

ABSTRACT

Title of dissertation: **THE ROLE OF INPUT IN
DISCOVERING PRESUPPOSITION TRIGGERS:
FIGURING OUT WHAT
EVERYBODY ALREADY KNEW**

Rachel Dudley, Doctor of Philosophy, 2017

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This dissertation focuses on when and how children learn about the meanings of the propositional attitude verbs *know* and *think*. *Know* and *think* both express belief. But they differ in their veridicality: *think* is non-veridical and can report a false belief; but *know* can only report true beliefs because it is a veridical verb. Furthermore, the verbs differ in their factivity: uses of *x knows p*, but not uses of *x thinks p*, typically presuppose the truth of *p*, because *know* is factive and *think* is not. How do children figure out these subtle differences between the verbs, given that they are so similar in the grand scheme of word meaning? Assuming that this consists in figuring out which of an existing store of mental state concepts (such as belief) to map to each word, this dissertation highlights the role of children's linguistic experiences, or input, with the verbs in homing in on an adult-like

understanding of them.

To address the **when** question, this dissertation uses behavioral experiments to test children's understanding of factivity and show that some children can figure out the contrast by their third birthday, while other children still have not figured it out by 4.5 years of age. This is earlier than was once thought, but means that there is a lot of individual variation in age of acquisition that must be explained. And it means that children do not just get better at the contrast as they get older, which leaves room for us to ask what role linguistic experiences play, if we can explore how these experiences are related to the variation in when children uncover the contrast.

In order to address the **how** question, the dissertation lays out potential routes to uncovering the contrast via observing direct consequences of it or via syntactic and pragmatic bootstrapping approaches which exploit indirect consequences of the contrast. After laying out these potential routes, the dissertation uses corpus analyses to provide arguments for which routes are most likely, given children's actual experiences with the verbs. In particular, trying to track the direct consequences of the contrast will not get the learner very far. But alternative routes that rely on indirect consequences such as the syntactic distributions of the verbs or their discourse functions, provide clear signal about the underlying contrast.

Finally, the dissertation discusses the consequences of this picture for the semantic representation of *know* and *think*, as well as the linguistic, conceptual, and socio-pragmatic competence that children must bring to the table in order to uncover the contrast.

THE ROLE OF INPUT IN DISCOVERING PRESUPPOSITION
TRIGGERS:
FIGURING OUT WHAT EVERYBODY ALREADY KNEW

by

Rachel Dudley

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Dedication

To my parents Leslie and Varner, who have supported me from the start. Sorry for all the birthdays, holidays and family weddings that I've missed while at school, for all the times you called and got my voicemail, and for all the times that I was tired and grumpy when you finally did get me on the phone. But all these sacrifices, and the others you've made over the years, helped get me to where I am today. I hope you like having another Dr. Dudley in the family!

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I'm fortunate to have found myself in environments that are very nurturing, both intellectually and emotionally, over the years. A lot of who I am and the science that I do is a product of these environments, so I am grateful to everyone who has been a part of them.

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Arriving at NYU for undergrad, it took me a while to find the right environment to fit into. I was taking pre-med courses (so I could go into the family business, of course), but I also really enjoyed learning new languages. Someone suggested that I follow this passion for languages and become a UN translator by majoring in linguistics. Of course, this was a crazy recommendation, because translating is not what linguistics is all about, but also because there's no way that I have the disposition needed to be a UN translator. But, not knowing any of this, I started taking courses in the linguistics department. There,

I had some great teachers and mentors, including Chris Barker, Chris Collins and Gillian Gallagher, who helped me start to understand what linguistics is, and to fall in love with it.

After college I was lucky enough to get to be a Baggett Fellow at Maryland, and that's where everything really got started. As a Baggett, I got to work with some fabulous mentors, Valentine Hacquard and Jeff Lidz, and some really interesting graduate students, like Kaitlyn Harrigan, Shevaun Lewis, Naho Orita, Aaron Steven White, and had some really supportive office mates, Erin Bennett and Cybelle Smith. That year, I really drank the Maryland koolaid, and there was no way that I could go to grad school anywhere else. I loved the really challenging but supportive intellectual environment, and the fact that the department really felt like a family. So I'd really like to thank everyone who has been a part of that family over the years.

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Chapter 1

Introduction

This dissertation focuses on when and how children learn about the meanings of the propositional attitude verbs *know* and *think*. *Know* and *think* both express belief. But they differ in their veridicality: *think* is non-veridical and can report a false belief; but *know* can only report true beliefs because it is a veridical verb. Furthermore, the verbs differ in their factivity: uses of *x knows p*, but not uses of *x thinks p*, typically presuppose the truth of *p*, because *know* is factive and *think* is not. How do children figure out these subtle differences between the verbs, given that they are so similar in the grand scheme of word meaning? Assuming that this consists in figuring out which of an existing store of mental state concepts (such as belief) to map to each word, this dissertation highlights the role of children's linguistic experiences, or input, with the verbs in homing in on an adult-like understanding of them.

To address the **when** question, this dissertation uses behavioral experiments to test children's understanding of factivity and show that some children can figure out the contrast by their third birthday, while other children still have not figured it out by 4.5 years of age. This is earlier than was once thought, but means that there is a lot of individual variation in age of acquisition that must be explained. And it means that children do not just get better at the contrast as they get older, which leaves room for us to ask what role linguistic experiences play, if we can explore how these experiences are related to the

variation in when children uncover the contrast.

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Finally, the dissertation discusses the consequences of this picture for the semantic representation of *know* and *think*, as well as the linguistic, conceptual, and socio-pragmatic competence that children must bring to the table in order to uncover the contrast.

1.1 The subtle contrast between *know* and *think*

When do children figure out that *know* means KNOW and *think* means THINK given the very subtle differences in their meanings? And what kinds of experience do they have which help them uncover these differences between *know* and *think*?

If we consider the entire lexicon, these verbs have very similar meanings. Both *know* and *think* can be used to talk about beliefs because sentences like (1) and (2) both entail (3a).

- (1) John knows that Mary is home.
- (2) John thinks that Mary is home.
- (3) a. John has the belief that Mary is home.
b. Mary is home.

However, *know* differs from *think* is that it is veridical and in that it is factive¹. As a veridical verb, *know* sentences entail the truth of their complements (e.g., (1) entails (3b)) and thus can only report on beliefs that are true. On the other hand, *think* is non-veridical, so a sentence like (2) does not entail (3b) and *think* can report on beliefs that are either true or false.

Furthermore, as a factive verb, uses of *know* sentences not only entail, but tend to presuppose, or take for granted, the truth of their complements, and these presuppositions “project” in entailment-canceling contexts such as in the scope of negation. Thus, a sentence like (4) also presupposes (3b) and should only be used if the speaker can take for granted that Mary is actually home. In contrast, *think* is not factive, and when we hear a sentence like (5) we might even infer that (3b) is false and that Mary is not actually home because the truth of the complement does not project.

(4) John doesn't know that Mary is home

(5) John doesn't think that Mary is home

¹Note that these terms tend to refer to different concepts across disciplines. Within philosophy, the term “factive” is often used to refer to the same phenomena that linguists would call “veridical”.

1.2 When is the contrast mastered?

At what age do children understand that *know* presupposes the truth of its complement while *think* does not? The most direct tests of their understanding ask whether children will infer that the complement of *know* is true, even under an entailment-canceling operator like negation, while they will not make the same inference for *think*. If children do this, it suggests that they understand the projective behavior of *know* and thus understand it to be factive.

For many years, behavioral studies on children's understanding of *know* and *think* tended to conclude that children do not successfully map the contrast between the verbs until late in childhood (Harris 1975, Macnamara et al. 1976, Johnson and Maratsos 1977, Scoville and Gordon 1980, Wimmer and Perner 1983, Abbeduto and Rosenberg 1985, Baron-Cohen et al. 1985, Moore and Davidge 1989, Moore et al. 1989, Falmagne et al. 1994, Wellman et al. 2001, Wellman and Liu 2004, Léger 2008, Fabricius et al. 2010). However, a new body of experimental evidence (which includes the behavioral studies reported in this dissertation) suggests that these early studies underestimated children's abilities. Instead, newer studies suggest that children can comprehend and produce *know* in adult-like ways by the time that they are three years old, but that there can be variability in the age of acquisition because some children still don't understand the factivity of *know* at 4.5 years (Dudley et al. 2015, Hacquard et al. 2016, Harris et al. 2017, as well as behavioral studies reported in Chapter 4).

Newer studies suggest that the contrast is mastered earlier than previously thought. But this is still relatively late in development, at least when we consider the relative fre-

quency of *know* and *think* in the everyday conversations that children are exposed to. Naively, one might assume that the age of acquisition of some word would be related to how often the learner gets experience with that word. But *know* and *think* are prime examples of words that seem challenging for learners because they are acquired so much later than other, less frequent words.

At the earliest, *know* and *think* are mastered around three years of age, and, at the outside, they are mastered around 4-5 years. Now consider the word *apple*. According to normed parent report data, over 90% of children understand this word by 18 months and over 90% produce this word by 23 months (Dale and Fenson 1996). With respect to the frequency of the words, tokens of the lexeme *apple* occurred 37 times while tokens of the lexemes *know* and *think* occurred 1608 and 1300 times respectively, in one representative corpus of parent-child conversations (MacWhinney 2000, Gleason 1980). So words like *know* and *think* are approximately 40 times more frequent than words like *apple*, but they are mastered about 2-3 years later than words like *apple*. Of course, this is not a precise empirical investigation of differences in age of acquisition, but these back-of-the-envelope calculations immediately raise some questions. What makes mastery of words like *know* and *think* so much harder than words like *apple*?

1.3 Why such ‘hard’ words?

In the past, theorists have pinned the difficulty of learning these words on either (i) the late acquisition of their underlying concepts or (ii) the difficulty of observing their referents in the environment. But recent advances in developmental psychology have

upturned both of these perspectives on the source of difficulty.

The first perspective draws on findings from the Theory of Mind literature suggesting that children do not represent false beliefs as measured by so-called “explicit” false belief tasks (see Wimmer and Perner 1983, Wellman et al. 2001, and more details in Chapter 3). Children do not represent false beliefs—on this account—because they lack the relevant mental state concepts (such as beliefs) to do so. Thus the delay in mastery of words like *know* and *think* as compared to words like *apple* has to do with the nature of the concepts that these words token, and the concept APPLE is in place before the concepts KNOW and THINK.

The second perspective instead assumes that the concepts are in place, and that the difficulty actually lies in successfully mapping KNOW to *know* and THINK to *think*. In general, mapping problems involve identifying a form and a meaning and relating the two, for example relating *apple* to APPLE. The idea is that there is a stock of concepts that the learner has access to and that learning a new word involves mapping a linguistic form to one of these concepts. Experiences are always vital to language acquisition, but when framing word learning as mapping, learners do not “acquire” or “build” word meanings through experience. Instead, they use this experience to determine which of an existing stock of concepts is the meaning of a new word, thereby “uncovering” or “discovering” what the underlying concept is. Experience allows the learner to rule out different possibilities and home in on a narrower and narrower set of candidates for mapping. But why would mapping KNOW to *know* be harder than mapping APPLE to *apple*? There are at least a couple different possibilities on the market.

Traditionally, mapping problems like these were considered difficult because it was

thought to be “hard” to observe the physical correlates of mental states (Gleitman 1990). So children would struggle to realize when mental state concepts were tokened within a conversation, and, as a consequence, they would not entertain these concepts as candidates for word meaning.

Another, newer idea would be that children do not entertain these concepts as candidates for mapping to word meaning, but not because they cannot observe mental states. Instead, they would fail to realize that these concepts are good candidates for mapping because they are not salient within everyday conversations (see Westra 2017, Westra and Carruthers 2017). But this leaves open the question of why such concepts would not be salient, so it is not very explanatory beyond being a more precise characterization of the phenomenon. As developed more fully later in this dissertation, one possibility would be that beliefs and knowledge—and attributions of them in order to explain the behavior of others—are not salient because they are so ubiquitous within the context of everyday interactions. Thus, aspects of children’s experience will need to highlight the salience of these concepts in order to help solve the mapping problem for words like *know* and *think*.

Recent experimental advances have upturned the conceptual and observability perspectives, suggesting that the saliency perspective is the best of the three. While children traditionally fail explicit or elicited-response measures of Theory of Mind (see Wellman et al. 2001 for a meta-analysis), the new literature on children’s spontaneous belief tracking in implicit Theory of Mind tasks (see Scott and Baillargeon 2017 for a recent review) suggests that even infants have some level of sensitivity to the mental states of others (such as beliefs) and their contents—as early as the first or second year of life. Perhaps these representational capacities continue to develop across childhood, but the foundation

for belief concepts seems to be in place from very early in development, suggesting that conceptual explanations of children's difficulty attributing mental states are not entirely explanatory. It is not entirely uncontroversial within the developmental psychology literature to claim that the concepts are in place early on (see, for example, Hutto et al. 2011, Rakoczy 2012, Carruthers 2013). But let's grant that the concepts are in place by the first or second year of life (see Chapter 3 for more discussion). Even if the concepts are accessible to the child, there is still a non-trivial mapping problem: namely, realizing that the word refers to this particular concept, because of the salience (or lack thereof) of the concept within a conversation. Perhaps this is what leads to the acquisition delay?

If infants are capable of spontaneous belief tracking in experimental paradigms, then it stands to reason that they are able to do so in at least some natural contexts. And if they can do that, then these concepts cannot be completely "closed to observation" (Gleitman, 1990), but are rather part of the vocabulary of concepts that infants have and part of the store of concepts that they can recognize as tokened in the world around them. So what does make these words so hard, if not their late-acquired concepts or observability? Well, our third possibility is still open, and it is consistent with adult performance in human simulation paradigm tasks. These tasks place adult participants in the shoes of the learner and ask them to infer the meanings of novel words (Gillette et al. 1996), and it turns out that adults fail to guess attitude verb meanings even when it would be correct to do so. We don't want to infer too much from adults' performance in these tasks, because they tend to adopt the strategy of guessing very general words (e.g., *thing* for novel nouns), but it is suggestive that attitude meanings are not considered very salient possibilities for novel verbs. And conditions that raise the salience of attitude verb meanings

lead to an increase in adults correctly guessing them (Gillette et al. 1996, Papafragou et al. 2007). So we can assume that mapping difficulties originate in the relative salience of concepts within conversation, and ask which conditions make them more or less salient.

1.3.1 A new explanation of the source of difficulty

Consider the ways that we talk to each other on a daily basis. We often ask each other questions like *Do you have the time?* and *Can you pass the salt?* But we don't intend these questions literally; few people, if any, could literally possess the time, or lack the ability to pass a salt shaker. Instead, we use these questions to perform more indirect speech acts like request that the addressee tell us the time, or pass us the salt. But in order to understand these indirect speech acts, we have to be able to reason about the underlying beliefs, knowledge, abilities, desires and intentions at play. For example, a speaker probably asks whether an addressee has the time because they want to know what it is and they think that the addressee knows it, and that the addressee will be able to reconstruct these goals. So, when a child is asked *Can you pick up your toys?*, they might understand this as a directive to tidy up, but in order to do so they would have to attribute a certain set of beliefs and intentions to the speaker.

Now consider the kinds of discourse functions that we regularly use *know* and *think* sentences for. Saying something like *I think that it's cold in here* roughly equates to asserting *It's cold in here* (and can even function as a request to turn down the air conditioner), while asking something like *Do you know where the bathrooms are?* roughly equates to asking *Where are the bathrooms*, at least for all practical purposes. Given that

the bare complements achieve about the same discourse function as the sentences with the attitude verbs, how is a child supposed to realize that attitude verb meanings are at play in one case but not the other? Recall that they are already attributing beliefs, knowledge and intentions right and left in order to understand the other things that their parents say to them, so at first blush, nothing would seem that different about these cases.

1.4 How do children solve the mapping problem?

How are mapping problems solved in general? Meanings cannot be learned by direct observation of them, because they are not the kinds of things we can see in the world around us. Instead, we can observe some consequences of the meanings and try to infer back to what the meanings might be. In this way, all evidence about the meanings of words are indirect, but we can talk about “direct” cues as those from consequences that are more closely related to the underlying meanings. As an example, consider how we might learn the meaning of *apple* via these “direct” cues: we see that it is often used to talk about apples and infer that it must mean APPLE.

At first blush, mapping problems seem trivial, especially in the case of words like *kick* or *apple*, because we can see kickings and apples in the world around us and we can map a speaker’s use of *kick* or *apple* to them. Upon reflection, the problem seems a lot less trivial because this mapping between world and word is often more tenuous. Language exhibits displacement in time and space so we need not talk about things that are present in the speech situation; we can talk about yesterday’s kick or offer to retrieve an apple from another room for someone. And the environment around us might be very complex,

such that it could be difficult to identify the relevant referent in the world; which thing in a full fridge is an *apple* and why isn't *kick* a name for shoes? Not to mention metaphorical or idiomatic uses of language (e.g., *apple of my eye*) or how objects in the environment can appear different across contexts (e.g., apple pie). We will set aside issues that have been well-discussed in the literature, such as Quinean underdetermination and Goodman's problem of induction (Goodman 1955, Quine 1960, Kripke 1982). But even if we do not concern ourselves with these problems, the task is still not trivial. Even assuming that all the relevant concepts and cognitive structures are in place, evidence is still needed to figure out which concept is tokened in a particular instance.

Recognizing the problems for this theory in these simple concrete cases, there are other words which seem to be more recalcitrant to mapping because they are acquired much later in development. Examples of such "hard" words include *know*, *think*, *hope*, *too*, *the* and *liberty*. Some of these 'hard' words are used very frequently in conversation, including *think*, *know*, *too* and *the*. But, the underlying meanings of these words will not be very salient in the context of their use, the way that more 'concrete' meanings might be. For example, consider a scenario when a father is preparing a snack for his child. He might say something like: *Let's find you a snack. I think there's an apple in the fridge. I know the cheese is in there. And the juice is too.* In this context, many concepts will be available to the child, but some will be salient (e.g. snack, cheese, apple, juice, fridge, dad, hunger, etc) and others will be less salient (e.g. belief, knowledge, truth, uniqueness, additivity). What would make the child consider these less salient options for the meaning of a new word? Even adults do not immediately entertain these less salient mental state meanings for novel words, unless they are given some reason to treat them as relevant

(Gillette et al. 1999, Papafragou et al. 2007). Why? Mental states underlie all uses of all words, which makes them poor candidates for the meaning of any particular word. Consider our lunch-preparation scenario. The father believes that there is an apple in the fridge and knows that this information would be relevant to his child, the listener. He could say *I think that there's an apple in the fridge*, but he could just as easily say *There's an apple in the fridge*. Beliefs and knowledge underlie what we say and why we say it, thus belief attributions can serve to help explain behavior. In fact, beliefs and knowledge might be some of the most commonplace concepts that are tokened in everyday life. As a result, the learner might assume that beliefs function as the vehicle to get messages across, and should be factored out of guesses about the content of the message. If so, the learner would need some kind of cues that beliefs and knowledge would be relevant candidates for word meaning, in order to know to factor them back in.

If part of the problem in mapping these 'hard' meanings consists in realizing that they are relevant, what evidence can tell the child that they are relevant? In the general case, several options are available (situational cues, socio-pragmatic cues, lexical cues and syntactic cues) and they each provide different kinds of information:

- Situational cues from what is salient in the context: mealtime contexts raise the salience of food, false belief contexts raise the salience of beliefs (Ninio 1983, Yont et al. 2003, Papafragou et al. 2007)
- Socio-pragmatic cues from inferring a speaker's intentions, among other things: when she says *the apple* she intends to refer to that apple. Knowing that a speaker is referring to an apple when uttering a sentence that contains *apple* makes it salient

that *apple* means APPLE (Grice 1975, Baldwin et al. 1996, Bloom 2002b).

- Lexical cues from knowledge about the surrounding “easy” words: *eat* describes a relation between agents (e.g., *I, you, John, Mary, the dog*) and edible things (e.g., *apples, cheese, cookies, pizza*). *John ate the apple* makes salient the possibility that *eat* expresses a relationship between agents and edible things (Pinker 1994, Grimshaw 1994).
- Syntactic cues from the distribution of words: uses of *kick* in transitive frames make salient events with two participants, uses of *swim* in intransitive frames make salient events with one participant, uses of *think* with embedded complements make salient relations between individuals and propositions (Fillmore 1970, Zwicky 1971 Jackendoff 1972, Grimshaw 1979, Pinker 1989, Levin 1993).

To sum up, a learner cannot directly observe what concepts are tokened by an utterance. As a result, all mapping problems are inference problems and require a wide variety of evidence to try and figure out what that underlying concept may be. Relevant sources of information include: perceptual abilities to parse the environment, a conceptual repertoire, socio-pragmatic abilities to interpret the actions and intentions of others, and the ability to parse and interpret the linguistic signal. I will argue that the cues that prove most relevant to learning about *know* and *think* are socio-pragmatic cues and syntactic cues.

1.5 Possible routes to factivity and veridicality

Children begin to figure out the contrast between *know* and *think* around 3 years. What kind of evidence helps them to figure it out? What are the possible routes to uncovering this contrast? If you thought learning the meaning of a word like *think* was hard, then determining the difference between *know* and *think* should be just as hard. The contrast between *know* and *think* hinges on whether the contents of the beliefs that they are used to discuss are true or common knowledge. If beliefs are not a salient aspect of interactions where *know* and *think* are uttered, then the truth of those beliefs or whether those beliefs are shared will not be salient either.

Aside from the usual mapping challenges in word learning (Clark 1993), 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. How might children solve the mapping problem for triggers?

One strategy would be to track the background assumptions that a speaker makes when using a presupposition trigger:

- (6) 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.

