1

Acquiring the factivity of *know*

Rachel Dudley
Institut Jean Nicod & Laboratoire de Sciences Cognitives et Psycholinguistique, Département d'études cognitives, ENS, EHESS, PSL Research University, CNRS

Meredith Rowe
Harvard University

Valentine Hacquard
University of Maryland

Jeffrey Lidz
University of Maryland

Abstract Presupposition triggers are linguistic expressions whose use is reliably correlated with some content that the speaker presupposes, or takes for granted. This has implications for how presupposition triggers can be used within a discourse and the behavior of presupposed content diverges from that of asserted content in predictable ways. How do children acquire presupposition triggers; how do they figure out which words are reliably associated with presuppositions, thereby accessing all the implications that this has? What kind of evidence is useful for discovering presupposed, as opposed to other content, and will this evidence differ based on the properties of a trigger? One intuitive possibility is that children uncover presupposed content by directly tracking what speakers presuppose when using presupposition triggers. This strategy may fail for triggers where the presupposition is not systematically supported in context, as with "soft" presupposition triggers (Abusch 2010). In this paper, we ask we ask how children acquire the soft trigger *know* and its close relative *think*. *Know* and *think* both express belief, but differ in their veridicality and factivity. Veridical verbs like *know* entail the truth of their complements while non-veridicals like *think* do not. Factive verbs like *know* furthermore presuppose the truth of their complements, while non-factives like *think* do not. How do children figure out such subtle differences between the verbs? We examine

∗ We thank Pranav Anand, Peter Carruthers, Daniel Harris, Paul Harris, Nick Huang, Ellen Lau, Shevaun Lewis, Paula Rubio-Fernandez, Evan Westra, Alexander Williams and Aaron Steven White for helpful discussion, as well as audiences at University of Maryland, University of Pittsburgh, ZAS, Central European University, Harvard University, University of Pennsylvania, ENS, MACSIM 6, BUCLD 41, LSA 2017, MINSIM, SALT and the members of the UMD Project on Children's Language Development. Special thanks go to Grace Hynes and Rebecca Magazine for assistance with data collection. At UMD, this work was supported in part by an NSF BCS grant (1124338) to V. Hacquard and J. Lidz, and an NSF doctoral dissertation improvement grant (1628110) to V. Hacquard, J. Lidz and R. Dudley. At ENS, this work was supported in part by ANR-11-0001-02 PSL* and ANR-10-LABX-0087 IEC.

a corpus of child-directed speech to see what cues could help children differentiate verbs like *know* from those like *think*. We show that speakers use *think* and *know* in potentially unexpected ways, which cast doubt on the feasibility of tracking (i) what speakers take to be false in order to pick up on the non-veridicality of *think*, and (ii) tracking what speakers presuppose to pick up on the factivity of *know*. We show that there are, however, more reliable indirect cues from the syntactic distribution and the discourse functions of *think* and *know*. Ultimately, the learnability issues that arise from the way speakers use these verbs in speech to children support pragmatic over semantic accounts of how *know* gets associated with its presupposition. They further suggest that children may need to rely on rather indirect distributional cues from syntax and pragmatic function — which correlate with differences in factivity and veridicality between the two verbs — to acquire these meaning differences.

Word count: 16934

Keywords: factivity, presupposition triggers, language acquisition, linguistic input

1 Introduction

In this paper, we take a step towards resolving how children acquire presupposition triggers, and whether this process is dependent on the properties of a given trigger, by articulating and testing hypotheses about how children might acquire one representative trigger, the factive verb *know*. Aside from the usual word learning challenges of mapping sound to meaning (Clark 1995), presupposition triggers present some additional challenges. Children need to identify the content which is conventionally associated with a word and determine along which dimensions it should be packaged into their representation of the word. There is no systematic morphological cue that a particular expression is a presupposition trigger. So there must be some aspect of children's experience with a presupposition trigger that indicates its status as a trigger.When and how do children figure out which linguistic expressions are associated with presuppositions? The acquisition literature typically focuses on

the **when** question (Falmagne et al. 1994, Léger 2008, Syrett et al. 2009, Berger & Höhle 2012, Jasbi 2015, among many others), and remains mostly silent on the **how** question (see Schulz 2003 for a notable exception).

In the formal semantics literature, when the **how** question is broached, the assumption is that children figure out presupposed content by directly tracking what speakers presuppose when using presupposition triggers (see for instance Matthewson 2006).

(1) Pay attention to everything that speakers presuppose and notice that whenever expression X is used, *p* is always common knowledge. Conclude that *p* is a presupposition triggered by X.

The **direct** route in (1) is essentially an extension of the associationist view of how the mapping problem is solved for non-presupposed content. To illustrate with a basic, non-presuppositional example: children can map the meaning APPLE to the form *apple* because it is uttered in the presence of apples. But even for *apple*, this is not a trivial task, as familiar issues of induction arise (Goodman 1955, Quine 1960, Kripke 1982), as well as empirical issues: we often talk about objects when they are not present (e.g, *Would you like an apple for your snack?*), and even when present, they are usually embedded within complex scenes (e.g., *We have an apple somewhere in this fridge*). Taking this strategy for presupposition triggers raises further conceptual and empirical issues.

The new conceptual issues arise because the evidence needed for (1) is different in kind from the evidence needed for cases like *apple*. Presupposed content is generally backgrounded. It is not the topic of discussion and less attention is drawn to it as a result. Noticing it requires not only keeping track of the environment,

but also the mental states of the conversational participants. Some (and perhaps all) presuppositions might thus fly under the child's radar. And even noticing a reliable association with speaker presuppositions does not determine that these associations should be conventionally encoded, given that many reliable associates of word use are not so encoded (e.g., being made up of molecules is not part of our representation of *chair* even if it were true of all chairs that we use the word to describe). Furthermore, nothing in the grammatical form of a trigger reveals its status as a trigger in the same way that being a noun, for example, reveals that *apple* might denote an object kind (except perhaps in the case of a few triggers, such as focus phenomena). Can children sidestep or overcome these challenges to figure out which background assumptions to associate with particular linguistic expressions?

The new empirical issues center on whether the necessary correlations between trigger use and speaker presuppositions are available in the input. The direct strategy in (1) is useful to the extent that these speaker presuppositions are all and only those reliably triggered in children's experience. But speakers make all kinds of presuppositions when they speak, and many of these presuppositions are not conventionally associated with any particular expression (Stalnaker 1977). Moreover, some presuppositions are not identifiable as such. For example, the presuppositions of "soft triggers" (Abusch 2010) seem to be more easily defeasible than that of other triggers (Abusch's "hard triggers"). Soft triggers allow "informative" uses where their typical presupposed content is not part of the common ground, at least in adult speech. How are soft triggers used in speech to children? If speakers fail to reliably presuppose the relevant presupposition with soft triggers, such a direct

route as (1) may not be tenable, and children may need to rely on other — more **indirect** — routes to identify the trigger.

In this way, acquisition can bear on a main issue that presupposition raises for formal semantics: **the triggering problem**, or the problem of how to account for the sources of different presuppositions. Do they have semantic sources, in virtue of being lexically encoded as an arbitrary component of meaning? Or do they have pragmatic sources, being dependent on other, non-presuppositional, aspects of meaning? Like theorists, children must address this problem in acquiring their native language. If we can understand how they tackle it, we might start to find our solutions as well. We assume that — all else equal — semantic theories, in virtue of requiring arbitrary encoding, will demand that the learner be able to access such direct evidence as required by (1). Additions to lexical entries should require some burden of proof, or reach some threshold of confidence, perhaps based on strong correlations with use of the lexical item. If this were not the case, we might expect lexical entries to have residues of all kinds of things that are incidentally weakly correlated with use of the item. In the case of presuppositions triggers, we should therefore expect semantic theories to capture triggers whose presuppositions regularly project, are supported in the discourse, etc. But what about for triggers where this is not the case? For such triggers, pragmatic accounts of presupposition should be more explanatory; since pragmatic presuppositions are not independent of other aspects of meaning and arise given general pragmatic principles or biases that the learner has about backgrounding calculi, the threshold may not be so high, and indirect evidence may suffice.

In this paper, we set the conceptual issues discussed above to the side and try to get some traction on the empirical issues discussed above: what information sources might reliable for the mapping of presupposition triggers in language acquisition. As a case study, we examine the cues that could help children identify presupposition triggers by focusing on *know*, which is a **factive** verb and thus taken to presuppose that the proposition expressed by its complement is true (Kiparsky & Kiparsky 1970, Stalnaker 1977). We focus on *know* because it patterns with soft triggers in some ways and with hard triggers in others, and because it is particularly frequent in speech to children (MacWhinney 2000), as compared to other presupposition triggers. Furthermore, there is another high frequency attitude verb, *think*, which is closely related to *know* but is non-factive, and can serve as a comparison case.

Know and *think* can both be used to describe a subject's beliefs. But only *x thinks p* sentences such as (2) can be used to describe false beliefs, while *x knows p* sentences like (3) necessarily describe "true" beliefs. Factive verbs like *know* furthermore presuppose the truth of the proposition expressed by their complements. Thus, while the speaker of both (2) and (3) can be taken to assert (4a), only the speaker of (3) must assume that (4b) is also true.

(2) John thinks that Mary is home.

(3) John knows that Mary is home.

(4) a. John has the belief that Mary is home.

b. Mary is home.

How do children figure out that *know* means KNOW and *think* means THINK?[1] We examine a corpus of child-directed speech to see what cues children hear in the input to address this question.

Under a semantic account of the triggering problem for factivity, the factive presupposition is an arbitrary component. Thus, directly tracking the contrast in what speakers presuppose when they use *know* vs. *think* should be required to discover the factivity distinction between the verbs. Under a pragmatic account, factivity is a consequence of veridicality: *know*, unlike *think*, is associated with a veridicality entailment, which gets backgrounded for pragmatic reasons. Thus, observing the veridicality contrast between the two verbs might be sufficient to uncover the factivity contrast between them.

As we will see, direct evidence to either contrast is sparse in the input. Direct cues to veridicality and factivity rely on tracking the discourse status of the proposition expressed by the complement: Is it true or false? Is it taken for granted or not? The veridicality contrast may be obscured by the many "assertive" uses of **think** — where the speaker endorses the truth of the complement — if they lead children to think that the verb rarely reports false beliefs. The factivity contrast may be obscured by the many "informative" uses of *know* — where the relevant presupposition is not supported in context — if they lead children to think that no presupposition is

1 We focus here on *know* and *think*, because these verbs are relatively frequent in speech to children. Note, however, that the epistemic and doxastic vocabulary in English is much richer than these two verbs (e.g., *believe*, *assume*, *discover*, *be right*, *be certain*, *be sure*, *be aware*, etc.). As a result, the hypothesis space that the learner must navigate is large and the learning problem is more complex than mapping *know* to KNOW and *think* to THINK. But, even focusing in on the narrow contrast of *know* and *think*, we will see that figuring out the differences between them is not trivial given the kind of experiences that children have with these words.

triggered. As far as these discourse status cues are concerned, the verbs may be almost indistinguishable.

Given this, distinguishing *think* and *know* may require more indirect routes. We consider two other types of indirect distributional cues: (i) differences in the syntactic distribution of *know* and *think*, and (ii) differences in the kinds of discourse moves that speakers use *know* and *think* sentences to achieve. In contrast to the more direct cues above, we show that children get ample evidence for these two kinds of indirect cues. *Know* is a responsive verb while *think* is not, and responsivity has long been linked to veridicality and factivity in the literature (Hintikka 1975, Ginzburg 1995, Egré 2008, among others). Children are exposed to syntactic distributions which clearly signal the (non-)responsivity of the verbs, and might thus be able to uncover the underlying meaning contrasts between *know* and *think* through a **syntactic bootstrapping** mechanism. Furthermore, the meaning of an expression constrains the ways that it can be used (Grice 1975). In children's experience, *think* and *know* naturally lend themselves to different speech acts, reflecting the differences in their underlying meaning: *know* has interrogative discourse functions (e.g., *Do you know where the toy is?*, *I don't know*) which reflect that it relates the subject to the true answer of the embedded question; *think* has "assertive" discourse functions (e.g., *I think the toy is lost*) which reflect that it expresses a commitment of the subject to the truth of the complement. They might thus be able to uncover the contrast between *know* and *think* via a **pragmatic bootstrapping** mechanism.

