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On the Acquisition of Attitude Verbs

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Abstract

Attitude verbs, such as *think*, *want*, and *know*, describe internal mental states that leave few cues as to their meanings in the physical world. Consequently, their acquisition requires learners to draw from indirect evidence stemming from the linguistic and conversational contexts in which they occur. This provides us a unique opportunity to probe the linguistic and cognitive abilities that children deploy in acquiring these words. Through a few case studies, we show how children make use of syntactic and pragmatic cues to figure out attitude verb meanings and how their successes, and even their mistakes, reveal remarkable conceptual, linguistic, and pragmatic sophistication.

1. INTRODUCTION

A theory of word learning faces two basic challenges. First, it must delineate the range of hypotheses that learners can consider in positing meanings for new words. This part of the theory will be informed by both linguistic theory, which can unearth constraints on possible linguistic meanings and how these interact with each other, and the study of concepts and cognitive development, since even the very earliest word meanings seem to connect to rich assumptions about how the world works and how concepts are connected to each other (Carey 2009, Gleitman & Papafragou 2013, Gopnik et al. 1999, Spelke & Kinzler 2007). Second, such a theory must specify the role that experience plays in fixing the meaning of a word form. Given that the pairing of form and meaning is arbitrary, this will require observation of that form in relation to both linguistic and extralinguistic aspects of its context. But, as has been observed by authors as diverse as Quine (1960), Chomsky (1959), and Gleitman (1990), a learning theory that treats the learner's experience of the extralinguistic context in purely sensory-perceptual terms will not be able to deliver the subtleties even of children's initial ideas about word meaning. And, as Chomsky (1959) emphasized, speakers are under no obligation to talk about what is happening around them. What people say is determined by their communicative goals: whether they are trying to provide or get information, issue commands or warnings, make promises or speculate about the future. But these goals are not always transparent, as they depend on the speaker's beliefs and desires about both the world and those they are talking to. Learning the meaning of a word, then, must involve unraveling all of that psychology to determine what role that particular word contributes to the communicative intents of the person who uttered it.

Nowhere is the complex interplay between extralinguistic cognition, communicative intentions, and possible word meanings more evident than in the acquisition of attitude verbs: verbs that describe the contents of people's minds, such as beliefs or desires (for overviews on their semantics, see Grano 2021, Pearson 2020). Because such verbs name internal states of mind, they present special challenges to learners. First, they describe concepts like belief, which may not readily be accessible. Second, mental states leave much less of a signature on the mind-external world than do words referring to actions (*jump*), properties (*purple*), or object kinds (*rabbit*), so it is not obvious from the physical environment when people intend to refer to them. Mental states, like beliefs and desires, are always implicitly present in conversations, in virtue of the fact that conversations involve agents whose beliefs and desires drive those conversations. But because of this ubiquity, these mental states turn out to be rarely conversationally salient when attitude verbs are used, at least in English. This is because speakers often use these verbs to indirectly assert ("I *think* it's raining" to proffer that it's raining), question ("Do you *know* what time it is?" to ask for the time), or request ("I *want* you to go to bed" to order one to go to bed).

These challenges with attitude verbs seem to be reflected in their acquisition profile. While *think* and *want* both occur between 10,000 and 20,000 times per million words in child-directed speech, children do not show adult-like performance on tasks testing their acquisition until well into the preschool years. In contrast, a word like *car* occurs only about 1,000 times per million words, but nearly every 30-month-old speaker of English knows it. And we observe important differences among attitude verbs. Difficulties in understanding attitude reports with *think* or *know* persist until at least age 4, whereas 3-year-olds seem to have no trouble with *want*.

Understanding both why attitude verbs are acquired later than words that occur less often and how different attitude verbs vary in their acquisition profiles provides a unique opportunity to probe the linguistic and cognitive abilities that children deploy in acquiring these words, the expectations that children have about how syntax and semantics relate to each other, and children's appreciation of what people are likely to think, want, and talk about. To this end, we can draw on

insights from a wide range of fields, including linguistics, cognitive development, and philosophy of mind and language. When we bring these literatures together, we see how the acquisition of attitude verbs depends on rich conceptual frameworks, pragmatic and communicative sophistication, and core properties of the syntax-semantics interface.

We focus here on a few attitude verbs, among the most frequent and first to appear in children's speech. We begin with the well-documented asymmetry in the acquisition of *want* and *think* and what this asymmetry can tell us about how children learn these words. We then turn to how children acquire the more subtle meaning differences between *think* and *know* and, again, what their successes and failures can tell us about the acquisition process. For both types of contrasts (belief versus desire, belief versus knowledge), we show that children must—and do—rely on indirect cues, stemming from the linguistic and conversational context in which the verbs occur, and that through their successes, but even in their failures, children display sophisticated conceptual, linguistic, and pragmatic abilities.

2. ACQUIRING ATTITUDE MEANINGS: SYNTACTIC AND PRAGMATIC BOOTSTRAPPING

In any word learning situation, learners can make use of various potential sources of information. First, the situational or physical context in which the word is used: what is going on in the world, what the speaker is attending to (for a word like *rabbit*, there might be a fuzzy animal scurrying by that the speaker is looking at). Second, the conversational context in which the word occurs: what the topic of conversation is, what has been said, what the speaker is trying to achieve (perhaps we are talking about pets or making dinner plans). Finally, the linguistic context: what other words the target word co-occurs with and in what syntactic frames (perhaps *rabbit* co-occurs with *the* or *a*).