This is essentially an extension of the associationist view of how the mapping problem is solved for non-presupposed content (Locke 1948, Smith 1995, Yu and Smith 2011). It seems simple and straightforward enough, but there are problems that emerge upon reflec-

tion. To illustrate, let us recall our basic, non-presuppositional example: children can map the meaning APPLE to the form *apple* because it is uttered in the presence of apples. Even for *apple*, this is not a trivial task; 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 is all the more difficult because the relevant content is backgrounded, and speakers make all kinds of background assumptions which are not conventionally associated with the words they use. Are children sensitive to backgrounded content in solving mapping problems within language acquisition? And how should they figure out which of the speaker's background assumptions are systematically associated with triggering expressions and which are not?

Turning to the specific contrast between *know* and *think*, direct cues would need to be informative about the different patterns of entailment with the two verbs (veridicality) and/or whether those entailments are backgrounded (presupposition). In order to observe these differences, the child would need to keep track of the propositions expressed by the complements of the two verbs, then compare them against what is known within the discourse context, so we can call direct cues to veridicality and factivity “discourse status” cues.

1.5.1 Discourse status of complement cues to veridicality

Veridical verbs are those that entail the truth of their complements, so cues about the veridicality contrast would involve tracking the truth of propositions expressed by the

verbs' complements:

- (7) **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.

Given these kinds of cues, what would children's experiences have to look like in order to map the appropriate contrast? How would they realize that *think* isn't veridical? In practice it may be hard to understand when something is false in a given context, so the clearest evidence could come from cases where the belief that is reported on is contrasted with the perspective within the conversational context. For example, (8) contrasts the belief of someone outside the conversation with the beliefs of the conversational participants. And (9) contrasts the past beliefs of the speaker with their current beliefs.

- (8) She thinks that Bill is coming to the party, but we know that he isn't.
- (9) I thought that Bill was coming to the party, but now I realize that he isn't.

These contrasts could highlight the relative truth of the different beliefs and help children realize that *think* is non-veridical, especially if we never see *know* in similar contexts (10-11).

- (10) She knows that Bill is coming to the party, # but we know that he isn't.
- (11) I knew that Bill was coming to the party, # but now I realize that he isn't.

1.5.2 Discourse status of complement cues to factivity

Factive verbs are those that presuppose the truth of their complements, so cues about the factivity contrast would involve tracking the truth of propositions expressed by the verbs' complements and what is already established in the common ground:

- (12) **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 uttered. Conclude that *p* is a presupposition triggered by *x knows p* but not *x thinks p*.

1.5.3 Conceptual challenge for routes using discourse status cues

Now that we have laid out these two types of discourse cues, we can consider their utility, given what we know about the words involved and the kinds of representational capacities that children have in place by 3 years. In principle, children could keep track of these cues. They are able to attribute beliefs to others around them. They are able to recognize what is true, or matches their expectations in a given context, as is needed for the veridicality cues. They are able to recognize what is part of a shared body of knowledge, as is needed for the factivity cues. For more details, see the discussion in Chapter 3.

But it is not clear that children would do this, in practice. Three issues might make this challenging: that (i) the relevant evidence is backgrounded; (ii) *think* is an 'assertive' verb and its use can often foreground the proposition expressed in the complement as the "main point" (Urmson 1952, Hooper 1975, Simons 2007), which could obscure its

non-veridicality; and (iii) *know* is a “soft” presupposition trigger (Abusch 2010) because it does not reliably exhibit the behavior of presupposition triggers, which could obscure its factivity.

First, the kind of information that children would have to track to figure out the factivity contrast (i.e. what a speaker presupposes) is often backgrounded by its very nature, instead of being a salient aspect of their everyday interactions involving the words, and children might only pay attention to it in solving a particular mapping problem if they have reason to think that it is relevant to that problem. 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. Moreover, speakers make all kinds of presuppositions when they speak, and many of these presuppositions are not conventionally associated with any particular expression (Stalnaker 1974); for example, writing this dissertation in English presupposes that the audience can read English - no word or expression would have triggered that presupposition. 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 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?

Second, *think* is an ‘assertive’ predicate (See Chapter 2 for more details). As a result, the speaker will be committed to the truth of the proposition, and the listener might conclude that it is true. If this kind of assertive use of *think* occurs in speech to children with any frequency, then children might be willing to incorrectly conclude that *think* is a veridical verb, or one that entails the truth of its complement. This could effectively neutralize the veridicality contrast between the verbs. As a consequence, the second challenge involved in mapping the contrast between *think* and *know* would be the noise obscuring any signal about their (non-)veridicality.

Since both verbs might be regularly used to discuss beliefs which the speaker endorses, a veridicality contrast might be difficult to uncover. Perhaps the way to figure out the difference rides on the factivity contrast - realizing that the speaker takes the truth of the complement for granted with *know* but not *think*. But, a third challenge would come from the fact that *know* is a so-called ‘soft’ presupposition trigger. Speakers can use *know* to inform their interlocutors that the proposition expressed in the complement is true when that information is not already part of the common ground (see Chapter 2 for more details). When this happens, the factivity contrast between *know* and *think* can be neutralized. As competent adult speakers, we don’t have trouble accommodating the presupposition in such cases because we understand that *know* is a factive presupposition trigger and we are able to accommodate the speaker’s presupposition. But if you are a child who isn’t already aware of *know*’s factivity, then how would you break in? This presents a chicken-and-egg problem: the *know* utterances that would tell the learner that *know* is a presupposition trigger tend to be cases that will not look presuppositional unless

the learner already knew *know* to be a presupposition trigger (which is not true for all presupposition triggers for that matter). As a result, the learner who tracks whether *know*'s complements express information that is already part of the common ground, might conclude that *know* does not occur in a subset of the cases where *think* occurs. Instead, they would have to conclude that the verbs differ in their factivity based on relative—or probabilistic differences—in the distribution of *know* and *think*, instead of categorical differences. In fact, these informative uses of *know* could be helpful, but not for this factivity route to the contrast. Instead, they may help children figure out that the complement is entailed—that the verb is veridical—but not that it is factive. Thus the third challenge involved is the potential noise that could obscure any signal about the factivity contrast².

1.5.4 Some alternatives from indirect consequences of the contrast

Discourse status cues provide one route to the (non-) veridicality or (non-)factivity of *know* and *think*, but there are potential empirical and conceptual challenges to this type of route. Might there be different, perhaps less direct, cues to the differences between the verbs that are more readily available in children's experience? In this section, we discuss how these differences may provide an indirect route to the (non-)factivity of *know* and *think*.

There are other kinds of consequences of underlying meanings that aren't so direct. These alternative cues are more indirect and come from distributional information. For

²Although figuring out that a predicate is factive may be enough to conclude that it is factive, at least if the veridicality entailment is backgrounded, as in pragmatic accounts of presupposition trigger. See Chapter 2 for more details.

example, we might infer that *eat* describes a relation between two individuals (the eater and the eaten) because it takes two arguments.

Compared to more direct cues from the discourse status of the complement, these cues can provide a tradeoff in utility. Distributional cues are used in solving mapping problems more generally, so there is no need to specify why the cues would be relevant to the contrast between *know* and *think* in particular, and we know that children do notice and use these kinds of cues for other words. But these indirect cues require principled links between meaning and syntactic distribution, and as discussed in Chapter 2, the field has not yet come to a consensus on what these principled links would look like for the case of *know* and *think*.

Setting aside the issues of whether these links are principled, there are two candidates for indirect routes to the contrast between *know* and *think*: cues from the syntactic distributions and discourse functions of the two verbs. The syntactic distribution of *know* differs from the syntactic distribution of *think*. For example, both verbs take that-clauses but only *know* takes embedded interrogatives (Egre, 2008; Ginzburg, 1995; Hinktikka, 1975; Karttunen 1977). Furthermore, there are differences in the kinds of discourse moves that speakers use these verbs to make, which might be reflected in the input; *think* can be used to hedge assertions, but *know* is used to make indirect requests for information or ask indirect questions (Clark, 1979; Searle, 1975; Urmson, 1952).

1.5.4.1 Cues from syntactic distributions of verbs

Given the recent findings which support syntactic bootstrapping to solve mapping problems for other meaning contrasts between attitude verbs (Asplin 2002, Hacquard 2014, Hacquard and Lidz under review, Harrigan et al. 2016, Lidz et al. 2016, White et al. 2016), it seems possible that children could use syntactic distributions from their input to figure out the difference between *know* and *think*, provided that there are principled links between syntactic distribution and differences in factivity that they would be privy to.

As discussed in Chapter 2, some authors argue that there is a correlation between a predicate's factivity and its ability to take both declarative (13) and interrogative (14) 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.

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

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

Egré (2008), 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. However, as discussed in Chapter 2, there are many counterexamples to the generalization that any verb which embeds both declaratives and interrogatives is a factive (e.g., *tell*, *decide*,

demonstrate, etc). Thus, the link between question embedding and factivity may not be entirely principled, or perhaps the picture is more complicated but syntactic distributions are still informative (see White and Rawlins 2016, as well as discussion in 2).

1.5.4.2 Cues from discourse functions of verbs

Attitude verbs lend themselves to different kinds of indirect speech acts; (15a) can function as an indirect (weak) assertion about the time, instead of a statement about the speaker's beliefs, while (15b) can function as an indirect command instead of a description of the speaker's desires. And these indirect speech acts are informative about the meanings of the verbs. *Think* expresses a judgment of truth and assertions are the expression of such judgments. Desire verbs like *want* express preferences, and commands are the expressions of such preferences.

- (15) a. I think it's time to eat.
b. I want you to eat.

Just as the syntactic distributions of the verbs might be informative, the different types of discourse moves that the verbs are used to achieve could provide clues as to their underlying meanings. The meaning of an expression constrains the ways that it can be used (Grice 1957), so understanding how a speaker uses some word could help one to understand what it means. *Know* and *think* are routinely used to perform different kinds of indirect speech acts (as introduced in Chapter 2). *Know* can easily be used to request information (16) while *think* can easily be used to make indirect assertions (17).

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

b. A: Sorry, I don't know

c. A': In the kitchen

(17) I think it's raining.

While the literal act performed by the speaker of (16a) 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 (17) is a mere assertion about a belief state, but it can easily be used to proffer that it is raining (indirect assertion). An explanation—along the lines of Searle (1975)—of the naturalness of these indirect speech acts with *know* and *think* would be tied to the different conditions on successful performance of the primary illocutionary acts (i.e., asking for the location of the keys or claiming that it's raining). For (16), the speaker cannot accomplish this request without the expectation that the addressee knows where the keys are, and for (17), the speaker should not assert that it is raining without believing it.

Such pragmatic enrichments could hinder the learner in uncovering the underlying contrast. However, if systematic enough, these indirect speech acts could also help 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 understand the illocutionary force of the indirect speech acts in (16a) and (17), which we have reason to believe given the discussion in Chapter 3.

Here is how such pragmatic bootstrapping could go in the case of *know* and *think*. Imagine that the child hears an utterance like *I VERB₁ 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 the question expressed by the complement (e.g., What time is it?).

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 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 and Stokhof 1984, Spector and Egge 2015, Uegaki 2015); and (iii) uniform accounts where the two complement types are posited to have the same denotation (Ciardelli et al. 2013, 2015, Theiler 2014, Theiler et al. 2016). If the two complements are underlyingly related, as in the reductive or ambiguity accounts, knowledge about instances of *know Q* would be informative about instances of *know p* and vice versa.

1.5.5 Utility of indirect cues

Now that we have seen what these “indirect” cues entail, how useful are they in comparison to the more “direct” discourse status cues? For indirect cues there are perhaps two big challenges. The first would be the requirements that they place upon the child and the kind of child-internal linking principles between syntax and semantics or between pragmatics and semantics that must be brought to bear if children can use these cues to infer anything about the meaning of *know* and *think* from their distributions. The second would be that for pragmatic bootstrapping to work, the child would need to be sensitive to the intended illocutionary force of their interlocutors’ utterances. But this could potentially backfire. Indeed, *know* and *think* can sometimes be used for other kinds of indirect speech acts, such as indirect commands (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 given that they can be used for indirect commands (in the same way they might infer *want* expresses a preference via its routine usage in indirect requests such as *I want you to go to bed!*, see Hacquard and Lidz (under review) and discussion in Chapter 2)?

Following proposals by Hacquard (2014) and Hacquard and Lidz (under review), I would like to suggest that pragmatic and syntactic bootstrapping might work in tandem, and mutually constrain the kinds of hypotheses that learners will entertain for the meanings of *know* and *think*. Generally, we know that the meaning of an expression is related to both (i) what kinds of sentences that expression occurs in and (ii) what speakers use that expression to achieve. Either of these links can be error-prone, but when interpreted

in conjunction, any particular counterexample may be distinguishable from truly informative data. 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. According to the pragmatic-syntactic bootstrapping hypothesis for attitude verb meanings (Hacquard 2014, Hacquard and Lidz under review), the learner makes use of both syntactic and pragmatic cues to home 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.

How would this pragmatic-syntactic approach work for *know* and *think*? *Know* often occurs in utterances like *Do you know Q* which function as indirect questions and that have embedded questions as complements. These pragmatic and syntactic cues would converge to suggest that *know* is the kind of verb which relates the attitude holder to the

true answer to *Q*. In contrast, *think* often occurs in utterances like *I think p* which function as indirect assertions and have complements that express propositions. These cues could converge to tell the learner that *think* is the kind of verb which expresses the commitment of the attitude holder to the embedded proposition. But, 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.

1.6 This dissertation

To sum up, this dissertation pursues the idea that indirect speech act uses of attitude verbs both hinder and help the learner, depending on the grain size at which they approach the mapping problem. In order to do this, I first develop hypotheses about which types of information would in principle be informative about the factivity/veridicality distinction. With respect to the relevant contrasts between *know* and *think*, there are at least three possible sources of information:

- Direct cues from the status of the complements in a discourse (Do they express information which is true or false? Do they express information which is part of the common ground or not? Does this differ between the verbs?)
- Indirect cues from the syntactic distributions (What kinds of complements do the verbs embed? Do they differ?)
- Indirect cues from the pragmatic distributions (What kinds of conversational goals do speakers have in using the verbs? Do they differ?)

In Chapter 2, I describe the target knowledge of *know* and *think* that children must acquire and describe the semantic, syntactic and pragmatic properties of the two verbs and related words. I discuss different theories of how presuppositions are related to triggers and whether there are syntactic and pragmatic correlates of the factivity and veridicality distinctions.

In Chapter 3, I review evidence which suggests that, in principle, children have in place by three years the requisite conceptual knowledge, abilities and mechanisms that they would need in order to observe the direct consequences of the contrasts, or indirect consequences of them.

In Chapter 4, I ask when children finally figure out the factivity distinction, so that we know which ages we need to explore the input for. I find that children start to master this distinction as early as 3, but there is a lot of individual variation in when this occurs, so we will have plenty of room to look at which input differences, if any, are related.

In Chapter 5, I investigate which types of evidence are potential cues in children's actual experience, through the first corpus study which examines these aspects of children's experience with *know* and *think*. This corpus study finds that although the verbs occur relatively frequently, discourse status cues are relatively infrequent. Additionally, the discourse status differences between the complements of *know* and *think* are essentially neutralized. This neutralization comes from the fact that *know* is often used to introduce information that is not already part of the common ground and that *think* is often used "assertively". As a result, discourse status cues are sparse in the input, and could even lead children to map KNOW to *think*. In contrast, indirect cues from syntactic distributions and discourse functions are found to be prevalent and clearly distinguish the

verbs. *Know* embeds both interrogative and declarative complements, while *think* embeds only declaratives. And *know* is used to ask and answer questions while *think* is used to proffer information. Evidence from multiple corpora are considered and, on average, even children with different input receive the same kinds of evidence underlyingly, on average.

In Chapter 6, I develop methods for examining the relationship between input cues and children's ultimate understanding of the verbs. Getting away from average input, what is the nature of the relationship between input and children's understanding of the contrast? Is individual variation in children's input related to individual variation in children's understanding of *know*'s factivity?

In Chapter 7, I summarize the findings of the empirical studies reported in the dissertation, and what implications they have for the acquisition of *know* and *think*.

Chapter 2

Semantics, syntax and pragmatics background

2.1 Semantics of *know* and *think*

When we ask when and how children begin to uncover the subtle contrast between *know* and *think*, what is it that they are uncovering? In the grand scheme of word meanings, *know* and *think* are quite similar; both can be used to describe a subject's beliefs (18-19). But they differ in two subtle dimensions: their veridicality and their factivity. *Know* is a veridical verb and *think* is not: only *x thinks p* sentences such as (18) can be used to describe false beliefs, while *x knows p* sentences like (19) 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 (18) and (19) can be taken to assert (20a), only the speaker of (19) must assume that (20b) is also true. Thus, in acquiring a word like *know* and its non-veridical and non-factive counterpart *think*, children face a complex task; they must determine that *know* both entails and backgrounds the truth of its complement, while *think* does not.

(18) John thinks that Mary is home.

(19) John knows that Mary is home.

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

b. Mary is home.

2.1.1 Presuppositions

Speaker presuppositions arise when a “speaker takes something for granted in performing an illocutionary act” (Karttunen and Peters 1979). Certain expressions known as presupposition **triggers** are conventionally associated with presupposed content: their use seems to consistently trigger a particular presupposition. Presupposition triggers include clefts (Delin and Oberlander 1995, Prince 1986), aspectual verbs (Simons 2001, Abusch 2002), factives (Kiparsky and Kiparsky, 1970), definite descriptions (Strawson, 1950), and names (Van der Sandt, 1992).

At first blush, presupposition triggers tend to exhibit the same set of related core properties (Stalnaker 1973, Chierchia and McConnell-Ginet 2000, Simons 2001, Abusch 2002, Abusch 2010, Abbott 2006, Roberts 2012, Tonhauser et al. 2013). First, presuppositions typically project out of contexts where other entailments are canceled: the presupposition in (21) survives in (22). Second, triggers are typically infelicitous out of the blue (e.g., (21) uttered discourse-initially), because of their unsupported presuppositions. Finally, because presuppositions are backgrounded, their content cannot serve as a felicitous answer to a question (e.g., (21) is an infelicitous answer to questions about John’s dinner but a felicitous answer to a question about John’s breakfast).

(21) John had wine for breakfast **too**.

(22) a. It’s not true that John had wine for breakfast **too**.

b. Did John have wine for breakfast **too**?

c. John might have had wine for breakfast **too**.

d. If John had wine for breakfast **too**, the lunch meeting will go terribly.

But, not all presupposition triggers share the same pattern of behavior (Chierchia and McConnell-Ginet 2000, Simons 2001, Abbott 2006, Klinedinst 2010, Charlow 2009, Chemla 2009, Fox 2012). The presuppositions of “soft triggers” (Abusch 2010) seem to be more easily defeasible than that of other triggers (Abusch’s “hard triggers”). Examples of soft and hard triggers are given in (23-24).

(23) Soft triggers: cognitive factives, change-of-state and achievement predicates

(24) Hard triggers: *too, even, it-clefts*, emotive factives(?)

Unlike hard triggers (those with the properties discussed above), the presupposed content of soft triggers can provide interlocutors with information that was not already common knowledge, and thus be uttered discourse initially (25), address the Question Under Discussion (QUD) (26), and fail to project out of entailment-canceling operators (27) (Karttunen 1971b, Stalnaker 1974, Gazdar 1979, van der Sandt 1992, Chierchia and McConnell-Ginet 2000, Simons 2001, Beaver 2004, Abbott 2006 and Romoli 2011, among many others).

(25) John hasn’t stopping drinking wine for breakfast.

(26) a. Has John had a drinking problem?

b. He stopped drinking wine for breakfast last week!

(27) John hasn’t stopped drinking wine for breakfast because he never, in fact, had a habit of doing so.

2.1.1.1 Cognitive vs. emotive factives

Factives can be roughly divided into two classes: ones that express cognitive states and ones that express emotive states. Cognitive factives (e.g., *realize*, *discover*, *forget*) take true complements, and the truth of the complement is furthermore typically presupposed (Kiparsky and Kiparsky 1970, Karttunen 1971, Hooper and Thompson 1973, Hooper 1975). Cognitive factives are a prime example of soft triggers, given that their presuppositions are easily defeasible (see 28 from Karttunen 1971).

(28) 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. As we see in the following set of sentences, both (29) and (30) presuppose (31a) and (31b).

(29) John hates that it is raining.

(30) If John hates that it's raining.

(31) a. It's raining

b. John thinks that it's 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, based on the fact that their presuppositions seem to survive in Karttunen's (1971) contexts (32), in contrast to cognitive factives (28).

(32) If I am **happy** later that I did not tell the truth, I won't confess it to everyone.

Simons (2007) and Abrusán (2011), however, assume that all factives are soft triggers. Support for this comes from the fact that they seem acceptable in ignorance contexts, like cognitive factives (compare 33a with 33b modified from Simons 2001).

(33) Upon noticing a couple arguing at the next table:

- a. Perhaps she's not **happy** that he's having an affair.
- b. Perhaps she's **discovered** that he's having an affair.

The status of *know* is also controversial. Its presupposition seems less easily cancellable than other cognitive factives (compare 34 to 28 and 32).

(34) 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 (35), 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 the majority of uses of *x knows p* in speech between adults are, in fact, "informative" in that they provide hearers with new information (Spencer 2003). Second, Simons (2007) shows that the complement of *know* can provide content which addresses the QUD (36). Lastly, *p* does not always project out of family-of-sentences contexts with *x knows p*, as in examples provided by Beaver (2010), including (37).

- (35) a. Did you **know** that John won the lottery? (uttered discourse initially)
- b. No, I didn't. That's amazing!

(36) a. Where was Louise yesterday?

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

(37) ...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, ex. 32)

The cluster of properties in (35-37) might make *know* seem no different from a non-factive verb like *think*—at least with respect to its status as a presupposition trigger. To compare with *know*, *think* has “assertive” or “evidential” uses (Urmson 1952, Hooper 1975, Simons 2007, see Section 2.3 for more details). As a result, it can be used to provide new information (38), to address the QUD (39), and the complement of *think* can even appear to project, even when the complement of *know* does not (see 40 modified slightly from Simons et al. 2017).

