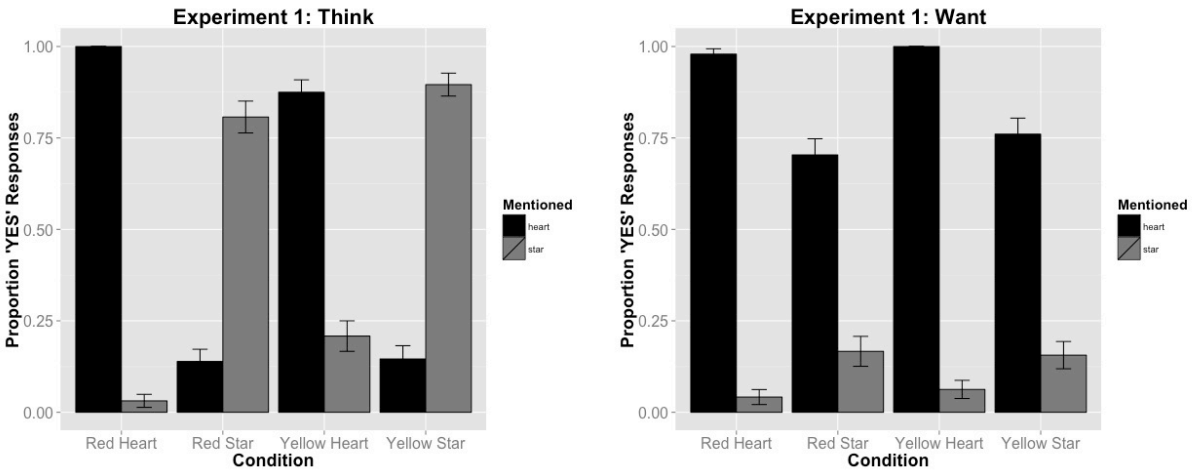
3.1.4.1. Analysis

In line with previous work, we find that children are adult-like with *want*, but influenced by reality with *think*. Proportion *yes* responses for all conditions are shown in table 6 and figure 3. Highlighted responses show conditions in which children's responses differed from target responses.

TABLE 6: Experiment 1: Between- and Within-Subjects Conditions

VERB (between subjects)	CONDITION (within subjects)	MENTAL STATE STATUS	Mentioned Shape	Target	Proportion *Yes* (SD)
THINK	1. RED HEART	TRUE BELIEF FULFILLED DESIRE	Heart	Yes	1.00 (0)
			Star	No	.03 (.17)
	2. RED STAR	FALSE BELIEF UNFULFILLED DESIRE	Heart	Yes	**.14 (.35)**
			Star	No	**.85 (.40)**
	3. YELLOW HEART	FALSE BELIEF FULFILLED DESIRE	Heart	No	**.87 (.33)**
			Star	Yes	**.22 (.41)**
	4. YELLOW STAR	TRUE BELIEF UNFULFILLED DESIRE	Heart	No	.05 (.21)
			Star	Yes	.91 (.31)
WANT	5. RED HEART	TRUE BELIEF FULFILLED DESIRE	Heart	Yes	.98 (.14)
			Star	No	.04 (.20)
	6. RED STAR	FALSE BELIEF UNFULFILLED DESIRE	Heart	Yes	.70 (.46)
			Star	No	.17 (.37)
	7. YELLOW HEART	FALSE BELIEF FULFILLED DESIRE	Heart	Yes	1 (0)
			Star	No	.06 (.24)
	8. YELLOW STAR	TRUE BELIEF UNFULFILLED DESIRE	Heart	Yes	.76 (.43)
			Star	No	.16 (.36)

FIGURE 3: Experiment 1: Between- and Within-Subjects Conditions



As shown above, children are adult-like in their responses to *want*, which match the "desire" predictions but not to *think* sentences, which match the "reality" predictions.

We ran a 2x2x2x2 ANOVA over all between- and within-subjects conditions: Verb, Mentioned, Shape and Color, and find main effects and interactions that support the above conclusions. The data in Table 6 shows that children are influenced by the mentioned shape for *want* but not *think* sentences. Overall, we see that in the *want* conditions, children assent to mentioned heart sentences 86% of the time, and to mentioned star sentences only 9.75% of the time. For *think* sentences, however, we do not see children taking the mentioned shape into account. Rather, they are at chance, assenting to mentioned heart sentences 51.5% of the time, and mentioned star sentences 50.25% of the time. We find a reliable 2-way interaction between Verb and Mentioned, supporting this observation ($F(1,376) = 914.95$, $p < .0001$). Because mentioned shape is so important for participants in the *want* condition, we also find a main effect for Mentioned ($F(1,376) = 261.07$, $p < 0.0001$), and a 3-way interaction between Verb, Mentioned and Color ($F(1,376) = 5.04$, $p = .0253$).

Children are also sensitive to reality in the *think* conditions. This is particularly evident in the false belief conditions, the RED STAR (2) and the YELLOW HEART conditions (3). In these conditions, Froggy has a belief about the shape based on color, but the belief is false. We thus expect children to respond based on reality, not belief. As expected, we see that in the RED STAR conditions, children assent to sentences in which 'star' is mentioned (85% *yes*-responses), and reject sentences where 'heart' is mentioned (14% *yes*-responses). We see the same pattern in the YELLOW HEART conditions (3): the clue is yellow, so the puppet believes it to be a star, but in reality, it is a heart. Again, children respond based on reality—assenting to sentences that mention 'heart' (87% *yes*-responses) and rejecting sentences that mention 'star' (22% *yes*-response). The data is supported by our statistical analysis. We find an interaction between Mentioned and Shape ($F(1,376) = 360.51$, $p < .0001$), demonstrating that children respond differently to items in which mentioned shape matches actual shape compared to when they do not. Although we do not predict this for *want*, we find that children are strongly influenced by reality (i.e. match between mentioned and shape) for *think*, which is likely driving this interaction. This is confirmed by the 3-way interaction between Mentioned, Shape and Verb ($F(1,376) = 133.97$, $p < .0001$). In sum, we replicate previous findings: children are adult-like with *want*, but influenced by reality when there is a conflict with *think*.

3.1.4.3. Experiment 1 Summary

When children are tested under the same experimental conditions for both verbs, 4-year-olds are still much better at interpreting *want* than *think*. Children are influenced by reality only with *think* sentences about someone's false belief.

3.2 Experiment 2

Experiment 1 provided a novel demonstration that children's success with desire sentences precedes their success with belief sentences, using a single task that makes both beliefs and desires relevant. This effect was revealed between participants. In experiment 2, we manipulate verb within participants, so that we can be sure that the *think/want* asymmetry can be observed within the same children.

3.2.1. Experiment 2: Subjects

Participants were 48 children aged 4,0 to 5,0 (mean=4,7). An additional 5 children were excluded: 2 got too many controls wrong, and 3 did not finish the task. Children were recruited from the greater Washington DC area, through a recruitment database or through local preschools, and tested either in the Project on Children's Language Learning lab at the University of Maryland, or at local preschools.

3.2.2. Experiment 2: Design and Materials

The design and materials very similar to experiment 1 (see section 3.1), except that Verb was a within-subjects factor, meaning that each child heard test sentences with both *want* and *think*, (23) and (24).

(23) *Froggy wants it to be/thinks that it's a heart!*
(24) *Froggy wants it to be/thinks that it's a star!*

In a 2x2x2x2x2 design, we tested four within-subjects factors: verb (*want* vs. *think*), color (red vs. yellow), shape (heart vs. star) and mentioned shape (heart vs. star). Because each subject heard test sentences with both *think* and *want* in a blocked design, we tested order (1, *think*-first (n=24) vs. 2, *want*-first (n=24)) as a between-subjects factor. The child's response of *yes* or *no* was the dependent measure. Just as in experiment 1, on every trial, Froggy had both a belief and a desire about the next shape. His "belief" about the identity of the shape was dictated by the color of the clue. When color correctly predicted shape (RED HEART, YELLOW STAR conditions), his belief was true. When it did not (RED STAR, YELLOW HEART), his belief was false. Similarly, his desire for a heart was sometimes fulfilled (heart conditions), sometimes not (star conditions). As in experiment 1, each participant encountered every possible combination of realized and non-realized beliefs or desires. However, because we added an additional within-subjects factor, we also needed to adjust the number of items in each condition, as simply doubling the number of items would have resulted in a task that was much too long. Because the red and yellow heart items are essentially controls, children in experiment 2 got only 2 of each per verb (one "heart" and one "star" mention each). We also reduced the number of red and yellow star items to 6 each per verb (three "heart" and three "star" mention items per verb). This makes a total of 32 test items per child (table 7).