Given that attitude verbs describe mental states, cues from the physical context are bound to be limited. However, there is ample, albeit more indirect, information about attitude verb meanings stemming from the linguistic and conversational contexts in which they appear that learners could exploit.

Take an attitude report like in example 1, with a novel verb *dax*. Because attitude verbs describe internal states, little in the physical context could indicate that *dax* expresses a mental state, let alone the kind of mental state that it expresses. As competent English speakers, however, we might infer from the fact that *dax* appears with a sentential complement that it does express some kind of mental state. We might further infer from the fact that this complement is finite that *dax* is more likely to express a belief than a desire and, conversely, that *gorp* in example 2 is more likely to express a desire than a belief. Gillette et al. (1999) confirm experimentally that at least adults can infer attitude meanings on the basis of syntactic information, even when the visual context is not helpful.

(1) Mom daxes that Andy is in bed.
(2) Mom gorps Andy to go to bed.

Because of their lack of physical correlates, Gleitman (1990) and Landau & Gleitman (1985) propose that the acquisition of attitude verbs requires relying on the linguistic context and specifically on syntactic bootstrapping—inferring a word's meaning by exploiting principled links between its meaning and its syntactic distribution. For instance, if learners expect attitude verbs to express a relation between an individual and a proposition, they might infer from hearing a verb with a subject and a sentential complement that it could denote an attitude. If they further expect belief, but not desire, verbs to take finite complements, they might further infer that *dax*,

but not *gorp*, expresses some kind of belief. Thus, if there are principled links between attitude verb meanings and the types of complements that they take, then learners privy to these links could exploit them to infer the meanings of attitude verbs, based on their syntactic distribution. The vast literature on the syntax and semantics of attitude verbs arguing for such principled links makes syntactic bootstrapping a promising avenue for attitude verb learning (see, e.g., Anand & Hacquard 2013, Anand et al. 2019, Bolinger 1968, Djärv 2019, Egré 2008, Farkas 1985, Giannakidou 1997, Ginzburg 1995, Hooper 1975, Lohninger & Wurmbrand 2020, Moulton 2008, Portner & Rubinstein 2012, Villalta 2008, White & Rawlins 2018).

Learners may further be able to exploit cues from the conversational context. Attitude verbs are often used for indirect speech acts, as in examples 3–5. Such uses of attitude verbs background the mental state they describe: The main point (Simons 2007, Urmson 1952) of the utterance in example 3 is not a belief description but to convey that the proposition expressed by its complement is likely true. The main point of the utterance in example 4 is not a desire description but a request for what is expressed by its complement. And the main point of the utterance in example 5 is not a question about a knowledge state but about what is expressed by its complement. Such backgrounding could make it difficult for learners to extract literal from speaker meaning and figure out the verbs' semantic contribution.

(3) I think it's 5 PM. *Indirect assertion*: It's 5 PM.
(4) I want you to tell me the time. *Indirect request*: Tell me the time!
(5) Do you know what time it is? *Indirect question*: What time is it?

However, this backgrounding could also turn out to be a feature, rather than just a bug. Searle (1975) argues that the reason why utterances like those in examples 3–5 are so well suited for indirect speech acts is because their literal content expresses a precondition of the indirect act (to assert *p*, one must believe *p*; to request *p!*, one must want *p*; and to ask *p*?, one must believe one's addressee can answer *p*). If learners were to perceive the force of speakers' intended illocutionary acts, they could infer from perceiving the utterance in example 3 as an indirect assertion that *think* expresses a commitment to the truth of the complement, from perceiving the utterance in example 4 as an indirect request that *want* expresses a desire, and from perceiving the utterance in example 5 as an indirect question that *know* expresses a relation to a true answer. Such pragmatic bootstrapping seems at least possible, given the growing evidence that young children perceive the intent of indirect requests (Begus & Southgate 2012, Shatz 1978, Spekman & Roth 1985) and questions (Evans et al. 2014, Goodhue et al. 2020, Grosse et al. 2010).

This strategy could, however, backfire, given that any attitude report can be used for virtually any kind of speech act: *Think* in example 6, for instance, can be used to order one's child to go to bed. In Hacquard & Lidz (2019), we propose a hypothesis we call pragmatic syntactic bootstrapping, according to which syntactic and pragmatic bootstrapping mutually constrain each other, such that learners would only use pragmatic cues consistent with syntactic cues. In example 3, both the pragmatic function (indirect assertion) and the syntactic frame (finite complement) are consistent with a belief meaning, but they are not in example 6 (indirect request and finite complement).

(6) I think it's time for bed!

Thus, despite the dearth of physical cues as to their meanings, different attitude verbs may leave identifiable footprints in both the linguistic and conversational contexts, the types of complements they take, and the pragmatic function they routinely serve. Through the case studies we describe below, we examine the role that syntax and pragmatics play in helping or hindering the acquisition of attitude verbs.

3. BELIEF VERSUS DESIRE VERBS

A broad literature finds an asymmetry in the acquisition of *want* and *think*. Specifically, up to age 4, children tend to reject (true) *think* sentences that report a false belief but have no such difficulties with (true) *want* sentences that report an unfulfilled desire, as in examples 7 and 8, adapted from Perner et al. (2003), in scenarios in which Andy is watching TV in spite of his mother's belief or desire.

(7) Mom thinks that Andy is going to bed.
(8) Mom wants Andy to go to bed.