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

(39) a. Where's Mary?

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

(40) 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! (while Phil is incorrectly searching on the street)

A': He doesn't **think** that the car's parked in the garage! (while Phil is stubbornly searching on the street)

2.1.1.2 “Informative” presuppositions

Practically speaking, there are many ‘informative’ uses of soft presupposition triggers (41), where the relevant presupposed content is not something that all interlocutors

can take for granted (Karttunen 1974, Stalnaker 1998, 2008, Abbott 2000, 2008, Simons 2001, Spenader 2002, Spenader 2003, Gauker 1998, von Stechow 2008).

- (41) a. We **regret** that children cannot accompany their parents to commencement exercises. (Karttunen 1974)
- b. I can't come to the meeting because I have to pick up **my cat** at the veterinarian. (Stalnaker 1998)

These informative cases provide interlocutors with new information: (41a) can be used to inform attendees of the commencement exercises that children are not welcome, and (41b) can be used to inform an interlocutor that the speaker has a pet cat. But these should be considered presupposition triggers, because projection still obtains (42)¹.

- (42) a. It's not true that we **regret** that children cannot accompany their parents to commencement exercises.
- b. If I can't come to the meeting because I have to pick up **my cat** at the veterinarian, then they might fire me.

So these data present a puzzle. Under the classic view, felicitous use of a sentence like (41b) or (42b) would require that the information that the speaker has a cat be part of the common ground—so that all interlocutors can take it for granted—otherwise some kind of infelicity should obtain. But the sentences in (41a-42b) can all be uttered felicitously even when their presuppositions are not supported in the common ground. What should we do in the face of this puzzle? Abandon our definition of presupposition triggers

¹Although see Tonhauser et al. 2013 for discussion of non-presuppositional phenomena which also project.

(Gauker 1998, 2008), or sweep these cases under the carpet as not truly presuppositional, at least in the sense that hard triggers are presuppositional (Wilson 1975, Boer and Lycan 1976, Simons 2003, Abbott 2006, Simons et al. 2010, Tonhauser et al. 2012)? What we make of these ‘informative’ cases will depend on how we tackle the **triggering problem**, or how we think that presuppositions come to be associated with triggers in the first place.

2.1.2 The triggering problem

The literature on presupposition triggering asks how different expressions get to be associated with their presuppositions, and the differences between soft and hard triggers motivate different kinds of accounts. Under semantic accounts (Heim 1983, among others), presupposed content is conventionally associated with its trigger. In contrast, pragmatic accounts (Stalnaker 1974, among others) argue that presuppositions are conversationally derived from general conversational principles.

2.1.2.1 Semantic theories

Semantic accounts, following Strawson (1950) and Frege (1948), define presuppositions according to patterns of entailment. For example, A is taken to presuppose B just in case B is true whether A is true or false. If both A and $\neg A$ entail B, then A presupposes B. Under this kind of account, a presupposition can be seen as a precondition for successful assertions. 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, 1992) and Van der Sandt (1992) treat presuppositions

as constraints imposed on the conversational context that are arbitrarily specified in the lexicon.

According to Lewis (1979), following on suggestions by Karttunen (1974) and Stalnaker (1974), there is a way to handle “informative” presuppositions, maintain semantic theories such as the classic view and keeping triggers like *regret* and *my X* within the family of presuppositional phenomena under semantic theories, but explaining away these inconvenient cases: **presupposition accommodation** (43):

- (43) If at time t something is said that requires presupposition P to be acceptable, and if P is not presupposed just before t , then - *ceteris paribus* and within certain limits - presupposition P comes in existence at t . (Lewis 1979, p340)

But accommodation is a powerful tool, and many authors have struggled with whether or how to constrain it (Thomason 1990, Stalnaker 1998, von Stechow 2008, Roberts 2015). One option discussed by Roberts (1996) constrains accommodation via **presupposition recognition**; in order to accommodate a presupposition, one has to (i) recognize that there was a presupposition, and then (ii) recognize what the content of that presupposition was (as intended by the speaker). And it might also be true that one has to (iii) decide that this is the kind of content that one should be willing to accommodate, in this context (e.g., because the speaker is an authority, or because the information is not controversial). As a result, **presupposition failure** should occur when presupposition recognition fails. For competent adult speakers of the language, this first step should be trivial when a presupposition trigger is used, so everyday cases of presupposition failure should hang on (ii) and (iii).

So the ease of accommodation and therefore the felicity of unsupported presuppositions should be correlated with the ease of (ii) and (iii). Holding (iii) constant, let's consider the effect of (ii). Accommodation is easier when the specific content of the presupposition is easier to retrieve. We would predict that sentences with soft triggers like *know* wear their presuppositional content on their sleeve (44), while sentences with hard triggers like *too* would not (45).

(44) Did you know that John is having dinner in New York tonight?

(45) # Tonight, John is having dinner in New York, too. (Kripke 1990)

And this prediction holds up. The would-be presupposed content for (44) is carried in the sentence itself, so knowing that *know p* presupposes *p*, a hearer could easily identify what presupposition was intended. In contrast, the would-be presupposed content of (45) is mostly extra-sentential. We know that the presupposition will be something along the lines of “some other event parallel to John’s having dinner in NY also happened”, but exactly what that event would be we cannot know without the discourse context (and identification of the focus associate of *too*).

With respect to cognitive factives, any account must also capture the ease with which their presuppositions are “canceled”, or fail to project. For semantic accounts, this would mean that the presuppositions are often accommodated locally. In addition to this mechanism of “global” accommodation where we can enrich the context to support an unsupported presupposition, so-called “local” accommodation accounts for cases where presuppositions do not project (Heim, 1983). Alternatively, for pragmatic accounts, cancellation is expected because presuppositions are conversationally derived.

2.1.2.2 Pragmatic theories

In contrast to semantic accounts, pragmatic accounts sidestep the need for accommodation because they treat presuppositions 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 (Karttunen 1974, Kempson 1975, Wilson 1975, Boer and Lycan 1976, Karttunen and Peters 1979, Levinson 1983, Chierchia and McConnell-Ginet 2000, Kadmon 2001, Simons 2001, 2004, Atlas 2005, Abrusan 2011). Under Stalnaker's proposal, the constraints are based on the entailments associated with a presupposition trigger (Stalnaker 1973, 1974). Presuppositions arise, given general conversational principles (Grice 1989), when what is uttered has too many contributions to make. Since it is unorderly to make multiple contributions at once, one contribution gets foregrounded (or asserted), the others backgrounded (or presupposed). Stalnaker, however, fails to explain which contribution gets backgrounded. Subsequent pragmatic accounts try to resolve this by aiming to derive which contributions tend to be backgrounded, often using alternative-based accounts (Hamblin 1973, Rooth 1985).

For Abusch (2010), soft triggers bring to mind lexical alternatives. Given the additional pragmatic assumption that one of the alternatives must be true, any entailment shared by all the alternatives will be presupposed (see also Chemla 2010, Romoli 2015). For example, the soft trigger *win* has as its alternative *lose* (46). Under Abusch's account one of the alternatives must be true. One thing that the alternatives in (46) share is the fact that John participated in the race, which is the presupposition that we get for *win* (47). Similar reasoning applies for other triggers, such as *stop* (48-49).

- (46) a. John won the race (*presupposes*: John participated in the race)
- b. John lost the race (*presupposes*: John participated in the race)
- (47) John didn't win the race (*presupposes*: John participated in the race)
- (48) a. John stopped smoking (*presupposes*: John used to smoke)
- b. John continued smoking (*presupposes*: John used to smoke)
- (49) John didn't stop smoking (*presupposes*: John used to smoke)

For Simons and colleagues (e.g., Simons 2001, Simons et al. 2010, 2014), contributions that do not address the QUD get backgrounded (and thus project). Accordingly, any entailment can, in principle, be backgrounded. Abrusan (2011) keeps from Simons et al. the idea that what projects is what is not at-issue (i.e., what is not “main point”), but provides soft triggers a grammatically-based “default” main point.

Several pragmatic accounts of factivity (Stalnaker 1974, Simons 2001) propose that factive sentences like (50) have (at least) two relevant entailments: a doxastic entailment (*x believes p*) that is typically foregrounded (51a) and a veridical entailment (*p*) which is typically backgrounded (51b).

- (50) John knows that Mary is home.
- (51) a. John has the belief that Mary is home.
- b. Mary is home.

For Stalnaker (1974), 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. However, this account fails to predict that the *p* entailment is the one which

is typically backgrounded. Following Stalnaker, several authors have tried to provide accounts for why p gets backgrounded (Simons 2001, Abusch 2002, 2010, Abrusan 2011, Tonhauser et al. 2013, Simons et al. 2017, among others). For example, Tonhauser et al. (2013) propose that what gets backgrounded is anything that doesn't address the QUD or get presupposed by all the relevant alternative answers to the QUD. In response, Abrusan (2011) points out that this may be too permissive, and argues for a default grammatical main point: any entailment about the running time of the main event is "main point". The rest can be backgrounded, unless it is 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.

While the original Stalnakerian view leaves open the possibility that all presupposition triggering is pragmatic, Stalnaker himself admits that some presupposition may need to be arbitrarily specified in the lexicon. The recent pragmatic accounts of presuppositions all concern soft triggers, and aim at capturing the ease with which their presuppositions can be canceled, in comparison with those of hard triggers. Thus hard triggers may be semantic presuppositions. One prominent view for hard triggers is that the presupposed content is anaphoric (e.g., Roberts 1986). Hence presuppositions may form a heterogeneous class and be triggered from different sources (although see Abrusan 2016).

All of these accounts suffer some short-comings. The semantic theory requires rampant local accommodation. Is this something that we should posit and why should this occur with soft triggers but not hard triggers? As for the pragmatic accounts, lin-

guistic expressions come with all kinds of entailments (e.g., event predicates entail that the event takes place in time and space). What decides which of them should be part of the backgrounding calculus and which of the entailments should be backgrounded? For *know*, why the veridical entailment, rather than the doxastic entailment? As pointed out by Abusch (2002, 2010), this is particularly dire, given the existence of a predicate like *be right* which seems to have roughly the same entailments as *know*, but tends to background the doxastic entailment (54a) and foreground the veridical entailment (54b).²

(52) John knows that Mary and Bill are having an affair.

(53) John is right that Mary and Bill are having an affair.

(54) a. John has the belief that Mary and Bill are having an affair.

b. Mary and Bill are having an affair.

2.1.3 Semantic vs. pragmatic accounts and implications for acquisition

What implications do these different accounts have for the language learning problem? Consider how the learner would discover that a lexical item triggers a presupposition. We can assume (not uncontroversially) that the learner knows antecedently that presupposition triggers exist, and perhaps even which kinds of words might trigger presuppositions. It is hard to imagine what kind of experience would reveal this, if it was not already known by the learner. But the learner still has the difficult mapping task of deciding exactly which lexical items trigger presuppositions, and this will have to come

²Note that this problem may not be fatal if *be right* and *know* are not fully symmetrical (see Schlenker 2010, Anand and Hacquard 2014, Anand 2016).

through their experiences with the lexical items.

For semantic accounts, the link between the presupposed content and the rest of the trigger's meaning would be arbitrary, so uncovering the presupposition would be independent from learning about other aspects of the trigger. In fact, the learner would have to directly observe that there is a speaker presupposition that is reliably associated with the trigger in order to conclude that it is a trigger. Thus, triggers which are relatively soft and occur in lots of 'informative' cases such as those in (41) would present a clear challenge to the learner. Global accommodation helps to rescue the semantic theory from these cases, but it cannot rescue the learner. You must recognize a presupposition in order to accommodate it. If the learner does not already recognize the presupposition, they will have no evidence for it in these 'informative' cases.

In contrast, pragmatic accounts would constrain the learning problem quite differently. Although it is still an active area of interest exactly how pragmatic accounts work, they make the presupposition a consequence of other aspects of the verbs meaning. Thus, uncovering the presupposition is not independent from learning other things about the trigger, and thus 'soft' triggers would not pose such a challenge for the learner; they might not be able to directly notice that these triggers reliably occur with speaker presuppositions, but they would be able to notice other, more indirect consequences. And 'informative' uses of 'soft' triggers might even help to highlight the would-be presupposed content as an entailment.

And specifically for the case of *know*, pragmatic accounts might be the most explanatory. 'Informative' uses are prevalent in speech between adults (Spencer 2003), and might also be prevalent in speech to children. If so, these uses will obscure *know*'s

underlying factivity. If they help to highlight that the complement is entailed, they might help the learner to uncover the veridicality contrast with *think*. Would this be enough to also get the factivity contrast off the ground? Can we derive factivity from veridicality?

2.1.4 Relationship between factivity and veridicality

At first blush, veridicality and factivity seem to be correlated. Predicates like *know* and *discover* that entail (55a,56a) their complements, also presuppose (55b,56b) them. And predicates like *argue* and *be certain* neither entail (57a,58a) nor presuppose (57b,58b) their complements.

- (55) a. John knew that Mary is a linguist [# but in fact Mary is not one]
b. Did John know that Mary is a linguist?
- (56) a. John discovered that Mary is a linguist [# but in fact Mary is not one]
b. Did John discover that Mary is a linguist?
- (57) a. John argued that Mary is a linguist [but in fact Mary is not one]
b. Did John argue that Mary is a linguist?
- (58) a. John was certain that Mary is a linguist [but in fact Mary is not one]
b. Was John certain that Mary is a linguist?

But there are also predicates which suggest that veridicality and factivity are not perfectly related. For example, both *demonstrate* and *be right* entail their complements (59a,60a), but neither presupposes its complement (59b,60b).

- (59) a. John demonstrated that Mary is a linguist [# but in fact Mary is not one]

- b. Did John demonstrate that Mary is a linguist?
- (60)
- a. John was right that Mary is a linguist [# but in fact Mary is not one]
 - b. Was John right that Mary is a linguist?

While these examples clearly show that not all veridicals are factive, Anand and Hacquard (2014) have argued that there is a relationship between veridicality and factivity, at least within certain subclasses of attitudes. Within the class of doxastic—or belief—predicates, all the veridicals are factive and the non-veridicals are non-factive, while predicates like *demonstrate* and *be right* are not doxastic, but instead communicative verbs. This perspective suggests that the link between veridicality and factivity may be principled, as advocated by pragmatic theories of factivity. If so, the consequence would be that the learning problem is simplified. Children would only need to discover that *know* is veridical and *think* is not, in order to get the factivity contrast off the ground.

2.2 Syntax of *know* and *think*

Know and *think* have very similar meanings in the grand scheme of things, and the syntactic distributions that they can occur in are relatively similar as well. Both verbs take declarative complements (61) and prepositional complements (62), and neither verb can occur with an indirect object even though other verbs can (63).

- (61) a. John thinks that Mary is a linguist.
 - b. John knows that Mary is a linguist.
- (62) a. John thinks about the rumor.

- b. John knows about the rumor.
- (63)
- a. * John thinks Bill that Mary is a linguist.
 - b. * John knows Bill that Mary is a linguist.
 - c. John tells Bill that Mary is a linguist.

But there are also differences in the kinds of complements that they can take. *Know*, unlike *think*, can embed both nominal (64) and interrogative (65) complements.

- (64)
- a. * John thinks the rumor.
 - b. John knows the rumor.
- (65)
- a. * John thinks whether is a linguist.
 - b. John knows whether Mary is a linguist.

2.2.1 Question embedding and relation to semantics

Verbs like *know* are “responsive” verbs, in that they can embed both declarative and interrogative complements (Lahiri, 2002). To see this, we can compare *know* to similar but non-factive and non-veridical verbs *think* and *wonder*:

- (66)
- a. John knows that Mary is home.
 - b. John thinks that Mary is home.
 - c. * John wonders that Mary is home.
- (67)
- a. John knows where Mary is/whether she is home
 - b. * John thinks where Mary is/whether she is home
 - c. John wonders where Mary is/whether she is home

Many authors have noted the correlation between factivity or veridicality and question embedding³, (Hintikka 1975, Ginzburg 1995, Egré 2008, among others). *Know*, but not *think* or *wonder*, is a responsive verb because it can embed both kinds of complements. And only *know* is a veridical verb, and it is veridical with respect to both of its complements. Out of the sentences in (66), only (66a) entails that Mary is home. And out of the sentences in (67), only (67a) entails that John knows Mary's location. However, there are some counterexamples to the generalization that responsives are factives or veridicals. For example, *decide* is responsive (68a), but it does not entail (68b) or presuppose (68c) its complement.

- (68) a. John decided who is a linguist
b. John decided that Mary is a linguist [but in fact Mary is not one]
c. Did John decided that Mary is a linguist?

But this kind of example is not entirely surprising. Consider the kind of relations that responsive predicates might express. When they embed declarative complements they might express a relation between an individual and a proposition, which could be false or true⁴. When they embed interrogative complements they might express an answer to a question, which could be any old answer or it could be the *true* answer. If so, it would make sense that responsive predicates could be either non-veridical or veridical, depending on the type of relation that they express and the relationship between their

³This section largely sets aside discussion of emotive factives like *regret*, *love*. Including them would substantially complicate the picture here, which is already quite complicated.

⁴We might also call true propositions “facts” (Fine 1982, Parsons 1993, Harman 2003, Moltmann 2003, King 2007, among others).

different kinds of complements.

How are the complements in (66a) and (67a) 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 and Egré 2015, Uegaki 2015); and (iii) uniform accounts where the two complement types are posited to have the same denotation (Ciardelli et al. 2013, Ciardelli et al. 2015, Theiler 2014, Theiler et al. 2016). If the two complements are underlyingly related, as in the reductive or ambiguity accounts, knowledge about instances of *know Q* would be informative about instances of *know p* and vice versa.

2.2.2 Implications for acquisition

We have seen that *know* and *think* occur in some overlapping syntactic frames, but not others. For example, both verbs can take declarative complements, but only *know* can take interrogative complements. Furthermore, we have seen that responsive verbs, which are those that can take both declarative and interrogative complements, are also veridical and factive, at least within the subclass of doxastic verbs. What implications do these facts have for the language learning problem? Essentially, these facts open up a syntactic bootstrapping approach to uncovering the underlying meaning contrast between *know* and *think*. Syntactic bootstrapping (which is introduced in greater detail in Chapter

3) is a learning strategy that exploits principled links between a word's meaning and its syntactic distribution (Landau and Gleitman 1985, Lasnik 1989, Gleitman 1990, Naigles 1990, Lidz 2006). If the links are not principled, than bootstrapping would not provide much explanatory power, because it would require a story about how the unprincipled links were uncovered by the learner. In the theoretical literature, it's still not settled whether these links between syntactic distribution and factivity are principled, or exactly what they are (e.g., something as simple as responsiveness, or something more complex, see for example White and Rawlins 2016). But without settling the theoretical debates, we can still ask whether children are exposed to the right kinds of distributions to use a syntactic bootstrapping approach with *know* and *think*. What would this approach look like?

First, children might notice that *know* and *think* embed sentential complements, such as in (66a), and infer that they are propositional attitude verbs that express a relation between an individual and a proposition (as opposed to, for example, eventive verbs like *kick* which express a relation between individuals). Next, they might notice that *know* and *think* do not occur in contexts that communicative verbs occur in, such those in (69-70), and infer that they are doxastic verbs. Finally, they might notice that *know* is a responsive verb since it also takes interrogative complements, and infer that it is a veridical verb (and thus also a factive, at least under pragmatic accounts of factivity).

- (69) a. * The book knows that Mary is the murderer
b. * The book discovers that Mary is the murderer
c. * The book thinks that Mary is the murderer

- d. * The book wonders who the murderer is
 - e. The book is right that Mary is the murderer
 - f. The book demonstrates that Mary is the murderer
 - g. The book tells us that/whether Mary is the murderer
- (70) a. * John thought/knew/discovered to us that Mary is the murderer
- b. John said/demonstrated/argued to us that Mary is the murderer

This can give rise to a picture where there are many types of predicates, but only one set of factives (see Figure 2.1). Or there could be a more complicated picture because there could be a more complex set of linking principles where more than just question embedding is at play (see White and Rawlins 2016).

2.3 Pragmatics of *know* and *think*

We rarely mean exactly what we literally say, and we often say things intending to get our interlocutors to perform some kind of behavior. To illustrate, (71-72) can both function as prompts for someone to shut the door to the seminar room.

(71) Would you be willing to shut the door?

(72) Can you shut the door?

What we infer the speaker to intend varies depending on what we know about the conversational context and the interlocutors, but there are some ways that this inference can be constrained (Grice 1957, Searle 1975). For Searle (1975), the sentences in (71-72) can

Figure 2.1: Types of predicates

#	predicates	class	factive?	veridical?	responsive?
I	<i>think</i>	privative	no	no	no
II	<i>wonder</i>	privative	no	no	no
III	<i>be certain</i>	privative	no	no	yes
IV	<i>know</i>	privative	yes	yes	yes
V	<i>argue</i>	communicative	no	no	no
VI	<i>tell</i>	communicative	no	no	yes
VII	<i>be right</i>	communicative	no	yes	no
VIII	<i>demonstrate</i>	communicative	no	yes	yes

serve as indirect speech acts, when uttered, because they express conditions on successful performance of such an indirect speech act, including preparatory conditions, propositional content conditions and sincerity conditions. For example, (72) is a question about the addressee's abilities that can function as a request to have the door closed because such a request could not be fulfilled if the addressee wasn't able to do so (preparatory condition).

We also perform indirect speech acts with like *know* and *think* (73-74). Literally, (73) is a question about the addressee's knowledge and (74) is a statement about the speaker's beliefs, but we tend to use these kinds of sentences to do more than talk about beliefs and knowledge.

(73) Do you know where the restrooms are? (*intending: Where are the restrooms?*)

(74) I think it's time for lunch. (*intending: It's lunchtime.*)

Like other so-called “assertives” (Hooper 1975), *think* can be used this way because it can be used to report on the speaker's belief or to proffer the content of the embedded clause (see also Urmson 1952, Simons 2007). In principle, asserting something is different from asserting that you believe it, but in practice, the difference is neutralized. To see the difference, when we utter sentences like (74), our beliefs are not always at issue. Consider (76) and (77) as answers to the question in (75).