Ultimately, we will show that the learnability issues that arise from the ways parents use *think* and *know* support pragmatic over semantic accounts of the triggering problem for the soft trigger *know*. Morever, they support a bootstrapping account

where learners make use of indirect cues to the meaning of attitude verbs, stemming from their observed syntactic distribution and discourse function.

The rest of the paper continues as follows: Section 2 provides a brief background on presuppositions and on factivity more specifically. Section 3 reviews what we know about children's early understanding of *know* and *think*. We present our corpus results in Sections 4 and 5: in Section 4, we show that discourse status cues to the factivity/veridicality contrast are sparse. In Section 5, we show that the different syntactic distributions and discourse functions of *know* and *think* nonetheless provide useful, indirect cues as to the factivity/veridicality contrast. In Section 6, we compare the direct and indirect routes for *know* and *think*. We conclude in Section 7.

2 Factivity: semantic and pragmatic background

2.1 Theories of presupposition triggering

The literature on presupposition triggering asks how different expressions get to be associated with their presuppositions. Two main types of accounts have emerged. Semantic accounts, following Strawson (1950) and Frege (1948), define presuppositions according to patterns of entailment. For example, if a sentence presupposes p, then the question of the sentence's truth can only arise if p is true. Adopting this perspective, authors such as Karttunen (1974), Heim (1983), and Van der Sandt (1992) treat presuppositions as constraints imposed on the conversational context that are arbitrarily specified in the lexicon. In contrast, pragmatic accounts of presupposition treat them as constraints on what the speaker can do with a presupposition trigger and the conditions that must be met in order to felicitously and successfully utter sentences with this trigger (Kempson 1975, Wilson 1975, Boër & Lycan 1976, Kart-

tunen & Peters 1977, Stalnaker 1977, Levinson 1983, Chierchia & McConnell-Ginet 2000, Kadmon 2001, Simons 2001, 2003, Abrusán 2011).

While the original Stalnakerian view leaves open the possibility that all presupposition triggering is pragmatic, Stalnaker himself admits that some presuppositions may need to be arbitrarily specified in the lexicon (but see Abrusán 2016). The recent pragmatic accounts all concern soft triggers, and aim at capturing the ease with which their presuppositions can be canceled, in comparison with those of hard triggers. One prominent view for hard triggers is that the presupposed content is anaphoric.

2.2 Cognitive vs. emotive factives

Factives can be roughly divided into two classes: cognitive factives and emotive factives. Cognitive factives (e.g., *realize*, *discover*, *forget*) take true complements, and the truth of the complement is furthermore typically presupposed ((Kiparsky & Kiparsky 1970). Cognitive factives are a prime example of soft triggers, given that their presuppositions are easily defeasible (see 5 from Karttunen 1971).

(5) If I **realize** later that I have not told the truth, I will confess it to everyone.

Emotive factives (e.g., *regret*, *hate*, *be happy*) have an additional entailment that the subject has an emotional attitude towards that complement. Emotive factives background not only the truth of their complement, like cognitive factives, but also that their subject believes the complement to be true (6).

(6) John hates that it is raining.

While cognitive factives are generally assumed to be soft triggers, the status of emotive factives is more controversial. Abbott (2006) assumes that they are hard triggers, while Simons (2007) and Abrusán (2011) take all factives to be soft triggers.

The status of *know* is also controversial. Its presupposition seems less easily cancelable than that of cognitive factives (compare 7 to 5).

(7) If I **know** later that I have not told the truth, I will confess it to everyone.

Yet its presupposition is often not contextually-supported (8), at least in naturalistic speech between adults. Utterances of *x knows p* can be used when the addressee has no reason to take the truth of the complement for granted. Discourse initial uses of *x knows p* are felicitous and most uses of *x knows p* in speech between adults are, in fact, "informative" in that the content expressed by the complement is new information (Spenader 2003). Moreover, Simons (2007) shows that the complement of *know* can provide content which addresses the QUD, and is thus at issue (9). Lastly, *p* does not always project out of family-of-sentences contexts with *x knows p*, as in (10) (Beaver (2010)).

(8) a. Did you **know** that John won the lottery? (uttered discourse initially)

b. No, I didn't. That's amazing!

(9) a. Where was Louise yesterday?

b. I **know** from Henry that she was in Princeton. (Simons 2007)

(10) . . . I haven't tried this with wombats though, and if anyone discovers that the method is also wombat-proof, I'd really like to **know**. (Beaver 2010)

To make matters even more difficult for the language-learning child, the cluster of properties in (8-10) might make *know* seem no different from a non-factive verb

like *think* — at least with respect to its status as a presupposition trigger: *Think* can also be used to provide new information (11), or address the QUD (12), and the complement of *think* can even appear to project, even when the complement of *know* does not (see 13 modified slightly from Simons et al. 2017).

(11) I **think** that Mary won the lottery! (uttered discourse initially)

(12) a. Where's Mary?

b. I **think** she's at home.

(13) Q: Why is it taking Phil so long to get back here?

A: He doesn't **know** that the car's parked in the garage!

A': He doesn't **think** that the car's parked in the garage!

2.3 Theories of factivity

Any account of cognitive factives must capture the ease with which their presuppositions are canceled. For semantic accounts, where presuppositions are conventionally associated with the factive trigger, this means that the presuppositions are often accommodated locally (Heim 1983). For pragmatic accounts, cancellation is expected because presuppositions are conversationally derived.

Several pragmatic accounts of factivity (Stalnaker 1977, Simons 2001) propose that factive sentences like (14) have (at least) two relevant entailments: a doxastic entailment (*x believes p*) that is typically foregrounded (15a) and a veridical entailment (*p*) which is typically backgrounded (15b).

(14) John knows that Mary is home.

(15) a. John has the belief that Mary is home.

b. Mary is home.

For Stalnaker (1977), both of these entailments cannot be put forward at once given that they are independent of each other, so — to be orderly — one of the entailments gets backgrounded. Following Stalnaker, several authors provide accounts for why *p* gets backgrounded (Simons 2001, Abusch 2002, 2010, Abrusán 2011, Tonhauser et al. 2013, Simons et al. 2017, among others). Abrusán (2011) argues for a default grammatical main point: any entailment about the running time of the main event is "main point", while other entailments get backgrounded, unless they are targeted by the QUD or focus. For Abusch (2002, 2010), *be aware* and *know* evoke the lexical alternative *be unaware*. Since both alternatives entail *p*, it follows that *p* is true, under the defeasible assumption that at least one of the alternatives is true. Simons et al. (2017) propose a similar account that derives the relevant alternatives pragmatically instead of lexically.

If pragmatic accounts are on the right track, they provide a a potentially easier avenue for the learnability problem as compared to semantic accounts: all that the child would need to figure out is that *x knows p* both entails *x believes p* and *p*, and could then rely on some principled pragmatic reasoning to figure out that — all else equal — *p* typically gets backgrounded. The learnability challenge would then be to figure out the (non-)veridicality of the verbs — that *x knows p* entails *p*, but that *x thinks p* doesn't. As we will see, the actual exposure that children receive with *know* and *think* shows that even this is not trivial.

3 Children's understanding of the (non-)factivity of *think* and *know*

Previous research suggests that children may not differentiate *think* and *know* in the relevant ways before four years (Macnamara et al. 1976, Johnson & Maratsos 1977, Shatz et al. 1983, Abbeduto & Rosenberg 1985, Moore & Davidge 1989, Moore et al. 1989). Some even argue that children lack a fully mature understanding of *know* well into grade school (Harris 1975, Hopmann & Maratsos 1978, Scoville & Gordon 1980, Falmagne et al. 1994, Schulz 2003, Léger 2008). Recent studies like Harris et al. (2017) and Dudley et al. (2015) however suggest that a fully adult-like understanding of some aspects of the verbs is possible by three years.

3.1 Children's understanding of belief reports

Much of the developmental literature suggests that children have difficulty understanding that *think* can express false beliefs until at least four years of age. Unlike adults and older children, three-year-olds typically reject a sentence like *John thinks that Mary is home* in contexts where Mary is not home, even if John thinks that she is (Johnson & Maratsos 1977, Wellman et al. 2001, De Villiers & Pyers 2002, Sowalsky et al. 2009, Lewis et al. 2012, Lewis 2013, Lewis et al. 2017). Thus children seem to treat *think* as if it were veridical, just like *know*.

There are two main explanations of this failure, one conceptual and one pragmatic. The traditional explanation (Wimmer & Perner 1983, and following) links it to conceptual development. Under this view, young children lack the ability to represent false beliefs (or the ability to metarepresent), and hence any linguistic expressions used to express false beliefs will not be understood in an adult-like way. However, a growing number of studies suggest that very young infants understand

false beliefs, when tested via implicit tasks (Onishi & Baillargeon 2005, among others). This has led to alternative, pragmatic or task-dependent explanations of these failures (Siegal & Beattie 1991, Hansen 2010, Rubio-Fernández & Geurts 2013, Helming et al. 2014). In particular, Lewis et al. (2012), Lewis (2013), Lewis et al. (2017) argue that children's errors with *think* sentences are pragmatic in nature, and result from a tendency to assume that *think* sentences are used to indirectly assert their complement (see also Shatz et al. 1983, Diessel & Tomasello 2001). When children hear *John thinks that Mary is home*, they tend to assume that the speaker is indirectly asserting that Mary is home, and they reject this indirect assertion when they know that Mary is in fact not home. As we will see, this assumption may result from an input effect: most of children's experience with *think* sentences involve such indirect assertion uses. In support of the pragmatic view, Lewis et al. (2012) show that increasing the salience of belief, by having two characters with conflicting beliefs, drastically improves preschoolers' performance. Lewis et al. (2017) further show that three-year-olds can reject false *think* sentences based on their literal meaning, suggesting that they have access to it.

3.2 Children's understanding of factivity

In production, factives emerge quite early. The first uses of *know*–which is the most frequent factive in child productions–emerge around 30 months (Shatz et al. 1983), with the first unambiguous uses of *know* to refer to mental states just before the third birthday, and the first uses involving unambiguously true complements emerge around the fourth birthday (Schulz 2003). However, Harris et al. (2017) suggest that at least some analyses of children's speech underestimate how early children develop

a mature understanding of *know* because they exclude utterances like *I don't know* from analyses, on the basis that they are merely "idiomatic negative expressions" (Shatz et al. 1983) used "to demur or withdraw from a conversation". Harris et al. find that *I don't know* is actually used in an adult-like manner to respond to information-seeking requests before the third birthday.

Some comprehension studies ask when children understand that *know* statements are stronger, or more informative, than *think* statements, either because *know* statements express greater certainty from the speaker or the subject, or because statements about knowledge entail weaker statements about beliefs. These studies have been taken to show that young children can't differentiate the two verbs, but this could be due to a variety of reasons that are independent from understanding the verbs' (non-)factivity: children could have trouble computing implicatures with these verbs at younger ages, perhaps because they don't realize that they need to choose the more informative statement if both statements are accurate; they could have trouble making such judgments about the verbs in an explicit, verbal task; or they may not realize when *think* should be a relevant alternative to *know* (Macnamara et al. 1976, Johnson & Maratsos 1977, Abbeduto & Rosenberg 1985).

More relevant to children's understanding of factivity, several studies probe whether children understand that verbs like *know* — but not non-factive *think* — allow the truth of their complements to project out of an entailment-canceling context like negation. These studies ask children to infer whether *p* is true when they hear utterances like *x doesn't know that p* and *x doesn't think that p*. Many of these studies suggest that younger children do not reliably infer that the complement to *know* is true (Harris 1975, Hopmann & Maratsos 1978, Scoville & Gordon 1980, Léger

2008). However, Dudley et al. (2015), using a simplified task in a more naturalistic context, show that some three-year-olds do.