TABLE 7: Experiment 2: Within-Subjects Conditions

CONDITION	**Desire**	**Belief**	**# per verb**
RED HEART	Fulfilled	Realized	2
RED STAR	Unfulfilled	Non-Realized	6
YELLOW HEART	Fulfilled	Non-Realized	2
YELLOW STAR	Unfulfilled	Realized	6

All materials were identical to those described in experiment 1 (section 3.1.2).

3.2.3 Experiment 2 Procedure

The procedure was identical to that described in experiment 1 (section 3.1.3). Although there were more test items in experiment 2, the duration of the experiment was still around 25 minutes per child, because there were fewer "heart" items, which are more time-consuming due to the awarding of stickers for these items.

3.2.4. Experiment 2: Results

Children's responses were coded online by the second experimenter. Like in experiment 1, there are three possible response patterns—desire, belief and reality (tables 2, 3 and 4 from section *3.1.4.*). Adult-like responses are again to respond based on Froggy's desire when the sentence is about what he *wants*, and based on beliefs when it is about what he *thinks*. In experiment 1, children were adult-like in the *want* conditions, but gave reality-based responses in the *think* conditions. Assuming that their representations of the verbs are robust and not sensitive to priming effects, we expect the same pattern in experiment 2.

Children's responses were measured in percent *yes*-responses. In experiment 1, sentences in the RED HEART condition were controls, because responses should be the same, whether based on desire, belief *or* reality: children should say *yes* when a heart is mentioned (31) and *no* when a star is mentioned (32), regardless of verb (see Table 5). In experiment 2, however, we counted all heart items as controls, as we had fewer RED HEART condition items overall in this experiment, and we saw that children's responses were extremely consistent for all heart conditions in experiment 1. Children had to get three out of four of the heart items correct to be included in the study. We excluded 2 children for failing to meet these criteria.

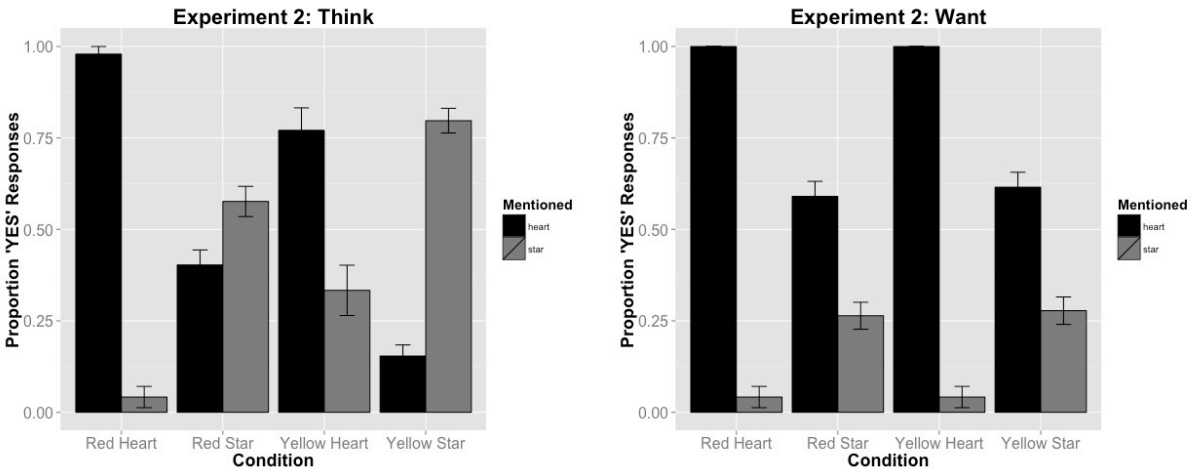
3.2.4.1. Analysis

Replicating experiment 1, we find that children are adult-like in interpreting *want*, but influenced by reality with *think*. Proportion *yes* responses for all conditions are shown in table 8 and figure 4. Highlighted responses show conditions in which children's responses differed from target responses. Overall, the conditions in which Froggy's mental state conflicted with reality were closer to chance in experiment 2 compared to experiment 1, showing that seeing both verbs caused children to be more susceptible to reality. However, the overall pattern of responses still looks very similar to experiment 1, with children differing from the adult-like pattern in the false belief cases (2, 3) more than in the unfulfilled desire cases (6, 7).

TABLE 8: Experiment 2: Within-Subjects Conditions

VERB (within subjects)	CONDITION (within subjects)	MENTAL STATE STATUS	Mentioned Shape	Target	Proportion Yes (SD)
THINK	1. RED HEART	TRUE BELIEF FULFILLED DESIRE	Heart	Yes	.98 (.14)
			Star	No	.04 (.20)
	2. RED STAR	FALSE BELIEF UNFULFILLED DESIRE	Heart	Yes	**.40 (.49)**
			Star	No	**.58 (.50)**
	3. YELLOW HEART	FALSE BELIEF FULFILLED DESIRE	Heart	No	**.77 (.42)**
			Star	Yes	**.33 (.48)**
	4. YELLOW STAR	TRUE BELIEF UNFULFILLED DESIRE	Heart	No	.15 (.36)
			Star	Yes	.80 (.40)
WANT	5. RED HEART	TRUE BELIEF FULFILLED DESIRE	Heart	Yes	1.0 (0)
			Star	No	.04 (.20)
	6. RED STAR	FALSE BELIEF UNFULFILLED DESIRE	Heart	Yes	.59 (.49)
			Star	No	.26 (.44)
	7. YELLOW HEART	FALSE BELIEF FULFILLED DESIRE	Heart	Yes	1.0 (0)
			Star	No	.04 (.20)
	8. YELLOW STAR	TRUE BELIEF UNFULFILLED DESIRE	Heart	Yes	.61 (.49)
			Star	No	.28 (.45)

FIGURE 4: Experiment 2: Within-Subjects Conditions



Even in a verb-within-subjects blocked design, children are more adult-like in their responses to *want*, which match the "desire" pattern than in their responses to *think*, which match the "reality" pattern.

We ran a 2x2x2x2x2 ANOVA over all between- and within-subjects conditions: Verb, Mentioned, Shape, Color and Order. The statistical analysis supports our conclusion, and replicates the findings from experiment 1. The data in Table 11 shows that children are influenced by mentioned shape for *want* but not *think* sentences. In the *want* conditions, children assent to mentioned heart sentences 80.2% of the time, and to mentioned star sentences only 15.7% of the time. This observation is supported by a reliable 2-way interaction between Verb and Mentioned ($F(1,781) = 97.29$, $p < 0.0001$). Because mentioned shape is so important for participants in the *want* condition, we also find a main effect for Mentioned ($F(1,781) = 231.24$, $p < 0.0001$), and a 3-way interaction between Verb, Mentioned and Color ($F(1,781) = 11.60$, $p<0.0001$). We also find that children are sensitive to reality in the *think* conditions. They assent to sentences in which mentioned shape matches actual shape, and reject sentences in which there is a mismatch. For the Heart conditions, children assent to mentioned heart sentences 87.5% of the time and mentioned star sentences only 37.5% of the time. For Star conditions, they assent to mentioned star sentences 68.7% of the time, and to mentioned heart conditions only 27.8% of the time. This is supported by statistical analysis. A reliable interaction between Mentioned and Shape ($F(1,781) = 282.56$, $p < 0.0001$) demonstrates that children responded differently to items in which mentioned shape and actual shape match, as compared to when they do not. Although we do not see this for *want*, the effect is strong enough for the *think* sentences to drive this interaction. This is confirmed by the reliable 3-way interaction between Mentioned, Shape and Verb ($F(1,781) = 19.71$, $p < .0001$). Critically, we find no main effect of Order ($F(1,781) = 2.36$, $p = 0.13$), and no interaction between Order and Verb ($F(1,781) = 0.028$, $p = 0.87$). In sum, we replicate the findings from experiment 1.