(75) What time is it?

(76) I think it's 3pm.

(77) I don't know ~~what time it is~~.

These seem like felicitous answers even though mental states weren't raised as relevant by the question. In fact, (77), or other references to ignorance, are potentially the only felicitous way to respond to the question if no answer is available. Why? Well, an analysis along the lines of Searle (1975) can naturally be extended here to say that even a direct speech act like (75) could not be asked without meeting some preparatory conditions; we can only truthfully, felicitously ask information-seeking questions of our interlocutors if we assume they have the beliefs or knowledge about the answers. Notice how ubiquitous this is: whether interpreting indirect speech acts or direct speech acts, the beliefs of our interlocutors are always implicated.

2.3.1 Implications for acquisition

We have seen that *know* and *think* have different sets of discourse functions. *Know* can be used to ask (73) or answer (77) questions, while *think* can be used to proffer information (74). What implications does this have for the language learning problem?

As discussed in Chapter 1, the ‘assertivity’ of *think* (Urmson 1952, Hooper 1975, Simons 2007) might create some issues for the language learner who is trying to directly observe consequences of the veridicality contrast between the verbs. If speakers regularly use *think* sentences to proffer the complement, it might seem to the learner like they are endorsing it, and therefore that it is true. If so, this might diminish the chances that the learner would have to use discourse status of the complement cues to uncover the veridicality contrast between *know* and *think*.

Such pragmatic enrichments with *know* and *think* could potentially create a further acquisition challenge, as children need to untangle pragmatic from semantic contributions. However, under a pragmatic bootstrapping approach, these indirect speech acts, if systematic enough, could in fact be a feature, and not a bug for the learner, as they could provide valuable cues about the underlying meanings of *know* and *think*. This is provided that children understand enough about what the speaker is trying to get across to understand the illocutionary force of the indirect speech acts that they are exposed to (see Chapter 3 for more details on why we believe that children can do this). However, there are potential challenges to the pragmatic bootstrapping approach. Consider the nature of parent-child conversations. Parents often use language to direct their children’s behavior, and there is an inherent power imbalance between parents and children. In such cases,

almost any type of utterance could function as a command (e.g., *I want you to go to bed, I think it's time for bed, You know it's bedtime, right?*). But we would not want children to conclude that *want, think* and *know* all have desire meanings. As discussed in Chapter 1, and revisited later in Chapters 5 and 6, pragmatic bootstrapping may work best when constrained by other mechanisms, like syntactic bootstrapping.

Chapter 3

Developmental background

When do children have the relevant abilities and mechanisms in place to be able to use the four potential routes laid out in Chapter 1? In order to even solve the mapping problem for *know* and *think*, they must have access to mental state concepts like belief and knowledge. In order to use discourse status cues to veridicality, they must be able to recognize what is true with respect to some standard, and in order to use discourse status cues to factivity, they must be able to recognize what information they share with others around them. If children are using the syntactic bootstrapping approach for *know* and *think*, we would want some evidence that they use this approach for uncovering other kinds of distinctions in the attitude verb domain. And finally, if they are to use the pragmatic bootstrapping route, we would hope that they could somewhat flexibly recognize the intentions of the speakers around them. So when do all these things fall into place?

3.1 Conceptual understanding

When do children have mental state concepts in place? This question has been explored extensively for the past three or four decades in the literature on children's developing Theory of Mind, or mindreading abilities. Having a Theory of Mind entails being able to represent the mental states of others, as well as being able to use those representations in reasoning about behavior (Premack and Woodruff 1978 and associated commentary,

Wimmer and Perner 1983, Baron-Cohen et al. 1985). For several decades, this literature was focused around so-called “explicit” or elicited-response tasks that test children’s ability to make explicit judgments—through verbal and behavior responses—about another agent’s false beliefs (which might differ both from reality and from the child’s own beliefs).

One such task is the change of location task, where it is established that an agent has a particular justified belief about an object (e.g., that it is in location A because they placed it there) and then, while the agent is absent, their object is moved to a new location (e.g., location B), making their belief inconsistent with the current state of reality. To test their understanding of the agent’s false belief, children are asked questions about what the agent would think, say or know about the location of the object and where they might look for the object. The typical, well-replicated result here is that children who are at least four years of age are able to acknowledge that the agent has the false belief that their object is in location A, even while children themselves believe that the object is in location B. In contrast, three-year-olds incorrectly insist that the agent believes the object to be in location B (Wellman et al. 2001).

These results contributed to the orthodox view that children lacked a full Theory of Mind before four years of age (Perner et al. 1987). But the orthodox view was challenged by those who argued that these results were due to a competence-performance asymmetry in mindreading abilities (Leslie 1994, Surian and Leslie 1999, Scholl and Leslie 2001, Leslie et al. 2004, Yazdi et al. 2006), whereby children’s performance errors in the traditional elicited-response false belief tasks (such as the change of location task) could be due to immature executive functioning (Leslie and Polizzi 1998, Carlson and Moses

2001, Carlson et al. 2015) consistent with performance errors that adults have been shown to make (Apperly et al. 2005); or pragmatic issues (Siegal and Beattie 1991, Sullivan and Winner 1993, Pham et al. 2012 Rubio-Fernández and Geurts 2016, Rubio-Fernández and Geurts 2013, Helming et al. 2014, Helming et al. 2016, Westra 2016, Westra and Carruthers 2017, Lewis 2013, Lewis et al. 2017).

In the past few decades, these challenges have also been supported by a rising tide of experimental evidence that children can attribute false beliefs, and predict behaviors on the basis of them, well before their fourth birthday, when assessed via an appropriate paradigm (see Baillargeon et al. 2016 for a recent review). This evidence comes from multiple paradigms considered to be “implicit” measures of children’s Theory of Mind because they do not require children to make explicit judgments about what other individuals believe, but instead measure their sensitivity to the beliefs of others via other behaviors. These studies demonstrate that even infants as young as 6 months are sensitive to the contents of others’ beliefs. Different paradigms that have been used to demonstrate young children’s competence with false beliefs include: violation of expectation or looking time studies (Onishi and Baillargeon 2005, Surian et al. 2007, Song and Baillargeon 2008, Poulin-Dubois and Chow 2009, Scott and Baillargeon 2009, Kovács et al. 2010, Scott et al. 2010, Träuble et al. 2010, Yott and Poulin-Dubois 2012, Scott et al. 2015) where children’s interest in novel or unexpected stimuli are gauged; anticipatory looking measures (Clements and Perner 1994, Garnham and Ruffman 2001, Southgate et al. 2007a, Senju et al. 2011) which ask what children will spontaneously predict within an experimental context; helping paradigms (Buttelmann et al. 2009, Knudsen and Liszkowski 2012, Buttelmann et al. 2014, Buttelmann et al. 2015) where children assist other individ-

uals; as well as affective measures (Moll et al. 2015, Moll et al. 2017); neural measures (Southgate and Verneti 2014, Kamps et al. 2015); and cross-cultural comparisons thereof (Barrett et al., 2013). Given this new set of findings from “implicit” tasks, it is clear that even children as young as 6 months have some ability to represent the beliefs of others, and might therefore have conceptual understanding of beliefs.

3.2 Prerequisites for uncovering veridicality contrast

Around 2-3 years, children spontaneously confirm true statements and deny false statements (Pea, 1982). While younger children are not speaking enough for us to measure this type of behavior, they also reject information that is not consistent with what they believe to be true; at 16 months, children can recognize when familiar objects are intentionally mislabeled and they try to correct the speaker who provides these incorrect labels (Koenig and Echols, 2003). Thus, children are able to represent when information is true or false relative to some standard (in this case the standard would be conventions for names of objects).

However, up until the age of 3, children sometimes fail to recognize when others make false statements, even when they have access to information which allows them to conclude that these statements are false. One study found that 2.5-year-old children trust false testimony from others about the location of a hidden object even when they themselves have seen the hiding event (Jaswal, 2010), and studies have found similar results in other contexts (for reviews see Mascaro and Morin 2014, Jaswal and Konrad 2016). One interpretation of this kind of result would be that children are unable

to represent false propositions (just as some interpret the findings in the Theory of Mind literature to suggest that children are unable to represent false beliefs). But these errors might have more to do with children's understanding of authority or their pragmatic difficulty in the face of others' assertions, than with semantic or representational errors with truth. Perhaps they understand that these statements conflict with their own knowledge, but conclude that the speaker must have information that they do not have access to which motivates these claims. Or perhaps they recognize these statements as assertions and understand that there are conversational maxims which pressure speakers to only assert true claims (Grice 1975). In fact, Mascaro and Morin (2015) and Mascaro et al. (2016) demonstrate that children are able to understand false statements and false beliefs, even while they trust the deceptive testimony of others. These authors propose that errors are merely due to children's trusting nature. Children might trust the deceptive statements of others because they perceive them as assertions and assume that asserted content is true; the apparently immature errors that children make are instead due to their understanding of communication.

This pragmatic-error interpretation is supported by evidence that children are sensitive to verbal and non-verbal signals of communicative cues and use these them in learning or reasoning about the world, such as when making generalizations about category membership, as young as 10 months through preschool (Topál et al. 2008, Egyed et al. 2013, Király et al. 2013, Butler and Markman 2014, Kovács et al. 2016). Within the literature on children's trust in testimony, studies have shown that children can reject deceptive testimony when it is not associated with communicative or intentional cues (Jaswal et al. 2010, Heyman et al. 2013). And recent work by Mascaro and Kovacs (in prep, discussed

in Mascaro and Sperber 2016) suggests that this trusting tendency in the presence of communicative cues strengthens between 15 and 24 months of age before falling off at 3 years, which is consistent with the development of children's immature expectations about assertions and what they commit the speaker to.

3.3 Prerequisites for uncovering factivity distinction

3.3.1 Understanding of other presupposition triggers

With respect to presuppositions, the findings in the literature are mixed. But there is some indication that children are aware of them quite early. Despite this early awareness, children may not deploy their understanding of presuppositions in the full range of contexts that adults do. Berger and Höhle (2012) show that German preschoolers are aware of the presupposition associated with the focus particles *auch* 'also' and *nur* 'only'. Hamburger and Crain (1982) show that preschoolers' performance on relative clause interpretation is a function of the pragmatic use of relative clauses; children are able to succeed at interpreting object relatives only when relative clauses are used to distinguish two entities that are otherwise similar (e.g., *the sheep that the lion bit* vs. *the sheep that the dog bit*). Syrett et al. (2009) find that three-year-olds are aware of the uniqueness presupposition associated with *the*, and that they are able to use that information in an online task. Trueswell and colleagues show that children fail to use the discourse context in concert with the uniqueness presupposition of *the* in order to help them resolve a PP attachment ambiguity (Trueswell et al. 1999), but that they are nonetheless able to use one structure when the discourse demands it (Hurewitz et al. 2000).

3.3.2 Understanding of shared bodies of knowledge

Children take into account a lot of information about the speaker across different kinds of contexts. Young children understand ambiguous requests (Liszkowski, 2005), and they take into account information they have about the speaker and the context in determining how to resolve the ambiguity (Repacholi and Gopnik 1997, Tomasello and Haberl 2003, Moll and Tomasello 2006, Babelot and Marcos 1999, Saylor and Ganea 2007, Liebal et al. 2009, Ganea and Saylor 2007, Salomo et al. 2010). To take one example, in a helping paradigm (Warneken and Tomasello 2006, Warneken and Tomasello 2007), 21-month-olds rationalized about what a speaker intended (Grosse et al. 2010). Did they want an object that was close to the child but far from them? When the speaker was physically able to get the closer object, children assumed that the farther object was the target of the request. When the speaker was otherwise occupied and could not retrieve the closer object on their own, children assumed the closer object was the target of the request.

3.4 Prerequisites for syntactic bootstrapping

Do children have the abilities needed to utilize the syntactic route to the contrast between *know* and *think*? Linguistic contexts can be informative about the verbs that occur in them (Fillmore 1969, Fillmore 1970, Kiparsky and Kiparsky 1970, among many others). Verbs that occur in intransitive frames such as *The girl gorp*ed are less likely to describe two-participant events or causal events than verbs that occur in transitive frames like *The boy blicked the ball*. Likewise, verbs that take finite sentential complements,

such as *He daxed that the dog was outside*, are more likely to describe mental states of belief than verbs that take non-finite sentential complements, such as *He thunted the dog to go outside*. This indicates that there are relationships between the formal properties of clauses and the semantic properties of verbs that the learner might be able to take advantage of via syntactic bootstrapping. Verbs like *think* and *know* which have been hailed as some of the “hardest” words to learn based on situational context alone (Gleitman 1990, Gleitman et al. 2005). But the syntactic form of an expression is more easily observable than the underlying meaning, so it can serve as a basis for children to bootstrap themselves into the meaning. Syntactic bootstrapping is a learning strategy that exploits principled links between a word’s meaning and its syntactic distribution (Landau and Gleitman 1985, Lasnik 1989, Gleitman 1990, Naigles 1990, Lidz 2006). A growing literature suggests that children are able to use some syntactic properties of clauses to learn about the meaning of the verbs that occur in them. For instance, children interpret verbs in transitive clauses as describing events that have at least two participants (Naigles 1990, Fisher et al. 1994, Naigles et al. 1993, Naigles 1996, Yuan and Fisher 2009, Fisher et al. 2010, among many others). These preferential looking studies suggest that two-year-olds know that novel verbs that appear in transitive clauses (like our *blick*) refer to different kinds of events than novel verbs that occur in intransitive clauses (like our *gorp*), but what about the novel attitudes *dax* and *thunt*? The literature on syntactic bootstrapping with attitudes is still in its infancy because children’s sensitivity to relationships between syntactic frame and verb meaning have not been fully explored outside of the action verb domain. What kind of syntactic bootstrapping strategy could be employed for attitudes? And do children bootstrap the meanings of attitude verbs from their syntactic

distributions?

With respect to attitude verbs, the syntax and semantics literature argues that there are systematic relationships between the syntactic properties of biclausal sentences and the semantic classes of attitude verbs that occur in them (see for instance Bolinger 1968, Hooper 1975, Stowell 1981, Farkas 1985, Grimshaw 1990, Pesetsky 1991, Giannakidou 1997, Villalta 2008, Anand and Hacquard 2013).

For example, attitudes divide most broadly into two semantic classes: dubbed “representational” (e.g., *think*, *discover*) and “non-representational” (e.g., *want*, *entice*) by Bolinger (1968). Representational verbs like *think* tend to embed finite complements (78a) while non-representational verbs tend to embed non-finite complements (78b).

- (78) a. I think it’s time for bed.
b. I want you to go to bed.

As a result, early syntactic bootstrapping hypotheses for attitude verbs were tied very closely to the finiteness of their complements. But this approach runs into trouble as soon as we look to languages besides English. In languages like German and Spanish, the complements of both kinds of verbs are tensed. And in languages like Mandarin, tense-marking is absent.

There are however other properties which correlate with the split. In Romance languages like Spanish, belief attitudes take complements with indicative mood while desire attitudes take complements with subjunctive mood. In English, belief attitudes allow preposing of their complements while desire attitudes do not (*His mom went to the store*, *John thought/*wanted*). So cross-linguistic comparisons highlight a more ab-

stract generalization which unifies these different cases: that representational verbs are those that embed complements which are similar to unembedded declarative clauses and non-representational verbs are those that embed other kinds of complements (Dayal and Grimshaw 2009, Hacquard 2014, Hacquard and Lidz. in prep). For example, the complement of (78a) looks like the main clause in (79a) which is a declarative clause. The complement of (78b) is similar to (79b) which is an imperative clause.

- (79) a. It's time for bed.
b. Go to bed!

To set the groundwork for developmental studies of this approach, previous work has found that adults are aware of relationships between the meanings of attitudes and their syntactic frames (Gillette et al. 1999, White et al. 2014a, 2016) and 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. 2014b, White 2015, White et al. 2016).

Research on bootstrapping attitudes in children is still rare, but 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. Even before children understand verbs like *think* and *want* in adult-like ways, they are distinguishing the verbs along the same lines as theorists would. Children seem to master *want* at a very young age (around 2-3 years) and they understand that someone's desires can conflict with reality (Moore et al. 1995, Rakoczy et al. 2007, Harrigan et al. 2016). In contrast, as reported in previous sections, children seem to make typical mistakes with *think* (until 3-4 years) where they apparently

fail to respond as though beliefs can conflict with reality (John and Maratsos 1977, de Villiers 1995, de Villiers 2005, De Villiers and De Villiers 2000, Perner et al. 2003, Sowalsky et al. 2009, Lewis et al. 2013, Lewis 2013, Lewis et al. 2017). As discussed further in Chapter 4, these mistakes are consistent with the view that children can distinguish *think* from *want* and understand that verbs like *think* can be used to proffer for foreground the proposition expressed by their complement.

And when we consider the role that complement clauses play in this process, there are a few recent studies which provide support, specifically for the role of finiteness in English. Focusing on children's understanding of *hope*, which is a relatively unfamiliar verb for children, Harrigan et al. (2016) found that children's responses differed based on the kind of complement it occurred with (*hope that* vs. *hope to*). And findings from Asplin (2002) and Lidz et al. (2016) have suggested that the complement plays a role in deciding what meanings a novel attitude verb might have.

3.5 Prerequisites for pragmatic bootstrapping

3.5.1 Understanding speakers' intentions

When do children have the abilities that underlie the pragmatic route to the contrast between *know* and *think*, such as the ability to reason about what speakers intend? Long before using presupposition triggers—and in some cases, even before speaking—young children show sophisticated pragmatic abilities. Very young infants can interpret the behavior of others as goal-directed, even in some of the same situations where adults would (Gergely et al. 1995, Csibra et al. 2003, Woodward 1998). And, when they are older, they

can sometimes understand how those goal-directed intentions related to the language that a speaker uses (Reeder 1980, Bloom 2002a, Halberda 2006). 12-month-olds seem to understand that speakers can try to achieve certain goals only through language and not other non-linguistic vocalizations (Vouloumanos et al., 2012). Between 12-24 months, children demonstrate that they understand communicative exchanges (both verbal and non-verbal) where information is requested by one interlocutor, given by another interlocutor and then used by the requester. Young children participate in such communicative exchanges themselves (Behne et al. 2012, Begus and Southgate 2012, Southgate et al. 2007b), and they express surprise when other interlocutors violate their expectations about such communicative exchanges (Song et al., 2008). They even understand that attitude verbs such as *know* can be used in such communicative exchanges (Harris et al. in press: e.g, Q: *Where are the keys?* A: *I don't know* or Q: *Do you know where my keys are?* A: *I don't*).

3.5.2 Understanding requests

Language can be used to perform actions or get others to perform actions, through more or less indirect means (Searle 1975). Children have a lot of experience with this phenomenon, given that most utterances that parents direct at children are intended to direct their behavior (Gelman and Shatz, 1977). Shatz (1978a) found that 2-year-olds respond appropriately to indirect requests. In fact they tend to respond with action/some behavioral response whether the request is a direct one (*Pick that up!*) or an indirect one (*Can you pick that up?*) (see also Bates 1971).

One debate in the literature is about whether these are behavioral rules that chil-

dren employ, or whether they actually have adult-like understanding of the relationship between the form of utterance and the speaker's intentions from a young age? Is this just an action strategy or some pragmatic process that derives the speaker meaning from literal meaning? One answer lies in how flexibly children apply this kind of reasoning. Some authors argue that children respond only to a limited set of indirect forms (Shatz, 1978b). But others respond that we should not necessarily expect children to be as flexible as adults in understanding these discourse moves. Even if the mechanism for reasoning (Grice 1975) is the same, the inputs that are considered relevant to the reasoning could differ, leading children to make a different set of conclusions from adults.

3.5.3 Understanding questions

With respect to questions, ambiguity arises because there are two different readings of questions such as *Do you know what time it is?* and *Do you know your teacher's name?*. One reading is as a request for information (this is the indirect speech act) that is paraphrasable with an unembedded question (*What time is it?* or *What's your teacher's name?*). Another is as a knowledge question (direct speech act). Do children understand these different readings? Questions serve many purposes in communication with children (Shatz 1979), and these purposes are sometimes contextually dependent (Garvey 1975, Walker and Armstrong 1995). Grosse and Tomasello (2012) find that children can distinguish genuine information-seeking questions from knowledge-testing question, but we know from other studies that they still respond to both kinds with a behavioral response which can either indicate their knowledge or offer up the requested information. They do

seem to understand *know* questions as information-seeking because they do not just affirm or deny their own knowledge in response to these questions (*Yes, I know it*); instead they give similar rates of ‘elaborative’ responses (*It’s three pm*) to *do you know Q* questions as they do to unembedded wh-questions. But they do recognize the direct speech act as well, and occasionally respond to it (Evans et al., 2014).

Chapter 4

Behavioral studies

When does the contrast between *know* and *think* emerge in development? Children seem to produce the verbs from a relatively early age (around 2.5 years) but the previous literature suggests that adult-like understanding of the contrast is more delayed (until 4 years or older). Is this an accurate picture of children's understanding, or can the production and comprehension findings be brought more in line with each other?

The experiments reported in this chapter suggest that the contrast can be figured out much earlier than 4. They demonstrate that children understand *think* to be non-factive from as early as their third birthday. We also find that some children understand *know* to be factive early on in the third year, but there is more individual variation in understanding of *know* than of *think*.

