Syntactic Bootstrapping in the Acquisition of Attitude Verbs: *think, want* and *hope*

Kaitlyn Harrigan, Valentine Hacquard, and Jeffrey Lidz

1. Introduction

Attitude verbs, like *think, want* and *hope,* seem to be acquired later than other verbs. Moreover, some attitude verbs (*want*) seem to be acquired later than others (*think*). Why should this be? Perhaps observability is a bigger problem than in other cases of word-learning. Psychological events like *thinking* and *wanting* do not have direct physical correlates unlike objects like *dog* or *cat*, or events like *running* or *eating*. Although on the surface, this seems to be a huge problem, it may not be as difficult as it initially appears to be.

Advances in cognitive development have revealed that from a very young age, all humans share common conceptual and perceptual capacities, which have been argued to weaken the force of Quine's famous induction problem. From just a few months old, infants have rich concepts of continuity of objects, gravity, event representation and more (Behl-Chadha 1996, Carey 2009, Eimas & Miller 1990, Mandler 1988, Quinn & Eimas 1986, Soja, Carey & Spelke 1991, Spleke & Kestenbaum 1986, Spelke, Kestenbaun, Simons & Wein 1995, Xu & Carey 1996, and others), and these concepts shape their perception and attention in a way that may restrict candidate word meanings. In addition, infants have been shown to track the minds of others with astonishing ease. From the first months of life, infants give privileged status to human agents, and are sensitive to conversation partners' goals and perspectives. They attribute goal-directedness to human agents from as young as 5 months of age (Woodward 1996). This sensitivity to other people's minds also aids children in language acquisition. Children can track eye-gaze and use it to learn new words by 16 months old (Baldwin 1991, Bloom 2000, Moore & Corkum 1994, Smith, Jones & Landau 1996, Plunkett 1997). By age 2, children are adult-like in their interpretation of indexical pronouns, which shift reference based on conversational roles (Moyer, Harrigan, Hacquard & Lidz 2014). Given the salience of psychological states in infant reasoning, 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, then there is no conceptual barrier to learning attitude verbs.

Indeed, some attitude verbs do seem to be acquired easily. Children start producing *want* to express desires as young as 18 months (Bartsch & Wellman 1995). They further seem to be very good at understanding sentences with *want* by around 3 years of age (Bartsch & Wellman 1995; Hadwin & Perner 1991; Harrigan, Hacquard & Lidz, submitted; Repacholi & Gopnik 1997; Stein & Levine 1989; Wellman & Banerjee 1991; Wellman & Bartsch 1988; Wellman & Wooley 1990, Yuill 1984; and others). This suggests that the concept of desire is readily available to very young children, that they are proficient from a very young age at tracking others' minds, *and* that their sophisticated cognitive capacities allow them to link the word *want* to the concept of desire with relative ease. For the verb *think*, however, we see a different trajectory. Many studies have found that children have difficulty understanding sentences with *think* well into their fourth year, in particular when the sentences refer to someone's false belief (de Villiers 1995; 2005; 2007; de Villiers & de Villiers 2000; de Villiers & Pyers 2002; Johnson & Maratsos 1977; Lewis 2013; Perner et al. 2003; Wellman, Cross & Watson

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2000; Wimmer & Perner 1983; and others). Given the evidence for children's rich cognitive capacities and social sensitivity that make other word learning, including some attitude verbs, so easy, why should we see such difficulty with *think*?

A number of hypotheses have addressed the *think-want* asymmetry: some invoke differences in the concepts themselves (Flavell 1988: Forguson & Gopnik 1988; Perner 1988; 1981; (Perner, Sprung, Zauner & Haider 2003; Perner, Zauner & Sprung 2005; Perner & Ruffman 2005); others invoke syntactic differences (de Villiers & de Villiers 2000; de Villiers 2005; de Villiers 2007; de Villiers & de Villiers 2009) or differences in the speech acts they are used for (Lewis, Hacquard & Lidz 2012, Lewis 2013, Hacquard & Lidz 2013, Hacquard 2014). Regardless of the cause of difficulty with *think*, a vast number of studies confirm this differential sensitivity to reality in interpreting sentences with *think* as compared to sentences with *want*. Thus, from an early age, and before they even fully master these verbs, children treat *think* and *want* very differently. This suggests that there must be cues in the learners' environments, which allow them to categorize *think* and *want* differently by 3 years of age.