3.2.4.3. Experiment 2 Summary

When children hear both *think* and *want* in the same experiment, they are adult-like with *want* and influenced by reality with *think*. This suggests that the *think/want* asymmetry is a strong effect, even within individuals. Additionally, it shows that the task demands are not too high for children to switch between interpretations, even when they get multiple sentence conditions in a blocked design. This will become important in experiment 4.

3.3. Experiments 1 & 2 Discussion

Previous literature suggests that there is an asymmetry in children's mastery of *think* and *want*. However, those verbs were tested with different methods and experimental contexts. In the experiments presented here, we have controlled for possible experimental differences by testing both verbs in a single experimental context that makes both beliefs and desires relevant. Again, we find that children (4-year-olds) are influenced by reality only when interpreting *think* sentences. This is true both for between and within-participants comparisons of the verbs.

We can now use the same experimental set-up, which makes salient both beliefs and desires, to test children's interpretation of the unfamiliar attitude verb *hope*. The patterns in experiments 1 and 2 provide a standard against which belief/desire interpretations can be assessed. We predict that when *hope* appears with a nonfinite complement, children will assign it a desire meaning, and their responses will resemble their responses to *want*. However, when it appears with a finite complement, children will assign it a belief meaning, and their responses will resemble their responses to *think*. In particular, children will be lured by reality in false belief contexts.

3.4. Experiment 3

Experiments 1 and 2 show that, even in an identical experimental context, children respond systematically differently to sentences about conflicting desires (*want*) compared to sentences about conflicting beliefs (*think*). We hypothesize that children's ability to categorize attitude verbs differently at such a young age stems from their different syntactic distributions. To test whether children use syntactic environment as a cue to attitude verb meaning, we test their interpretations of sentences with *hope*, manipulating syntactic frame. This verb provides an ideal test case for several reasons. *Hope* is a real verb in English which shares semantic features with both representationals and preferentials, and can occur in syntactic frames associated with both classes of verbs. Additionally, children are not exposed to *hope* nearly as much as they are to *want* and *think*. Thus, they may know that it is a word of their language, and possibly that it is an attitude verb, but nonetheless may not know its precise meaning.

3.4.1. Experiment 3: Subjects

Participants were 48 children aged 4,0 to 5,0 (mean=4,6). 4 additional children were excluded, 2 due to getting too many controls incorrect, 1 due to parental report of the child's exposure to English as less than 80%, and 1 who did not finish the task. Children were recruited from the greater Washington DC area, through a recruitment database, and tested either in the Project on Children's Language Learning lab at the University of Maryland.

3.4.2. Experiment 3: Design and Materials

Experiment 3 used the same game task as experiments 1 and 2 (see section 3.1), where both the beliefs and desires of a character are relevant: the context should not independently bias children toward interpretations based on desire, belief or reality, which will ultimately provide evidence that any differing interpretations stem from the manipulation of the syntax. Experiments 1 and 2 demonstrate that children are able to get desire, reality and belief interpretations (albeit very few of the last type) in this experimental set-up, depending on the type of sentence that they hear. This shows that the context alone is neutral, and so any differing interpretations across conditions in experiment 3 must be driven by the syntactic manipulation. As in the previous experiments, on every trial, Froggy has both a *desire* about shape—because he always wants it to

be a heart, and a *belief*—because when it is red, he thinks it's a heart and when it's yellow he thinks it's a star. The silly puppet, *Booboo* utters test sentences about what Froggy *hopes*, either with a finite complement (25/26) or a nonfinite complement (27/28). The child's job is again is to say whether Booboo is correct or incorrect.

(25) *Froggy hopes that it's a heart!*
(26) *Froggy hopes that it's a star!*
(27) *Froggy hopes to get a heart!*
(28) *Froggy hopes to get a star!*

3.4.3. Experiment 3: Procedure
The procedure here was identical to that of experiment 1, described in section 3.1.3.

3.4.4. Experiment 3: Hypotheses and Predictions
This experiment tests whether children are sensitive to syntactic frame in interpreting an unfamiliar attitude verb. If they are, we expect different performance in the *hope-to* (nonfinite) and *hope-that* (finite) conditions. Specifically, we expect children to give desire interpretations (like *want*) with a nonfinite complement, and reality responses (like *think*) with a finite complement.

If children are not sensitive to syntactic frame in interpreting *hope*, there are several possible patterns of results we might see. If children already have an adult-like semantic representation for *hope*, or at least know that in this context it references desires, we expect their responses to pattern with *want*, irrespective of complement. If children do not know the meaning of *hope*, and guess its meaning through some non-syntactic strategy, we expect to see chance performance, and no differences between the *hope-to* and *hope-that* conditions.

3.4.5. Experiment 3: Results
Children's responses were coded online by the second experimenter. As in experiments 1 and 2, there are three possible response patterns—desire, belief or reality responses, shown in table 5. If children know that *hope* references Froggy's desires, we expect desire-based responses regardless of syntax: children should assent to both (26) and (28). If children do not yet know the meaning of *hope*, and are sensitive to syntax, we expect desire responses in the *hope-to* condition, and reality responses in the *hope-that* condition: they should assent to (28) regardless of what the shape actually is, but to (26) only when the shape actually *is* a heart.

Children's responses were measured in proportion 'yes'-responses. Just like in experiment 1, Red heart items were counted as controls—because this is a true belief and fulfilled desire case: we predict the same responses whether the participant responds based on desire, belief *or* reality. We excluded participants who got fewer than 6 out of the 8 red heart items correct. We excluded 2 children for this reason.

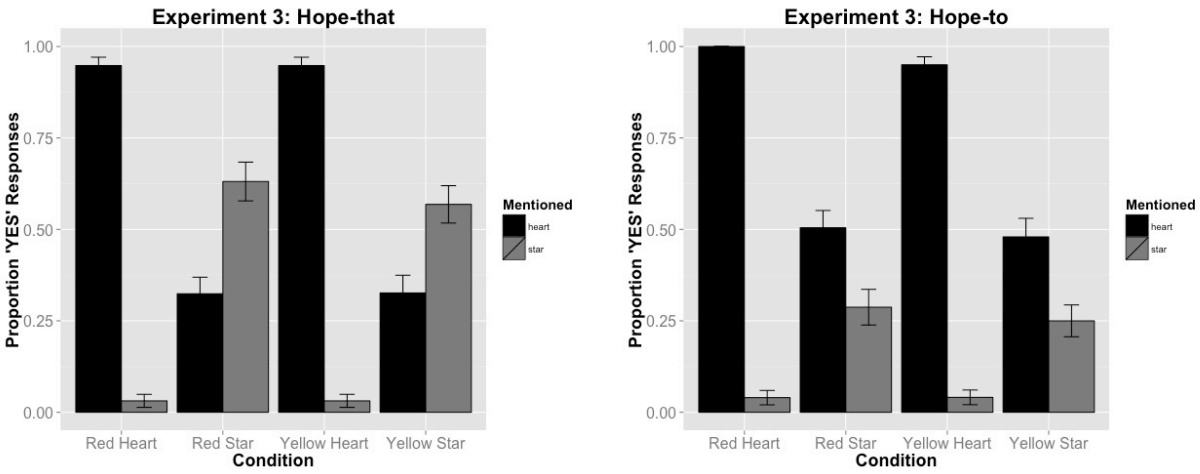
3.4.5.1. Analysis
We find that children are more likely to give desire responses (i.e. look adult-like) in the *hope-to* condition, and to be influenced by reality (i.e. traditional false belief error) in the *hope-that* condition. Proportion *yes* responses are shown in table 9 and figure 5. Highlighted responses show conditions in which children's responses differed from target responses (*yes* to mentioned

heart, *no* to mentioned star). Notice that children differ from the target only in *hope-that* conditions, and only in cases in which the mentioned does not match reality.