4.1 Production of *know* and *think*

With respect to production, factives emerge quite early. Shatz et al. (1983) was one of the first studies to look at child productions of attitude verbs over time, using the Abe corpus (Kuczaj, 1978). Shatz et al. find that *know* is the most frequent doxastic verb in children's productions and uses of it emerges around 30 months. *Think* occurs almost half as often as *know* and emerges a few months later. According to analyses by Shatz et al., *know* is used across a wider range of functions than *think*. They found that

think was most often used to describe the mental states of others or to modulate the force of an assertion (hedging) while *know* was more often used to draw the attention of an interlocutor, to request information, or in utterances such as *I don't know* and *You know what?* One of the most frequent uses of *know* was in the “idiomatic negative expression” *I don't know*, but this use decreased over time (65% of all attitude tokens at two and a half years to 6% at the end of the third year). According to Shatz et al. these early productions were phrase-centric and thus not indicative of a flexible adult-like understanding (see also Diessel and Tomasello 2001). But their analyses placed high requirements on children because utterances like (80) were needed to demonstrate true “mental state” talk with the verbs, because they suggest that the child is aware of the difference between the mental state concepts that *think* and *know* express.

(80) Before I thought this was a crocodile; now I know it's an alligator. (Shatz et al. 1983; 309)

Using parent report data, Bretherton and Beeghly (1982) also found that *know* is one of the most common attitude verbs produced by children, but it is because of the frequency of *I don't know*. And focusing on factives in particular, Schulz (2003) has argued that the first unambiguous productions of *know* to refer to mental states just before the third birthday, and the first productions that involve unambiguously true complements emerge around the fourth birthday (Schulz 2003). As a result, this literature suggests that the verbs are used for limited functions and that uses which are flexible and adult-like do not emerge until around the 4th birthday. But perhaps having analyses that require utterances like (80)—which are rare even in adult speech—and ignore the most frequently occurring

utterance-types like *I don't know* place the bar too high for children to demonstrate their understanding.

New studies confirm that these older analyses do not capture the sophistication of children's uses for words like *know*. Older analyses underestimate how early children develop a mature understanding of *know* because they exclude utterances like *I don't know* from analyses, arguing that they are merely used "to demur or withdraw from a conversation" (Shatz et al. 1983, Harris et al. 2017). Instead, Harris and colleagues find that *I don't know* is actually used in an adult-like manner to respond to information seeking requests before the third birthday, much in the same way that adults use the verbs (see data in Chapter 5).

4.2 Studies of comprehension

4.2.1 Understanding of *think*

Previous studies show that children have difficulty with *think* until at least four years of age (Johnson and Maratsos 1977; Wellman et al. 2001; De Villiers and Pyers 2002; de Villiers 2005; Sowalsky et al. 2009; Lewis et al. 2012; a.o.). For example, consider the scenario in (81):

- (81) False belief scenario: Mary has already made it home for the day, but John wrongly believes that she is at the office.
- a. John thinks that Mary is at the office.
 - b. Mary is at the office.

In this scenario, adults and older children assent to (81a), but three-year-olds reject it. Three-year-olds seem to respond based on the truth of the complement clause (81b) (false in this scenario), instead of the entire sentence. What explains these early errors?

There are a few possible explanations:

1. **Conceptual Hypothesis:** Children's initial difficulty with *think* reflects difficulty with the belief concept that *think* expresses or the corresponding representations. They reject sentences like (81a) because of their inability to attribute the right belief to John. John's belief could be problematic either because it conflicts with reality or with the child's own beliefs. This could boil down to representational issue (beliefs can be false but I fail to represent them) or a conceptual issue (representations can conflict, but not belief representations). See Johnson and Maratsos (1977), Tardif and Wellman (2000), Perner et al. (2003), among many others.
2. **Syntactic Hypothesis:** Three-year-olds' errors come from a syntactic mis-analysis of *think* sentences. They fail to understand the *that*-clause to be embedded under *think*, so they treat it as an independent clause. This could be due to something like a conjunctive analysis (*p and John thinks it*) or an analysis that does not include the *think* at all (*p*). As a result, they only attend to the embedded clause.
3. **Semantic Hypothesis:** Children's non-adult responses are due to a failure to recognize the non-factivity of *think*. Instead, children may represent *think* as either factive or veridical. See Johnson and Maratsos (1977), Abbeduto and Rosenberg (1985).
4. **Pragmatic Hypothesis:** Children's difficulty with *think* is merely pragmatic in na-

ture. The reason children respond to the truth of the complement clause in (81a) is the same reason adults sometimes respond to the truth of the complement of *think*. As discussed in Chapter 2, verbs like *think* can be used to proffer the content of its complement by endorsing the subject's beliefs, in which case the complement clause carries the main point of the utterance, and the matrix clause get demoted to parenthetical status (*p because John thinks so*). Children's failures are due to a tendency to assume such endorsement readings for *think* sentences, even in situations where adults do not. See Lewis et al. 2012, 2017; Lewis 2013, Urmson 1952, Hooper 1975, Rooryck 2001, Simons 2007, Westra 2016, Westra and Carruthers 2017.

Lewis et al. (2012, 2017), and Lewis (2013), provide initial evidence against the Conceptual and Syntactic Hypotheses. They show that three-year-olds are not attending solely to the complement clause, and argue that children respond to the truth of the complement clause only in contexts in which they assume that it is being proffered by the speaker. In contexts in which parenthetical interpretations are disfavored, or in scenarios where the literal meaning is false, three-year-olds respond to the truth of the entire clause, in an adult-like way, even in false belief scenarios. Consider the variant of scenario (81) in (82):

- (82) False belief scenario 2: Mary is at the office, but John wrongly believes that she is at home.
- a. John thinks that Mary is at the office.
 - b. Mary is at the office.

In this scenario, the sentence (82a) is false, even though the complement clause (82b) is true. In such cases, three-year-olds reject sentences like (82a), just like adults. Lewis et al. argue that the reason three-year-olds' performance improves in this kind of false belief scenario is that parenthetical interpretations in which the speaker endorses the reported belief are blocked: the speaker cannot endorse a belief of John's that he does not hold. If children are sensitive to the literal meaning, they can reject these sentences based on their falsity. These results argue against the Syntactic Hypothesis. Indeed, children's adult-like responses are unexpected if children merely respond to the truth of the complement: they should accept the sentence, since the complement is true. Furthermore, it shows that three-year-olds are able to provide adult-like responses, even in contexts in which the subject has a false belief, suggesting that their difficulty is not conceptual, contra the Conceptual Hypothesis.

Lewis's results, however, are still consistent with the last two hypotheses (Semantic and Pragmatic): children's difficulty with *think* could either be due to a (cancelable) tendency to assume that speakers typically endorse the truth of the complement, or to a factive/veridical understanding of *think*. Note that in the scenario in (82), we would typically reject the sentence "John knows that Mary is at the office". Do three-year-olds' responses then reflect a factive or veridical understanding of *think*?

4.2.2 Understanding of *know*

This literature suggests that children do not learn how *know* is different from *think* until 4 years or older, but there are some conflicting findings that make it difficult to

draw conclusions about children's understanding of *know*. Some studies find that *think* is understood well earlier, and children struggle to figure out that *know* is different from it. Other studies suggest that *know* is the better-understood verb and that children mistakenly treat *think* as if it meant something like *know*. As a result, it is hard to know what conclusions to draw from this body of research. Moreover, these studies use different methods to probe different aspects of children's competence with different sets of research questions. Perhaps considering the different kinds of tasks can help us to better understand what children know about these verbs before their 4th birthday?

There are two main types of questions that researchers are attempting to address in this literature: complement-oriented research questions and attitude oriented research questions. Complement-oriented designs test children's understanding of the complements in *know* and *think* sentences. These designs are the most informative about children's understanding of factivity, especially when they involve entailment-canceling operators. In contrast, attitude-oriented designs are more concerned with children's understanding of what mental states can be attributed using these verbs and under which conditions they can be felicitously used. As a result, they are not necessarily informative about factivity distinctions because they actually test meta-awareness of meanings, looking for children's explicit understanding of the differences in meaning that *think* and *know* express. While informative about children's holistic understanding of the verbs and their usage patterns, attitude-oriented tasks do not readily distinguish between children's understanding of factivity and their understanding of other dimensions which distinguish *know* and *think*. Consider the sentences in (83-85). When we hear (83) we may have the intuition that John is certain about his belief. But this intuition is not correlated with

factivity, given that *be certain* also expresses similar levels of certainty, but is non-factive (85).

(83) John knows that Mary is home [# but she isn't]

(84) Bill thinks that Mary is home [but she isn't]

(85) David is certain that Mary is home [but she isn't]

Without hearing the second clause in these examples, we might think that John or David are better sources of information about Mary's location than Bill. But we may think this because we might have some scalar understanding of knowledge such that it implies belief. Or because those who know something will have better justification than those who merely think something. Or because speakers who use the word *know* are more certain about the truth of the belief that they are ascribing than those who use *think*. Thus, it can be hard to pin conclusions from these tasks to differences in factivity, as opposed to any other differences.

There are also two main families of dependent measures that are used in this literature: inference-based tasks and felicity judgment tasks. These two families of tasks are interestingly different because they both test the relationship between sentences and situations that those sentences can describe, but in different directions. In inference-based tasks, participants are asked to infer something about the experimental situation, given some linguistic stimuli that prime their inferences. In contrast, felicity-based tasks ask participants to judge whether some sentence is an adequate description of an experimental situation. Felicity-based judgments are related to truth-value judgment tasks (TVJTs) in that they are better for testing aspects of meaning that are tied to truth, such as entail-

ments from asserted content. But inference-based tasks are more appropriate for testing other aspects of meaning that are more contextually based or backgrounded, such as implicatures and entailments from presupposed content.

Although these two dimensions are orthogonal in principle, they tend to be correlated in the literature. Most complement-oriented tasks use inference-based paradigms, and most attitude-oriented tasks use felicity-based paradigms, with the exception of studies by Moore and colleagues which use inference-based paradigms. Given these connections between research questions and paradigms, there is a third issue to consider in evaluating their findings: how naturalistic the experimental context is. For example, with inference-based tasks, care must be taken to ensure that the paradigm is age-appropriate because there are certain inferences we wouldn't expect children to make at particular ages—even without considering their knowledge of mental state terms—given that they do not have the same world knowledge as adults.

Attitude-oriented tasks with felicity judgments include those by Macnamara et al. (1976), Johnson and Wellman (1977), and Abbeduto and Rosenberg (1985). In these tasks, children are presented with stories that involve beliefs which may be true or false, justified or unjustified. After the stories children are asked to make explicit judgments about whether attitude reports involving *know* or *think* are good descriptions of the events in the story. Target responses include “yes” or “no” answers to polar questions (e.g. Does the character in the story think/know that...?) or judgments about whether knowledge reports are more apt than belief reports (e.g., Does the character know that... or does he think that...?). These authors concluded that three-year-olds had not achieved mastery of the verbs but that four- and seven-year-olds had. However, three-year-olds' poor perfor-

mance may be due to the metalinguistic nature of these tasks and to difficulty comparing the relative acceptability of two sentences.

Complement-oriented tasks with inferential judgments include those by Harris (1975), Hopmann and Maratsos (1978), Abbeduto and Rosenberg (1985) and Léger (2008). These tasks look at whether children understand the verbs to be factive by measuring whether they tend to infer that their complements are true. Harris and Abbeduto and Rosenberg present minimal contexts and ask children to provide an explicit judgment about the complement to *know* or *think* when it is an independent sentence (86). While these tasks require explicit judgments, they can be considered inference-based tasks because the judgment would be impossible without making the relevant inference. In these tasks, children do not begin to respond in expected ways until much older than 4 years.

(86) If I told you that:

- a. The teacher did not know that Tim was absent.
- b. Was Tim absent?

Hopmann and Maratsos and Leger, however, do not require explicit judgments because they ask children to act out the inferences that they have made with a set of toys. Hopmann and Maratsos found that some children responded as if the complement was true, regardless of the attitude verb, and that this tendency was stronger with the youngest children. Leger compared understanding of cognitive factives (87) to emotive factives (88) and found that children were more adult-like on emotive factive items in that they responded as if the complement was true more often. However, these findings could be due to the nature of the act out tasks involved; children could behave like adults for a different

reason, namely that they want to make the doll happy.

- (87) a. The doll knows that she has a turtle.
b. The doll knows that she doesn't have a turtle.
c. The doll doesn't know that she has a turtle.
d. The doll doesn't know that she doesn't have a turtle.
- (88) a. The doll is happy that she has a turtle.
b. The doll is happy that she doesn't have a turtle.
c. The doll isn't happy that she has a turtle.
d. The doll isn't happy that she doesn't have a turtle.

Moore and colleagues (Moore et al. 1989, Moore and Davidge (1989)) tried to bring these two different families of tasks into conversation with each other. They recognized that inference-based tasks might require fewer abilities that are orthogonal to verb understanding, but they want to test hypotheses about attitude-oriented research questions. The participants' job was to determine which box contained the toy after hearing two puppets utter sentences like "I *know* it's in the red box" and "I *think* it's in the blue box." The studies by Moore and colleagues all found that three-year-olds were unable to reliably use the *know* statement over the *think* statement (or any other contrast between attitude verbs for that matter), but that children four and over could. While these results demonstrate that four-year-olds can do something that three-year-olds cannot, it does not demonstrate that three-year-olds do not understand that *know* is factive. Perhaps they do not pick the more informative *know* statement because they have trouble computing the implicature (by noticing that the puppet who used the *think* sentence could also have used

know and reasoning that the puppet did not because they did not actually know, or have good justification for their belief).

Given this large body of studies, are there any remaining questions that we could ask about children's understanding of the verbs? Yes. These studies tend to conclude that children do not understand the distinctions between *know* and *think* until well into grade school, and the earliest age at which competence is found is 4 years. But these studies test meaning distinctions which are distinct from factivity, such as certainty (Macnamara et al. 1976, Johnson and Maratsos 1977, see also discussion of examples in 83 and 85), or involve task-specific actions which are neither familiar nor natural for children younger than 4 (Harris 1975, Hopmann and Maratsos 1978, Abbeduto and Rosenberg 1985, Leger 2008). Would it be possible to find that children have an adult-like understanding of the factivity difference between *know* and *think* at 3 years if we controlled for these task artifacts?

4.3 Research questions

What kind of representations do three-year-olds' have for *think* and *know*? Is their *think* factive or non-factive? Is their *know* factive or non-factive?¹

To preview the results reported in the following studies, we find that from 3 children understand *think* to be non-factive (Study 1) and that they are figuring out the factivity of

¹While it would also be informative to test children's understanding of the (non-)veridicality of the two verbs in addition to their (non-)factivity, we will see in later sections that this task is not the best tool to assess veridicality understanding, given that it asks participants to infer what is true they trust the experimenters involved.

know during this age range (Study 1,2). Furthermore, we find that there is significant individual variability in when children figure out the factivity of *know* which is not well correlated with age (Study 2), suggesting that there is a role for the quality of experience as well as the quantity of experience in learning this meaning contrast.

4.4 Study 1

In order to assess three-year-olds' understanding of the factive and non-factive verbs *know* and *think* and the inferences that they license, we designed a simple task² that allows them to demonstrate their knowledge without being hindered by orthogonal difficulties. This was a complement-oriented, inference-based task which asked participants to make inferences in a more naturalistic context than previous tasks. Using clues in the form of attitude reports about the location of a toy, the participant's goal is to infer its location.

4.4.1 Methodology

Participants were seated in front of two boxes (one red and one blue). They were told that the experimenter would hide one toy in either of the boxes and their task was to find the toy, after the experimenter gave them a clue. Participants were also informed that a puppet (Lambchop) would be joining the game as well, but was too shy to do anything but whisper to the experimenter. An occluder kept participants from seeing where the experimenter hid toys and there was always a toy hidden in each box, despite what participants were told. This was done in order to avoid participants learning from

²This study was previously reported in Dudley et al. 2015.

negative evidence.

On each trial, the occluder would rise and the puppet would whisper in the experimenter's ear before the experimenter delivered a clue in the form of an attitude report (test sentence). Upon hearing the clue, participants were asked to select the box that they thought the toy was in. We manipulated two factors within subjects: verb-type (think, know) and negation-type (none, matrix, embedded). Accordingly children heard *think* and *know* sentences, with or without negation, as in (89).

- (89) a. No negation
- i. Lambchop thinks that it's in the red box (**think-none**)
 - ii. Lambchop knows that it's in the red box (**know-none**)
- b. Matrix negation
- i. Lambchop doesn't think that it's in the red box (**think-matrix**)
 - ii. Lambchop doesn't know that it's in the red box (**know-matrix**)
- c. Embedded negation
- i. Lambchop thinks that it's not in the red box (**think-embedded**)
 - ii. Lambchop knows that it's not in the red box (**know-embedded**)

Participants were given three trials for each of the sentence types in (89), as well as three control trials with the test sentence *It's not in the red/blue box*. Responses were coded as selections of the box mentioned in the test sentence, or as selections of the other box.

Note that this task requires children to accommodate the presupposition when it is not in the common ground. We decided that this was a necessary trade-off in order to

better assess young children's knowledge, using a natural, non-metalinguistic task. However, this task may still underestimate their knowledge of presupposition. Even if children recognize *know*'s factivity, they may still have difficulty accommodating the presupposition that the complement clause is true in order to pick the mentioned box, as we discuss later.

4.4.2 Hypotheses and predictions

There are four logical possibilities for children's understanding of these verbs: (i) children understand the (non-)factivity of these verbs in a fully adult manner but previous tasks have obscured their competence; (ii) children lack the understanding that *know* is factive, thereby treating both verbs as non-factive; (iii) children understand *know* in an adult manner but also treat *think* as a factive, which is why they tend to assume that its complement is true; or (iv) children fail to recognize the factivity of *know*, but incorrectly treat *think* as a factive.

These possibilities make the following predictions, which are summarized schematically below in Figure 4.1:

(i) If children are adult-like, they will only pick the mentioned box when they hear sentences with no negation or *know*-matrix sentences.

(ii) If children treat *know* as a non-factive, they should only pick the mentioned box when they hear sentences without negation.

(iii) If children treat *think* as factive, they should pick the mentioned box when they hear sentences with no negation or with matrix negation.

(iv) If children understand both verbs incorrectly, then they should pick the mentioned box for sentences with no negation and for think-matrix sentences.

Hypothesis	(i)	(ii)	(iii)	(iv)
Lambchop thinks that it's in the red box	✓	✓	✓	✓
Lambchop knows that it's in the red box	✓	✓	✓	✓
Lambchop doesn't think that it's in the red box	✗	✗	✓	✓
Lambchop doesn't know that it's in the red box	✓	✗	✓	✗
Lambchop thinks that it's not in the red box	✗	✗	✗	✗
Lambchop knows that it's not in the red box	✗	✗	✗	✗

Figure 4.1: Summary of predictions by sentence-type: selections of the mentioned box

As shown in Figure 4.1, the matrix negation trials will be the crucial ones for distinguishing between hypotheses in determining participants' understanding of the factivity of the two verbs.

4.4.3 Participants

Child participants were 40 three-year-olds (age range: 3;1 - 3;11 years;months, mean age: 3;6, 19 boys). All children were reported to be monolingual speakers of English by their parents and all were recruited from the University of Maryland Infant Studies Database. Ten adults also participated. They were recruited from an undergraduate introductory linguistics course at University of Maryland and participated for course credit.

4.4.4 Results

4.4.4.1 Control items

Control items were three trials with the following clue: *It's not in the red/blue box*. For these trials, participants needed to choose the other box (not the mentioned box) at least two out of three times in order to be included in the analyses. Nine out of the ten adult participants chose the other box on every trial. The tenth participant failed to choose the correct box on these trials, and was excluded from analyses. Out of the 40 three-year-old participants, 9 of them failed the control items (by picking the other box only once or never), and were therefore excluded from analyses. Additionally, three child participants were excluded due to experimenter error, leaving a total of 28 children (age range: 3;1 - 3;11, mean age: 3;6, 12 boys).

4.4.4.2 Adult results

Adult data (n=9) is given in Figure 4.2. Adults always chose the mentioned box for *think*-none sentences *know*-none trials. They never chose the mentioned box for *think*-embedded and *know*-embedded trials. Finally, adults chose the mentioned box on 4% of *think*-matrix trials and 74% of *know*-matrix trials.

4.4.4.3 Child results

Child participants' performance (n=28) is given in Figure 4.3. Overall, children tended to pick the mentioned box for *think*-none and *know*-none trials. They picked the other box for *think*-matrix, *think*-embedded and *know*-embedded trials. On *know*-matrix

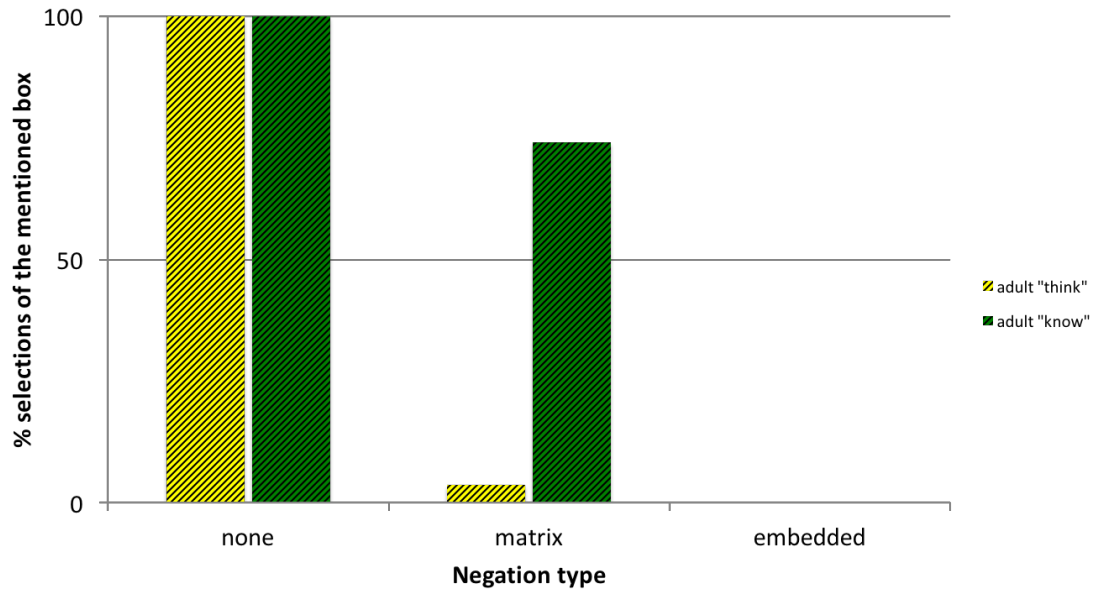


Figure 4.2: Adult performance, Study 1

trials, they picked the mentioned box about 40% of the time.