Conventional wisdom ties this linguistic asymmetry to a corresponding conceptual asymmetry, whereby the concept of desire is acquired early but the belief concept awaits maturation of a theory of mind around age 4. However, infancy researchers over the past 20 years have uncovered a wealth of evidence showing that children reason about other people's beliefs from as early as 6 months of age. This suggests that the difficulties children display with *think* cannot be attributed to conceptual development. We argue instead that these difficulties are more superficial and pragmatic in nature, stemming from children's expectations about how attitude verbs are used in conversation. In Section 3.1, we review the literature on the development of the concepts of belief and desire. In Section 3.2, we provide evidence against a conceptual explanation for children's difficulty with *think* and in favor of a pragmatic explanation instead. In Section 3.3, we discuss what the differing acquisition profiles of the two verbs reveal about how children figure out their meaning. We argue that children differentiate belief and desire verbs by exploiting concurring cues from the verbs' syntactic and pragmatic distribution, and we provide evidence for such pragmatic syntactic bootstrapping.

3.1. Conceptual Development of Belief and Desire

If children cannot reason about beliefs or entertain a belief concept similar to that of adults, then they have no hope of acquiring words that pick out this concept. And, indeed, many have argued that while children have an adult-like desire concept by age 3, they lack an adult-like belief concept until age 4, due to an immature theory of mind.

Turning to desire first, Wellman & Woolley (1990) find that 2-year-olds successfully predict actions related to people's simple desires. Using implicit tasks, Woodward (1998) finds that even 5-month-olds expect people to act in accordance with their goals, which could be seen as an early form of desire representation, at least with respect to objects (Gergely & Csibra 2003). Other tasks look at older infants' ability to represent conflicting desires. In a classic task, Repacholi & Gopnik (1997) show that 14- and 18-month-olds appropriately represent the desires of an agent that differ from the child's own. However, success on these tasks arguably does not require a full-fledged concept of desire: Perhaps young children grasp that others have desires that differ from their own, so long as these desires do not conflict with each other, or with reality. Even in the classic Perner et al. (2003) study above, the reported desire in example 8 is not truly counterfactual, unlike the reported belief in example 7, as example 8 most naturally reports a desire about a future state of affairs.

Building on studies by Moore et al. (1995), Rakoczy et al. (2007), and Rakoczy (2010), Harrigan et al. (2018) tested whether 3-year-olds understand that agents can have desires that conflict with their own or with reality. A first experiment presented children with stories in which two characters had conflicting desires [e.g., Mom wanted Megan to remain in the shopping cart, but Megan wanted to get out of the cart (and did so)]. Then a puppet summarized, as in example 9:

(9) Mom wants Megan to be in the shopping cart right now.

Three-year-old children correctly responded to the puppet's statement independent of whether the desired state conflicted with reality or with the other character's desires.

A second experiment tested children's understanding that people can have desires that conflict with their own. Children played a game with a puppet in which cards were flipped over to reveal a color. For one color, the child got to stamp their game card; for another color, the frog puppet got to stamp its game card; for a third color, both got to stamp; and for a fourth, neither did. A second puppet, Booboo, was trying to learn the rules of the game and made utterances like those in examples 10a and 10b:

(10a) You want the card to be green.
(10b) Froggy wants the card to be red.

Three-year-olds were consistently able to correctly judge Booboo's statement, even when it reported a desire that conflicted with the actual card color or with the child's desire. Thus, by age 3, children seem to have an adult-like understanding of *want* and its underlying desire concept.

Turning to the belief concept, many studies show that preschool-aged children struggle with false belief. We illustrate here with the change-of-location false-belief task (Wimmer & Perner 1983), in which children are asked how a character with a false belief will behave. In a representative story, a boy named Maxi is helping his mom put away groceries. He puts some chocolate in the blue cupboard before going out to the playground. While he is gone, Maxi's mom uses the chocolate to make a cake and puts the leftovers in the green cupboard. Then Maxi returns to eat some chocolate. Children are asked the question in example 11:

(11) Where will Maxi look for the chocolate?

In Wimmer & Perner's (1983) study and the dozens of similar studies that followed, 3-year-olds appear to be biased by their own knowledge: In response to the question in example 11, they often say that Maxi will look for the chocolate in its actual location rather than where he put it. In a meta-analysis of 178 studies, Wellman et al. (2001) found that children respond based on reality more often than not until about age 3.5 and start responding based on beliefs at about age 4. If this behavior reflects a lack of an adult-like belief concept, children's non-adult-like understanding of belief reports also follows: Children reject example 7 because they cannot conceptualize Mom having a false belief.

This hypothesis, however, encounters two empirical challenges. First, although performance on linguistic and nonlinguistic tests of belief understanding are closely correlated, children generally succeed earlier on the linguistic tasks (de Villiers 2005, de Villiers & Pyers 2002, Hale & Tager-Flusberg 2003, Lohmann & Tomasello 2003, Milligan et al. 2007, Tager-Flusberg & Joseph 2005), undermining the idea that the development of adult-like comprehension of *think* is held back only by the delayed development of belief. It further suggests that children's difficulty with the change of location task may track something beyond conceptual access. Many researchers argue that traditional false-belief tasks are fundamentally flawed as measures of young children's underlying competence since they require an explicit decision and response. And indeed, children seem to be able to reason about false beliefs long before their fourth birthday, when they are tested with more implicit measures, or if the critical question or task is less direct (Buttlemann et al. 2009, Knudsen & Liszkowski 2012, Rubio-Fernández & Geurts 2013, Scott et al. 2012, Southgate et al. 2010) or the processing demands on the response lessened (Bartsch 1996, Hala & Chandler 1996, Setoh et al. 2016, Surian & Leslie 1999, Yazdi et al. 2006).