TABLE 9: Experiment 3: Percent *yes*-responses by Condition

VERB (between subjects)	CONDITION (within subjects)	MENTAL STATE STATUS	Mentioned Shape	Target	Proportion *Yes* Responses
HOPE-THAT	1. RED HEART	TRUE BELIEF FULFILLED DESIRE	Heart	Yes	.95 (.22)
			Star	No	.03 (.17)
	2. RED STAR	FALSE BELIEF UNFULFILLED DESIRE	Heart	Yes	**.32 (.47)**
			Star	No	**.63 (.49)**
	3. YELLOW HEART	FALSE BELIEF FULFILLED DESIRE	Heart	Yes	.95 (.22)
			Star	No	.03 (.17)
	4. YELLOW STAR	TRUE BELIEF UNFULFILLED DESIRE	Heart	Yes	**.32 (.47)**
			Star	No	**.57 (.50)**
HOPE-TO	5. RED HEART	TRUE BELIEF FULFILLED DESIRE	Heart	Yes	1.0 (0)
			Star	No	.04 (.20)
	6. RED STAR	FALSE BELIEF UNFULFILLED DESIRE	Heart	Yes	.50 (.50)
			Star	No	.29 (.46)
	7. YELLOW HEART	FALSE BELIEF FULFILLED DESIRE	Heart	Yes	.95 (.22)
			Star	No	.04 (.20)
	8. YELLOW STAR	TRUE BELIEF UNFULFILLED DESIRE	Heart	Yes	.48 (.50)
			Star	No	.25 (.44)

FIGURE 5: Experiment 3: Between- and Within-Subjects Conditions



As shown above, children are adult-like, responding based on desires in the *hope-to* conditions, but respond based on reality in the *hope-that* conditions.

We ran a 2x2x2x2 ANOVA over all between- and within-subjects conditions: Frame, Mentioned, Shape and Color, and find main effects and interactions that support the above conclusions. Children are influenced by mentioned shape for *hope-to* but not *hope-that*, predicting a 2-way interaction between Frame and Mentioned. We find a 2-way interaction confirming this relation ($F(1,376) = 15.76$, $p < .0001$). Mentioned shape is critical for desire interpretations, which we see overwhelmingly in the *hope-to* conditions. When they hear *hope-to*, children assent to mentioned heart sentences 73.3% of the time, and to mentioned star sentences only 15.5% of the time. This is supported by the Frame and Mentioned interaction, and also drives a main effect for Mentioned ($F(1,376) = 192.64$, $p < 0.0001$). Children are sensitive to reality in the *hope-that* conditions. When interpreting *hope-that*, children tend to assent to sentences in which mentioned and actual shape match (95% *yes* responses for heart, 60% for star), and reject sentences in which they don't (3% *yes* responses for mentioned star in a heart condition, 32% for mentioned heart in a star condition). Supporting this, we find an interaction between Mentioned and Shape ($F(1,376) = 204.15$, $p < .0001$), showing that children respond differently to items in which mentioned shape matches actual shape compared to when it does not. We do not see this pattern as strongly for *hope-to* sentences, as children in this condition tend to respond based on desire, although there is also some influence from reality. The reality effect (i.e. match between mentioned and shape) is much stronger, however, for *hope-that* sentences, which is confirmed by the 3-way interaction between Mentioned, Shape and Frame ($F(1,376) = 13.62$, $p = .0003$). In sum, we find that children interpret *hope* differently depending on syntactic frame. They treat it more like a desire verb with a nonfinite complement, and more like a belief verb with a finite complement. This suggests that syntactic frame is an important information source in children's early categorization of attitude verbs.

3.3.4.3. Experiment 3 Summary

Experiment 3 tests children's sensitivity to syntactic frame when interpreting an unfamiliar attitude verb in a context which makes both belief and desire salient. We find that children show different responses with *hope* depending on the syntactic frame in which it is presented, suggesting that they use syntax as a cue to attitude verb meaning. With a nonfinite complement, they are more likely to treat *hope* as if it is about desires, with a finite complement, they make

the same reality-error as with *think*. This suggests that at least one of the factors that triggers the traditional false belief error is the syntax of finite complement clauses, or perhaps more abstractly, declarative syntax in complement clauses.

Although this experiment shows that children are sensitive to syntactic frame in interpreting an attitude verb, it does not necessarily provide direct evidence of *learning*. To shed more light on the learning process, experiment 4 looks at how syntactic distribution influences interpretation during the experiment. This study explores how children's hypothesis about *hope*'s meaning is formed during the task, and how flexible it is. We investigate this by manipulating syntactic frame within subjects.

3.4. Experiment 4

In the previous experiment, we saw that children are influenced by syntactic frame when they interpret an unfamiliar attitude verb. However, it does not tell us about how they use the frame, and whether the information gleaned from the frame they heard contributes to building a semantic representation for the verb. We don't know whether the meaning they build for *hope* in the experiment would apply in later cases when the syntactic context had changed, or whether they solely use the frame directly to interpret the sentence without building an actual hypothesis about the meaning of the verb. Additionally, if they *do* use the frame information to build a semantic representation, the previous experiment doesn't tell us about how much input is required, and how children ultimately use the different frames they hear a verb in to settle on an adult-like representation.

Experiment 4 investigates the question of how children use syntactic frame, and how flexible they are in the meaning they attribute based on frame (cf. Naigles et al. 1993). As in experiment 3, we give children sentences with *hope* in a context that makes both belief and desire salient. This time, however, we give children sentences with *hope* in both syntactic frames—a finite and a nonfinite complement. This allows us to see how children integrate information from both frames, and whether they build a meaning representation that changes when the syntactic frame changes. Do children treat each trial as an individual case, or do they integrate information from previous trials into their semantic representation? Additionally, we ask whether the information provided by each of these types of frames is equally informative. By manipulating the order in which each frame type is presented, we can see whether the effects are different based on which frame children are exposed to first.

3.4.1. Experiment 4: Subjects

Participants were 48 children aged 4,0 to 5,0 (mean=4,6). Three additional children were excluded, 1 due to getting too many controls incorrect and 2 who did not finish the task. Children were recruited from the greater Washington DC area, through a recruitment database or through local preschools, and tested either in the Project on Children's Language Learning lab at the University of Maryland, or at local preschools.

3.4.2. Experiment 4: Design and Materials

Experiment 3 was the same game task used in experiment 2, (see section 3.2), except that instead of manipulating Verb (*want/think*) within subjects, we manipulated frame for *hope* in a blocked design. The child heard all test sentences (29)-(32) over the course of the experiment.

(29) *Froggy hopes that it's a heart!*
(30) *Froggy hopes that it's a star!*

(31) *Froggy hopes to get a heart!*
(32) *Froggy hopes to get a star!*

In a 2x2x2x2x2 design, we tested four within-subjects factors: frame (*hope-that* vs. *hope-to*), color (red vs. yellow), shape (heart vs. star) and mentioned shape (heart vs. star). Because each subject heard both *hope-that* and *hope-to* sentences in a blocked design, we tested order (1, *hope-that*-first (n=24) vs. 2, *hope-to*-first (n=24)) as a between-subjects factor. The child's response of *yes* or *no* was the dependent measure. Like previous experiments reported here, on every trial, Froggy had both a belief and a desire about the next shape. His "belief" about the shape was dictated by the color of the clue. When color correctly predicted shape (RED HEART, YELLOW STAR conditions), his belief was true. When it didn't (RED STAR, YELLOW HEART), his belief was false. Similarly, his desire for a heart was sometimes fulfilled (heart conditions), sometimes not (star conditions). Like in previous experiments, participants encountered every possible combination of realized and non-realized beliefs or desires. The distribution of items across Color/Shape conditions was identical to that of experiment 2 (table 10).