2. Syntactic Bootstrapping

In this paper, we explore one possible cue to young learners in their categorizing of *think* and *want*, namely the syntactic environment in which these verbs occur. Children have been shown in many word learning studies to be sensitive to syntactic structure (Fisher, Gertner, Scott & Yuan 2009; Fisher, Gleitman & Gleitman 1991; Fisher, Klinger & Song 2006; Gleitman 1990; Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, 2005; Landau & Gleitman 1985; Lidz, Gleitman & Gleitman 2003; Naigles 1990; Naigles 1996; Naigles & Kako 1993; Scott 2009; Pinker 1989; Yuan & Fisher 2009; and others). The syntactic bootstrapping hypothesis was originally proposed as a learning account for exactly this kind of case: words that might be particularly difficult to learn given their abstractness. However, most of the experimental evidence for syntactic bootstrapping over the years has focused on simple transitive and intransitive verbs that pick out events, or at whether attitude verbs as a class can be differentiated from other verbs. The few studies (Asplin 2002; Johnson, de Villiers, D'Amato, Deschamps & Huneke 2002) investigating whether syntax can help learners differentiate among subclasses of attitude verbs have not been able to show children's sensitivity to syntactic environment. In this paper, we present a novel experiment demonstrating that four year olds are sensitive to syntactic distribution when learning attitude verb meanings.

2.1. Principled Mappings

In order for a syntactic bootstrapping procedure to work for attitude verbs, two facts must be true. First, the link between attitude verb syntax and semantics must be principled. If the syntactic distribution is *not* informative about the semantics, tracking the syntax will not be a productive strategy for learners. Second, children must be sensitive to this link. Even if we see principled links, if children are not sensitive to attitude verbs' syntactic distributions, then syntactic bootstrapping will not be a likely learning account.

Attitude verbs have been argued to fall into two main semantic subclasses: "*representational"* attitudes, such as *think* or *believe*, which express judgments of truth; and non-representational, or "*preferential"* attitudes, such as *want* or *wish*, which express preferences (Bolinger 1968; Searle & Vanderveken 1985; Villalta 2000; 2008; Anand & Hacquard 2013).

The literature on mood selection in Romance shows that this split in representationality appears to be tracked by the syntax. Verbs like *think* select for complements in the indicative mood, while verbs like *want* select for complements in the subjunctive mood, as shown in the examples in (1) and (2) in French (Bolinger 1968, Hooper 1975, Farkas 1985 Giannakidou 1997, Villalta 2008, Anand & Hacquard 2013, among others).

(1) *Jean veut que Marie soit á Boston.*
Jean wants that Marie be-SUBJ in Boston.
'Jean wants Marie to be in Boston.'

(2) *Jean pense que Marie est á Boston.*
Jean thinks that Marie be-IND in Boston.

'*Jean thinks that Marie is in Boston.*'

In English, preferential verbs like *want* take a non-finite complement, while representational verbs like *think* take a finite complement (3)-(4).

(3) *Andy wants it to rain!*
(4) *Andy thinks that it's raining!*

Thus, both in English and in Romance, syntactic distribution may serve as a cue to the learner for what subclass a given attitude verb falls into: representational or preferential, though the cue is different across languages (finiteness for English; mood for Romance). 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.

Although the specific syntactic frames associated with each of the semantic classes differ cross-linguistically, they converge at an abstract level: the complements that representational attitudes take allow syntactic features found in declarative main clauses in that language (indicative mood for Romance, finiteness for English). The complements that preferential verbs take, on the other hand, do not allow main clause features in their complement (Dayal & Grimshaw 2009, Hacquard 2014). Thus, while not all languages make the same syntactic distinctions that English does, at the right level of abstraction (main clause syntax in embedded clauses), there may be a pattern that is potentially informative to the learner. In section 3, we present an experiment testing children's sensitivity to this pattern.