One prominent example of early success in false-belief reasoning comes from Onishi & Baillargeon (2005), who tested 15-month-olds in a violation of expectations task. Infants first saw an actor hide her toy in one of two boxes followed by several trials in which the actor came to hold either a true or false belief about the toy's location. In the test trial, infants expected the actor to reach into the box where she believed the toy was, regardless of whether her belief was true or false, and looked longer if she reached into the other box instead. Similar findings arise from a variety of tasks, including with infants as young as 6 months (Baillargeon et al. 2010, Buttlemann et al. 2009, Clements & Perner 1994, He et al. 2012, Kovács et al. 2010, Song & Baillargeon 2008, Song et al. 2008, Southgate & Vernetti 2014, Southgate et al. 2007, Surian et al. 2007; see Scott & Baillargeon 2017 for a review). These findings align with evidence that 2-year-olds engage in behaviors that seem to require attribution of beliefs to others, like attempts to deceive (Chandler et al. 1989) or help people with false beliefs about an object's location (O'Neill 1996).

The mounting evidence of infants' abilities to track and reason about beliefs casts serious doubt on a conceptual explanation of older children's difficulties with belief reports. We turn below to an alternative, pragmatic explanation.

3.2. Pragmatic Roots of Children's Difficulty with *Think*

Attitude reports are often used for indirect speech acts. *Think* in particular is routinely used for indirect assertions (Dudley 2017, Dudley et al. 2018, Howard et al. 2008). Lewis et al. (2012, 2017) investigated the possibility that children's difficulty with *think* results from their understanding of this fact. They argue that children know that people can be mistaken in their beliefs, but this knowledge is obscured by their difficulty understanding what speakers mean when using *think* in a sentence.

The literal meaning of a *think* sentence is a mere belief report and can be seen clearly in contexts in which we are reasoning about the motivations behind someone's actions:

(12) A: Why is Maxi opening the blue cupboard?
B: He thinks that there's chocolate in there.

Often, however, speakers use *think* sentences to do something more—namely, to proffer the complement, as in the dialogue below from Simons (2007):

(13) A: Why isn't Louise coming to our meetings these days?
B: Henry thinks that she's left town.

The literal content of B's answer is a belief report, which does not directly address A's question. B's utterance can naturally address A's question if B endorses the belief and thus proffers or indirectly asserts its content. With such parenthetical uses of *think* (Urmson 1952), the complement clause carries the main point of the utterance. The main clause gets demoted to parenthetical status and plays an evidential function (indicating the source of evidence for the proffering). Upon hearing B's utterance, C could intervene as follows:

(14) C: No she's not, she's home.

With this denial, C is responding not to the literal meaning of B's utterance but to the speaker's indirect assertion of the complement: C is not denying that Henry holds a particular belief but rather that Louise is out of town. We argue that this kind of denial underlies children's rejection of *think* sentences in scenarios in which they know the complement to be false: Their rejection is a rejection of the perceived speaker meaning—namely, an indirect assertion of the complement.

To see this, recall children's errors in false-belief contexts. In a scenario in which Andy is watching TV but his mother falsely believes that he is going to bed, 3-year-olds tend to reject example 7. Suppose that these children take the question under discussion to be what Andy is doing. In this context, an utterance of example 7 would amount to an indirect assertion that Andy is going to bed. Because they know that Andy is in fact watching TV, they should reject this false speaker meaning, the same way C rejects B's utterance in example 14. Under this view, children's rejection of *think* sentences is an adult-like response. Their error comes from overassuming indirect assertion uses and responding to that, when the speaker only intended to convey the literal meaning.

Lewis et al. (2012) manipulated the salience of belief to help children overcome their tendency to assume indirect assertion uses. Four-year-old children watched hide-and-seek stories in which one character hid and either one or two other characters looked for him. In the one-seeker false-belief condition, Swiper was hiding behind the curtain, but Dora mistakenly thought that he was behind the chest. Children had to judge the sentence in example 15. In the corresponding two-seeker condition, another character, Boots, was also looking for Swiper, but he correctly thought that Swiper was behind the curtain. Because Dora and Swiper have conflicting beliefs about the same situation, this scenario highlights the salience of the beliefs each have and biases children away from indirect assertion interpretations. Whereas 4-year-olds tended to reject the sentence in example 15 in the one-seeker condition, their performance significantly improved in the two-seeker condition.

(15) Dora thinks that Swiper is behind the chest.

Lewis et al. (2017) further tested whether 3-year-olds could respond to the falsity of a *think* sentence in a false-belief context, when the literal meaning of the *think* sentence is false but the complement is true. In a typical false-belief scenario, Swiper is hiding behind the curtain, but Dora thinks that he is behind the chest. In such a scenario, children reject the sentence in example 15, while adults accept it. In this context, the entire sentence is true, but the complement is false. According to the pragmatic hypothesis, children reject the sentence in example 15 because they assume an indirect assertion of the complement, which they know to be false. The crucial manipulation is a change in the target sentence. In the same false-belief scenario in which Swiper is behind the curtain and Dora thinks that he is behind the chest, children had to assess the target sentence in example 16:

(16) Dora thinks that Swiper is behind the curtain.