TABLE 10: Experiment 4: Within-Subjects Conditions

CONDITION	**Desire**	**Belief**	**# per verb**
RED HEART	Fulfilled	True	2
RED STAR	Unfulfilled	False	6
YELLOW HEART	Fulfilled	False	2
YELLOW STAR	Unfulfilled	True	6

All materials were identical to those described in experiment 1 (section 3.1.2).

3.4.3. Experiment 4: Procedure
The procedure here was identical to that of experiment 2, described in section 3.2.3.

3.4.4. Experiment 4: Hypotheses and Predictions
Experiment 3 showed that children are sensitive to syntactic frame in interpreting an unfamiliar attitude verb. In this experiment, we are interested in better understanding how the semantic representation is built up over multiple exposures. If children immediately integrate information gleaned from syntactic frame, we expect that their performance will change in the second block of this task. If children simply interpret each sentence individually and use syntactic frame to make an in-the-moment hypothesis about meaning, order should not have any effect. This would be similar to what we saw in experiment 2 with *think* and *want*—children did not treat *think* significantly different whether they got it in the first or second half of the experiment. The same was true for *want.*

3.4.5. Experiment 3: Results

Children's responses were coded online by the second experimenter. As in all previous experiments reported here, there are three possible response patterns—desire, belief or reality responses (table 5). In experiment 3, we saw that children were more likely to give desire responses with *hope-to*, and reality responses with *hope-that.* In this experiment, we expect to see the same pattern emerge in the first block. In the second block, however, there are two possible outcomes. One is that children's interpretations of *hope* are always driven by the current syntax in which it is presented: children should interpret *hope-that* identically regardless of block. The second is that children use their experiences with *hope* in the first half to hypothesize something about its meaning. If so, we expect children's responses in the second half to be influenced by the frame that they heard in the first half.

Children's responses were measured in percent *yes*-responses. Like in experiment 2, we counted all Heart items as controls. Children had to get three out of four of the total heart items correct to be included in the study. We excluded 1 child for failing to meet these criteria.

3.4.5.1. Analysis

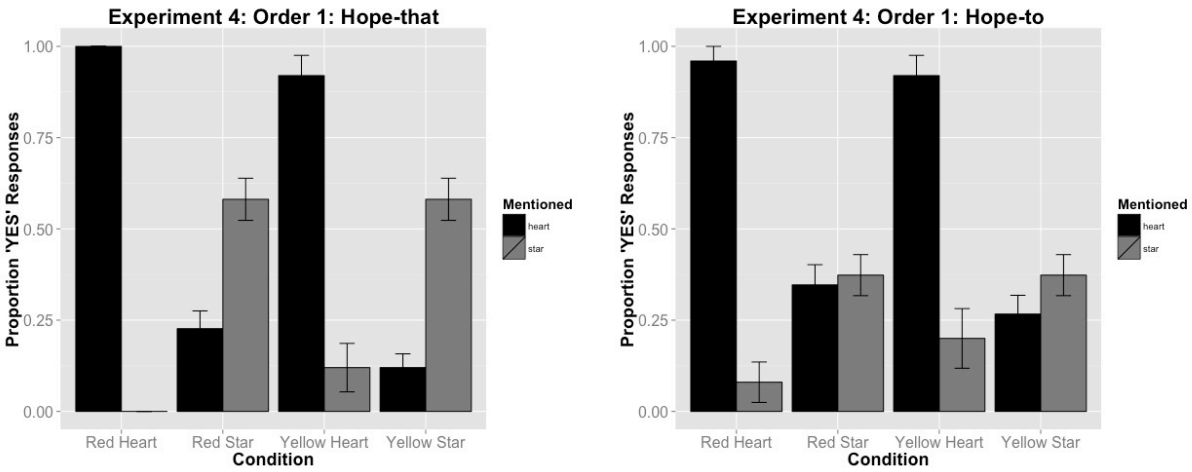
Because we are interested in the effect that the first block has on the second block, we present data for each block separately (table 11, figure 6). Looking only at the first blocks (italicized below), we largely replicate experiment 3. Children are more likely to give desire responses (i.e. look adult-like) in the *hope-to* condition, and to be influenced by reality (i.e. traditional false belief error) in the *hope-that* condition. Highlighted conditions in the first blocks show conditions in which children's responses differ from the adult-like pattern. Like in experiment 3, children are only non-adult-like for *hope-that*. In the second blocks (non-italicized data below), we see a different pattern. In order 1, when children have heard *hope-that* first, their data on the critical differentiating conditions (RED STAR/YELLOW HEART, marked with † in Table 11) doesn't look like the responses for *hope-that* or for *hope-to.* While they are influenced by the finite frame in the first half, this influence is not enough to completely override the nonfinite frame they hear in the second half. For Order 2, we also see that the first block influences responses in the second block. In this case, however, we see that the responses in the critical conditions (RED STAR/YELLOW HEART, marked with * in table 11) suggest desire responses, and look very similar to the responses for *hope-to* in the first block (and *hope-to* alone in experiment 3). Overall, we see that children are influenced by the syntactic frames that they heard in the first half of the experiment. The *amount* of influence, however, seems to vary with the particular order of frames—when children hear a nonfinite complement first, this early experience with a nonfinite complement seems to override the influence of the finite complement at a later point. When they hear a finite complement first, however, they are less influenced.

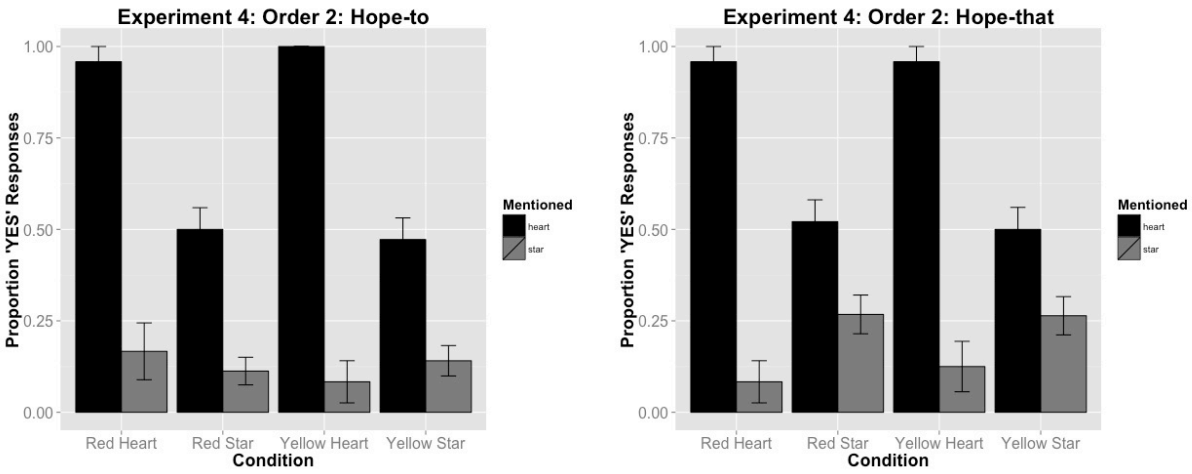
TABLE 11: Experiment 4: Proportion *yes*-responses by Condition

ORDER (between subjects)	CONDITION (within subjects)	Mentioned Shape	Target	Proportion *Yes* (SD) *Hope-that*	Proportion *Yes* (SD) *Hope-to*
ORDER 1 (*Hope-that* first)	1. RED HEART	Heart	Yes	*1.0 (0)*	.96 (.20)
		Star	No	*.0 (0)*	.08 (.28)
	2. RED STAR	Heart	Yes	***.23 (.42)***	.35† (.48)

		Star	No	***.58 (.50)***	.37† (.49)
	3. YELLOW HEART	Heart	Yes	*.92 (.28)*	.92 (.28)
		Star	No	*.12 (.33)*	.20 (.41)
	4. YELLOW STAR	Heart	Yes	***.12 (.33)***	.26† (.45)
		Star	No	***.58 (.50)***	.37† (.49)
ORDER 2 (*Hope-to* first)	5. RED HEART	Heart	Yes	.96 (.20)	*.96 (.20)*
		Star	No	.08 (.28)	*.17 (.38)*
	6. RED STAR	Heart	Yes	.52* (.50)	*.50 (.50)*
		Star	No	.26* (.45)	*.11 (.32)*
	7. YELLOW HEART	Heart	Yes	.95 (.20)	*1.0 (0)*
		Star	No	.13 (.34)	*.08 (.28)*
	8. YELLOW STAR	Heart	Yes	.50* (.50)	*.47 (.50)*
		Star	No	.26* (.44)	*.14 (.35)*

FIGURE 6: Experiment 4: Between- and Within-Subjects Conditions





As shown above, data in the first blocks of each order replicates findings from experiment 3. In the second blocks, children are influenced by syntactic frames that they heard earlier in the study, sometimes even enough to override the syntax of the current sentence.