2.2. Using 'hope'

Syntactic bootstrapping provides a plausible explanation for how children might categorize *think* and *want* by age 4: even if they haven't fully mastered the semantics of these verbs, the syntactic frames in which these verbs appear in might clue in the learner that *think* and *want* belong to two separate semantic classes.[1] To confirm this, however, we need to show that children are sensitive to syntactic complement when learning a novel attitude verb. Furthermore, we need to look at cases that may be less straightforward. Both *think* and *want* are very clear examples—syntactically and semantically—of the preferential and representational subclasses. *Want* expresses only a desire, while *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 representational and preferential verbs. Syntactically, we observe syntactic distributional facts that are consistent with both representational and preferential attitude verb classes. *Hope* can take both non-finite (5)-(6) and finite (7) complements:

(5) *Mom hopes to go to bed.*
(6) *Mom hopes for Andy to be in bed.*
(7) *Mom hopes that Andy is in bed.*

Interestingly, *hope* also shares meaning components with both representationals and preferentials. *Hope* has an obvious desire component. Sentences with *hope* always express a preference. In each of the above sentences, the *hoper* desires the content of the embedded clause. Thus, regardless of the syntactic frame, or the context, *hope* always expresses a desire. But *hope* also seems to have a belief component (Portner 1992, Scheffler 2008, Anand & Hacquard, 2013). Although sentences with *hope* express a desire, there seem to be restrictions on what that desire can be: the proposition expressed by the complement has to be a doxastic possibility for the subject. Imagine a scenario where Andy is playing outside, and Mom knows this. She can still *want* him to do something else, but it is infelicitous to say that she *hopes* he's doing something else (8)-(9).

(8) *Mom knows Andy is playing outside, but she wants him to be in bed.*

[1] See Hacquard 2014 and White 2015 for why children assume that *think* and *want* not only belong to separate classes, but to the correct representational and preferential classes.

(9) *#Mom knows that Andy is playing outside, but she hopes he's in bed.*

With *hope p*, the subject has to believe that *p* is a live possibility. Thus, while *think* express a commitment to truth, *hope* expresses a commitment to the possibility of truth.

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

One piece of evidence that the syntax may help children is their differential susceptibility to reality in interpreting *want* and *think*. Although the contextual input that children get about the meanings of attitude verbs may not be very helpful, we see that children categorize them by age 3. But, of course, *think* and *want* are quite common in the input. Looking in the CHILDES database (MacWhinney 2000), we found that *want* occurs 22,012 times per million utterances, and *think* occurs 10,187 times per million utterances. Although there is no necessary physical correlates that go along with these psychological acts, it is possible that they are getting at least some help from the situational contexts (perhaps along with the syntax) to figure out the meanings of *want* and *think*.

Hope is obviously much less frequent than *want* or *think*, and we know children still have difficulty with *think* at age 4. Again, looking in CHILDES (MacWhinney 2000), we find that children hear *hope* much less often than *want* or *think*. *Hope* occurs in child directed speech at a rate of only 364 times per million utterances. It is unlikely that children have had enough exposure to know what *hope* means by the age of 4. Do children understand that *hope* has a desire component? Do they understand that it has a doxastic component? And does this understanding get influenced by the kind of syntactic frame *hope* appears in?

3. An Experiment

In order to see whether children use syntactic environment as a cue to attitude verb meaning, we test children's interpretation of sentences with *hope*, manipulating syntactic frame.

3.1. Subjects

Participants were 96 children aged 4;0 to 5;0 (mean = 4;6). 12 additional children were excluded from the task, 8 due to getting too many controls incorrect, 2 due to parental report of the child's exposure to English as less than 80%, and 2 due to experimenter error.

3.2. Design and Materials

In this experiment, we use a task in which the child plays a game with a puppet, *Froggy*. The premise of the game is that the child and the experimenter pull shapes out of a box and show them to Froggy. The child and one experimenter are behind an occluder, while Froggy is on the other side. In front of the child and the experimenter is a box with 40 wooden shapes in it. 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 is that on every trial, it will be a heart that is pulled out of the box. 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. This way, on every trial, Froggy has both a *desire* about what the shape will be—because he always wants the shape to be a heart; and also a *belief* about what the shape will be—because when 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 a test sentences either about Froggy's mental

states, using sentences with *want* (10) or *think* (11) as control conditions; or sentences with *hope*, either with a non-finite complement (12) or with a finite complement (13).