In this scenario, the sentence in example 16 is false, but the complement is true. The pragmatic hypothesis and the conceptual hypothesis make different predictions. The former assumes that children have access to the literal meaning of *think* and thus predicts that children should correctly reject the sentence in example 16, based on its false literal meaning, regardless of the truth of its complement. The latter predicts that children should accept the sentence in example 16, given that they can only assume that Dora has a true belief about Swiper's location. The results supported the pragmatic hypothesis: Children's responses were highly influenced by the truth of the complement when the entire sentence was true (as in example 15). They tended to accept the sentence if the complement was true, reject it if the complement was false, and vary when the truth of the complement was unknown. Crucially, however, when the sentence was false (as in example 16), they correctly rejected it, regardless of the truth of the complement.

To sum up, 3-year-olds appear to have the right semantics for *think*, or at least understand that it commits its subject to the truth of its complement, even if the complement is actually

false;[1] they are able to respond to the literal meaning of a *think* sentence and reject it if it is false. They tend to further reject *think* sentences that are literally true but in which the speaker meaning they assume is false. They differ from adults only in overassuming indirect assertion uses.

Assuming that children have the right semantics for *think*, but pragmatics interferes, we ask why children do not make these kinds of errors with *want*. Given its meaning in the adult grammar, *want* does not lend itself as easily to indirect assertion uses. But how could children know this before they have fully mastered either verb? Why do they not hypothesize a meaning for *want* that would lend itself to routine indirect assertions? In the next section, we spell out a hypothesis under which syntax constrains children's hypothesis space for these verbs' meanings.

3.3. Pragmatic Syntactic Bootstrapping of Belief and Desire Verbs

Children distinguish *think* and *want* early, making errors with the former but not the latter. And because the errors they make depend on an understanding of both the semantics and pragmatics of belief reports, even 3-year-olds seem to know that *think* and *want* are semantically distinct. How do children learn to distinguish the two verbs and map them to the right concepts?

We argue that children use syntactic distribution as the primary source of evidence for these verbs' meanings (Gleitman 1990). As we saw above, the fact that a verb takes a sentential complement is suggestive of an attitude meaning (Fisher et al. 1991, Gleitman et al. 2005, Papafragou et al. 2007). Differences in the types of complements attitude verbs take could further help children differentiate between classes of attitudes. One major split within this space is between what Bolinger (1968) called representational (e.g., *think*, *know*, *say*) and nonrepresentational (or preferential) verbs (e.g., *want*, *demand*), which roughly correspond to belief versus desire verbs. Crosslinguistically, this split seems to be tracked syntactically by the types of complements the two classes of verbs take (Bolinger 1968, Farkas 1985, Giannakidou 1997, Hooper 1975, Villalta 2008): In Romance languages, the complements of representational versus preferential verbs differ in mood (indicative versus subjunctive), and in English, they differ in finiteness.

In Hacquard & Lidz (2019), we hypothesize that children expect different subclasses of attitude verbs to have different syntactic distributions, and they use the distributions to infer the semantic subclass, in accordance with the syntactic bootstrapping hypothesis (Gleitman 1990, Landau & Gleitman 1985). For this hypothesis to be explanatory, it must be that differences in the syntactic distribution of attitude verbs can be linked to crosslinguistically stable properties, so that it is possible for learners to link the distributional differences to those aspects of meaning that explain them. But while it is common to find distributional differences between representational and preferential verbs, the specific features linked to these classes vary across languages. There is, however, a higher-order generalization that links these classes to the syntax: Representational verbs take complements with syntactic features of declarative main clauses. The features distinguishing declarative main clauses from other clauses vary from language to language. In English, they include finite tense, lack of a complementizer, presence of subject/verb agreement, and obligatory overt subjects, among others. In other languages, finiteness is less useful, but other features are available: verb-second word order for German, indicative mood for Romance languages. When

[1]These results are compatible with children having a factive *think* (like *know*), such that children would assume that uses of *think* presuppose (take for granted) that its complement is true; see Section 4 for evidence against this possibility. Children's overassumption of assertive uses is also consistent with treating *think* as an illocutionary force marker (Diessel & Tomasello 2001). However, their rejections of false-belief ascriptions suggest they treat belief ascription as at-issue content.

the features of declarative main clauses occur in embedded clauses, they are good predictors of the kind of attitude verb that embeds them.

The link between representational attitudes and declarative main clauses further aligns with the canonical pragmatic function associated with declaratives. Declarative main clauses are typically used to make assertions. And when representational verbs are used to make indirect speech acts, these are typically indirect assertions. Recognizing the similarity in force between direct and indirect assertions and the formal similarity between declarative main clauses and complements of representational attitudes may play a key role in explaining why the abstract connections between verb meaning and complement type hold and how children could draw from parallels between the two to infer verb meaning.

In what follows, we provide evidence in support of this bootstrapping hypothesis. We first show that a virtual learner tracking syntactic features of declarative main clauses successfully categorizes representational versus preferential verbs in English and Mandarin Chinese. We then show that actual child learners use finiteness of the complement to attribute a belief or desire meaning to an unfamiliar attitude verb.

White et al. (2018a) verify that the semantic subclasses of attitude verbs have syntactic signatures. Building on a method pioneered by Fisher et al. (1991), they collected two kinds of judgments: (*a*) syntactic acceptability judgments for a set of 30 attitude verbs in 19 syntactic environments, which were used to identify subclasses of verbs based on the similarity of judgments across all environments, and (*b*) semantic similarity judgments in sets of three for all 30 verbs. They show that the verb similarities identified in the semantic similarity task are highly predictive of the similarities identified in the syntactic acceptability judgment task. These results indicate that attitude verbs with similar meanings have similar syntactic distributions. Having more carefully established the link between semantic subclasses of attitude verbs and their syntactic distribution, White et al. (2018b) asked whether these subclasses are reflected in speech to children in a way that would be detectable by learners. They built a computational model that tracked the features of declarative main clauses and the features of complement clauses in speech to children to identify those verbs whose complements most resembled declarative main clauses and assign them to the representational class. They found that this model effectively categorized both the representational and preferential verbs in English.