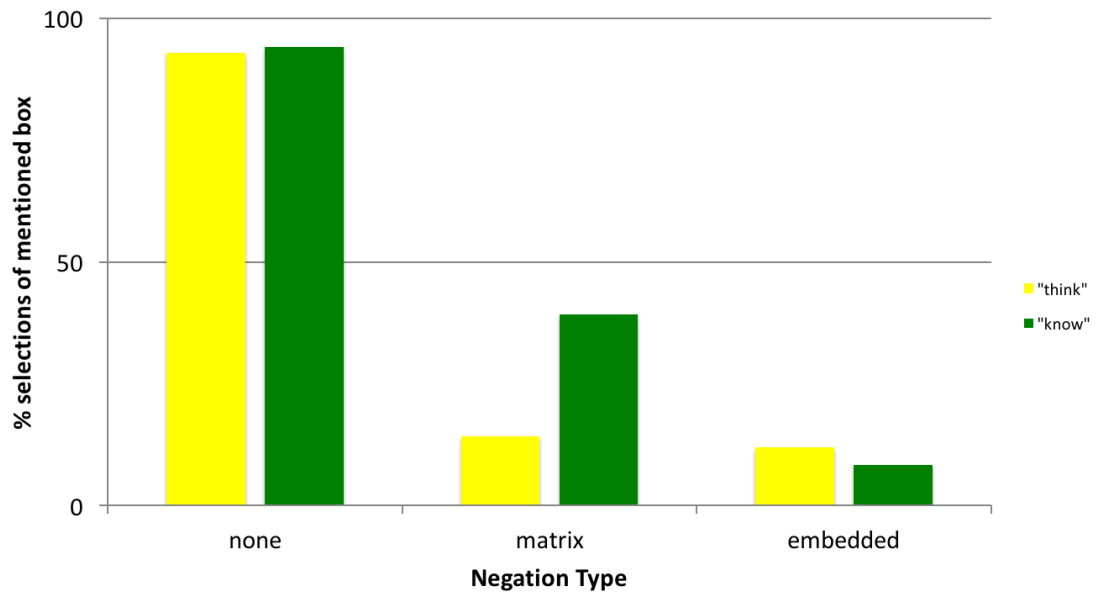


Figure 4.3: Three-year-olds' performance, Study 1

A 2x3 ANOVA revealed a significant main effect of verb-type ($F(1,21)=28, p<0.017$)

and negation-type ($p < 2.0e-16$) and a significant interaction between verb-type and negation-type ($p < .0072$). Planned comparisons revealed that children treat *think*-matrix sentences differently from *know*-matrix sentences ($p < .017$) and that they treat *know*-matrix sentences differently from *know*-embedded sentences ($p < .0088$). Out of all conditions with negation, children only pick the mentioned box when they hear sentences like *Lambchop doesn't know that it's in the red box*.

4.4.4.4 Performance in *think* conditions

All child participants performed completely adult-like on *think* trials; both child and adult participants picked the mentioned box when they heard *think*-none sentences but they picked the other box for both kinds of *think* sentences with negation. See Figure 4.4 for a comparison of adults' and three-year-olds' performance on *think* trials.

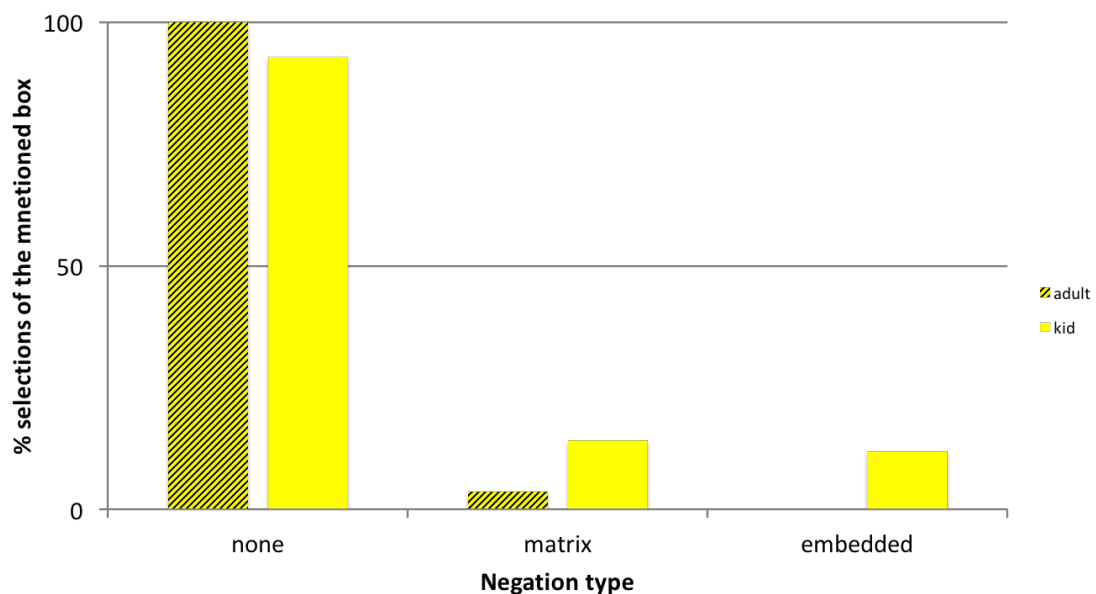


Figure 4.4: Performance on *think* across age groups, Study 1

Note that the performance of both adults and children in this task is consistent with the assumption that Lambchop was a reliable source of information. Neither adults nor children seemed to compute a quantity implicature from the use of *think p* in the context of *know p* and *p*: they always picked the mentioned box with affirmative *think* sentences. Given previous results from the literature, we expect that children would do so, but we had no such expectation for adult participants because an adult-like understanding of sentences like Lambchop thinks that it's in the blue box is consistent with the toy being in either the red or the blue box. We take the apparent lack of implicature computation in this task to be due to the “clue” status of the utterance: participants do not necessarily assume that the speaker is going to make her contribution as informative as possible, but that she will provide just enough information to help them guess the correct location of the toy.

4.4.4.5 Performance in *know* conditions

Children appear to perform like adults in some *know* conditions, but not others; they pick the same box as adults when they hear *know*-none and *know*-embedded sentences, but not *know*-matrix sentences. See Figure 4.5 for a comparison of adults' and three-year-olds' performance on *know*.

On *know*-matrix trials, which is where their behavior differs, adults tend to pick the mentioned box (consistent with a factive interpretation), but three-year-olds only pick the mentioned box about 40% of the time. An examination of individual performance on this measure suggests that this 40% performance is not due to chance performance (e.g.,

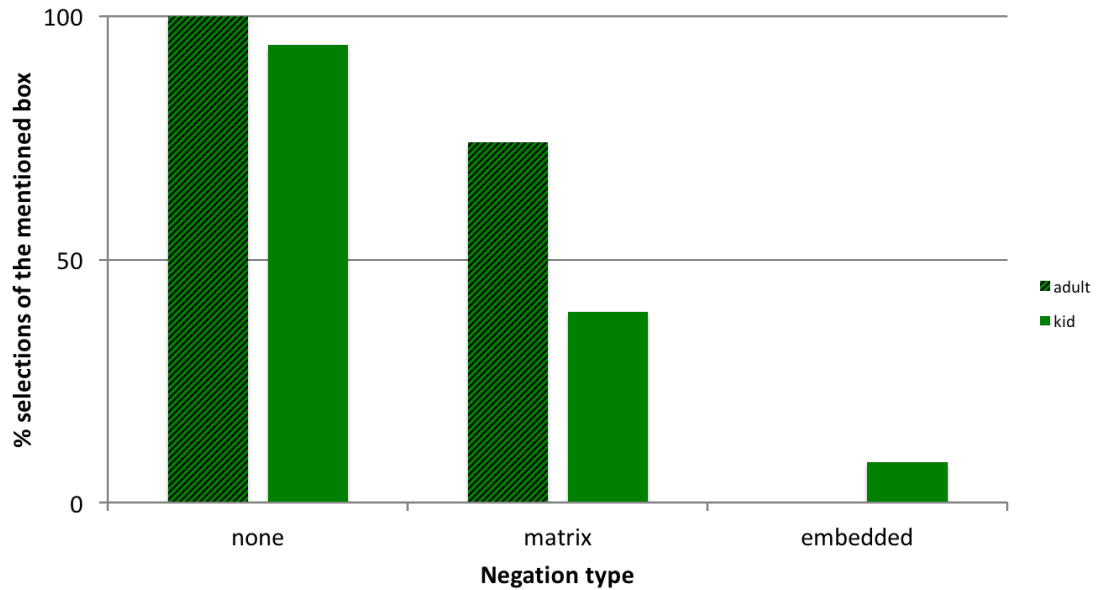


Figure 4.5: Performance on *know* across age groups, Study 1

if children did not know which box to pick, they would alternate between picking the mentioned box and the other box). If all three-year-olds were guessing where to look for the toy when they heard these sentences, we would expect to see children’s performance distributed normally around a mean accuracy of approximately 50%. However, children’s performance on *know*-matrix sentences is distributed bimodally, and not normally around the mean, as it is in other conditions. There is a group that seems to perform below chance (consistent with a non-factive interpretation) and a group that seems to perform above chance (consistent with a factive interpretation). See Figure 4.6 for an individual measure of performance.

Figure 4.6 shows that some three-year-olds always picked the mentioned box (consistent with a factive representation of *know*), but other three-year-olds always picked the other box (inconsistent with an adult-like understanding of *know*).

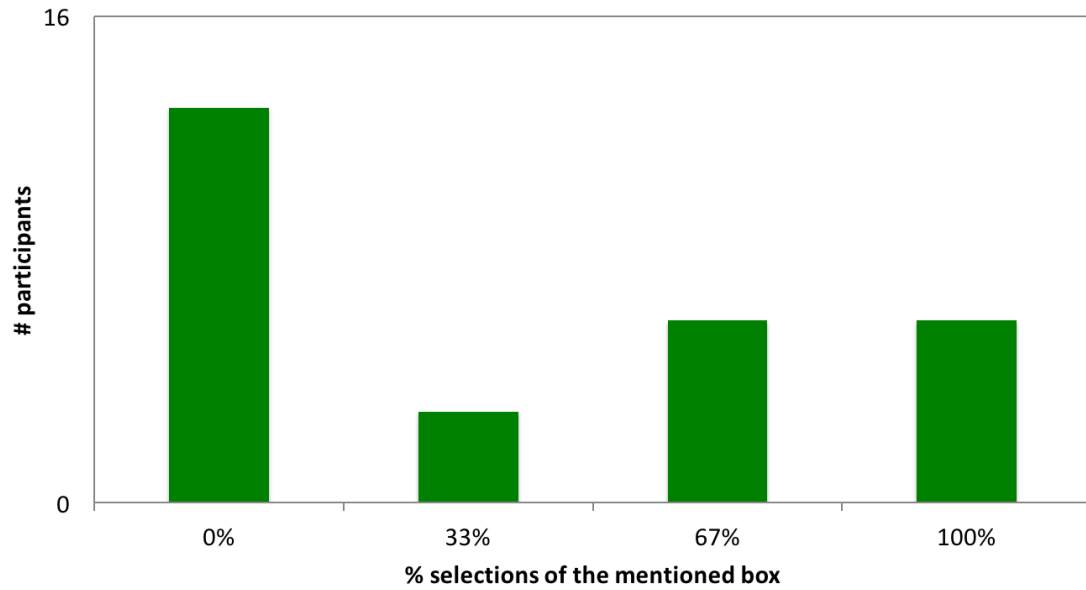


Figure 4.6: Individual performance in *know*-matrix condition, Study 1

4.4.5 Discussion

These results show that three-year-olds, as a group, differentiate the factive verb *know* from the non-factive verb *think*, based on their significantly different responses to *think* and *know* sentences with matrix negation. This finding contrasts with previous findings in the literature where three-year-olds tested on the distinction between these verbs systematically failed (Johnson and Maratsos 1977; Abbeduto and Rosenberg 1985), or were found to be at chance (Moore and Davidge 1989; Moore et al. 1989). Unlike those studies, this one did not require participants to explicitly compare *think* and *know* sentences to decide which was a better description of the events, or to provide definitions of the verbs. Instead, this task required children to make choices in a game based on some linguistic stimuli. We believe that the nature of the previous tasks masked children’s understanding of these verbs, and that our task was better able to assess their understanding.

Three-year-olds' high accuracy in all *think* conditions indicates that they have an adult-like understanding of *think*. Given their performance on the *think*-matrix sentences, we can conclude that three-year-olds, just like adults, understand *think* to be non-factive. When they hear sentences like (90), they do not infer that the toy is in the red box (which would be the expected outcome for a factive verb), but rather that the toy is in the blue box.

(90) Lambchop doesn't think [that it's in the red box]

These findings also suggest the need for a more sophisticated analysis of the developmental trajectory of verbs like *know* than was previously thought. A factive understanding of *know* may emerge earlier than four years of age. Some three-year-olds (about 43%) consistently behave like they have an adult-like understanding of *know*. However, other three-year-olds (about 57%) reliably treat *know* exactly like they treat *think*, namely as if it were non-factive. The apparent chance performance of three-year-olds in the *know*-matrix condition could result from averaging the performance of the adult-like and non-adult-like children together. Therefore, past studies which found three-year-olds to be at chance *know* conditions, like the studies by Moore and colleagues, might have yielded similar results if individual performance were measured.

To the extent that children's performance on our task is a direct reflection of their semantic representations for *know*, our data suggest that some children understand *know* to be factive by age three, but that others do not. It is, however, possible that even this simplified task is still obscuring three-year-olds' performance and that the failure of some to behave as if they understand *know* to be factive derives from an additional factor masking

their knowledge (some of these factors are discussed further in the following section).

4.4.6 Remaining questions

Is performance with *know* really variable? Are there different populations of children who understand *know* differently? If so, what explains that difference? Is understanding of *know* something that changes with age? Or do we have reason to think that it would be better related with other factors?

The results of Study 1 are suggestive that there are different populations of *know*-knowers, but there are several aspects of the study design which do not allow us to be sure about this:

- **Too few observations per condition:** In Study 1, we have three observations per condition per participant. This doesn't give us enough power to identify sources of variation. Another concern is that three items in each condition were too few to distinguish between chance-level performance and a small error rate. Since the children in our study were so young, they can make 1-2 errors for any number of irrelevant reasons (e.g., they were distracted by the toys), which would lead to 33% or 67% accuracy. In order to better distinguish between chance-performance and a few errors, we would need to increase the number of items in each condition.
- **Puppet as attitude holder:** In an inference-based task like Study 1, the inferences that a participant might make will be impacted by what is known about the speaker and the subject of the attitude reports. Perhaps children do not take puppets to be the kind of agents who could have epistemic access, or they do not trust the 'beliefs'

of a puppet the way that would trust the beliefs of an adult. Alternatively, they could over-empathize with the puppet and take it to be insulting when the experimenter says that the puppet “does not know” the location of the toy in front of the puppet herself. As a result, they could have an interpretation of the sentence where no projection obtains (which is possible for adults given the right contextual factors or intonation). This concern goes away if the adult holder were to be an adult experimenter and if they would be absent when the test items are delivered.

- **Role of puppet in game is unclear:** Recall that the puppet always whispered something to the experimenter, and after listening to the puppet, the experimenter gave the clue (e.g., *Lambchop knows it's in the red box*). Participants never heard what the puppet actually said. So, the participant may have made inferences not about the puppet's beliefs about the location of the toy, but instead about what the puppet said. One possibility is that the puppet uttered statements of the form “It's in the red box”. The experimenter, who was aware of the actual location of the toy, would then report what the puppet knows or thinks based on what it said. However, it's also possible to imagine that the puppet instead whispered statements such as “I think it's in the red box” or “I know it's not in the blue box”, in which case, the experimenter would merely serve as translator for the shy puppet by reporting “She thinks it's in the red box” or “She knows it's not in the blue box.” This conception of the interaction between the puppet and experimenter would lead to the expected ‘adult-like’ behavior in every condition but the *know*-matrix condition. In that case, the experimenter would be perceived to be relating the puppet's message: “I don't

know that it's in the red box.” But then the expected inference that the toy is in the red box would not be licensed. Possible continuations of “I don't know that p” include “I don't know that p because p is not true”, “I don't know that p because I know that q” or “I don't know that p because I don't have enough evidence.” While this possible interpretation of the experimental materials may have affected some participants, most adults and at least half of the children however behaved in a way consistent with the experimenter being responsible for giving the clue, and not serving as a mere translator. In order to be completely sure, the role within the game of the person whose beliefs and knowledge are reported on could be clarified in further experiments.

- **Infelicitous delivery of test items:** Another possibility that was motivated by our post-experiment consultations with the adult participants was that the test sentences were delivered with a child-directed prosody, which can lead to a different pattern of inferences based on the fact that focal stress on *know* can cancel its presupposition. In the future, the experimenter should deliver the clues in a more naturalistic manner, taking care not to produce infelicitous stress patterns.
- **Positive feedback:** In Study 1, participants always got positive feedback because there would be a toy hidden in both of the potential locations, despite what an adult-like understanding of the clue would suggest. Perhaps children with initial, or weak representations of *know* were unsure which box they should pick, and they guessed the first time they heard the relevant sentence. If they then found the toy in the non-adult-like location, perhaps they took this a feedback and updated their

representation to be non-factive. In order to control for this possibility, we should only hide toys in the locations that are consistent with adult behavior in the task.

- **Confusing labels for hiding locations:** In Study 1, our toy hiding locations were two boxes covered in polka dots. One box was a deep red color, which could be considered a relatively prototypical red. However, the “blue” box was actually closer to an aquamarine color. Thus, both the patterns and the colors of the boxes were not necessarily described as expected in the test items. Given that children are still mastering the extension of color terms in the preschool years, they might have been confused about the application of the terms *red* and *blue* to describe these boxes. Future studies would need to use more prototypical colors with no patterns.
- **Short age range:** In study 1, we test participants between their 3rd and 4th birthdays. Perhaps no development in understanding of the *know* occurs within this age range. In order to determine what kind of age effect might hold, we should extend the age range to include ages at which we know children have mastered the factivity of *know*, such as over 4 years.

4.5 Study 2

Despite trying to control for task artifacts that arose in the previous literature, Study 1 still failed to create a completely felicitous task. Furthermore, the task was not entirely appropriate to determine the nature of individual variation in understanding of *know*. Study 2 was designed to improve the paradigm by controlling for these issues and artifacts to determine whether children’s performance changes.

4.5.1 Methodology

The methodology for Study 2 is largely adopted from Study 1, with some changes. Experimenter 1 (E1) hides a toy in one of two boxes for the participant to find while an occluder blocks the participant's view. The hidden toys 'belong' to Experimenter 2 (E2, "Chris") but he is not very invested in the game, so he may or may not see where they are hidden. When E2 ducks into a cupboard to pick a toy for the next trial, E1 stage whispers test items to the participant as 'secret' clues to the toy's location. The test items are the same as in Study 1, with the exception of having a different subject (91).

- (91)
- a. Chris doesn't know that it's in the red box.
 - b. Chris doesn't think that it's in the red box.
 - c. Chris knows that it's in the red box.
 - d. Chris thinks that it's in the red box.
 - e. Chris knows that it's not in the red box.
 - f. Chris thinks that it's not in the red box.

In order to address the issues with Study 1, we changed the following aspects of the paradigm:

- **Number of observations:** doubled to six trials per condition.
- **Identity of attitude holder:** changed to adult experimenter, who is absent when test sentences are uttered.
- **Role of attitude holder:** to keep track of the toys that are played with and decide which toys to hide next. This experimenter keeps notes about the toys on coding

sheet, so could have seen where toys were hidden, or could be distracted with book-keeping task. At test, this experimenter is occupied with picking toy for next trial.

- **Delivery of test items:** clues are delivered in a whisper, and stress patterns are controlled.
- **Feedback:** toys are hidden only in the location that adults look for them (verified by norming study, n=12).
- **Location labels:** locations are more appropriate given labels *blue box* and *red box*. Solid hues that are vivid and prototypical.
- **Age range:** increased to 4.5 years.

4.5.2 Participants

Child participants were 28 three-year-olds (age range: 3;0-4;6 years;months, mean age: 3;8). All children were reported to be monolingual speakers of English by their parents and all were recruited from the University of Maryland Infant Studies Database. Seven adults also participated and were paid at a rate of \$10/hour.