(10) *Froggy wants it to be a heart/star!*
(11) *Froggy thinks that it's a heart/star!*
(12) *Froggy hopes to get a heart/star!*
(13) *Froggy hopes that it's a heart/star!*

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

In a 4x4 design, we tested sentence type as a between-subjects factor (*want* (n=24), *think* (n=24), *hope-to* (n=24), *hope-that* (n=24)), and "realization of mental state" as a within-subjects factor and the child's response of *yes* or *no* as the dependent measure. On every trial, Froggy has both a belief and a desire about what the next shape to be pulled out of the box is. Sometimes, he has a true belief (red heart, yellow star conditions), which we call "realized belief" situations. Sometimes, he has a false belief (red star, yellow heart conditions), which we call "non-realized belief" situations. Similarly, sometimes his desire for a heart is fulfilled (red/yellow heart conditions), which we call "realized desire" situations. Sometimes his desire for a heart goes unfulfilled (red/yellow star conditions), which we call "non-realized desire" situations. In the study, the participant encounters every possible combination of realized and non-realized beliefs and desires. Table 1 shows each of the within-subjects conditions.

TABLE 1: Experimental Conditions

Shape	**Desire**	**Belief**
Red Heart	Realized	Realized
Red Star	Non-Realized	Non-Realized
Yellow Heart	Realized	Non-Realized
Yellow Star	Non-Realized	Realized

The experiment includes 8 items of each type—4 yes-target sentences and 4 no-target sentences, for a total of 32 test items per child.

3.3. 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. The first experimenter also controlled the silly puppet, "Booboo," and read the filler and test sentences. Another experimenter sat on the other side of the occluder (across the table from the child and the first experimenter), and played Froggy. The second experimenter also coded the child's responses. Permission was obtained from parents to video record each subject for an additional round of coding off-line. The experiment began by the child being introduced to the puppet, "Froggy," with whom they would be playing the game. The first experimenter says the following to introduce the child to the puppet, and then the child goes through several practice sections in order to ensure that they understand all the necessary elements of the game, including Froggy's desires and beliefs in this context. The practice sections are detailed below.

3.3.1. Practice Sections

Practice Section #1: Practice with distribution. The first warm-up involves directing the child's attention to the distribution of colors and shapes. The shapes are already divided up on the table in front of the child. The child is asked to tell the experimenter if there are "a lot" or "just a few" of each of the four types. The point of this warm-up is for the child to notice the distribution of colors and shapes. This helps them get 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 box of 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—one of the points on the star shapes is the exact same size and shape as the point on the heart shapes. This means that neither the child, nor Froggy can see what the shape is. The child is told that they will be able to guess what the shape is, and 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 section is for the child to experience seeing the ambiguous clues, so that they truly 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 what Froggy's default guesses are—namely that when the clue is red, Froggy thinks it's a heart, and when it's yellow he thinks it's a star.

Practice Section #3: Froggy's default guess check. The next practice section just confirms that children are sensitive to what they have observed that Froggy guesses when he sees clues in the previous section. The experimenter checks this by asking the child what Froggy guesses when he sees each of the clue types—red and yellow. This ensures that the child understands what Froggy's beliefs are, given the clue that he sees. This practice section also ensures that the child realizes that even though Froggy always *guesses* a shape based on the color of the clue he sees, he still realizes that his guess is sometimes wrong. This is what makes sentences about Froggy's *hopes* felicitous, even when he has a false belief.

Practice Section #4: Practice with Booboo. In the final warm-up section of this task, children are introduced to the silly puppet, Booboo, who is going to watch them play the game with Froggy. The child is told that Booboo is silly, and that "he 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 [the child's] job is to help him out and tell him whether he's right or wrong so he can learn how to play the game." 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. While only the clue is visible to the child, Booboo says a sentence about what Froggy will guess given the color (14), and after the shape is taken out, Booboo says a sentence about whether Froggy likes that shape or not (15).

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

The child's job is to tell Booboo whether he said each of the sentences correctly. 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 when he says things about Froggy. This section also serves as a reminder of Froggy's desires and beliefs. If the child has any trouble correcting Booboo on this section, they are given help from the experimenter. We are in the process of coding these practice sections to look for correlations between performance on practice sections and test items.

3.3.2 Test Sentences

After all of the warm-up sections are finished, the box of shapes and the occluder are turned so that now that child can again 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.

3.4. Hypotheses and Predictions

This experiment tests whether children are sensitive to syntactic frame in interpreting an attitude verb with which they have little experience. If children are sensitive to syntactic frame, we expect to

see different performance in the *hope-to* and *hope-that* conditions on this task. We predict that children in the *hope-to* condition will perform like the children in the *want* condition, and children in the *hope-that* condition will perform like children in the *think* condition. This pattern of behavior would be informative about (at least one) of the strategies that children are using to interpret attitude verbs, and possibly to learn their meanings.