We see that children may start picking up on the factivity contrast between *think* and *know* as early as age 3. We now turn to what in their input might give it away.

4 Corpus study

4.1 Methodology

To investigate which cues to factivity are made available to children, we examined tokens of *know* and *think* in child ambient speech from the Gleason corpus in CHILDES (Masur & Gleason 1980, MacWhinney 2000). The Gleason corpus is comprised of conversations between 24 target children and their families recorded in the late 1970s in the Boston area. The families are all White and middle- or upper-middle-class[2]. The ages of the target children in this corpus range from 2-5 years, with an average age about 3.5.

The corpus includes dinner conversations in the home, and two separate play sessions in a laboratory setting between the child and each parent in turn. The content of the dinner conversations was left up to the participants and varied across families. The play sessions were somewhat more uniform because each parent was required to complete three activities with their child during the session: working with a toy car that could be taken apart; reading a picture book with no words; playing with a grocery store set. Together these four activities — dinner conversations, take-apart

2 This specific corpus was chosen with the ultimate goal being a comparison with corpora of families from different demographic groups in future work.

car, picture book, and grocery set — should lead to a naturalistic sample of speech and allow for a good look at the typical distribution of our target verbs in the input.

Know and *think* were relatively frequent in this corpus. We identified 1231 tokens of *know* and 1156 tokens of *think*. On average, each child might hear *know* sentences 17 times per conversation and *think* sentences 16 times per conversation. *Know* occurred in 3.7% and *think* in 3.5% of all child ambient utterances.

4.2 Coding scheme

Our coding scheme was designed to capture syntactic features of *know* or *think* tokens as well as their relationship to the surrounding discourse. We examined the types of subjects, tense, negation, complements and types of clauses that the verbs occur with. We also examined the projective contexts that the verbs occur in and the discourse status of the information expressed by their declarative complements. The possible codes for each category are illustrated below with actual examples from the Gleason corpus. Syntax-level codes (presented in Table 1) were made based on examining the utterance in isolation and therefore in the absence of any information about the surrounding discourse.

Discourse-level codes (16-18) were made on a subset of the utterances, as applicable. For these codes, 50 lines of the preceding discourse and 5 lines of the following dialogue were examined in order to establish a discourse context against which the utterance was evaluated. In most cases, this was more than necessary to determine what code to provide.

Category	Code	Description	Example
subject type	1st	has 1st person ϕ-features	`I know we'll find a place.`
	2nd	has 2nd person ϕ-features	`You think you're a little pig.`
	other	has neither 1st nor 2nd person ϕ-features	`He thinks it's a good place.`
tense type	present	has present tense agreement	`You know this room very well, huh?`
	past	has past tense agreement	`I thought you liked it?`
	other	has neither present nor past tense agreement	`I wanted to know if I'd heard of her doctors.`
negation type	absent	has negation	`I think the only thing to eat is mustard.`
	present	does not have negation	`I didn't know you sold books here.`
complement type	CP-Q	has a non-interrogative sentential complement	`Do you think he'll do it?`
	CP+Q	has an interrogative sentential complement	`You know what those are?`
	NP	has a nominal complement	`I know it.`
	PP	has a prepositional complement	`She doesn't know about it yet.`
	null	has no overt complement	`I just don't know.`
clause type	declarative	occurs in a statement	`I don't know.`
	polar interrogative	occurs in a polar question	`Do you think you can tell Rachel what you're doing?`
	wh-interrogative	occurs in a constituent question	`What do you think?`
projective contexts	negation	has negation	`I don't think there was a single Republican who had no opposition.`
	questions	occurs in an interrogative clause	`Ya know what happened?`
	modals	has a modal	`Perhaps he thinks the pipe is too small for them.`
	conditionals	occurs in the antecdent of a conditional	`So if Wanda thought about something, she went like this.`

Table 1 Syntactic codes by category

Discourse coding scheme: *discourse status of complement*

(16) **old**: information that has been previously mentioned in the discourse and accepted into the common ground

`...`

mother: `Because they're working in there.`

mother: `And they don't want you to come there now.`

mother: `After when they're finished you can come there.`

father: `They will be happy to have you.`

sister: `And me finished.`

mother: `I know you're finished, Rachi.`[3]

`...`

(17) **new**: information that has not been previously mentioned, or is uttered out-of-the-blue

3 example from conversation with John (4;2) at dinner, participants include the target child, his mother, his father and his siste r

...

child: You could have hot dogs.

father: Not for breakfast.

child: Mhm.

father: Well.

father: Look.

father: I know I want some milk.[4]

...

(18) **unclear**: information that has not been explicitly mentioned and accepted into the common ground, but which could be shared by the interlocutors, because of world knowledge, family routines, children's habits and preferences, or which could be inferred from the previous discourse

...

mother: Would you like a story?

child: What, Mama?

mother: Would you like a story?

child: Yeah.

mother: I saw a little tiny book over here.

mother: And I know you like little books.[5]

...

All utterances were coded by the first author and a subset were checked by one of two undergraduate research assistants. Different procedures were carried out for syntax-level codes and discourse codes due to the sample sizes available. For the majority of the syntax-level coding categories, 98% or more of the tokens were included in the reliability check. Since the reliability statistics were so high for each category, only 80% or more of the tokens were included for the last two

4 example from conversation with Isadora (3;7) during grocery-set play interaction, participants include the target child and her father

5 example from conversation with Victor (2;3) during picture-book play interaction, participants include the target child and his mother

syntactic-level categories to be checked (tense-type and complement-type). For all syntax-level categories, inter-coder agreement was high ($.99 < \kappa < .80$). For the one discourse-level category, 100% of the relevant tokens were included in the reliability check, given that only approximately 11% of the entire sample was eligible for discourse-level coding. For this discourse-level category, inter-coder agreement was not high ($\kappa = .44$). Arguably, this reflects how hard it is to track propositions within a naturalistic parent-child discourse and determine whether they express information that is part of the common ground or new to (some of) the interlocutors. We return to this issue in the results section.

4.3 Direct cues from discourse status of the complement

How do children figure out the two differences between *know* and *think*, namely that *know* is both veridical and factive while *think* is neither? The most direct route would be to track the discourse status of the information expressed by the complement:

(19) **Discourse status cues to (non-)veridicality**: Pay attention to everything that speakers say in using *know* and *think*, as well as what is true in the context of utterance. Observe that *p* is always true when *x knows p* is uttered, but not necessarily when *x thinks p* is uttered. Conclude that *know* entails the truth of its complement and that *think* does not.

(20) **Discourse status cues to (non-)factivity**: Pay attention to everything that speakers presuppose in using *know* and *think*. Notice that whenever *x knows p* is used, *p* is common knowledge but not whenever *x thinks p* is used. Conclude that *p* is a presupposition triggered by *x knows p* but not *x thinks p*.

Laying out these potential discourse status cues immediately raises a couple issues. For one, can children even track these types of information as they unfold in conversation, and do they actively do so? For another, does the input provide a clear enough signal in order to achieve the adult-like generalization about *know* and *think*? In this paper, we focus on the second issue. Previous empirical work suggests that these cues are not likely to appear in speech to children, at least if adults speak to children in much the same way that they speak to each other (Spenader 2003, Beaver 2010), but no study to date has explicitly evaluated the reliability of cues like (19) and (20) in children's linguistic input.

How reliable are discourse status cues to veridicality and factivity in speech to children? If the veridicality cues in (19) and the factivity cues in (20) are available, we should expect to find data like those in (21) and (22).

(21) Informative cues as to *think*'s non-veridicality: unlike *know*, *think* can be used to talk about false beliefs. As a result, informative cases would be utterances of sentences whose complements the speaker takes to be false.

  a. She thinks Bill is coming to the party ...but isn't she silly?

  b. I thought Bill was coming to the party ...but then I saw his RSVP.

(22) Informative cues as to *know*'s factivity: as compared with *x thinks p* utterances, *x knows p* utterances should more often describe information which is familiar to the interlocutors. Projective contexts should be particularly helpful. The following cases could be helpful for noticing that uses of *know* presuppose or entail the truth of the complement:

  a. Bill is coming to the party! Oh, does Mary know he's coming?

  b. Bill is coming to the party! Oh, I didn't know he was coming!

4.3.1 Veridicality data

First, we examined whose beliefs were under discussion in using *know* and *think* by tracking the subjects that occur with each verb — as an indication of whether the conversational participants took them to be true or false. The results are given in Figure 1. We find that the verbs are most often used with subjects that refer to the conversational participants: third person subjects occurred in less than 10% of tokens for either verb. This indicates that the beliefs under discussion are typically those of the interlocutors: the speaker (usually a parent, but sometimes another family member or experimenter) and an addressee (sometimes the target child and sometimes another person present); the beliefs of someone external to the conversation are rarely discussed. Furthermore, *know* occurs primarily with second person subjects (61% of all *know* tokens), *think* occurs primarily with first person subjects (61% of all *think* tokens). These data also suggest that there is a difference in whose beliefs are discussed with *know* vs. *think*. A chi-square test of independence was performed to determine the relationship between subject-types and verbs. The relation between these variables was significant, χ^2 (2, N = 2387) = 236.1, $p <$ .00001. Speaker's beliefs were discussed most with *think* and addressee's beliefs were discussed most with *know*.

Given that *think* is most often used to express the speaker's beliefs, we next asked how often these beliefs are described as currently held beliefs — and might thus be true, as far as a naive hearer might assume — or formerly held beliefs — which might seem false to the hearer. We thus looked at the types of tense that occurred with the verbs. The results are given in Figure 2. We find that both verbs occur most often in the present tense (95% of *know* tokens and 91% of *think* tokens). Past tense

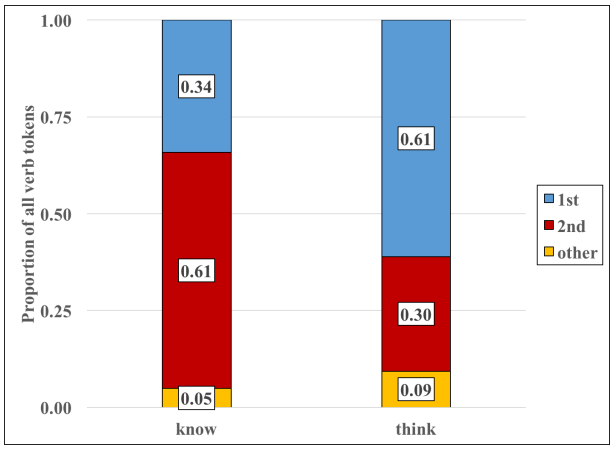

Figure 1 Subject-types within the sample, as a proportion of each verb

tokens of either verb were infrequent; these forms occur in only 4% of *know* tokens and 8% of *think* tokens. This indicates that the beliefs under discussion when using either verb are most often beliefs that are currently held.