3.4.4.1.1. Comparison of Blocks 1 for Orders 1 & 2

We first look at the first blocks only for orders 1 and 2, to ensure that we replicate the findings from experiment 3. We ran a 2x2x2x2 ANOVA over all between- and within-subjects conditions for block 1 of orders 1 and 2: Frame, Mentioned, Shape, and Color. Table 20 shows that, as in experiment 3, children are influenced by mentioned shape for *hope-to* but not *hope-that*, as revealed by a 2-way interaction between Frame and Mentioned ($F(1,376) = 29.97$, $p < .0001$). Because mentioned shape is critical for subjects getting a desire interpretation, we also find a main effect for Mentioned ($F(1,376) = 169.48$, $p < 0.0001$). Children are also very sensitive to reality in the *hope-that* conditions. We find an interaction between Mentioned and Shape ($F(1,376) = 191.87$, $p < .0001$), showing that children respond differently to items in which mentioned shape matches actual shape than when it does not. We do not see this pattern as strongly for *hope-to*, as children tend to respond based on desire, although there is also some influence of reality. The reality effect is much stronger, however, for *hope-that*, as confirmed by the 3-way interaction between Mentioned, Shape and Frame ($F(1,376) = 38.13$, $p < .0001$). In sum, the data for the first blocks of each order in experiment 4 replicate the findings from experiment 3—children interpret *hope* differently depending on syntactic frame: they treat it like a desire verb with a nonfinite complement, and a belief verb with a finite complement.

3.4.4.1.2. Analysis of between- and within-subjects conditions

We ran a 2x2x2x2x2 ANOVA over all between- and within-subjects conditions: Frame, Mentioned, Shape, Color, and Order. Like in previous experiments, we find a main effect of Mentioned ($F(1,799) = 293.93$, $p < .0001$), driven by the high number of desire responses overall. We also find an interaction between Mentioned and Shape ($F(1,799) = 268.76$, $p < .0001$) and between Mentioned, Shape and Frame ($F(1,799) = 7.84$, $p = .0052$), showing that, like in our previous experiments, children respond differently to the match between mentioned and actual shape depending on syntactic frame. We also see effects of Order. Sensitivity to mentioned shape (hallmark of desire responses) differs across orders, with an interaction between Mentioned and Order ($F(1,799) = 27.49$, $p < .0001$). Sensitivity to the relation between shape and mentioned

shape (the hallmark of reality responses), differs based on order. This manifests as an interaction between Shape, Mentioned and Order ($F(1,799) = 26.63$, $p < .0001$). These interactions show that children use information differently depending on the order in which they heard the syntactic frames. Children still show the classic patterns for responses in experiment 4—desire and reality responses, but these patterns are modulated not only by frame, but also by the order in which children are exposed to the frames. This suggests that they integrate syntactic information into their semantic representations across multiple exposures, and that they use syntactic frame not only as a cue to interpretation online, but also as a cue to learning the meaning.

3.4.4.1.3. Analysis of Order 1

Because children are influenced by the order in which they hear the syntactic frames for *hope*, it is helpful to analyze separately the data for orders 1 and 2. In order 1, children first hear *hope* with a finite complement. Table 20 shows that in the first half of the experiment, children perform as predicted for *hope-that* sentences—they are more likely to be influenced by reality than by desire. This is particularly evident for conditions in which reality differs from Froggy's desire (red and yellow star conditions (2 and 4). In these cases, in the first block, children are more likely to accept sentences with a mentioned star (58% *yes* responses for red, 58% for yellow) and reject sentences with a mentioned heart (23% *yes* responses for red, 12% for yellow). In the second block, however, we no longer see this pattern. Children are no more likely to accept sentences mentioning star (37% *yes* responses for red, 37% for yellow) than those mentioning heart (35% *yes* responses for red, 26% for yellow). They are not more likely to give reality responses than desire responses, demonstrating that they are both influenced by the syntax in the first and the second block. A 2x2x2x2 ANOVA over Frame, Shape, Color and Mentioned shows a reality effect overall, with an interaction between Mentioned and Shape ($F(1,408) = 243.41$, $p<.0001$). Additionally, we find a small interaction between Frame, Mentioned and Shape ($F(1,408) = 4.64$, $p = 0.032$), such that children are statistically more likely to give reality responses (i.e. pay attention to the match between mentioned and shape) depending on frame. Children are sensitive to syntactic frames that they have heard previously, and integrate this information into their semantic representation, and pay attention to the syntactic frame in which the verb is currently being presented.

3.4.4.1.4. Analysis of Order 2

In order 2, children first hear *hope* with a nonfinite complement. Table 11 shows that in the first half of the experiment, children perform as predicted for *hope-to* sentences—they are more likely to respond based on desire than reality, thus paying attention to mentioned shape. This is particularly evident for conditions in which reality differs from Froggy's desire (red and yellow star conditions, 2 and 4). In these cases, in the first block, children are more likely to accept sentences mentioning heart (50% *yes* responses for red, 47% for yellow) than sentences mentioning star (11% *yes* responses for red, 14% for yellow). In the second block, children are primed. Although they are now hearing *hope* with a finite complement, they are still more likely to accept mentioned heart sentences (52% *yes* responses for red, 50% for yellow) than mentioned star sentences (26% *yes* responses for red, 26% for yellow). This pattern differs greatly from the observed pattern for *hope-that* in the first block of order 1, and in experiment 3. A 2x2x2x2 ANOVA over Frame, Shape, Color and Mentioned shows for order 2 a main effect of Mentioned ($F(1,391) = 245.97$, $p<.0001$). This demonstrates that over both frames, children pay attention to mentioned shape, critical for desire responses. Critically, we find no interaction between

Mentioned and Frame ($F(1,391) = 0.86$, $p = 0.351$), showing that children do not use this information differently across the frames in these conditions. We also find no interaction between Frame, Shape and Mentioned ($F(1,391) = 0.017$, $p = 0.894$), which we would predict if children were influenced differentially by reality across the two frames. Although when children hear *hope-that* on its own they are influenced by reality, when they hear it after *hope-to* they are more likely to give desire responses, showing a strong priming effect of nonfinite syntax. These results show that children use previously experienced syntactic information to learn something about the meanings of attitude verbs. This suggests that syntactic bootstrapping is not just an interpretation "strategy", but rather an important learning mechanism tied to the acquisition of semantic representations.

3.4.4.2. Experiment 4 Summary

In experiment 4, we explored children's sensitivity to syntactic frame for attitude verb learning. We find that, like in experiment 3, children use syntactic frame as a cue to meaning. Additionally, we find that children integrate this information across multiple trials. When the frame changed in the second half of the experiment, children did not reliably change their interpretation, rather they seemed to integrate information from their previous experience with the verb. In the first blocks of each of the critical star conditions in experiment 4, we replicated the findings from experiment 3, showing that children are more likely to give desire-based responses with a nonfinite complement, and reality-based responses with a finite complement. However, in the second blocks of both star conditions, we see evidence of earlier trials influencing later trials, supporting the view that children build a meaning based on exposures in multiple frames. In order 1, children hear *hope-that* first and assign a belief interpretation, in the second block they hear *hope-to* and disregard the belief interpretation in favor of a desire interpretation. When children hear *hope-to* in the first block of order 1, they assign a desire interpretation. However, when they hear *hope-that* in the second block, they maintain their desire interpretation, despite the change in syntactic frame. In other words, the desire interpretation associated with the nonfinite frame is robust to prior exposure to the finite frame, but the belief interpretation associated with the finite frame cannot overcome prior exposure to the nonfinite frame. This suggests that the nonfinite frame may carry more weight about the meaning of the verb than the finite frame.