Huang et al. (2021) extended this model to Mandarin child-directed speech. Given that Mandarin displays widespread null arguments and impoverished morphology, including a lack of overt mood or finiteness distinctions, surface cues to declarative main clauses are much harder to find. Examples 17a and 17b illustrate how belief and desire verbs can appear with complement clauses that are string identical:

(17a) Wo **zhidao** [chi shuiguo].
I **know** eat fruit
'I know {I/you/he/she/it/...} eat(s) fruit.'

(17b) Wo **ai** [chi shuiguo].
I **love** eat fruit
'I love to eat fruit.'

However, certain features like modals, aspect markers, and overt subjects still distinguish declarative main clauses and can be found in complements of representational but not preferential verbs. Huang et al. (2021) show that even though these features of declarative main clauses are optional inside both declarative main clauses and the complements of belief verbs, they occur often enough in speech to children to be detected and used by the model to successfully distinguish the complements of representational and preferential verbs. Thus, the abstract link between declarative main

clauses and the complement of representational verbs appears to be detectable even in a language like Mandarin, where it might be hardest to find.

The viability of this syntactic bootstrapping procedure for attitudes requires not only that the relevant information be in principle detectable but also that it actually be readily detected and deployed by children. Harrigan et al. (2019) tested whether 4-year-olds use the finite/nonfinite complement distinction as evidence about the meaning of attitude verbs. They probed 4-year-olds' understanding of *hope*, a relatively uncommon verb in child-directed speech. *Hope* can occur with both finite and nonfinite complements and shows properties of both representational and preferential attitudes (Anand & Hacquard 2013, Portner 1992, Scheffler 2008), as it expresses a desire for a state of affairs that cannot be ruled out by one's beliefs (one can *want* this weekend to last forever but not *hope* that it does). The experimental setup in Harrigan et al. (2019) made both the beliefs and desires of a puppet, Froggy, salient and tested whether the syntactic shape of the complement influences children's interpretation of *hope*.

In this game, the child and one experimenter are behind an occluder, with Froggy on the other side. The child has a box with 40 wooden hearts and stars, 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. 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. Froggy loves stickers; therefore, his desire on every trial is that the shape be a heart. On each trial, before Froggy sees what the shape is, the child and the experimenter show him a clue, which is ambiguous as to shape but not color, by inserting a point (of the heart or the star) through an opening in the occluder. Thus, on every trial, Froggy has both a desire about shape (he always wants the shape to be a heart) and a belief about shape (when it is red, he always guesses that it is a heart, and when it is yellow, that it is a star). Another puppet, Booboo, utters test sentences about what Froggy wants (as in example 18), thinks (as in example 19), or hopes (as in examples 20–21). The child's task is to say whether Booboo is right.

(18) Froggy wants it to be a heart/star.
(19) Froggy thinks that it's a heart/star.
(20) Froggy hopes to get a heart/star.
(21) Froggy hopes that it's a heart/star.

The results reproduce the traditional split in performance with *think* and *want*. Children correctly judge *want* sentences even when the reported desire conflicts with reality, but they tend to incorrectly reject *think* sentences that report false beliefs. Crucially, children's responses to *hope* sentences differ depending on the syntactic frame in which they are presented. With a finite complement, their responses pattern like their responses to *think* sentences; with a nonfinite complement, they pattern like their responses to *want* sentences. These results thus reveal that children use complement syntax to identify aspects of an attitude verb's meaning: 4-year-olds treat *hope* as a preferential verb when it takes a nonfinite complement and as a representational verb when it takes a finite complement.

4. THINK VERSUS KNOW

In the previous section, we asked how children identify whether a verb falls into the representational or preferential classes and argued for a pragmatically informed syntactic bootstrapping procedure. In this section, we ask whether this kind of bootstrapping can be further extended to distinguish verbs within the representational class, focusing on the verbs *think* and *know*. Both verbs express a belief of the subject but differ in that *know* is both veridical and factive, unlike *think*, which is neither.

A verb, like *know*, is veridical if it entails the truth of its complement. This is illustrated in the sentences in example 22 below: If the sentence in example 22b is true, then the one in example 22c has to be true as well. *Think*, by contrast, is not veridical; thus, the sentence in example 22a does not entail the sentence in example 22c: The sentence in example 22a can be true, even if the one in example 22c is not. Because of this difference, only *think* can be used to report a false belief. *Know* can only report true beliefs.

(22a) Kim thinks Chris is home.
(22b) Kim knows Chris is home.
(22c) Chris is home.

Know and *think* also differ in factivity. *Know* is factive (Kiparsky & Kiparsky 1970)—that is, it tends to be used when speakers presuppose, or take for granted, the truth of its complement. The proposition expressed by the complement has to be part of the common ground (Stalnaker 1974). Thus, an utterance of example 22b typically assumes that example 22c is common knowledge between the speaker and the addressee. A hallmark of presuppositions is that they tend to project out of entailment-cancelling operators like questions or negation (Chierchia & McConnell-Ginet 1990). Thus, typically, just as with an utterance of example 22b, its negation, as in example 23b, takes for granted that Chris is home.