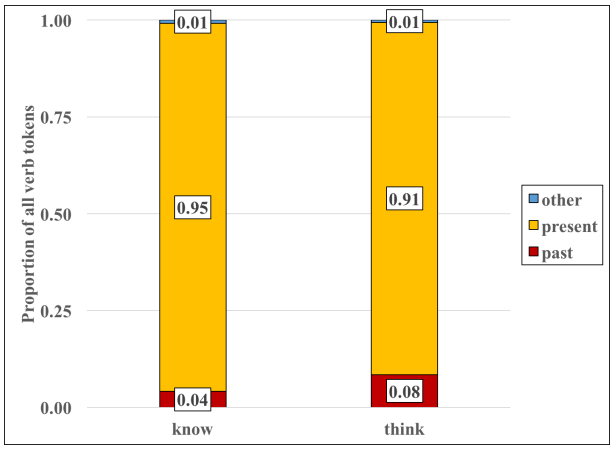

Figure 2 Tense-types within the sample, as a proportion of each verb

Pulling together the data discussed in this section, a particular picture of children's experience with *think* emerges. *Think* is often used in first person tokens in the present tense. These *I think p* tokens (which make up 47.6% of children's

input with *think*) cannot be used to report a false belief. What about the rest? We've already seen that there are very few third person subjects, but 30% of all *think* tokens have second person subjects. Out of these *think* tokens, most are in questions, which are unlikely to report false beliefs. 13.6% of *think* tokens are questions like *What do you think?* which clearly do not report false beliefs. Another 11.9% of *think* tokens are questions like *Do you think that p?*, which are often used to ask *p?* with the assumption that the addressee might have the answer. Given that the majority of *think* tokens (approximately 75%) are these *I think p* or *what do you think?* or *do you think p?* tokens, there may be very few opportunities to observe *think* as reporting a false belief overall. See Figures 6 and 7 and accompanying discussion in Section 5.2.1 for more details on questions and the relationship to subject-types.

4.3.2 Factivity data

To determine how often speakers presuppose *p* with *x thinks p* vs. *x knows p*, we first had to isolate the relevant *think* and *know* tokens, namely those with declarative complements.[6] In our corpus there were 796 *x thinks p* tokens and only 131 *x knows p* tokens.[7] For more details on what other complements occur in the corpus, see Section 5.1.1.

Given that we had only 131 *x knows p* tokens (only 11% of all *know* tokens in the sample), we used all of them in the subsequent analyses, as well as an equivalent

6 Declarative complements were isolated because factives do not entail the truth of their complement when the complement is a noun, preposition or embedded question, and because we did not want to assume that children could resolve the right complement type for null, or non-expressed, complements.

7 We also filtered out tokens where there was no definite proposition despite having a declarative complement. These included *wh*-questions (e.g., *Who does John know is coming to the party?*) and tokens where part of the complement was unintelligible to transcribers (marked in CHILDES transcripts as "xxx").

sample of *x thinks p tokens* (128 tokens or 11% of total *think* tokens). For these tokens, we examined the transcripts that they came from to determine how often *p* expressed information that was part of the common ground, using the discourse-level coding categories discussed above. Due to disagreement between coders, data for this coding category was re-categorized to provide the most generous estimate of what information was old. As reported here, "old" data includes the union of utterances which either coder marked as old; "new" data includes the intersection of utterances which both coders marked as new, and "unclear" data includes all other utterances (i.e., those that were marked as new by one coder and unclear by the other coder). The resulting data are provided in Figure 3.

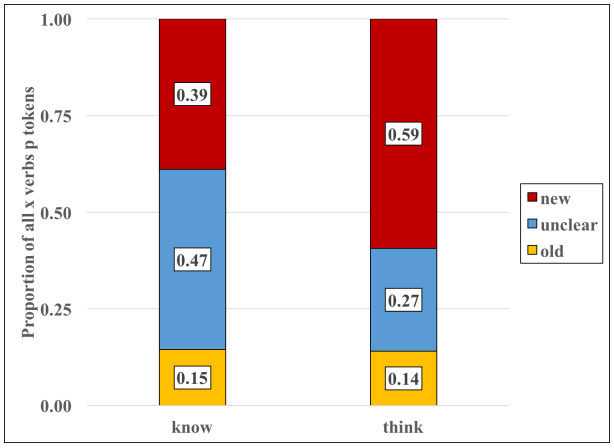

Figure 3 Status of the complements within the sample, as a proportion of *x verbs p* tokens for each verb

Even with this generous classification, we found that the complements of both *x thinks p* and *x knows p* tokens rarely expressed information that had been previously mentioned in the conversation and accepted into the common ground. In our sample, *p* described old information in only 15% of all *x knows p* tokens and 14% of all *x thinks p* tokens. Unclear and new tokens were far more frequent, and occurred in

different proportions for the two verbs. For *x thinks p* tokens in our sample, *p* most often described new information (59% of the tokens), while *x knows p* tokens were most often unclear tokens (47% of the tokens). A chi-square test was performed to determine the relationship between the two verbs and the status of their complements. The relation between these variables was significant, χ^2 (2, N = 259) = 12.59, $p <$ .002. Declarative complements more often expressed new information with *think* than with *know*.

However, we might want to ask if these patterns — while statistically significant — are also cognitively significant for children or can help them learn something about the factivity of *know* vs. the non-factivity of *think*. Does this kind of input distribution support the learning strategy that factives have complements which express common ground information, given that *x knows p* tokens are so rare, that *x thinks p* tokens are so frequent, and *p* expresses "old" information at similar rates for the two verbs? To determine this, we analyzed the cue validity of a complement expressing "old" information for determining which verbs are factive. A cue validity statistic expresses the reliability of a particular cue for identifying some category as a conditional probability with a value ranging between 0 on the low end and 1 on the high end (Brunswik 1956, Gibson 1966). In our sample, the probability of getting a *know* token given an "old" token is only .15, while the probability for *think* is .85. Thus our sample suggests that using declarative complements which express common ground information as a cue to factivity would lead the learner to sooner conclude that *think* is factive than that *know* is factive, due to the similar rates of "old" tokens for the two verbs and the fact that such cases are overwhelmingly more frequent for *think* than *know*.

Furthermore, to give a sense of what children are dealing with if they rely solely on this kind of cue, we can look at how often cues like this occur. Less than 20 tokens in the entire sample were *x knows p* tokens that could be evaluated for whether *p* is "old" information. This corresponds to 1.5% of all *know* tokens in this sample. If this is representative of children's experience, then children could expect to observe 5-6 such informative examples in every 10,000 utterances that they hear. Given estimates by Akhtar et al. (2004) based on data from Hart & Risley (1995), this would amount to approximately 1,500 such utterances by the point that children are beginning to differentiate between *know* and *think* at age 3. But such calculations should be taken with a grain of salt given the nature of corpus data and the size of our sample here.

However, if we want to be more generous to these kinds of cues, we can include the "unclear" cases (18) as tokens that can be classified as common knowledge from the perspective of the child. If so, we find that *know* occurs more often with known information (old/unclear in 62% of *x knows p* tokens) whereas *think* occurs more often with new information (new in 59% of *x thinks p* tokens). *Think* tends to be used with complements which express new information while *know* tends to be used with complements that express known information. However, the cue validity statistic does not improve much with this generous grouping: the cue validity for *know* only rises to .20 while *think*'s lowers to .80.

There are also cases where *know* does not take an overt complement, but might still provide discourse status cues to factivity. When *know* occurs with a non-overt complement, it is typically either in an utterance like (23b) which serves as the answer to a question, or in an utterance like (24b) which speakers use to acknowledge

that they are aware of some fact(s). This second kind of utterance could be a relevant cue to the discourse status of *know*'s complement, because the content of the (elided) complement is definitely given within the discourse, to the point that it can be elided.

(23) a. A: Where are my car keys?

b. B: I don't know ~~where your car keys are~~.

(24) a. A: This screw keeps falling out.

b. B: I know ~~that screw keeps falling out~~.

We separated this kind of context from the ones examined above with overt complements because it is not clear to us that children will consider these different cases comparable (or even be able to understand the relevance of utterances like (24b)). To see how often these cases occur in children's input, we examined all tokens where *know* occurred with a non-overt complement and asked how often that token functioned as a response to a question, as in (23b), or to a previous statement, as in (24b), or had an unclear function. We find that these potentially informative utterances, "declarative" null complements such as those in (24b) are relatively rare, occurring in only 14% of tokens where *know* takes a non-overt complement, similar to the rate of informative cases for the overt complements discussed above.

Lastly, we examined cases where *know* and *think* occur in p-family contexts to see what kind of evidence there is for the projective behavior of *know*, as compared to the non-projective behavior of *think*. In our sample, there are no occurrences of *know* or *think* in the antecedent of a conditional, or under a modal, but there are tokens of *know* and *think* that occur in negative and interrogative contexts. Negation data is presented here in Figure 4 and question data is presented in Figure 6 in Section 5.2.1, and these two figures collapse across all tokens of each verb, so they

do not distinguish between utterances like *She doesn't know p* and *She doesn't know Q*. From these two figures, we can infer that the number of *x knows p* tokens which occur within such a projective environment will be rare, given the relative rarity of *x knows p* tokens overall. In fact, only about 50 *x knows p* tokens occur in such contexts, less than 5% of children's total experience with *know*. In contrast, *x thinks p* tokens occur in projective contexts about 250 times, which makes up approximately 20% of children's experience with *think*. Furthermore, it is possible to have instances where *x thinks p* tokens appear projective (see example in 13, in the spirit of Simons et al. 2017). These facts suggest that using projective contexts to discover the factivity contrast between the verbs is not an altogether promising route.

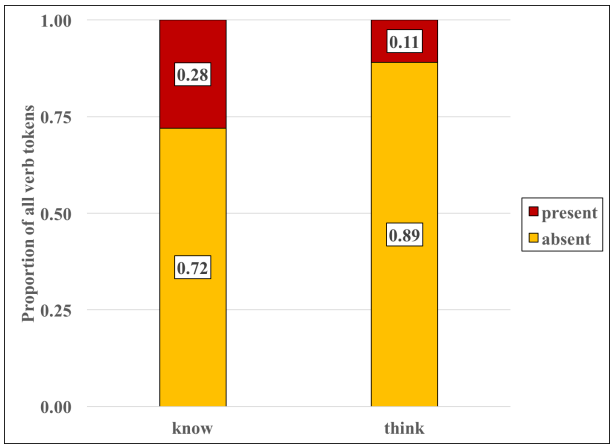

Figure 4 Negation-types within the sample, as a proportion of each verb

Now, there are some important caveats in considering our data. Our discourse-level coders failed to become reliable ($\kappa = .44$). It could be that our coding scheme was not appropriate to handle this task. It could also be that this task of tracking whether propositions are known given some prior discourse is actually quite difficult,

given the kinds of discourses that parents and children participate in. It is suggestive that children might have similar difficulty as our coders in deciding what the status of *p* is when they hear *x knows p* or *x thinks p*.

4.3.3 Discussion of discourse status cues

In this section, we have investigated the reliability of discourse status cues to the factivity and veridicality distinctions between *know* and *think* in children's linguistic input. We asked two specific questions: (i) how often is *think* used to describe false beliefs as compared to *know* and (ii) how often is *know* used to describe known information as compared with *think*.

In answer to the first question, we find that *think* is typically used to discuss the speaker beliefs (see Figure 1). These first person *think* sentences are rarely used in the past (Figure 2) or with negation (see Figure 4). Thus, in children's experience, speakers are often committed to the truth of the complements of *think* (see also Diessel & Tomasello 2001, Lewis et al. 2012, among others). As a result, there may be very few instances where a child could observe that *think* can be used to describe false beliefs and is thus non-veridical.

In answer to the second question, we find a difference in how often the complement of *know* vs. *think* is old information. But this difference (approx. a 40% - 60% split under the most generous estimates) is not of the kind that we would expect if children need to use the direct route. In fact, our analyses suggest that this kind of learning strategy might lead the learner to conclude that *think* is factive over *know*, which is not consistent with findings in the acquisition literature (Dudley et al. 2015, Hacquard et al. 2016). We further find that projective contexts are rare with these *x*

knows p tokens, suggesting that they might not be the most readily available context from which to learn about the factivity of *know*.

Whether children are able to make use of these subtle differences in the discourse status of the complements of *think* and *know* remains an open question for future research. For now, the fact that they are so subtle motivates looking to alternative routes for figuring out the factivity contrast between *know* and *think*.