4.5.3 Results

4.5.3.1 Adult results

Adult data (n=7) is given in Figure 4.7. Adults always chose the mentioned box for *think*-none, *know*-none, and *know*-matrix trials. They never chose the mentioned box

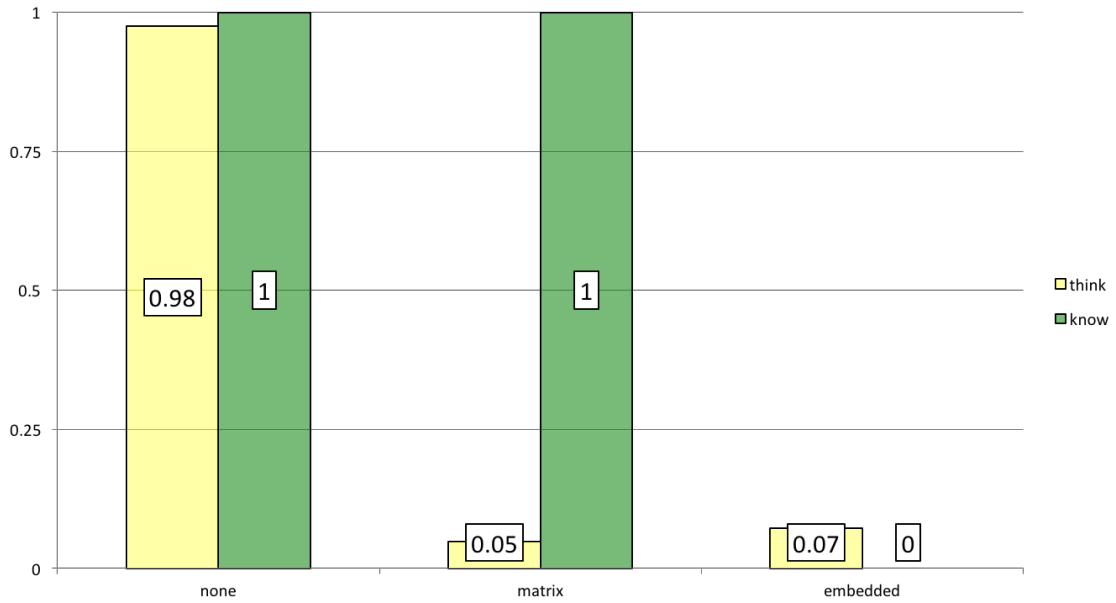


Figure 4.7: Adult performance, Study 2

for *think*-embedded, *know*-embedded, and *think*-embedded trials. This is the expected pattern of responses.

4.5.3.2 Child results

Child participants' data (n=28) is given in Figure 4.8. Children overwhelmingly pick the mentioned box when they hear *think*-none (87%) and *know*-none (95%) sentences. They predominantly pick the other box when they hear *think*-matrix (80%), *think*-embedded (80%) and *know*-embedded (90%) sentences. In the *know*-matrix condition, children only picked the mentioned box on 52% of trials. Notice that adult performance and child performance are comparable in all conditions except *know*-matrix, where children's performance is similar to Study 1.

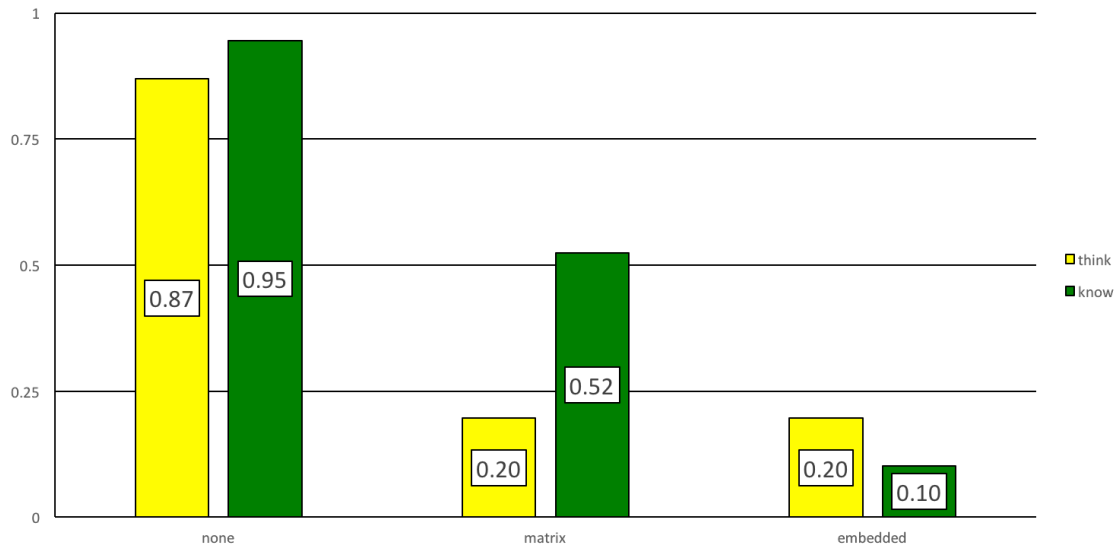


Figure 4.8: Children's performance, Study 2

4.5.3.3 Age effects

What explains the group's performance on *know*-matrix trials? Are children merely guessing in this condition, or are there systematic differences in children's performance? If different children understand the verbs differently, then what explains that variation? Are children's responses in the critical conditions (*know*-matrix and *think*-matrix) consistent with an age effect? Plots of individual variation in performance on these trials are given in Figure 4.9 and 4.10, respectively. Similar plots for the other conditions are given in Appendix A.

Figure 4.9 shows that there is variation across the entire age range in children's performance on *know*-matrix trials. Children do not seem to be clustered around 52% accuracy, which would be consistent with the entire group of children guessing. Instead, some children are clustered around 100% accuracy, others are clustered around 0% accuracy and there are a range of different patterns of response in between. What explains this

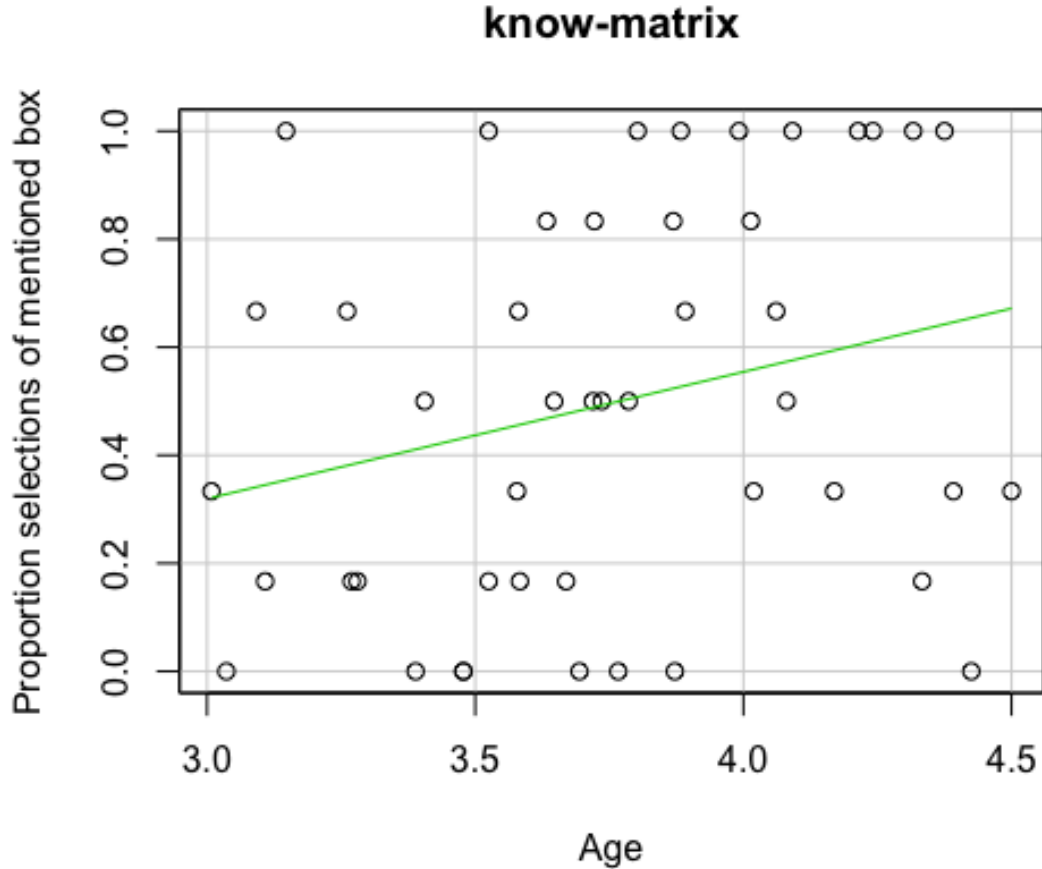


Figure 4.9: Individual performance in *know*-matrix condition, Study 2

systematic variation? There seems to be a correlation between age and how often children infer that the complement is true, as measured by their selections of the mentioned box. But this correlation doesn't explain too much of the variation in children's performance given the spread of the data. In contrast, Figure 4.10 shows that there is almost no age-related variation in how likely children are to infer that the complement is true with *think*-matrix items.

Using age (continuous) and sentence-type (*think*-matrix/*know*-matrix) as predictors, multiple regression analysis indicated that the two predictors and their interaction

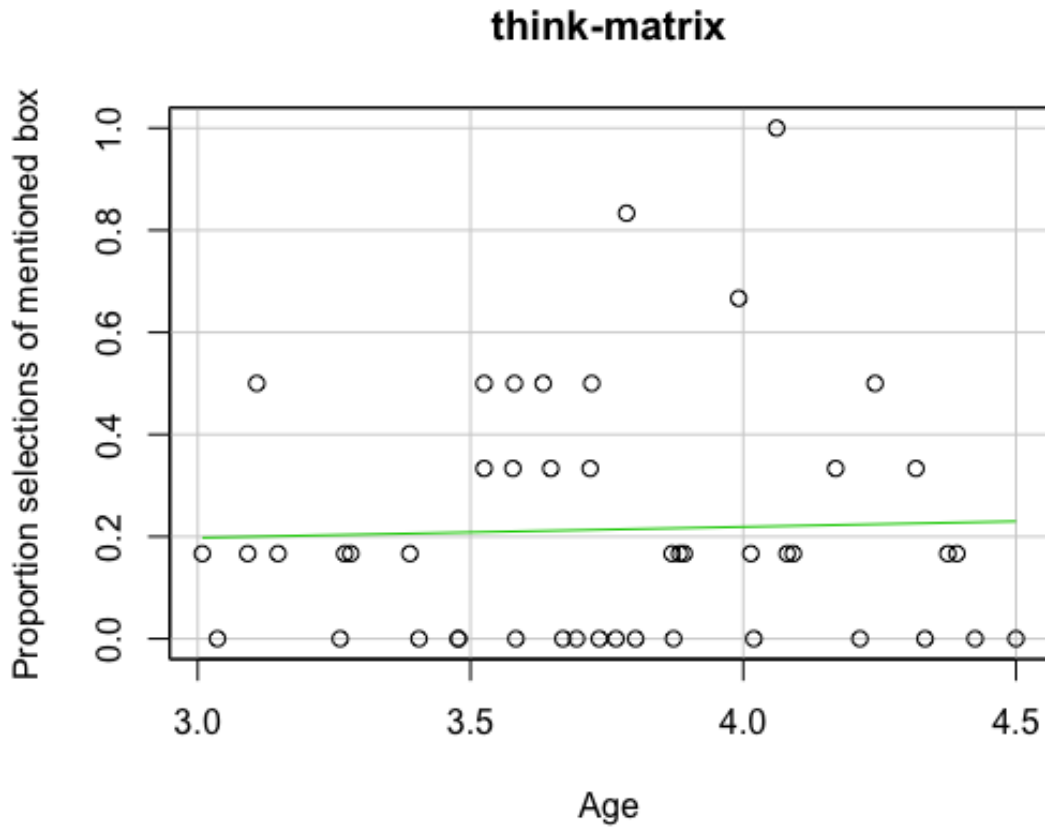


Figure 4.10: Individual performance in *think*-matrix condition, Study 2

term explained some of the variance ($R^2 = .1528$, $F_{3,332} = 19.96$, $p \ll .01$). Age ($\beta = .009$, $p \ll .01$), sentence-type ($\beta = .606$, $p < .04$), and their interaction ($\beta = .014$, $p \ll .01$) significantly predicted performance. Children were more likely to pick the mentioned box when they heard *know*-matrix sentences than when they heard *think*-matrix sentences and this tendency increased with age. Selections of the mentioned-box were correlated with age in the *know*-matrix condition, but only with marginal significance ($r = .34$, $p < .08$), and were not correlated with age in the *think*-matrix condition ($r = -.01$, $p < .97$).

4.5.4 Discussion

The purpose of Study 2 was to confirm the findings of Study 1. The results of Study 1 suggested that children had all mastered the non-factivity of *think* by 3 years, but that the factivity of *know* was mastered gradually by different children across this age range.

Study 2 finds slightly better performance within particular conditions, but the pattern of responses is similar to that of Study 1. Perhaps controlling for all the potential task artifacts leads to a more felicitous experimental context, or perhaps this increased performance is more related to the slightly older age of children in Study 2.

Children as a group have a non-factive representation of *think* and this representation does not significantly change across the preschool years. In contrast, representations of *know* show substantial variation across this age range. Some children seem to have a factive *know* and others seem to have a non-factive *know*. Given that conceptual understanding emerges at much younger ages, these differences between children's understanding of *know* are probably more related to how much experience they have with the verb.

This individual variation in understanding of *know* is not well related with age, so the relevant aspects of experience with *know* that differ may not be related to a child's age. We only found a marginal effect of age on performance in the *know*-matrix condition. But there are two possible explanations of why this effect is only marginal: perhaps age is truly a factor in developing adult-like representations of *know* and a larger sample would help us find this, or perhaps the effect looks marginal because younger children are underrepresented within the sample, and a few noisy data points bring down the average

performance within their age range. In order to distinguish between these options, we would have to more evenly sample children across the different age ranges.

4.6 Remaining questions

Setting aside whether there is a true effect of age on children performance and therefore their developing representations, these results raise big questions about children's representations of *know* in the preschool years. What accounts for the unexpected behavior in this task? Why do some children fail to pick the mentioned box when they hear *know*-matrix sentences? There are several possibilities that this series of studies cannot rule out:

- **Non-factive *know*:** these tasks get at exactly what is intended with adults. Some children have not developed a factive representation of *know*. Instead it may be merely veridical, or even non-veridical.
- ***Know* as hard trigger:** children represent *know* as hard trigger, unlike adults. Infelicity results when the speaker presuppositions of the *know* test items are unsupported in the discourse and they fail to accommodate it.
- ***Know* as even softer trigger:** children represent *know* as an even 'softer' trigger than adults would. As a result, presuppositions are very easily cancelable for them. But this seems implausible, given that a trigger which is any 'softer' would hardly be a trigger.
- **Failure to accommodate the presupposition:** children have an adult-like repre-

sentation of *know*, but fail to globally accommodate the unsupported presupposition in this particular case. This presupposition failure happens the same way it would with adults. Perhaps children have different limits in how willing they are to accommodate (Hamburger and Crain 1982, Crain et al. 1993). Adults are generally less likely to accommodate informative presuppositions when the stakes are high (e.g., presupposing election results on election day). Perhaps finding the toy is so important to children that they are unwilling to take the experimenter at her word (especially because she is the one hiding the toys and might be interpreted as trying to keep the child from succeeding). This cannot be the whole story, however, because reluctance to accommodate should lead to non-adult performance across *know* conditions and it only does in the *know*-matrix condition.

There must be some additional reason that the matrix negation sentences do not lead to accepting the truth of the complement while the others do. Future work should directly test whether children can perform adult-like on tasks that do not require accommodation, although this might be difficult considering children's Theory of Mind abilities at this age. In order to set up a task that doesn't require accommodation, the child has to be aware of the truth of *know*'s complement but respond to some other aspect of sentence in context. However, past studies with similar test sentences have found that children at this age have a hard time putting aside what they know to be true in order to respond to the truth of the sentence (Wellman et al. 2001, Sowalsky et al. 2009, Lewis et al. 2013, Lewis 2013, Harrigan et al. under review).

- **Local accommodation failure:** these children have an adult-like semantics for *know*. They differ from adults in this task by favoring local, rather than global accommodation of the presupposition. However, work by Bill et al. (2014) suggests that this is not likely since those authors find that children do not locally accommodate in their study.
- **Processing failure:** children have to represent presupposition, entailment-canceling operators, and the accommodation inference has to go through, and children have to plan a behavioral response. Perhaps children have the right representations, but fail to put all these pieces together in these tasks (see Hamburger and Crain 1984)? As children get older, executive functioning abilities develop and this process is more likely to succeed.

Consider the processing demands to succeed on our task. Children hear clues in the absence of context. Upon hearing the sentence “Lambchop doesn’t *know* that it’s in the red box”, they have to realize that the speaker used a factive verb, which presupposes the truth of its complement. They then have to infer from her use of ‘know’ that the speaker takes it for granted that the toy is in the red box. If the speaker takes it for granted that it’s in the red box (and is in a good position to be justified in doing so, since she hid the toy), it must be that it is in the red box. Children should then choose the red box. It is possible that for some children, this inference process is too demanding. In effect, they would have all the right pieces but they would be unable put them together in this task.

- **Multiple sources of performance:** two or more of the above possibilities co-exist,

in different groups of children.

4.7 Outlook from behavioral studies

What does the broader literature, including Study 1 and Study 2 tell us about the representations that children develop for *know* and *think*?

For *think*, previous studies suggest that the adult-like non-veridical and non-factive representation is in place by 4 years. But what is happening at 3? Two types of hypotheses were consistent with that literature: semantic and pragmatic ones. Under a semantic error hypothesis, children might have either a factive or veridical representation of *think*. If they had a factive representation, it would be very similar to adult understanding of *know*. If they had a veridical representation, they might assume that *think* can only report on true beliefs, but we would not expect to see projection. Under a pragmatic error account, children would have an adult-like representation, but they would assume that speaker intended to proffer the truth of the complement in uttering attitude reports with *think*.

The results of Study 1 and 2 rule out the possibility that typical errors with *think* in false belief scenarios are due to a factive representation for *think*. But that leaves us with the veridical version of a semantic error and the pragmatic error. Can these be distinguished at all? Many other accounts (such as those from Lewis and colleagues) appeal to pragmatic explanations of these errors, and they can be taken to explain a broader set of facts within the literature, including typical errors that children make in false belief tasks without *think*, as well as the order that children seem to master different Theory of Mind tasks (Wellman and Liu 2004, Westra 2016, Westra and Carruthers 2016). Prag-

matic accounts also provide possible explanations of why explicit knowledge access tasks are passed earlier than explicit false belief tasks, given that the test questions in knowledge access tasks do not present the same pragmatic issues as those in explicit false belief tasks. Furthermore, an account based on a veridicality error would be somewhat inconsistent with children's early successes on diverse belief tasks (see Wellman and Liu 2004 for discussion of these tasks). As a result, pragmatic accounts of early *think* errors seem to be most explanatory, but can we get any further evidence for such accounts if we examine children's input with *think* and consider what kinds of representations that input would make available? What would it mean for children to make the initial representational mistake that *think* is veridical and could they ultimately correct it by 4 years?

For *know*, the previous literature indicated that understanding of factivity did not emerge before 4 years, but Study 1 and Study 2 suggest that it does for some children, assuming that these studies are a straightforward assessment of the underlying representations. These studies show that adult-like behavior emerges during the preschool years, but at different times for different children. For some children, a factive representation emerges as early as 3, and for some later than 4.5 years. But what is puzzling is the difference in the amount of individual variation for the two verbs. Can children's input with *know* illuminate why there is so much variation?

Chapter 5

Corpus study

5.1 Research questions

How available are these different routes to the contrast? Are veridicality and factivity cues from the discourse status of the complement available, despite the ‘softness’ or *know* and the ‘assertivity’ of *think*? How available are syntactic and discourse function cues? Are these different kinds of complements or different speech acts present in linguistic input? If so, does the child use these kinds of cues in acquiring the difference between *know* and *think*? As of yet, there are no empirical findings showing that distributions of these verbs differ in speech to children at this level of granularity, nor that children utilize these kinds of cues in acquiring (non-)factivity.

5.2 Methods

To investigate which cues are made available to children, we examined tokens of *know* and *think* in child ambient speech from the Gleason corpus in CHILDES (Masur and 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-class¹. The ages of the

¹This specific corpus was chosen with the ultimate goal being a comparison with corpora of families from different demographic groups in future work.

target children in this corpus range from 2-5 years, but the average age is about 3.5.

The corpus includes dinner conversations in the home, as well as 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, but 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 and put back together; reading a picture book with no words; and playing with a grocery store set. Together these four activities—dinner conversations, take-apart 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% of all child ambient utterances and *think* occurred in 3.5% of them.

5.3 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 (92-94), tense (95-97), negation (98-99), complements (100-104) and types of clauses (105-107) that the verbs occur with, as well as the projective contexts that they occur in (108-111) and the status of the information that their declarative complements express (112-114). The possible codes for each category are illustrated below with ac-

tual examples from the Gleason corpus. Syntax-level codes (i.e., subject, tense, negation, complement, clause, projective contexts) were made based on examining the utterance in isolation and therefore in the absence of any information about the surrounding discourse. Discourse-level codes (i.e., status of information in complement clauses) 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.

Syntactic contexts

1. *subject-type*

(92) **1st**

a. I know we'll find a place. (father of Charlie, aged 2;11 years;months, play context)

b. I think so too. (father of Theresa, aged 4;2 years;months, dinner context)

(93) **2nd**

a. You know them pears that was there? (sister of Guy, 3;0, dinner)

b. You think you're a little pig. (mother of William, 2;3, dinner)

(94) **other** (3rd person subjects, definites, null subjects, etc.)

- a. She knows I'm going away. (mother of Victor, 2;4, dinner)
- b. He thinks it's a good place. (father of Susan, 3;2, play)

2. *tense-types*

(95) **present**

- a. You know this room very well, huh? (father of Wanda, 4;0, play)
- b. I think this is called a wrench. (mother of Patricia, 2;5, play)

(96) **past**

- a. I thought you liked it? (mother of Helen, 4;4, dinner)
- b. Knew you would. (mother of Nanette, 2;2, dinner)

(97) **other** (infinitive, future, etc.)