(23a) Kim doesn't think Chris is home.
(23b) Kim doesn't know Chris is home.

Think, however, is not factive: Its uses with or without negation do not take for granted the truth of its complement. Typically, neither the sentence in example 22a nor the one in example 23a take for granted that Chris is home. Note that this textbook presuppositional profile, however, is not always manifest in actual uses of *know* and *think*, making their acquisition even more challenging. In what follows, we turn to the questions of when and how children figure out the subtle meaning differences between the two verbs.

4.1. *Think* Versus *Know*: Acquisition Profile

Until recently, behavioral studies suggested that children do not successfully distinguish *think* and *know* until late in childhood (Abbeduto & Rosenberg 1985, Baron-Cohen et al. 1985, Falmagne et al. 1994, Harris 1975, Johnson & Maratsos 1977, Léger 2007, Macnamara et al. 1976, Moore & Davidge 1989, Moore et al. 1989, Scoville & Gordon 1980, Wellman & Liu 2004, Wellman et al. 2001, Wimmer & Perner 1983).

More recent work, however, argues that children can comprehend and produce *think* and *know* in adult-like ways by age 3 but that there is variability in the age of acquisition of *know* (Dudley et al. 2015, Harris et al. 2018). For example, Dudley et al. (2015) tested 3-year-olds' understanding of the difference in factivity of *think* and *know*, using a task that we refer to as the box task in which children had to find a toy hidden in one of two boxes (one red, one blue) based on a clue given by the experimenter. The critical comparison was between sentences like in examples 24a and 24b:

(24a) Lambchop doesn't think that it's in the red box.
(24b) Lambchop doesn't know that it's in the red box.

If children know that *know* is factive and *think* is not, then they should pick the red box after the clue in example 24b but not example 24a. Dudley et al. (2015) found that children chose the red box significantly more in the *know* condition than in the *think* condition, suggesting that

(*a*) 3-year-olds distinguish these verbs and (*b*) their tendency to make errors with *think* in false-belief contexts is not due to a factive *think*. But despite this overall success, only about half of the children treated *know* as factive. We next ask what role variability in experience might play in explaining variability in children's performance as a way to probe how children acquire the verbs.

4.2. Bootstrapping *Think* and *Know*

Because *think* and *know* differ in veridicality and factivity, the most direct evidence of the verbs' meaning differences should come from the conversational context and in particular the discourse status of the verbs' complement: With *know*, the complement has to be true and part of the common ground; with *think*, it can be false and not part of the common ground. To pick up on veridicality, children would have to notice that *think* can take a false complement but *know* cannot. To pick up on factivity, children would have to monitor what information is part of the common ground and notice that whenever *know* is used, the proposition expressed by its complement is old information.[2] But do speakers actually use *think* with a false complement in speech to children? And do they reliably use *know* in contexts that support the truth of its complement?

Through a close examination of how *think* and *know* are used in speech to children, Dudley (2017) shows that cues about the discourse status of the complement are sparse and potentially misleading. First, speakers very rarely use *think* with false complements. This is because most uses of *think* are for indirect assertions. Thus, false complements are not likely to be a reliable source of evidence about the nonveridicality of *think*. Second, Dudley finds that *know* is not reliably used in contexts in which the truth of its complement is part of the common ground. First, *know* rarely takes a declarative complement. Second, even when it does, *know* does not reliably occur in contexts in which the presupposition is supported: The complement expresses new information 40% of the time.[3] Thus, counterintuitively, information in the common ground is not a likely source for children's discovery that *know* is factive.

But while discourse status cues were sparse, Dudley (2017) found that *know* and *think* have clearly distinct distributions in terms of both the syntactic frames in which they appear and the types of indirect speech acts the verbs are used to perform, in a way that could support pragmatic syntactic bootstrapping. Turning to syntactic distribution, *think* mostly takes declarative complements [85% of the time; the rest of the time, it occurs with null complements (10%) or prepositional phrase complements (4%)]. *Know*'s complements are more varied, with 15% declarative, 52% interrogative ("Do you know where she is?"), 6% noun phrase complements, and 26% null complements ("I don't know").[4] If there exists a principled link between these verbs' meanings and the types of complements that they can take, the input provides clearly distinct syntactic profiles for the two verbs that could signal their semantic properties. And indeed, several authors have linked factivity or veridicality to responsivity (i.e., a predicate's ability to take both interrogative and declarative complements) (Egré 2008, Ginzburg 1995, Hintikka 1975). The exact semantic underpinnings of responsivity are still a matter of debate. White & Rawlins (2018) show that on its own, responsivity is not sufficient to distinguish factives from nonfactives like *say* or *decide*, but that

[2]Veridicality and factivity may be tightly related (see, e.g., Abrusán 2016, Anand & Hacquard 2014), so that learners may be able to derive *know*'s factivity for free from identifying it as a veridical belief verb.

[3]See Spenader (2003) for similar corpus results in adult-directed speech; for discussion of cases in which the presupposition of factives is not supported, see Beaver (2010), Karttunen (1974), Simons (2007), inter alia.