5 Alternative cues: syntax and discourse function

Cues from the discourse status of the information provide one route to the (non-)factivity of *know* and *think*. As we saw in the previous section, such cues are present in children's input but sparsely so. Might there be different, perhaps less direct, cues to factivity that are more readily available? As it turns out, *think* and *know* have very different distributions, both in terms of syntax and discourse function. In this section, we discuss how these differences may provide an indirect route to the (non-)factivity of *know* and *think*. Section 5.1 examines syntactic cues. We show that the two verbs differ in their syntactic distribution in the input, and sketch out an account of how children might infer the factivity contrast by exploiting these cues via a syntactic bootstrapping account. Section 5.2 examines cues from discourse function. We show that the two verbs are routinely used to perform different indirect speech acts in the input: indirect questions for *know*, indirect assertions for *think*. We sketch how children might infer the factivity contrast by exploiting these cues via a pragmatic bootstrapping account. In Section 5.3, we briefly sketch how syntactic and discourse function cues might work in tandem.

5.1 Syntactic cues and syntactic bootstrapping

The meaning of a linguistic expression may be difficult to observe. This is especially true for attitude verbs like *think* and *know* which have been hailed as some of the "hardest" words to learn based on situational context alone, given that they express mental states which are "closed to observation" (Gleitman 1990, Gleitman et al. 2005). But the syntactic distribution of an expression can be more transparent. Syntactic bootstrapping is a learning strategy that exploits principled links between a word's meaning and its syntactic distribution (Landau & Gleitman 1985, Lasnik 1989, Gleitman 1990, Naigles 1990, Lidz 2006). A growing literature suggests that syntactic bootstrapping plays a role in verb learning as children are able to use some syntactic properties of clauses to learn about the meaning of the verbs that occur in them. For instance, verbs in transitive clauses describe events that have at least two participants (Naigles 1990, Naigles et al. 1993, Fisher et al. 1994, Naigles 1996, Yuan & Fisher 2009, Fisher et al. 2010, among many others).

With respect to attitude verbs, the syntax and semantics literature argues that there are systematic relationships between the semantics and the syntax of attitude reports (see for instance Bolinger 1968, Hooper 1975, Stowell 1981, Grimshaw 1990, Pesetsky 1991, Anand & Hacquard 2013, White et al. 2017). Recent studies have started to show that children are sensitive to the kinds of complements that an attitude verb embeds when figuring out its meaning (Asplin 2002, Hacquard et al. 2016, Harrigan et al. 2016, Lidz et al. 2016, Harrigan et al. under review). Furthermore, evidence from computational modeling shows that a virtual learner can discover information about the semantics of an attitude verb from the kinds of sentences it occurs in (White et al. 2014, White 2015, White et al. 2017). Given

this, it seems possible that children could use syntactic distributions from their input to pick up on meaning differences between *know* and *think*, provided that there are principled mappings between meaning and distribution that they would be privy to.

Some authors argue that there is a principled correlation between a predicate's factivity and its ability to take both declarative (25) and interrogative (26) complements (Hintikka 1975, Ginzburg 1995, Egré 2008, among others). A factive like *know* takes both kinds of complements, whereas a non-factive like *think* only embeds declarative complements. Egré, for instance, posits that, for verbs which require their complements to be true (such as factive verbs), the difference between a declarative and interrogative complement is neutralized (i.e., to *know that it's raining* is to *know whether it's raining* and vice versa). Under this kind of account, a child could learn whether a verb is factive by observing whether it takes both declarative and interrogative complements.

(25) John knows/thinks that Mary is home.

(26) John knows/*thinks where Mary is.

5.1.1 Syntactic complement data

In order to look at the viability of a syntactic bootstrapping approach to learning the contrast between *know* and *think*, we examined the kinds of complements that occur with each verb. The results are shown in Figure 5.

Know takes declarative complements, as we saw before in Section 4.3.2, but it more often occurs with interrogative complements (52% of all *know* tokens). In contrast, *think* occurs primarily with declarative complements (85% of all *think* tokens). NP complements are very rare in this sample, occurring in 6% of *know*

tokens and 1% of *think* tokens (which are likely speech errors). PP complements are also rare, occurring in 4% of all *think* tokens and less than 1% of all *know* tokens. Null, or un-expressed, complements are relatively frequent, occurring in 26% of *know* tokens and 10% of *think* tokens. These are typically answers to questions (e.g., A: *Where are the keys?* B: *I don't know*) and responses to statements (e.g., A: *You left the keys in the kitchen* B: *I know!*) but some are speech errors or refer to the process of thinking (e.g., *She's thinking right now*).

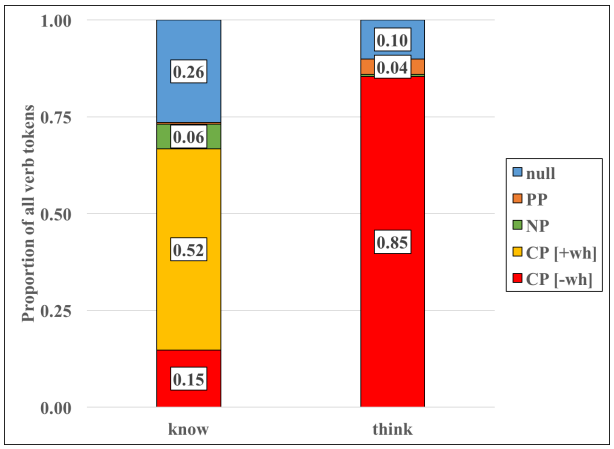

Figure 5 Complement-types within the sample, as a proportion of each verb

5.1.2 Discussion of syntactic cues and syntactic bootstrapping

These results suggest that, in children's experience, the overall syntactic distribution of *know* differs from that of *think*. These differences in distribution would support a syntactic bootstrapping approach to factivity that relies on *know* occurring with both declarative and interrogative complements and *think* occurring only with declaratives.

However, a syntactic bootstrapping approach faces some issues. One issue with Egré's specific account is that it relies on *whether*-complements, which are exceed-

ingly rare in speech to children; most interrogative complements are embedded *wh*-questions and these are an order of magnitude more frequent than embedded polar questions. But perhaps *whether*-complements are so informative that a small number of them are enough? More problematic for this bootstrapping account is that the generalization that factivity correlates with the ability to embed declarative and interrogative complements has been called into question, given its various counterexamples: Proffering verbs (*say*, *tell*) take questions but they are not factive (though, they can have "factive" uses, see Schlenker (2010), Anand & Hacquard (2014), Spector & Egré (2015), **?**; *decide* and *be certain* can also take questions, but they are not factive. Some of these counterexamples may be exceptions that may not be too problematic, if they are not verbs that children learn early on, as they could be acquired piecemeal later on. However, they suggest that the ability to embed interrogatives and declaratives may only be indirectly connected with factivity, and that additional syntactic and semantic properties may be at play.

5.2 Discourse function cues and pragmatic bootstrapping

The different types of discourse moves that the verbs are used to achieve could also provide clues as to their underlying meanings. The meaning of an expression constrains the ways that it can be used (Grice 1975), so understanding how a speaker uses some word could help understand its meaning.

Know and *think* are routinely used to perform different kinds of indirect speech acts. *Know* can easily be used to request information (27) and respond to information requests (27b) while *think* can easily be used to make indirect assertions (28).

(27) a. Q: Do you know where my keys are?

b. A: Sorry, I don't know

c. A': In the kitchen

(28) I think it's raining.

While the literal act in (27a) is a question about the addressee's knowledge state, it can easily be used to ask where the keys are (indirect question). Similarly, the literal act in (28) is a mere assertion about a belief state, but it can easily be used to proffer that it is raining (indirect assertion). Following Searle (1975), we can make sense of the naturalness of these indirect speech acts with *know* and *think* by tying them to the fact that they literally express different conditions on the successful performance of the indirect acts. (27a) literally expresses the preparatory condition of the indirect question: the speaker should assume that the addressee knows the answer to where the keys are. (28) literally expresses the sincerity condition of the indirect assertion: the speaker should believe that it is raining.

Such pragmatic enrichments could potentially create a further acquisition challenge, as children need to untangle pragmatic from semantic contributions. However, we would like to propose that these indirect speech acts, if systematic enough, could be a feature, and not a bug for the learner, as they could provide valuable cues about the underlying meanings of *know* and *think*, provided that children understand enough about what the speaker is trying to get across to pick up on the illocutionary force of the indirect acts in (27a) and (28) (we return to this question in section 6).

Here is how such pragmatic bootstrapping could go. Imagine that the child hears an utterance like *I VERB*$_1$ *that it's raining*. If the child understands that the speaker is putting forward the proposition that it's raining, she might infer that (i) VERB$_1$ expresses some kind of commitment (perhaps a belief) of the subject (the speaker) to

the proposition expressed by the complement (it's raining) and (ii) that the content of the complement is presented as new information, and hence not presupposed. If she hears an utterance like *Do you VERB$_2$ what time it is?* and understands the speaker to be requesting an answer to the question *What time is it?*, she may not understand exactly what VERB$_2$ means, but she may assume both that the speaker wants the true answer to this question and that the speaker believes that the subject (the addressee) has the desired true answer. These assumptions would allow the child to infer that VERB$_2$ is a kind of predicate which relates an individual (e.g., the child) to the true answer to a question (e.g., *What time is it?*).

Howard et al. (2008) provide some support for this pragmatic bootstrapping view, as the only published study to examine the relationship between input with attitude verbs and performance on a behavioral task that assesses understanding of the verbs. The tasks they use required three-year-old participants to decide whether a *know* statement or a *think* statement is more informative when the two statements conflict, as in (29) and similar to the methodology of Moore et al. (1989).

(29) A toy is hidden in one of two boxes and participants must find it. They receive the following clues:

a. Puppet A: I think it's in the blue box

b. Puppet B: I know it's in the yellow box

They find that two aspects of the input are related to performance on this kind of task. First, hearing *know* in more questions predicts higher accuracy while hearing *know* in more declaratives predicts lower accuracy. Second, hearing *know* occur with more first person subjects leads to worse performance.

Given this initial support, a pragmatic bootstrapping approach to learning the contrast between *know* and *think* seems plausible, but it leaves out the role of the complements. According to such pragmatic bootstrapping, a possible entryway into the factivity of *know* would be via its interrogative complement. How would this knowledge extend to uses of *know* with a declarative complement? This depends in part on how the two types of complements are related. Three options have been discussed in the literature for responsive predicates like *know*: (i) ambiguous accounts that posit two lexical items which take different complements (Karttunen 1977, George 2011); (ii) reductive accounts that posit one lexical item which takes one kind of complement, where interrogative complements are reduced to declarative complements or vice versa (Groenendijk et al. 1984, Spector & Egré 2015, Uegaki 2015); and (iii) uniform accounts where the two complement types are posited to have the same denotation (Ciardelli et al. 2013, Theiler 2014, Ciardelli & Roelofsen 2015, Theiler et al. 2016). If the two complements are underlyingly related, as in the reductive accounts, knowledge about instances of *know Q* would be informative about instances of *know p* and vice versa.

5.2.1 Direct speech act data

To determine the viability of a pragmatic bootstrapping approach to learning the contrast between *know* and *think*, we examined aspects of the verb's discourse distributions in speech to children.

First, we examined the kinds of direct speech acts that the verbs are used to perform as measured by the types of clauses that the verbs occur in. See Figure 6 for the results. We find that declarative clauses are the most prevalent, followed

by polar interrogatives and then *wh*-interrogatives. But there are differences in the kinds of clauses that occur most frequently with each verb. *Think* is used primarily in declarative clauses (64% of all *think* tokens) while *know* occurs almost equally in declaratives (50% of all *know* tokens) and polar interrogatives (49% of all *know* tokens). Interrogative clauses are rarer with *think*; only 20% of all *think* tokens are polar interrogatives and 17% are *wh*-interrogatives. A chi-square test of independence was performed to determine the relationship between clause-types and verbs. The relation between these variables was significant, χ^2 (2, N = 2387) = 310.83, $p < .00001$. This indicates that *think* is used primarily to make assertions while, in contrast, *know* is used more often in asking questions. In further analyses, *wh*-interrogatives and polar interrogatives are collapsed into one interrogative category.