3.5. Results

Children's responses were coded online by the second experimenter. There are three possible response patterns that we might expect to see given the experimental setup. The first expected pattern is one based on desires. Children behaving this way should assent to sentences that mention a heart, regardless of what shape and color the shape actually is. The second possibility is that children will give responses based on beliefs. In this case, 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. Finally, we may see responses based on reality. In this case, children should assent to sentences that mention the shape corresponding to the actual shape (regardless of color, nor desire or belief).

Given previous findings, we expect desire-based responses in the *want* condition, and reality-based responses in the *think* condition. If children know that *hope* in this context references the desires of Froggy, then we expect desire-based responses regardless of syntactic frame. If children do not yet know the meaning of *hope*, and are sensitive to the syntax, we expect desire responses in the *hope-to* condition, and reality responses in the *hope-that* condition.

Children's responses were measured in percent 'yes'-responses. Red heart items were counted as controls—because this is a realized belief and realized desire case, whether the participant responds based on desire, belief *or* reality, we predict the same pattern of responses. For this reason, we excluded participants who got fewer than 6 out of the 8 red heart items correct. We excluded 8 children for this reason. For the remaining children, we compared performance on *want* v. *think* and *hope-to* v. *hope-that* using 2x4 ANOVAs. For the *want* and *think* conditions, we ran a 2x4 ANOVA with percent *yes* responses as the dependent measure. We find a significant main effect of verb ($(F(1,344) = 4.67, p = .03)$), a significant main effect of sentence type ($(F(1,344) = 104.7, p < .0001)$), and an interaction between sentence type and realization of mental state ($(F(1,344) = 301.9, p < .0001)$). Children are adult-like in interpreting *want*, but influenced by reality when there is a conflict with *think*. In the *hope* conditions, we ran a 2x4 ANOVA with percent *yes* responses as the dependent measure. We find no main effect of frame ($F(1,376) = 0.67, p = 0.41$), but a main effect of realization of mental state ($F(1,376) = 57.63, p < .0001$), and an interaction between sentence type and realization of mental state ($F(1,376) = 4.49, p < .0001$). Children are more likely to give desire responses (i.e. look adult-like) in the *hope-to* condition, and more likely to be influenced by reality (i.e. traditional false belief error) in the *hope-that* condition. Data for all conditions shown in Table 2.

TABLE 2: Percent *yes*-responses by Condition

VERB	CONDITION	REALIZATION OF MENTAL STATE	Mentioned Shape	Target	% Yes
THINK	RED HEART	REALIZED DESIRE REALIZED BELIEF	Heart	Yes	100%
			Star	No	3%
	RED STAR	NON-REALIZED BELIEF NON-REALIZED DESIRE	Heart	Yes	14%
			Star	No	85%
	YELLOW HEART	NON-REALIZED BELIEF REALIZED DESIRE	Heart	No	87%
			Star	Yes	22%
	YELLOW STAR	REALIZED BELIEF NON-REALIZED DESIRE	Heart	No	5%
			Star	Yes	91%
WANT	RED HEART	REALIZED DESIRE REALIZED BELIEF	Heart	Yes	98%
			Star	No	0%
	RED STAR	NON-REALIZED BELIEF NON-REALIZED DESIRE	Heart	Yes	69%
			Star	No	14%

	YELLOW HEART	NON-REALIZED BELIEF REALIZED DESIRE	Heart	Yes	100%
			Star	No	2%
	YELLOW STAR	REALIZED BELIEF NON-REALIZED DESIRE	Heart	Yes	74%
			Star	No	13%