There are (at least) two possible reasons for this asymmetry. First, it could be that children's prior experience with *hope,* while limited, includes predominantly finite complements. We did a small analysis of instances of *hope* in the Gleason corpus of the CHILDES database (Gleason 1980, MacWhinney 2000). The Gleason corpus contains dinnertime conversation transcripts from the families of 24 children aged 2,1 to 5,2. The entire corpus contains 19 total uses of the word *hope* out of a total of 36,901 utterances. All uses of *hope* were from adults. Of these *hope* utterances, two were "I hope not", one was "I hope so" and two were *hope* as a noun. Fourteen utterances containing *hope* were used with a sentential complement. Of these, 13 had a finite complement, and only one a nonfinite complement, suggesting that children are more likely to be exposed to *hope* with a finite complement. As a result, the nonfinite frame could be more noticeable, and hence function as a strong cue to the desire meaning. Alternatively, it could be that the nonfinite frame is more informative for linguistic reasons, and more strongly linked to the underlying meaning. This asymmetry would make the nonfinite frame a more straightforward cue to the meaning of the embedding verb. We leave resolving this issue for further research.

3.6. Experiments 3 & 4 Discussion

Experiments 3 and 4 addressed children's sensitivity to syntactic frame in interpreting attitude verbs, by examining how they interpret individual sentences (experiment 3), and how information from syntax carries over future encounters of the same verb in a different frame. We have done this by looking at children's interpretation of *hope* sentences in two different syntactic frames: a nonfinite complement, which is typically associated with desire verbs, a finite complement, which is typically associated with belief verbs.

We have shown that children are sensitive to syntactic frame, suggesting that they use syntax as a cue for interpretation: when children hear a verb with a nonfinite complement, they tend to treat it as if it expresses desires, when they hear it with a finite complement, they make the same reality-error as with *think*. We have also shown that children integrate syntactic information across multiple uses, and that, at least for *hope*, the finite frame functions as a weaker cue than the nonfinite one.

4. Conclusions

Attitude verbs express psychological states whose contents are not directly observable. To figure out their meanings, children may thus need to rely on the linguistic context, specifically the syntactic frames, in which they occur as evidence about their meanings. For such syntactic bootstrapping to work, there need to be principled links between attitude meanings and their syntactic distribution, which children need to be able to exploit. This paper presents the first study showing that children use features of the clausal complement when interpreting an unfamiliar attitude verb.

Attitude predicates split in two main semantic classes: representationals (belief) and preferentials (desire). This split seems to be tracked by the syntax of the verbs' complements: in English, belief verbs take finite complements, desire verbs nonfinite complements. More generally, belief but not desire verbs take complements with syntactic hallmarks of declarative clauses. In a series of experiments that make belief and desire salient, we have tested children's interpretation of the verbs *think, want,* and *hope*. We have reproduced the long noted asymmetry in children's interpretation of *think* vs. *want*: children seem to be adult-like in their responses to *want*, but they make false belief errors in their responses to *think*. We have further shown that children's responses to the unfamiliar verb *hope* is highly influenced by the syntactic frame in which it appears: with a nonfinite complement, children's responses resemble desire responses, with a finite complement, they resemble their responses to *think*, making classic false belief errors. Hence, children make use of syntax when interpreting an unfamiliar attitude verb.

Our results further show that children use previously experienced syntactic information to learn something about the meanings of attitude verbs. When they hear *hope* in two different syntactic frames, their exposure to one frame influences their responses to the verb in another frame. This suggests that syntactic context provides evidence not just for online interpretation, but also for the acquisition of semantic representations.

References

Anand, Pranav, and Valentine Hacquard. 2013. *Epistemics and attitudes.* Semantics and Pragmatics 6(8).1–59.

Baldwin, Dare. 1991. *Infants' contribution to the achievement of joint reference.* Child Development 62.875–890.

Bartsch, Karen, and Henry M. Wellman. 1995. *Children talk about the mind.* New York, NY: Oxford University Press.

Bloom, Paul. 2000. *How children learn the meaning of words.* Cambridge, MA: The MIT Press.

Bolinger, Dwight. 1968. *Aspects of language.* New York, NY: Harcourt, Brace & World.

Buttelmann, David, Melinda Carpenter, and Michael Tomasello. 2009. *Eighteen-month-old infants show false belief understanding in an active helping paradigm*. Cognition 112.337–342.

Clark, Eve. 2009. *Speaker perspective in language acquisition.* Linguistics 28(6).1201-1220.

de Villiers, Jill G., and Peter A. de Villiers. 2000. *Linguistic determinism and the understanding of false beliefs.* In P. Mitchell & K. Riggs (Eds.), Children's reasoning and the mind, 189-226.

de Villiers, Jill G., and Peter A. de Villiers. 2009. *Complements enable representation of the contents of false belief: evolution of a theory.* In S. Foster-Cohen (ed) Language Acquisition, 169-195. Palgrave, Macmillan. Hove: Psychology Press.

de Villiers, Jill G., and Jennie Pyers. 2002. *Complements to cognition: a longitudinal study of the relationship between complex syntax and false-belief understanding.* Cognitive Development 17.1037–60.

de Villiers, Jill G., 1995. *Steps in the mastery of sentence complements*. Symposium paper, SRCD Convention, Indianapolis, March 1995.

de Villiers, Jill G., 2005. *Can language acquisition give children a point of view?* In J. Astington & J. Baird (Eds.), Why language matters for theory of mind, 186–219. New York, NY: Oxford University Press.

de Villiers, Jill G., 2007. *The interface of language and theory of mind.* Lingua 117.1858–1878.

Diesendruck, Gil, and Lori Markson. 2001. *Children's avoidance of lexical overlap: A pragmatic account.* Developmental Psychology 37(5).630-641.

Farkas, Donka. 1985. *Intensional descriptions and the romance subjunctive mood.* New York, NY: Garland.

Fisher, Cynthia H., Henry Gleitman, & Lila R. Gleitman. 1991. *On the semantic content of subcategorization frames.* Cognitive Psychology 23.331–392.

Fisher, Cynthia, Yael Gertner, Rose M. Scott, and Sylvia Yuan. 2009. *Syntactic bootstrapping.* Wiley Interdisciplinary Reviews: Cognitive Science 1.143–149.

Giannakidou, Anastasia. 1997. *The landscape of polarity items* (Doctoral thesis). University of Groeningen, The Netherlands.

Gillette, Jane, Henry Gleitman, Lila Gleitman, and Anne Lederer. 1999. *Human simulations of vocabulary learning.* Cognition 73.135–176.

Gleason, Jean Berko. 1980. *The acquisition of social speech and politeness formulae.* In H. Giles, W. P. Robinson, & S. M. P. (Eds.), Language: Social psychological perspectives. Oxford: UK: Pergamon.

Snedeker, Jesse, and Lila Gleitman. 2004. *Why it is hard to label our concepts.* In S. Waxman & D.G. Hall (Eds.), Weaving a Lexicon, 257-294. Cambridge, Mass: A Bradford Book.

Gleitman, Lila. 1990. *The structural sources of verb meanings.* Language Acquisition 1(1).3–55.

Gleitman, Lila, Kimberly Cassidy, Rebecca Nappa, Anna Papafragou, and John Trueswell. 2005. *Hard words.* Language Learning and Development 1(1).23–64.

Hacquard, Valentine. 2014. *Bootstrapping attitudes.* In T. Snider, S. D'Antonio & M. Weigand (Eds.), Proceedings of SALT 24.330–352. New York, NY: New York University. Linguistics Society of America.