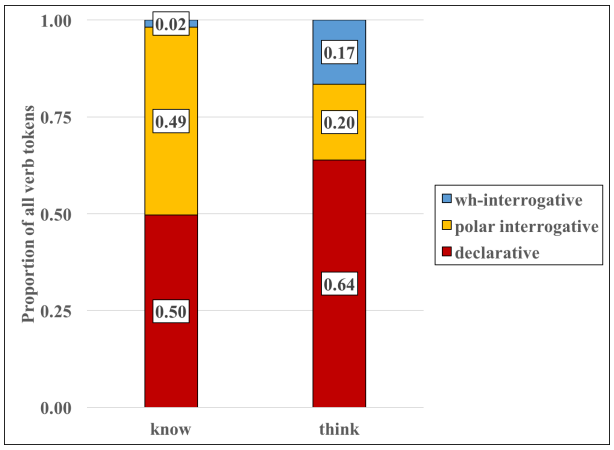

Figure 6 Clause-types within the sample, as a proportion of each verb

Furthermore, when we compare the types of clauses and subjects in the sample, we see that the kinds of subjects that occur in utterances are not unrelated to the clause-types (data in Figure 7). The vast majority of tokens with first person subjects

are declaratives (45% of the entire sample) and the vast majority of tokens with second person subjects are interrogative (39% of the entire sample). In contrast, interrogative clauses with first person subjects (2% of the entire sample) and declarative clauses with second person subjects (7% of the sample) are both rare. This may not be surprising, at least within the domain of belief verbs like *think* and *know*; when we speak, we may be more likely to assert our own beliefs than question them, and we may be more likely to ask about others' beliefs that claim what they are. A chi-square test of independence was performed to verify this relationship between clause-type and subject-type within our sample of belief verbs. The relation between these variables was significant, χ^2 (2, N = 2387) = 1445.57, $p < .00001$. Thus, in talking to children, adults tend to ask questions about the beliefs of others and assert things about their own beliefs, instead of asking about their own beliefs and declaring others' beliefs.

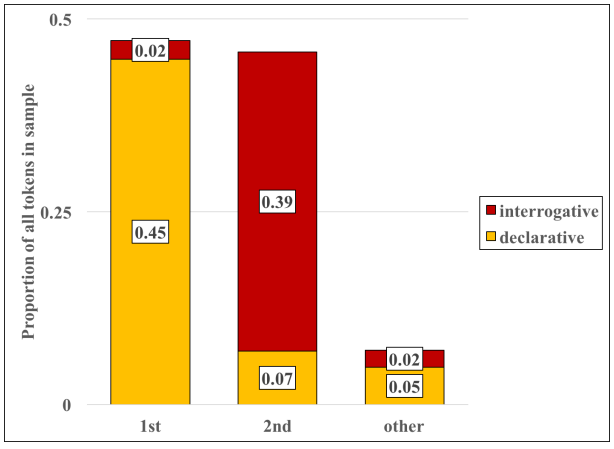

Figure 7 Clause-types by subject-types, as a proportion of entire sample

5.2.2 Indirect speech act data

The data presented in the previous sections suggest that *know* is used typically with (i) second person subjects (Figure 1), (ii) interrogative clauses (Figure 6), and (iii) interrogative complements (Figure 5), while *think* is typically used with (i) first person subjects, (ii) declarative clauses, and (iii) declarative complements. Is this data reflective of the kinds of indirect speech acts that *know* and *think* are used to achieve? We know that there is a relationship between subject-types and clause-types (Figure 7). How do the different complement-types distribute across these categories? How often do second person *know* questions also have interrogative complements, compatible with indirect requests for information (as in 27a)? And how often do first person *think* assertions have declarative complements, compatible with indirect assertions (as in 28)?

In our sample, *know* is frequently used to ask indirect questions (29.7% of all *know* tokens are polar questions with second person subjects and embedded questions) such as (30), or to answer questions (33.5% of all *know* tokens are assertions with first person subjects) as in (31). In contrast, *think* is most often used to make indirect assertions (41.3% of all *think* tokens are assertions with first person subjects, present tense, declarative complements and no negation) as in (32). This suggests that, in speech to children, *know* is most often used to request information or to answer requests for information, while *think* is mostly used to express commitment to some proposition. To the extent that children can make use of this kind of information, the distributions are there in the input to support a pragmatic bootstrapping approach.

(30) conversation with Helen (4;11) during play interaction, participants include the target child and her mother

mother: Well, do you know what the story's about?

child: What?

mother: Well, we'll see.

(31) conversation with Laurel (3;0) at dinner, participants include the target child, her mother and her father:

child: What's the other baby's name?

father: I don't know. (addressed to child)

father: What's the other baby's name? (addressed to mother)

(32) conversation with Bobby (4;2) at dinner, participants include the target child, his mother, his father and his sister:

father: What are you doing, mixing it all up?

child: That's for it can get warmer.

father: I think it's pretty warm now.

Note that parents often use *Do you know Q?* questions not as genuine information-seeking questions but as knowledge questions. But the children's responses indicate that they take these questions as indirect questions because they respond with the answer to the embedded question, or say *What?*, rather than answer yes or no:

(33) conversation with Helen (4;11) during grocery-set play interaction, participants include the target child and her mother

mother: Do you know what this is?

child: Powder.

mother: Yea, that's right. Soap powder.

To see the relevance of these kinds of speech act cues for distinguishing between *know* and *think*, we can calculate the validity of a speech act as evidence for a verb category. First taking potential indirect assertion tokens (those with first person subjects, in declarative clauses, with declarative complements and present tense),

the cue validity for *think* is .95 given that 95% of such tokens are *think* ones instead of *know* ones. For potential indirect questions (with second person subjects, in polar interrogative clauses with interrogative complements), the cue validity for *know* is 1, given that *think* is incompatible with interrogative complements. Thus, these indirect speech acts are not only informative about the underlying meanings of the verbs, but provide an exceedingly clear signal. Furthermore, if we abstract away from the complement types of the tokens, and just look at the role of subjects and clauses cues (see Figure 7) in differentiating the verbs, the cue validity values remain higher than those discussed for the discourse status factivity cues in Section 4.3.2. The probability of having a *think* token given a first person assertion is .61 and the probability of having a *know* token given a second person question is .77. These four cue validity values suggest that the discourse function cues given by the kinds of speech acts speakers use *know* and *think* for, provide a clearer signal than the discourse status cues given by what speakers presuppose when using *know* and *think*.

5.2.3 Discussion of discourse function cues and pragmatic bootstrapping

We have seen that speakers use *think* and *know* to perform different discourse functions, in ways that could provide clues as to the verbs' underlying meanings. *Think* is mainly used for indirect assertions with first person subjects. If the child understands that the speaker is indirectly asserting the content of the complement with these *I think p* utterances, she may infer that *think* expresses a commitment to the truth of the complement by the subject but that it does not trigger the presupposition that the complement is true. In contrast, *know* is mainly used for indirect questions with second person subjects. If the child understands that the speaker is indirectly

asking her *Q?* through these *Do you know Q?* questions, she may infer that *know* relates the subject to the true answer to *Q*.

But if children are able to use the intended force of the indirect act to infer the meaning of the direct act, might this backfire in cases where *know* and *think* are used for other kinds of indirect speech acts, such as indirect requests (e.g., *Don't you know I just cleaned that up?* and *I think it's time for bed*)? What would prevent the child from inferring that the underlying meanings of *know* and *think* express some kind of preference (in the same way they might infer *want* expresses a preference from its routine usage in indirect requests such as *I want you to go to bed!*, see Hacquard & Lidz to appear)? We would like to propose that pragmatic and syntactic bootstrapping might work in tandem, and mutually constrain the kinds of hypotheses that learners will entertain for attitude verb meanings.

5.3 Pragmatic syntactic bootstrapping

The meaning of an expression is related to both (i) the kinds of sentences that expression occurs in and (ii) what speakers use that expression to achieve. Either of these links can be error-prone, their convergence might help hone in on the right meaning.

According to the pragmatic syntactic bootstrapping hypothesis for attitude verb meanings (Hacquard 2014, Hacquard & Lidz to appear), learners make use of both syntactic distribution and discourse function cues to hone in on an attitude verb meaning. Different classes of attitude predicates take different types of complements, and this syntactic/semantics mapping is principled, in accordance with the traditional syntactic bootstrapping view. Verbs that express belief (*think*, *know*, *say*, etc.)

in English take finite complements, verbs that express preferences take non-finite complements (*want*, *order*, *tell*, etc.). But the same belief/desire split is tracked differently in different languages (e.g., mood selection in Romance, word order in German), in a way that could be challenging for a learner using syntactic cues to figure out verb meaning (how does a learner of German know to pay attention to word order cues, as opposed to mood?). Here is where pragmatic bootstrapping comes in handy: these different syntactic cues all converge at a more abstract level: belief verbs, but not desire verbs, in these various languages, all take complements that have syntactic hallmarks of declarative clauses in the respective languages (e.g., finiteness in English, indicative mood in Romance, verb second in German), the clause type typically associated with assertions. A verb like *think* takes declarative complements and is used for indirect assertions. From this the child may conclude that the verb expresses some commitment of the subject to the truth of the complement. However, when the indirect speech act and the syntactic complement do not line up (as in indirect requests uses of *think* sentences), the learner may know to refrain from making conclusions about the verbs' meaning.

For the case at hand, the most optimal indirect route to factivity may thus involve combining cues from the verbs' syntactic distribution (ability to take interrogative complement) and discourse function (indirect assertions vs. questions). What could be particularly powerful in the case of *know* and *think* is that there is an alignment across different aspects of the signal that children are exposed to.

6 Comparing routes

We find that *know* and *think* occur at similar rates in speech to children. Neither verb is frequently used to talk about beliefs outside of the conversational context: they rarely describe the beliefs of a non-interlocutor, previously held beliefs or beliefs that the conversational participants do not hold. But that is about where the similarities between the verbs' use end. *Know* is primarily used to ask questions about the addressee's beliefs, often with the intention to request information. In contrast, *think* is used to assert what the speaker believes, often with the intention to proffer the content of that belief. Relatedly, the verbs also have distinct syntactic distributions in terms of the complements they occur with. *Think* takes primarily declarative complements, while *know* embeds both interrogatives and declaratives.

We first examined direct cues to (non-)veridicality and (non-)factivity based on the discourse status of the information expressed by the complement. We found that the two verbs are distributed in ways that are distressingly similar. The ability for *think* to report false beliefs could be obscured from children given the frequency of *think* assertions about the speaker's beliefs. And any requirement that *know* report beliefs which are taken for granted could be obscured by the fact that *x knows p* tokens are not systematically used in contexts where *p* is common knowledge. Hence the signal may be there, but it is noisy.

In order to use the direct route for a trigger like *know*, children must: (i) track the common ground, (ii) track the propositions expressed in *know* and *think*'s declarative complements, (iii) compare these propositions to the common ground, (iv) evaluate these propositions for truth in the conversational context, (v) sort through noisy input distributions to (vi) discover an association for *know* where the propositions are true

and common knowledge, but not for *think*, and (vii) conclude that this association is a matter of convention that should be encoded into the representation of *know*. In principle, this process is possible. But in reality, any of these steps could fail.

We have seen that the relevant data is made available, but is very sparsely distributed across children's experience; the relative differences between *know* and its comparison case *think* are small. These small differences are statistically significant, but we do not know if they are cognitively significant, or salient, to children. With one potential measure of such salience — cue validity — we find that the kinds of contexts which should be diagnostic of factivity are actually more characteristic of the ways that *think* occurs in the input, suggesting that such an acquisition route would actually lead children to learn that *think* is factive more readily than *know*, which is inconsistent with findings from the language acquisition literature.

Furthermore, since speaker presuppositions are backgrounded, children might fail to attend to them, especially given that speakers make all kinds of presuppositions that aren't tied to any particular lexical item. When children do attend to speaker presuppositions and notice associations with particular words, they must then decide that this information needs to be conventionally encoded. A pragmatic account of the triggering problem for *know* might alleviate some of the pressure: perhaps all the child needs to discover is that *know* is veridical while *think* isn't. But, as we have seen, the evidence for such a distinction is also sparse, given that *think* is rarely used to report false beliefs in speech to children.