HOPE-TO	RED HEART	REALIZED DESIRE REALIZED BELIEF	Heart	Yes	100%
			Star	No	4%
	RED STAR	NON-REALIZED BELIEF NON-REALIZED DESIRE	Heart	Yes	50%
			Star	No	29%
	YELLOW HEART	NON-REALIZED BELIEF REALIZED DESIRE	Heart	No	95%
			Star	Yes	4%
	YELLOW STAR	REALIZED BELIEF NON-REALIZED DESIRE	Heart	No	48%
			Star	Yes	25%
HOPE-THAT	RED HEART	REALIZED DESIRE REALIZED BELIEF	Heart	Yes	95%
			Star	No	3%
	RED STAR	NON-REALIZED BELIEF NON-REALIZED DESIRE	Heart	Yes	32%
			Star	No	63%
	YELLOW HEART	NON-REALIZED BELIEF REALIZED DESIRE	Heart	No	95%
			Star	Yes	3%
	YELLOW STAR	REALIZED BELIEF NON-REALIZED DESIRE	Heart	No	32%
			Star	Yes	57%

Graphs for 2 conditions are shown below. The red heart condition, the control condition, is shown in Figure 1. Whether children respond based on reality, desire or belief, we predict that children will say 'yes' to a mentioned heart and 'no' to a mentioned star. As shown in Figure 1, the remaining children have no difficulty in this condition (after 8 children were excluded).

FIGURE 1: Red Heart Condition

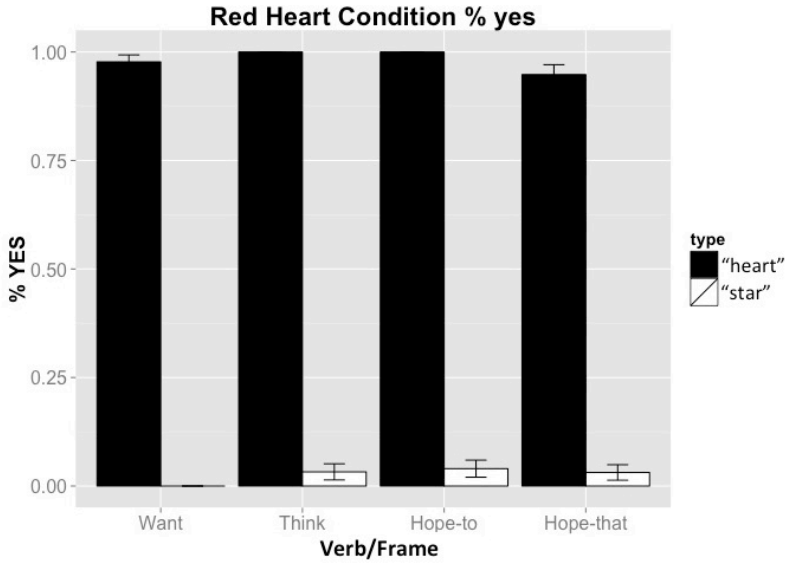
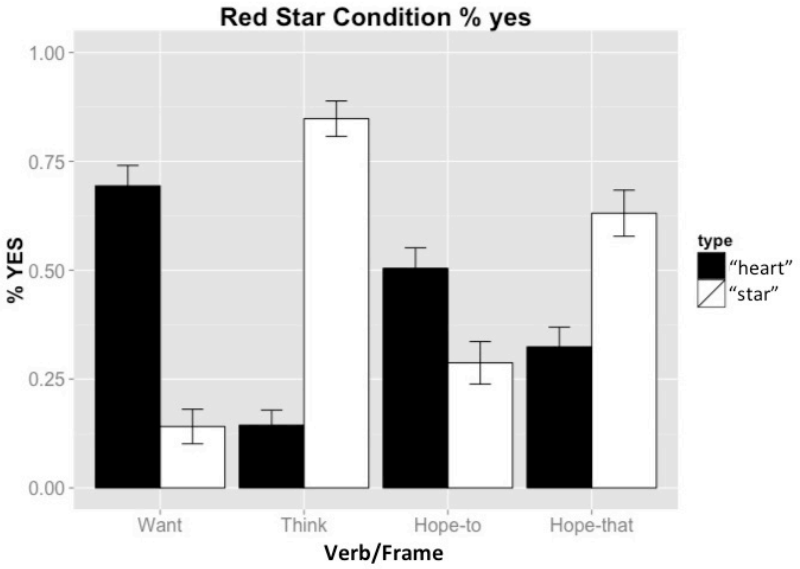


Figure 2 shows the red star condition. This condition is a non-realized belief and desire; therefore, reality patterns differently from both belief and desire responses. This condition allows us to compare the influence of reality in the *hope-to* and *hope-that* conditions. In this case, if children respond based on Froggy's beliefs or desires, they should say 'yes' to heart and 'no' to star. Reality responses will show the opposite pattern of responses. As evident in the graph, children are able to overcome the lure

of reality in interpreting sentences with *want,* but not *think*. In the *hope* conditions, we see that children are able to overcome the lure of reality in interpreting *hope-to* more often than in interpreting *hope-that,* where children are more likely to be influenced by reality. This condition shows both differential treatment of *hope-to* and *hope-that*, and that children are more likely to make the traditional false belief error in the *hope-that* case.