[4]The vast majority of these null complements are either an elided interrogative, in response to a question, when *know* is negated (A: "Q?" B: "I don't know ~~Q~~."), or an elided declarative, in response to a declarative, without negation (A: "*P*." B: "I know ~~*P*~~.").

it might become sufficient once other selectional factors, like the ability to take noun phrases as direct and indirect objects, are taken into account. As for pragmatic function, Dudley (2017) found that *think* and *know* are often used for indirect speech acts. On the one hand, *think* is mostly used for indirect assertions, with the most prevalent frame in which it occurs being "I think *p*." *Know*, on the other hand, is often used for indirect questions, with the most prevalent frames in which it occurs being "Do you know Q?" and, in response to a question, "I don't know." As described in Section 2, a learner attuned to speakers' illocutionary intents could infer from such uses that *think* expresses a commitment of its subject to the truth of the complement and that *know* relates its subject to the true answer to the question in the complement. Thus, the types of cues necessary to support both syntactic and pragmatic bootstrapping seem to be present in the input. However, neither type of cue is foolproof. Responsivity does not fully isolate factives; both *think* and *know* can be used for a variety of indirect speech acts. Dudley hypothesizes that just as in the contrast between belief and desire verbs, syntactic and pragmatic bootstrapping may be mutually constraining in this area and that children can exploit parallels between syntax (declarative versus interrogative complement) and pragmatic function (assertion versus question) to home in on belief or knowledge.

Dudley (2017) thus shows that there are two routes to the veridicality/factivity contrast distinguishing *think* and *know* that children could exploit in principle: One tracks the discourse status of the complement, the other, the verbs' syntactic and pragmatic function distribution. The former is more direct, but the cues are sparser; the latter is less direct and requires learners to expect principled links between a verb's meaning and its syntactic and pragmatic profile, but the cues are plentiful. To test which route learners actually use, Dudley (2017) asks whether differences in children's input predict differences in their understanding of factivity. To do so, she recorded conversations between individual child/parent pairs and tested each child on the box task from Dudley et al. (2015) reported in Section 4.1. Her preliminary results show both quantitative and qualitative effects: Children with the highest performance on the box task overall heard more *think* and *know* than children with the lowest performance. Moreover, low performers tended to hear more discourse status cues (false complement with *think*, presupposed complement with *know*) than high performers, who tended to hear more discourse function cues (indirect assertions for *think*, indirect questions for *know*). Thus, the feature of the input that best predicted children's performance was the kinds of indirect speech acts that their parents used, supporting the idea that an attitude verb's meaning is cued by the kinds of indirect speech acts it is used for, paired with the kinds of syntactic complements it takes.

5. CONCLUSIONS

The acquisition of attitude verbs presents particular challenges: They describe mental states that leave few cues in the physical world as to their content and are rarely at issue in the conversation, as these verbs are mostly used for purposes other than describing those states. Rather, they are used to make indirect assertions, requests, or questions concerning the content of the complement, at least in English. Because of these challenges, the acquisition of attitude verbs gives us a unique opportunity to probe what sources of information children draw from and what underlying conceptual, pragmatic, and linguistic capacities they deploy to make use of that information.

We have argued that learners acquire attitude verb meanings by exploiting links between these meanings and their syntactic distribution and, in particular, their appearance with declarative clauses, interrogative clauses, or both, informed by the canonical speech act associated with these clauses.

This hypothesis not only explains how children discover verb meanings but also helps us understand why they make errors with belief verbs in false-belief contexts but not with desire verbs

in unfulfilled-desire contexts. We have seen that with belief verbs, children have a tendency—but can refrain from—overassuming indirect assertions that are so typical of those verbs. Thus, when *think* is used to report a false belief, children tend to respond to a perceived pragmatic enrichment rather than to the literal meaning of the utterance. Hence, while it has sometimes been suggested that children are overliteral (e.g., Noveck 2001, inter alia), our results suggest that they are instead overpragmatic. This pragmatic overdrive seems to be in line with recent findings showing that, from infancy, children are attuned to the goals and beliefs of the speakers around them and that this sensitivity plays an essential role in getting language acquisition off the ground (e.g., Farroni et al. 2002, Senju & Csibra 2008, Song et al. 2008, Southgate et al. 2010, Vouloumanos et al. 2012). Our findings further corroborate the idea that children's pragmatic difficulties stem not from difficulties in reasoning about speakers' intentions but rather from difficulties in figuring out the conventional norms that regulate this system in the adult language (see, e.g., Lewis 2013, Papafragou & Skordos 2016, Pouscoulous 2012).

We have focused here mostly on English, in which attitude verbs from different semantic classes have clearly distinct syntactic and pragmatic profiles, which could help learners quickly distinguish belief from desire verbs but could lead to more entrenched indirect assertions assumptions with a verb like *think*. Ultimately, the viability of our proposal rests on whether it can apply to the acquisition of attitude verbs in languages with much less clear syntactic or pragmatic profiles. For syntax, we saw that even in a language like Mandarin, the split between representational and preferential attitudes is discoverable using declarative main clause syntax. However, we do not currently know whether variation in how easily these distinctions can be detected leads to corresponding variation in how quickly the verbs are acquired across languages. As for pragmatic function, languages differ in how readily attitude reports are used for indirect speech acts. In particular, languages that have other means to hedge assertions, like evidential markers or discourse particles, may be less prone to use attitude reports for indirect speech acts. Even within a language like English, there could be considerable variation across individuals or different sociolinguistic communities in how often they use indirect speech acts. And as Dudley (2017) showed, variation in parents' use of indirect speech acts relates to their children's success in acquiring factivity. But while there may well be variation in the strength and therefore reliability of the signal from each of these channels that could affect both how quickly children acquire the verbs and how prone they might be to false-belief errors, our results suggest that young children have the required conceptual, pragmatic, and linguistic scaffolding in place early in childhood to draw from rather indirect sources of information.

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Contents

Errata

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