Hacquard, Valentine, and Jeffrey Lidz. 2018. *Children's Attitude Problems: Bootstrapping verb meaning from syntax and pragmatics.* Mind and Language 33(3).1-18.

Halberda, Justin. 2003. *The development of a world-learning strategy.* Cognition 87(1).B23-B34.

Hansen, Mikkel. B. 2010. *If you know something, say something: Young children's problem with false beliefs.* Frontiers in Psychology 1(23).1-7.

Harrigan, Kaitlyn, Valentine Hacquard, and Jeffrey Lidz. 2015. *Syntactic bootstrapping and the acquisition of attitude verbs: think, want and hope.* In K. Kim (Ed.), Proceedings of WCCFL 33.196–206. Somerville, MA: Cascadilla Proceedings Project.

Harrigan, Kaitlyn, Valentine Hacquard, and Jeffrey Lidz. 2018. *Three-year-olds' understanding of desire reports is robust to conflict.* Frontiers in Psychology 9.119.

He, Angela, and Jeffrey Lidz. 2017. *Verb learning in 14- and 18-month-old English-learning infants.* Language Learning and Development. 13(3).

Helming, Katharina A., Brent Strickland, and Pierre Jacob. 2014. *Making sense of early false-belief understanding.* Trends in Cognitive Sciences 18(4).167–170.

Hooper, Joan B. 1975. *On assertive predicates.* In John Kimball (ed.) *Syntax and Semantics* 4.91-124.

Johnson, Carl, and Michael Maratsos. 1977. *Early comprehension of mental verbs: think and know.* Child Development 48.1743–1747

Knudsen, Birgit, and Ulf Liszowski. 2012. *Eighteen- and 24-month-old infants correct others in anticipation of action mistakes.* Developmental Science 15.113-122.

Kovács, Agnes M., Erno Teglas and Ansgar D. Endress. 2010. *The social sense: susceptibility to others' beliefs in human infants and adults.* Science 330(6012).1830-4.

Landau, Barbara, and Leila Gleitman. 1985. *Language and Experience. Evidence from the Blind Child.* Cambridge, MA: Harvard University Press.

Lewis, Shevaun, Hacquard, Valentine, and Lidz, Jeffrey. 2012. *The semantics and pragmatics of belief reports in preschoolers.* In A. Chereches (Ed.), Proceedings of SALT 22.247–267. New York, NY: New York University. Linguistics Society of America.

Lewis, Shevaun, Hacquard, Valentine, and Lidz, Jeffrey. 2017. *'Think' pragmatically: Children's interpretation of belief reports.* Language Learning and Development, 13(4).357–374.

Lidz, Jeffrey, Lila Gleitman, and Henry Gleitman. 2003. *Understanding how input matters: Verb learning and the footprint of universal grammar.* Cognition 87(3).151–178.

MacWhinney, Brian. 2000. *The CHILDES project: Tools for analyzing talk.* Mahwah, NJ: Lawrence Erlbaum.

Markman, Ellen, and Gwyn Wachtel. 1988. *Children's use of mutual exclusivity to constrain the meanings of words.* Cognitive Psychology 20(2).121-157.

Mervis, Carolyn, and Jacquelyn Bertrand. 1994. *Acquisition of the novel name-nameless category (N3C) principle.* Child Development 65(6).1646-1662.

Moore, Chris, Christopher Jarrold, James Russell, Alistair Lumb, Felicity Sapp, and Fiona Maccalium. 1995. *Conflicting desire and the child's theory of mind.* Cognitive Development 10.467–482.

Moyer, Morgan, Kaitlyn Harrigan, Valentine Hacquard, and Jeffrey Lidz. 2015. *'2-year-olds' comprehension of personal pronouns'.* In Proceedings of BUCLD 39.

Naigles, Letitia. 1990. *Children use syntax to learn verb meanings.* Journal of Child Language, 17(02).357–374.

Naigles, Letitia. 1996. *The use of multiple frames in verb learning via syntactic bootstrapping.* Cognition, 58(2).221–251

Onishi, Kristin, and Renee Baillargeon. 2005. *Do 15-month-old infants understand false belief?* Science 308.255–258.

Papafragou, Anna, Kimberly Cassidy, and Lila Gleitman. 2007. *When we think about thinking: The acquisition of belief verbs.* Cognition 105.125–165

Perner, Josef, and Ted Ruffman. 2005. *Infants' insight into the mind: How deep?* Science 308.214–216.

Perner, Josef, Manuel Sprung, Petra Zauner, and Hubert Haide. 2003. *Want that' is understood well before 'say that', 'think that', and false belief: A test of de Villiers's linguistic determinism on German-speaking children.* Child Development 74.179–188.

Perner, Josef, Petra Zauner, and Manuel Sprung. 2005. *What does 'that' have to do with point of view? Conflicting desires and 'want' in German.* In J. W. Astington & J. Baird (Eds.), *Why language matters for theory of mind.* 220–244. New York, NY: Oxford University Press.

Pinker, Steven. 1989. *Learnability and cognition.* Cambridge, MA: The MIT Press.

Portner, Paul. 1992. *Situation theory and the semantics of propositional expressions.* (Doctoral thesis). UMass Amherst.

Rakoczy, Hannes. 2010. *Executive function and the development of belief-desire psychology.* Developmental Science 13(4).648-661.

Rakoczy, Hannes, Felix Warneken, and Michael Tomasello. 2007. *'This way!', 'No! That way!'—3-year-olds know that two people can have mutually incompatible desires.* Cognitive Development 22.47–68.

Repacholi, Betty, and Alison Gopnik. 1997. *Early reasoning about desires: Evidence from 14- and 18-month-olds.* Developmental Psychology, 33(1).12–21.

Rubio-Fernández, Paula, and Bart Geurts. 2013. *How to pass the false-belief task before your fourth birthday.* Psychological Science 24(1).27–33.

Scheffler, Tatjana. 2008. *Semantic operators in different dimensions.* (Doctoral thesis). UPenn.

Scott, Rose M., Cynthia Fisher. 2009. *2-year-olds use distributional cues to interpret transitivity-alternating verbs.* Lang Cogn Process 24.777–803.

Southgate, Victoria, Atsushi Senju, and Gergely Csibra. 2007. *Action anticipation through attribution of false belief by 2-year-olds.* Psychological Science 18(7).587–592.

Sowalsky, Emily, Valentine Hacquard, and Tom Roeper. 2009. *Is PP opacity on the path to false belief? G*enerative Approaches to Language Acquisition North America (GALANA) 3.263–261.

Surian, Luca, Stefania Caldi, and Dan Sperber. 2007. *Attribution of beliefs by 13-month-old infants.* Psychological Science 18(7).580-6.

Truckenbrodt, Hubert. 2006. *On the semantic motivation of syntactic verb movement to C in German.* Theoretical Linguistics 32.257-306.

Villalta, Elizabeth. 2008. *Mood and gradability: An investigation of the subjunctive mood in Spanish.* Linguistics and Philosophy 31.467–522.

Wellman, Henry, and Banerjee. 1991. *Mind and emotion: Children's understanding of the emotional consequences of beliefs and desires.* British Jounral of Developmental Psychology 9(2).191-214.

Wellman, Henry, and Karen Bartsch. 1988. *Young children's reasoning about beliefs.* Cognition 30.239–277.

Wellman, Henry, and Jacqueline Wooley. 1990. *From simple desires to ordinary beliefs: the early development of everyday psychology.* Cognition 35(3).245-275.

Wellman, Henry, David Cross, and Julanne Watson. 2001. *Meta-analysis of theory-of-mind development: The truth about false belief.* Child Development 72.655–684.

Wimmer, Heinz, and Josef Perner. 1983. *Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception.* Cognition 13.103–128.

Woodward, Amanda L. 1998. *Infants selectively encode the goal object of an actor's reach.* Cognition 69.1–34.

Yuan, Sylvia, and Cynthia Fisher. 2009. *'Really? She blicked the baby?' Two-year-olds learn combinatorial facts about verbs by listening.* Psychological Science 20(5).619–626.