FIGURE 2: Red Star Condition



In the conditions where reality and desire make different predictions, we see different performance in the *want* and *think* cases, replicating many previous studies, and we also see different patterns of behavior in the *hope-to* and *hope-that* conditions.

3.6. Discussion

In this experiment, we looked at whether children are influenced by syntactic frame when interpreting an attitude verb that they may not know the meaning of, in a context where both belief and desire are salient. We found evidence for the syntactic bootstrapping hypothesis in the domain of attitude verbs: children are sensitive to the syntactic frame in which they hear the verb *hope*, suggesting that they use syntax as a cue when they are interpreting a potentially unknown attitude verb. This study shows that when children hear a verb with a non-finite complement, they are more likely to treat it as if it is about desires, whereas when they hear a verb with a finite complement, they make the same reality-error that we see in their interpretation of *think*.

4. Conclusion

In this paper, we have probed children's sensitivity to syntactic frame when interpreting attitude reports through an experiment testing whether four year olds are sensitive to syntactic distribution when interpreting a (potentially unknown) attitude verb. We compared children's interpretation of the verbs *want, think*, and *hope* in a context where both belief and desire interpretations were salient. We replicated previous findings pointing to an asymmetry between the influence of reality in children's interpretation of *think* vs. *want:* children overcome the lure of reality in interpreting sentences with *want*, but not *think.* We also looked at children's interpretation of sentences with *hope* in two different syntactic frames: with a non-finite complement—a syntactic frame typically associated with verbs that express desires; and with a finite complement—a syntactic frame typically associated with representational verbs. We found that children were able to overcome the lure of reality in interpreting

hope with a non-finite complement, correctly getting desire-based interpretations. However, when children heard *hope* with a finite complement, they made the same reality-errors as with *think*. Our results suggest that whatever is causing children's difficulty with *think* generalizes beyond *think*: a finite complement leads to reality-based errors, a nonfinite complement doesn't.

There are two ways in which the syntax might help. According to a weak version of the syntactic bootstrapping hypothesis, perhaps children have already figured out meanings for verbs like *think* and *want*: when they encounter a novel verb, they use syntactic frames to make analogies based on verbs they already "know". Of course, given that they haven't fully mastered *think* by that age (as evidenced by their reality-based errors), we would still want to know how they knew to treat *want* and *think* differently in the first place.

According to a stronger version of the syntactic bootstrapping hypothesis, there are principled links between the kinds of complements that verbs take and their underlying semantics, to which children are privy (e.g., representationality is connected to finiteness of the complement—or more generally, a complement with main clause syntax). Children exploit these links whenever they encounter a novel verb, and know to allocate it to the right semantic class. But again, since children haven't fully mastered *think* (as evidenced by their reality-based errors), we would want to know how children map these verbs to the representational and preferential classes, and yet still make consistent reality based errors.

One possibility is that children consistently make mistakes with representational attitudes like *think* for pragmatic reasons (Lewis, Hacquard & Lidz 2012, Lewis 2013). Representational attitudes express judgments of truth, and as such, they can be used by speakers to make indirect assertions, via an implicit endorsement of these judgments of truth. A learner might notice the syntactic parallel between direct assertions (syntax of declarative main clauses) and indirect assertions (a verb that selects for a complement with the syntax of declarative main clauses). This may lead her to hypothesize that if verb selects for a finite complement, its meaning lends itself to indirect assertions: the verb expresses a judgment of truth that the speaker can endorse. This will also lead her to make reality-based mistakes: if she assumes that the speaker is indirectly asserting a proposition that she knows to be false, she will reject this indirect assertion (see Hacquard and Lidz 2013 and Hacquard 2014 for a proposal along these lines).

Whether the stronger version of the hypothesis turns out to be true or not, we have at least seen some evidence that children's are attuned to the syntactic environment in which attitude verbs appear in, and that it influences the meanings they hypothesize for these verbs.

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