Another possible route exploits earlier-developing syntactic knowledge to bootstrap into lexical semantic knowledge. In order to use this syntactic route, children

must: (i) track syntactic distributions in their input, (ii) notice differences in the distributions of *know* and *think* and (iii) reason about the explanation of this difference via principled syntax-semantics links. Can children do this?

As we saw in section 5.1, there is growing support from other cases of attitude verb acquisition that syntactic bootstrapping is at play (Harrigan et al. 2016, Lidz et al. 2016), but not for a contrast of this grain size, let alone this particular contrast. Furthermore, counterexamples that challenge the principled nature of the link between factivity and question embedding still remain.

Finally, the discourse function route has children use pragmatic bootstrapping to discover the factivity contrast for *know* and *think*, by exploiting the types of indirect speech acts these verbs are used for. In order to use this route, children must: (i) track the intentions of their interlocutors, (ii) track the words that are used by their interlocutors, (iii) notice relationships between them and (iv) reason about the nature of those relationships via pragmatics-semantics links. Can children do this?

In some ways, the pragmatic information required for the discourse function cues is the most salient information, given that it has social importance. It is not unreasonable to think that children can infer speaker meaning, especially if there are some constrained contexts with good extralinguistic and paralinguistic cues to their parents' intentions. Previous studies show that children pick up on the intended illocutionary force of indirect speech acts, like requests or questions (Shatz 1978, Spekman & Roth 1985, Grosse & Tomasello 2012). As for our relevant verbs, studies show that children are sensitive to the assertivity of *think*, and that they may, in fact, assume indirect assertion uses of *think* sentences to a fault (Shatz et al. 1983, Diessel & Tomasello 2001, Lewis et al. 2012, 2017). We have also seen that children tend to

respond to the indirect questions expressed with *Do you know Q?*. Over-weighting these discourse function cues could lead the children to make certain errors, like ascribing desire meanings to *think* and *know*, when they are used to make indirect commands.

In principle, all of these routes are possible, but they place different cognitive and linguistics demands on children. Given the relative strength of the signal from the syntactic and discourse function cues, relative to the discourse status cues, and the fact that children seem to have the prerequisite cognitive and linguistic demands to exploit these cues, we believe that a combination of the syntactic and pragmatic function route is the more likely. But which ones do children actually use? Perhaps children make use of a combination of them, as multiple sources of information may be necessary for solving such difficult or subtle mapping problems (Gleitman et al. 2005). Alternatively, all the routes may be viable and children may utilize whichever one is made most available to them in their individual experience. And there is some indication in this dataset that children can have vastly different experiences. For example, when we consider the types of subjects which occur with each verb in children's experience, there is some variation. While *know* occurs with 1st person subjects in about 30% of cases on average, the range for individual children is between 15-60%. Similarly, *know* occurs with 2nd person subjects in about 60% of cases on average, the range is between 15-85%. In fact, experiences can be so different that two out of the 24 children get distributions of subjects with *know* that are closer to their peers' experiences with *think* than the peers' experiences with *know*. What we do not yet know is how this individual variation impacts children's understanding of the verbs, and how this supports (or fails to support) different

routes. To see which route children actually use, we would need a way to correlate input to comprehension. We are currently conducting such a study to gain some experimental insight into which set(s) of cues are related to children's understanding of factivity (see Dudley 2017 for preliminary results).

7 Conclusion

We examined a corpus of child-directed speech to determine which cues to the (non-)factivity of *know* and *think* are made available to children. Direct cues from the discourse status of the complement as old or new information are sparse: our data suggest that children do not have many opportunities to observe that speakers presuppose *p*, when they hear *know*. This is because *x knows p* utterances are relatively rare. When they occur, they are not systematically used to presuppose the truth of *p*, and when compared with *think p* sentences, the rates of old vs. new information differ, but not very starkly. As a result, children may not have reliable opportunities to observe that *know* is used to talk about established facts — whereas *think* is not. If these data are reflective of children's experience generally, then there is some signal in the relatively few instances they get to learn from, but this signal is very noisy. If a child can use these cues, it will be via probabilistic reasoning about slight differences in proportions within their experience; children would have to actively entertain factivity as a hypothesis and the learning trajectory would be slow because the data would have to accrue over a long period of time.

However, *know* and *think* have different syntactic distributions, and they are used to perform different discourse moves. *Think* most often embeds declarative complements whereas *know* embeds both declarative and interrogative complements.

Know is used most often to ask or answer information-seeking questions (i.e, *Do you know where…? No, I don't know*) whereas *think* is used to proffer or hedge assertions (i.e., *I think that you…*). Given that both types of cues (syntactic and discourse function) are available to children, we've argued that they could provide alternative routes to the factivity contrast.

Could syntactic bootstrapping alone be sufficient? Perhaps not, given all the counterexamples to the generalization that only factives take both interrogative and declarative complements. Could pragmatic bootstrapping alone be sufficient? Probably not, as *think* and *know* can also be used for indirect requests. But syntactic and pragmatic bootstrapping could work in tandem and mutually constrain each other.

If this is on right track, then indirect cues to factivity may be more helpful to children than discourse status cues to factivity, given the ways that parents use the verbs in conversation. It's unclear whether this strategy would be available in acquiring other factive presupposition triggers. However, *know* is the most frequent factive in both the input and child productions (Shatz et al. 1983, MacWhinney 2000). Perhaps these discourse cues serve to inform the child that *know* is factive and they can then bootstrap this knowledge to other verbs which have similar syntactic distributions. Alternatively, it could be that–unlike in naturalistic speech between adults–the presuppositions of other cognitive factives are more clearly signaled in the input.

Finally, this indirect strategy which relies on both syntactic distributions and discourse functions is unlikely to apply to all presupposition triggers. For hard triggers in particular, discourse status cues may be much more reliable, while

indirect cues may be much sparser in the input. As a comparison case, we are currently exploring cues to the presuppositional content of the hard trigger *too* and its acquisition profile.

What do these conclusions about input imply for a theory of *know*'s factivity? The ways that speakers use *know* in speech to children make the direct route of observing what speakers presuppose to pick up on the factivity of *know* unlikely. Hence, from a learnability point of view, a semantic account of the triggering problem for *know* is unlikely. Instead, a pragmatic account, according to which the factivity of *know* follows from its veridicality is given more support. But even then, picking up on the veridicality of *know*, in comparison to the non-veridicality of *think* is not trivial, given the way speakers use the two verbs. As a consequence, children may have to exploit more indirect cues to the veridicality/factivity contrast than one might have thought.

References

Abbeduto, Leonard & Sheldon Rosenberg. 1985. Children's knowledge of the presuppositions of know and other cognitive verbs. *Journal of Child Language* 12(03). 621–641.

Abbott, Barbara. 2006. Where have some of the presuppositions gone. *Drawing the boundaries of meaning: Neo-Gricean studies in pragmatics and semantics in honor of Laurence R. Horn* 1–20.

Abrusán, Márta. 2011. Predicting the presuppositions of soft triggers. *Linguistics and philosophy* 34(6). 491–535.

Abrusán, Márta. 2016. Presupposition cancellation: explaining the ?soft–hard?trigger distinction. *Natural Language Semantics* 24(2). 165–202.

Abusch, Dorit. 2002. Lexical alternatives as a source of pragmatic presuppositions. In *Proceedings of salt*, vol. 12, 1–19.

Abusch, Dorit. 2010. Presupposition triggering from alternatives. *Journal of Semantics* 27(1). 37–80.

Akhtar, Nameera, Maureen Callanan, Geoffrey K Pullum & Barbara C Scholz. 2004. Learning antecedents for anaphoric one. *Cognition* 93(2). 141–145.

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

Anand, Pranav & Valentine Hacquard. 2014. Factivity, Belief and Discourse. In Luka Crnič & Uli Sauerland (eds.), *The Art and Craft of Semantics: A Festschrift for Irene Heim*, vol. 1, 69–90. Cambride, MA: MIT Working Papers in Linguistics.

Asplin, Kristen Nicole. 2002. *Can complement frames help children learn the meaning of abstract verbs?*: University of Massachusetts, Amherst dissertation.

Beaver, David. 2010. Have you noticed that your belly button lint colour is related to the colour of your clothing. *Presuppositions and Discourse: Essays Offered to Hans Kamp. Elsevier, Philadelphia, PA* 65–99.

Berger, Frauke & Barbara Höhle. 2012. Restrictions on addition: children's interpretation of the focus particles auch 'also'and nur 'only'in german. *Journal of child language* 39(02). 383–410.

Boër, Steven E & William G Lycan. 1976. The myth of semantic presupposition .

Bolinger, Dwight. 1968. Postposed main phrases: an English rule for the Romance subjunctive. *Canadian Journal of Linguistics* 14(1). 3–30.

Brunswik, Egon. 1956. *Perception and the representative design of psychological experiments*. Univ of California Press.

Chierchia, Gennaro & Sally McConnell-Ginet. 2000. *Meaning and grammar: An introduction to semantics*. MIT press.

Ciardelli, Ivano, Jeroen Groenendijk & Floris Roelofsen. 2013. Inquisitive semantics: a new notion of meaning. *Language and Linguistics Compass* 7(9). 459–476.

Ciardelli, Ivano A & Floris Roelofsen. 2015. Inquisitive dynamic epistemic logic. *Synthese* 192(6). 1643–1687.

Clark, Eve V. 1995. *The lexicon in acquisition*, vol. 65. Cambridge University Press.

De Villiers, Jill G. & Jennie E. Pyers. 2002. Complements to cognition: A longitudinal study of the relationship between complex syntax and false-belief-understanding. *Cognitive Development* 17(1). 1037–1060.

Diessel, Holger & Michael Tomasello. 2001. The acquisition of finite complement clauses in english: A usage based approach to the development of grammatical constructions. *Cognitive Linguistics* 12. 97–141.

Dudley, Rachel. 2017. *The role of input in discovering presupposition triggers: Figuring out what everybody already knew*: University of Maryland dissertation.

Dudley, Rachel, Naho Orita, Valentine Hacquard & Jeffrey Lidz. 2015. Three-year-olds' understanding of know and think. In *Experimental perspectives on presuppositions*, 241–262. Springer.

Egré, Paul. 2008. Question-embedding and factivity. *Grazer Philosophische Studien* 77(1). 85–125.

Falmagne, Rachel Joffe, Joanna Gonsalves & Sarah Bennett-Lau. 1994. Children's linguistic intuitions about factive presuppositions. *Cognitive Development* 9(1).

1–22.

Fisher, Cynthia, Yael Gertner, Rose M. Scott & Sylvia Yuan. 2010. Syntactic bootstrapping. *Wiley Interdisciplinary Reviews: Cognitive Science* 1(2). 143–149.

Fisher, Cynthia, D Geoffrey Hall, Susan Rakowitz & Lila Gleitman. 1994. When it is better to receive than to give: Syntactic and conceptual constraints on vocabulary growth. *Lingua* 92. 333–375.

Frege, Gottlob. 1948. Sense and reference. *The Philosophical Review* 57(3). 209–230.

George, Benjamin Ross. 2011. *Question embedding and the semantics of answers*. University of California, Los Angeles.

Gibson, James Jerome. 1966. The senses considered as perceptual systems. .

Ginzburg, Jonathan. 1995. Resolving questions, I & II. *Linguistics and Philosophy* 18(6). 459–527, 567–609.

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

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

Goodman, Nelson. 1955. *Fact, fiction and forecast*, vol. 74. JSTOR.

Grice, H Paul. 1975. Logic and conversation. In *Syntax and semantics*, vol. 3, 41–58. Academic Press.

Grimshaw, Jane. 1990. *Argument structure*. Cambridge, MA: MIT Press.

Groenendijk, Jeroen, Martin Stokhof et al. 1984. On the semantics of questions and the pragmatics of answers. *Varieties of formal semantics* 3. 143–170.

Grosse, Gerlind & Michael Tomasello. 2012. Two-year-old children differentiate test questions from genuine questions. *Journal of child language* 39(01). 192–204.

Hacquard, Valentine. 2014. Bootstrapping attitudes. In *Semantics and linguistic theory*, vol. 24, 330–352.

Hacquard, Valentine, Rachel Dudley, Christopher Baron & Jeffrey Lidz. 2016. Factivity is acquired over the preschool years. Proceedings of the 28th Annual Boston University Conference on Language Development.

Hacquard, Valentine & Jeffrey Lidz. to appear. Children's attitude problems: Bootstrapping verb meaning from syntax and pragmatics. *Mind and Language* .

Hansen, Mikkel B. 2010. If you know something, say something: young children's problem with false beliefs. *Frontiers in psychology* 1.

Harrigan, Kaitlyn, Valentine Hacquard & Jeffrey Lidz. 2016. Syntactic bootstrapping in the acquisition of attitude verbs: think, want and hope. In *Proceedings of wccfl*, vol. 33, .

Harrigan, Kaitlyn P, Valentine Hacquard & Jeffrey Lidz. under review. Conflicting desires do not make interpreting want harder .

Harris, Paul L, Bei Yang & Yixin Cui. 2017. 'i don't know': Children's early talk about knowledge. *Mind & Language* 32(3). 283–307.

Harris, Richard J. 1975. Children's comprehension of complex sentences. *Journal of Experimental Child Psychology* 19(3). 420–433.

Hart, Betty & Todd R. Risley. 1995. *Meaningful differences in the everyday experience of young American children*. Baltimore: Paul H. Brookes Publishing Co.

Heim, Irene. 1983. On the projection problem for presuppositions. *Formal semantics–the essential readings* 249–260.

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

Hintikka, Jaakko. 1975. 'different constructions in terms of the basic epistemological verbs: A survey of some problems and proposals. *The Intentions of Intensionality* 1–25.

Hooper, Joan B. 1975. On Assertive Predicates. In John P. Kimball (ed.), *Syntax and Semantics*, vol. 4, 91–124.

Hopmann, Marita R & Michael P Maratsos. 1978. A developmental study of factivity and negation in complex syntax. *Journal of Child Language* 5(02). 295–309.

Howard, Alice Ann, Lara Mayeux & Letitia R Naigles. 2008. Conversational correlates of children's acquisition of mental verbs and a theory of mind. *First Language* 28(4). 375–402.

Jasbi, Masoud. 2015. Mapping projective content: An investigation of too in english. *Unpublished manuscript* .

Johnson, Carl Nils & Michael P Maratsos. 1977. Early comprehension of mental verbs: Think and know. *Child Development* 1743–1747.

Kadmon, Nirit. 2001. Formal pragmatics semantics, pragmatics, presupposition, and focus .

Karttunen, Lauri. 1971. Some observations on factivity. *Research on Language & Social Interaction* 4(1). 55–69.

Karttunen, Lauri. 1974. Presupposition and linguistic context. *Theoretical linguistics* 1(1-3). 181–194.

Karttunen, Lauri. 1977. Syntax and semantics of questions. *Linguistics and philosophy* 1(1). 3–44.

Karttunen, Lauri & Stanley Peters. 1977. Requiem for presupposition. In *Annual meeting of the berkeley linguistics society*, vol. 3, 360–371.

Kempson, Ruth M. 1975. *Presupposition and the delimitation of semantics*. Cambridge University Press Cambridge.

Kiparsky, Paul & Carol Kiparsky. 1970. Fact. In Manfred Bierwisch & Karl Erich Heidolph (eds.), *Progress in Linguistics: A Collection of Papers*, 143–173. The Hague: Mouton.

Kripke, Saul A. 1982. *Wittgenstein on rules and private language: An elementary exposition*. Harvard University Press.

Landau, Barbara & Lila R. Gleitman. 1985. *Language and experience: Evidence from the blind child*, vol. 8. Harvard University Press.

Lasnik, Howard. 1989. On certain substitutes for negative data. In *Learnability and linguistic theory*, 89–105. Springer.

Léger, Catherine. 2008. The acquisition of two types of factive complements. In *Language acquisition and development: Proceedings of gala 2007*, 337–347.

Levinson, Stephen C. 1983. Pragmatics (cambridge textbooks in linguistics) .

Lewis, Shevaun. 2013. *Pragmatic enrichment in language processing and development*: University of Maryland dissertation.

Lewis, Shevaun, Valentine Hacquard & Jeffrey Lidz. 2012. The semantics and pragmatics of belief reports in preschoolers. In *Proceedings of salt*, vol. 22, 247–267.

Lewis, Shevaun, Valentine Hacquard & Jeffrey Lidz. 2017. "Think" pragmatically: Children's interpretation of belief reports. *Language Learning and Development* 1–23.

Lidz, J. 2006. Verb learning as a probe into children's grammars. *Action meets word: How children learn verbs* 429–449.

Lidz, Jeffrey, Rachel Dudley & Valentine Hacquard. 2016. Children use syntax of complements to determine meanings of novel attitude verbs. Proceedings of the 28th Annual Boston University Conference on Language Development.

Macnamara, John, Erica Baker & Chester L Olson. 1976. Four-year-olds' understanding of" pretend"," forget", and" know": Evidence for propositional operations. *Child Development* 62–70.

MacWhinney, Brian. 2000. *The CHILDES Project: Tools for analyzing talk. transcription format and programs*. Mahwah, NJ: Lawrence Erlbaum Associates 3rd edn.

Masur, Elise F & Jean B Gleason. 1980. Parent–child interaction and the acquisition of lexical information during play. *Developmental Psychology* 16(5). 404.

Matthewson, Lisa. 2006. Presuppositions and cross-linguistic variation .

Moore, Chris, Dana Bryant & David Furrow. 1989. Mental terms and the development of certainty. *Child Development* 167–171.

Moore, Chris & Jane Davidge. 1989. The development of mental terms: Pragmatics or semantics? *Journal of Child Language* 16(03). 633–641.

Naigles, L., Henry Gleitman & Lila Gleitman. 1993. Syntactic bootstrapping and verb acquisition. *Language and cognition: a developmental perspective. Norwood, NJ: Ablex* .

Naigles, Letitia. 1990. Children use syntax to learn verb meanings. *Journal of child language* 17(2). 357–374.

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

Onishi, Kristine H & Renée Baillargeon. 2005. Do 15-month-old infants understand false beliefs? *science* 308(5719). 255–258.

Pesetsky, David. 1991. Zero syntax: vol. 2: Infinitives.

Quine, WV. 1960. Word and object. .

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

Van der Sandt, Rob A. 1992. Presupposition projection as anaphora resolution. *Journal of semantics* 9(4). 333–377.

Schlenker, Philippe. 2010. Local contexts and local meanings. *Philosophical Studies* 151(1). 115–142.

Schulz, Petra. 2003. *Factivity: Its nature and acquisition*, vol. 480. Walter de Gruyter.

Scoville, Richard P & Alice M Gordon. 1980. Children's understanding of factive presuppositions: An experiment and a review. *Journal of Child Language* 7(02). 381–399.

Searle, John R. 1975. *Indirect speech acts*. na.

Shatz, Marilyn. 1978. Children's comprehension of their mothers' question-directives. *Journal of Child Language* 5(01). 39–46.

Shatz, Marilyn, Henry M Wellman & Sharon Silber. 1983. The acquisition of mental verbs: A systematic investigation of the first reference to mental state. *Cognition*

14(3). 301–321.

Siegal, Michael & Karen Beattie. 1991. Where to look first for children's knowledge of false beliefs. *Cognition* 38(1). 1–12.

Simons, Mandy. 2001. On the conversational basis of some presuppositions. In R. Hasting, B. Jackson & Z. Zvolensky (eds.), *Proceedings of Semantics and Linguistic Theory 11*, 431–448. Ithaca, NY: Cornell University.

Simons, Mandy. 2003. Presupposition and accommodation: Understanding the stalnakerian picture. *Philosophical Studies* 112(3). 251–278.

Simons, Mandy. 2007. Observations on embedding verbs, evidentiality, and presupposition. *Lingua* 117(6). 1034–1056.

Simons, Mandy, David Beaver, Craige Roberts & Judith Tonhauser. 2017. The best question: Explaining the projection behavior of factives. *Discourse Processes* 54(3). 187–206.

Sowalsky, Emily, Valentine Hacquard & Tom Roeper. 2009. Is pp opacity on the path to false belief. In *Generative approaches to language acquisition north america (galana)*, vol. 3, 263–261.

Spector, Benjamin & Paul Egré. 2015. A uniform semantics for embedded interrogatives: An answer, not necessarily the answer. *Synthese* 192(6). 1729–1784.

Spekman, Nancy J & Froma P Roth. 1985. Preschool children's comprehension and production of directive forms. *Journal of Psycholinguistic Research* 14(3). 331–349.

Spenader, Jennifer. 2003. Factive presuppositions, accommodation and information structure. *Journal of Logic, Language and Information* 12(3). 351–368.

Stalnaker, Robert. 1977. Pragmatic presuppositions. In *Proceedings of the texas conference on performatives, presuppositions, and implicatures. arlington, va: Center for applied linguistics*, 135–148. ERIC.

Stowell, Timothy Angus. 1981. *Origins of phrase structure*: Massachusetts Institute of Technology dissertation.

Strawson, Peter F. 1950. On referring. *Mind* 320–344.

Syrett, Kristen, Christopher Kennedy & Jeffrey Lidz. 2009. Meaning and context in children's understanding of gradable adjectives. *Journal of semantics* 1–35.

Theiler, Nadine. 2014. A multitude of answers: embedded questions in typed inquisitive semantics. *ILLC, University of Amsterdam MA thesis* .

Theiler, Nadine, Floris Roelofsen & Maria Aloni. 2016. A uniform semantics for declarative and interrogative complements. *Manuscript, ILLC, University of Amsterdam* .

Tonhauser, Judith, David Beaver, Craige Roberts & Mandy Simons. 2013. Toward a taxonomy of projective content. *Language* 89(1). 66–109.

Uegaki, Wataru. 2015. *Interpreting questions under attitudes*: Massachusetts Institute of Technology dissertation.

Wellman, Henry M, David Cross & Julanne Watson. 2001. Meta-analysis of theory-of-mind development: the truth about false belief. *Child development* 72(3). 655–684.

White, Aaron S, Valentine Hacquard & Jeffrey Lidz. 2017. Semantic information and the syntax of propositional attitude verbs. *Cognitive science* .

White, Aaron Steven. 2015. *Information and incrementality in syntactic bootstrapping*: University of Maryland dissertation.

White, Aaron Steven, Rachel Dudley, Valentine Hacquard & Jeffrey Lidz. 2014. Discovering classes of attitude verbs using subcategorization frame distributions. In Hsin-Lun Huang, Ethan Poole & Amanda Rysling (eds.), *Proceedings of the 42nd annual meeting of the North East Linguistic Society*, .

Wilson, Deirdre. 1975. Presuppositions and non-truth-conditional semantics .

Wimmer, Heinz & Josef Perner. 1983. Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition* 13(1). 103–128.

Yuan, Sylvia & Cynthia Fisher. 2009. "Really? She Blicked the Baby?" Two-Year-Olds Learn Combinatorial Facts About Verbs by Listening. *Psychological Science* 20(5). 619–626.

Rachel Dudley
Institut Jean Nicod
29 rue d'Ulm
Paris, France 75011
rachel.dudley@ens.fr

Meredith Rowe
Longfellow Hall
13 Appian Way
Cambridge MA 02138
meredith_rowe@gse.harvard.edu

Valentine Hacquard
1401 Marie Mount Hall
College Park, MD 20742
hacquard@umd.edu

Jeffrey Lidz
1401 Marie Mount Hall
College Park, MD 20742
jlidz@umd.edu