- a. I wanted to know if I'd heard of her doctors. (father of Martin, 2;6, dinner)
- b. I'm trying to think of what we have here. (mother of David, 4;2, dinner)

3. *negation-type*

(98) **absent**: no negation present in attitude clause

- a. I think the only thing to eat is mustard. (mother of Guy, 3;0, play)
- b. I know it's not a big favor. (mother of Victor, 2;4, dinner)

(99) **present**: negation present in attitude clause

- a. I don't think there was a single Republican who had no opposition. (father of John, 4;2, dinner)
- b. I didn't know you sold books here. (mother of Xavia, 4;0, play)

4. *complement-type*

(100) **declarative** (both finite and non-finite)

- a. I know they better get a second car. (mother of Patricia, 2;5, dinner)
- b. Do you think he'll do it? (father of William, 2;3, play)

(101) **interrogative**

- a. You know what those are? (mother of Charlie, 3;0, dinner)
- b. I don't know if it matters. (father of Martin, 2;6, play)

(102) **noun phrase**

- a. I know it. (father of Laurel, 3;0), dinner)
- b. Do you know any of the numbers? (father of Patricia, 2;6, play)

(103) **preposition phrase**

- a. She doesn't know about it yet. (mother of Katie, 3;2, dinner)
- b. I just thought of something else I needed. (father of Frank, 5;2, play)

(104) **null**

- a. I just don't know. (mother of David, 4;2, dinner)
- b. What do you think? (mother of Guy, 3;0, play)

5. *clause-type*²

(105) **declarative:**

- a. I don't know. (mother of Victor, 2;4, dinner)
- b. Because they think they're too young. (mother of Nanette, 2;2, dinner)

(106) **polar interrogative:**

- a. Ya know what happened? (mother of Bobby, 4;2, dinner)
- b. Do you think you can tell Rachel what you're doing? (father of Helen (4;11, play)

(107) **wh-interrogative**

- a. How do you know that? (mother of William, 2;3, dinner)
- b. What do you think? (mother of Eddie, 4;3, play)

6. *projective contexts*

(108) **negation**

- a. I don't think there was a single Republican who had no opposition. (father of John, 4;2, dinner)
- b. I didn't know you sold books here. (mother of Xavia, 4;0, play)

(109) **questions**

- a. Ya know what happened? (mother of Bobby, 4;2, dinner)

²Imperatives are not included in this coding scheme because they did not occur with *know* and *think* in this corpus.

b. Do you think you can tell Rachel what you're doing? (father of Helen (4;11, play)

(110) **modals**

a. Perhaps he thinks the pipe is too small for them. (father of Susan, 3;2, play)

b. Then you probably know how it works. (mother of Wanda, 3;11, play)

(111) **conditionals**

a. How are you gonna call if you don't know what his name is? (father of Charlie, 2;11, play)

b. So if Wanda thought about something, she went like this. (father of Wanda, 4;0, dinner)

Discourse contexts

vii. *status of information in complement clause*

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

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

mother: That's true.

mother: Jimmy Carter would win.

father: I just wanted to make sure last time.

mother: That what?

sister: I going in there.

mother: I don't think so.

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.

sister: Please.

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

a. conversation with Isadora (3;7) during grocery-set play interaction, participants include the target child and her father:

father: But we're gonna do shop for some breakfast food.

father: Right?

father: I wanna good cereal.

father: Can you find a good cereal in your store for me?

child: Mhm.

father: Which kind of good cereal is that?

child: Um there's drinks in here too.

father: There're drinks too?

child: You could have hot dogs.

father: Not for breakfast.

child: Mhm.

father: Well.

father: Look.

father: I know I want some milk.

father: Can I have one of these?

- (114) **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
- a. conversation with Victor (2;3) during picture-book play interaction, participants include the target child and his mother:

mother: Okay.

child: Are dey in dere?

mother: I don't see them in the front.

mother: Where are they?

child: In here.

mother: Here.

mother: Lemme see.

child: What, Mama?

mother: May I see?

child: Don't take a peek.

mother: Take a peek?

child: No.

mother: Don't take a peek.

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.

All utterances were coded using this scheme 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 syntactic-level categories to be checked (tense-type and complement-type). For all syntax-level categories, intercoder 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,

intercoder 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.

5.4 Results

5.4.1 Veridicality cues

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 5.1. We find that the verbs are most often used with subjects that refer to the conversational participants, given that subjects which were not first or second person 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, $\chi^2(2, N = 2387) = 236.1, p < .00001$. Speaker's beliefs were discussed most

with *think* and addressee's beliefs were discussed most with *know*.

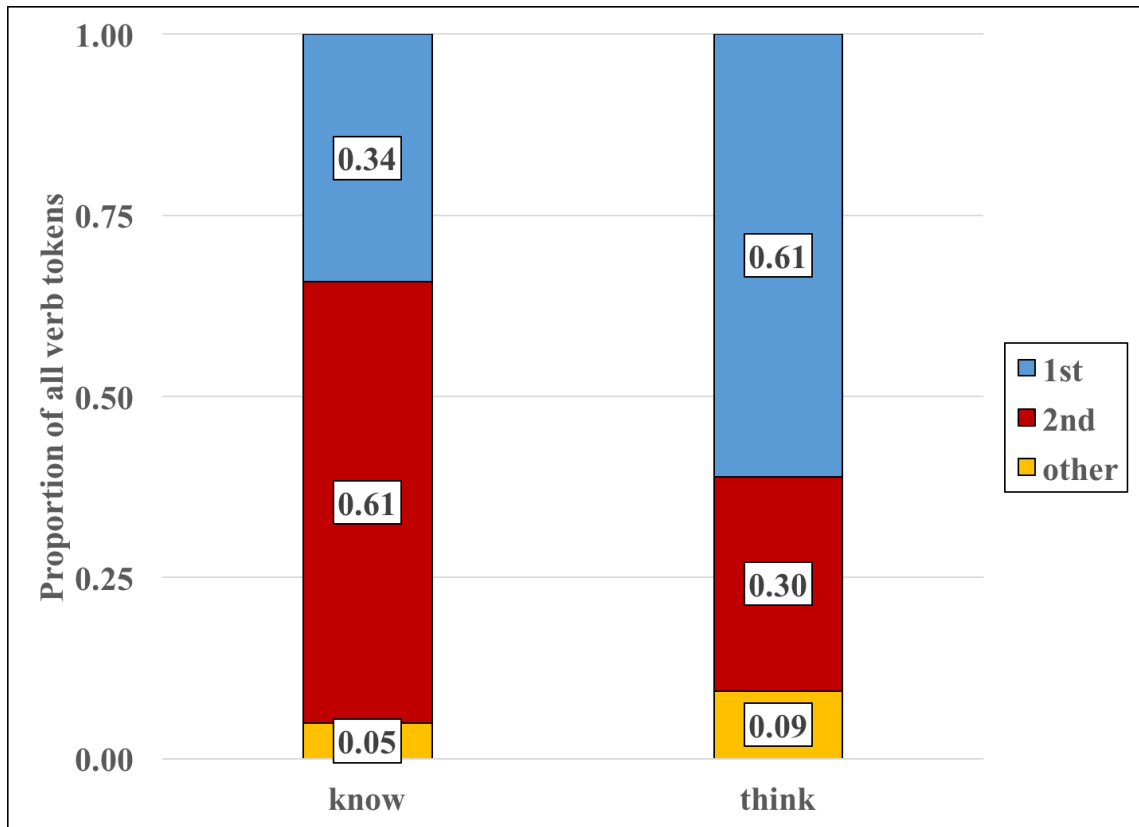


Figure 5.1: Subject-types within the Gleason sample, as a proportion of each verb

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 5.2. We find that both verbs occur most often in the present tense (95% of *know* tokens and 91% of *think* tokens). Past tense 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, as opposed to formerly held.

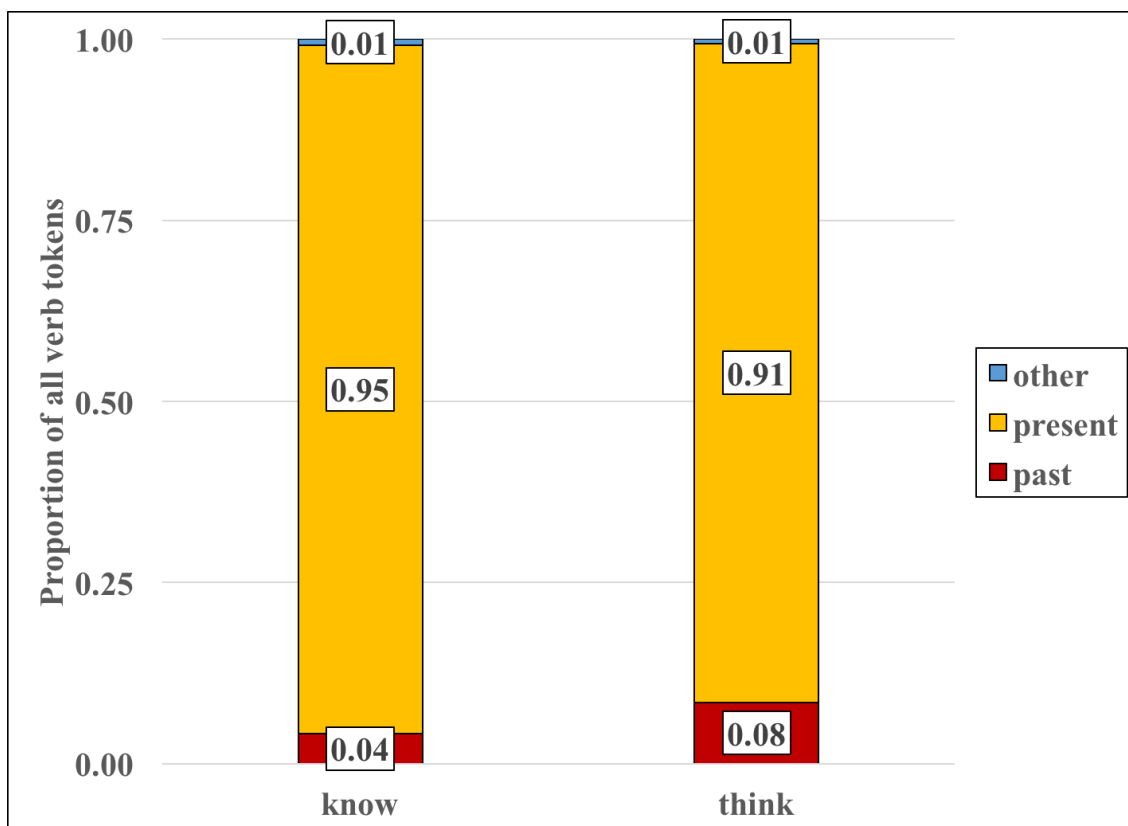


Figure 5.2: Tense-types within the Gleason sample, as a proportion of each verb

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, there are some questions, but these are unlikely to report false beliefs either. 13.6% of *think* tokens are questions like *What do you think?* which clearly do not report false beliefs. And 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 the the majority of *think* tokens (approximately 75%) are

these *I think p* or *what do you think?* or *do you think p?* tokens, there are very few opportunities to observe *think* as reporting a false belief overall. See Figures 5.6 and 5.7 and accompanying discussion in Section 5.4.4 for more details on questions in the sample and the relationship to subject-types.

5.4.2 Factivity cues

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.³ In our corpus there were 796 *x thinks p* tokens and only 131 *x knows p* tokens.⁴ For more details on what other complements occur in the corpus, see Section 5.4.3.

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 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

³Declarative 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 could not be sure to recover the right complement type for null, or non-expressed, complements.

⁴We also filtered out tokens with declarative complements if they were in *wh*-questions or if part of the complement was unintelligible (marked in CHILDES transcripts as “xxx”) such that the corresponding proposition was unrecoverable.

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 5.3.

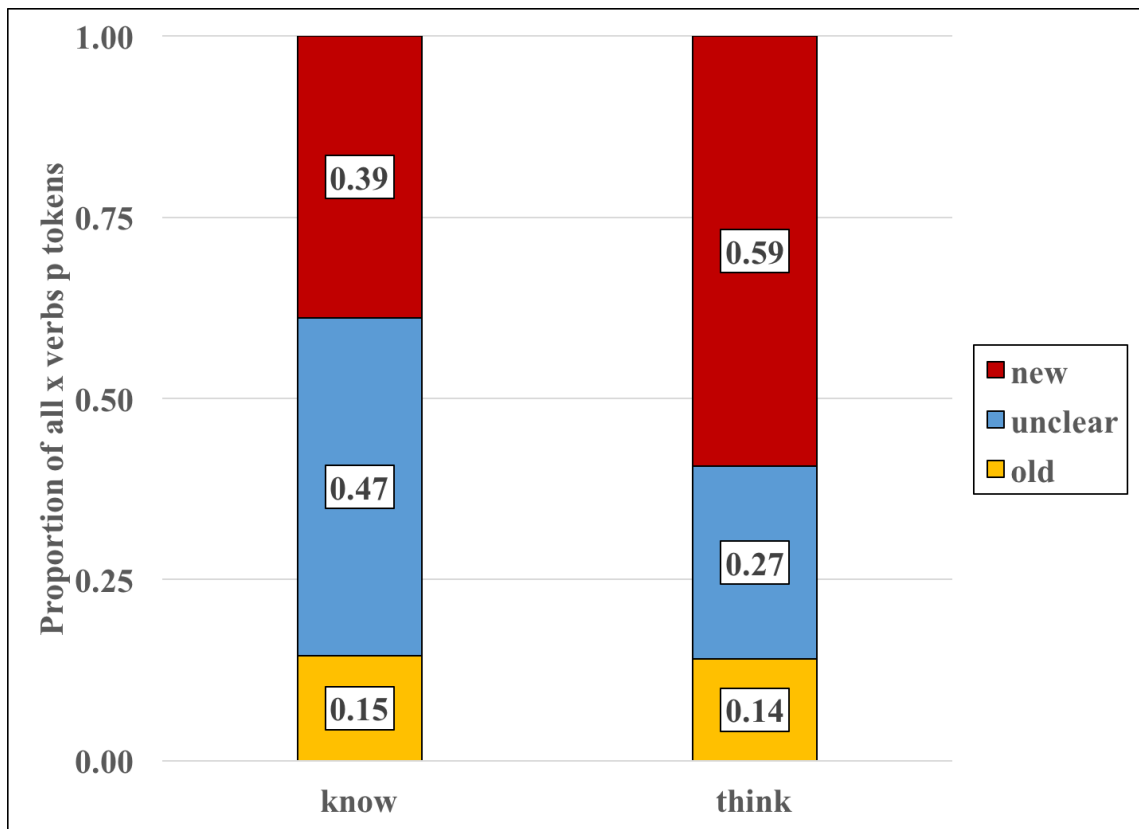


Figure 5.3: Status of the complements within the Gleason sample, as a proportion of x verbs p tokens for each verb

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, $\chi^2(2, N = 259) = 12.59, p < .002$. 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 indicative of the 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 Hart and Risley’s (1995) data, 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 kinds of sampling issues that arise with 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 (114) 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.

Finally, we also examined how often these *x knows p* tokens occurred in p-family contexts which could be informative about the projection behavior of *know*. We found that out of the 131 *x knows p* tokens, only 50 of them (36%) occurred in projective contexts and they were exclusively under negation and question operators (with no conditional

or modal contexts). Negation data is presented here in Figure 5.4 and question data is presented in Figure 5.6 in Section 5.4.4.

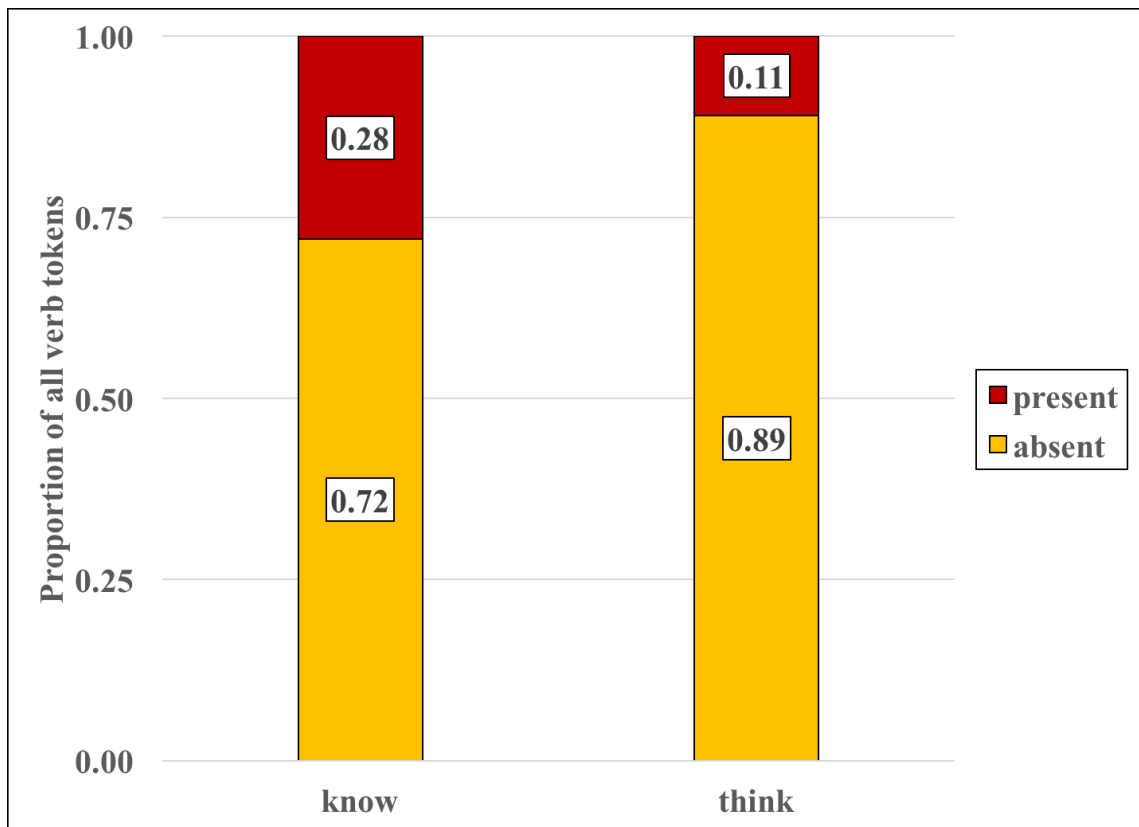


Figure 5.4: Negation-types within the Gleason sample, as a proportion of each verb

Now, there are some important caveats in considering our data. Our discourse-level coders failed to become reliable ($\kappa = .44$). This could be taken to suggest that our coding scheme was not appropriate to handle this task. It could also be taken to suggest that this task—tracking whether propositions are new or 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—or more difficulty for that matter—to our coders in deciding what the status of p is when they hear x *knows* p or x *thinks* p .

5.4.3 Syntactic cues

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 5.5.

Know takes declarative complements, as we saw before in Section 5.4.2, 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). This kind of distribution would support a syntactic bootstrapping route to the contrast assuming a principled link between responsive predicates (those which embed both interrogative and declarative complements) and factivity (or veridicality).

5.4.4 Discourse function cues

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 functions in speech to children.

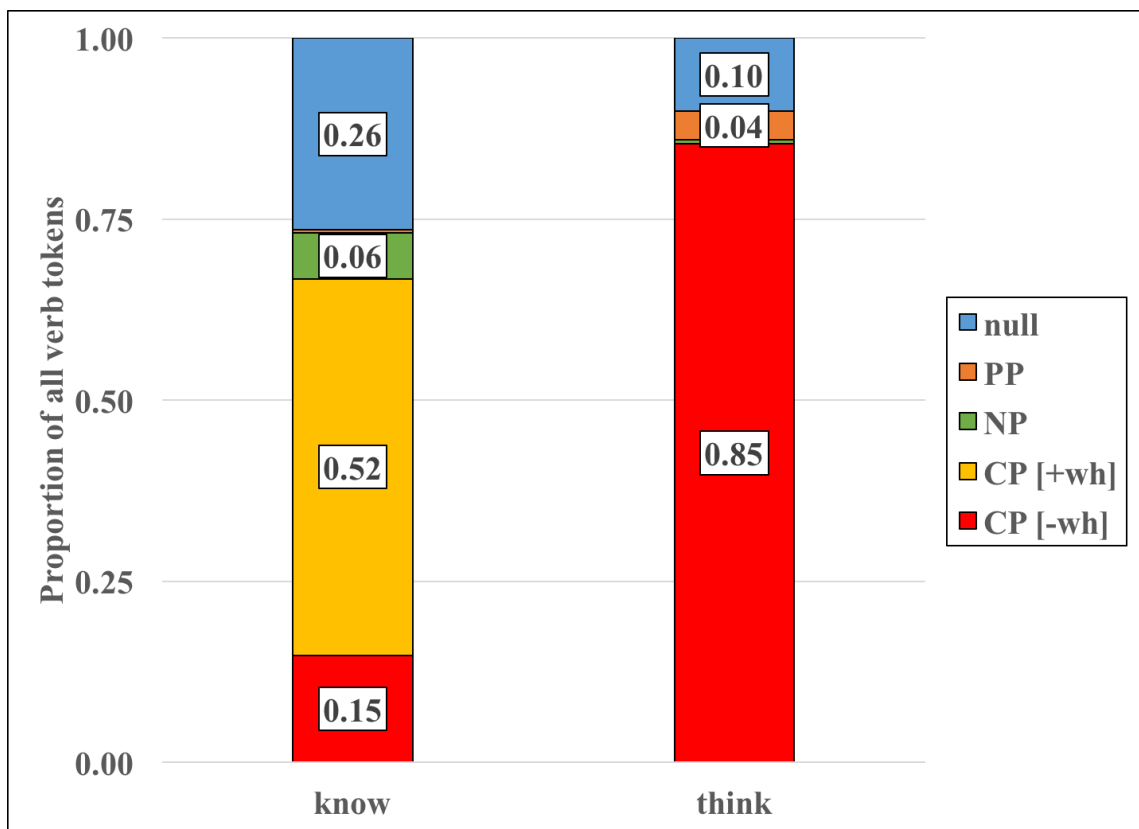


Figure 5.5: Complement-types within the Gleason sample, as a proportion of each verb

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 5.6 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, $\chi^2 (2, N = 2387) = 310.83, p < .00001$. 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.

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 5.7). 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 than claim what they are. A chi-square test of independence was performed to

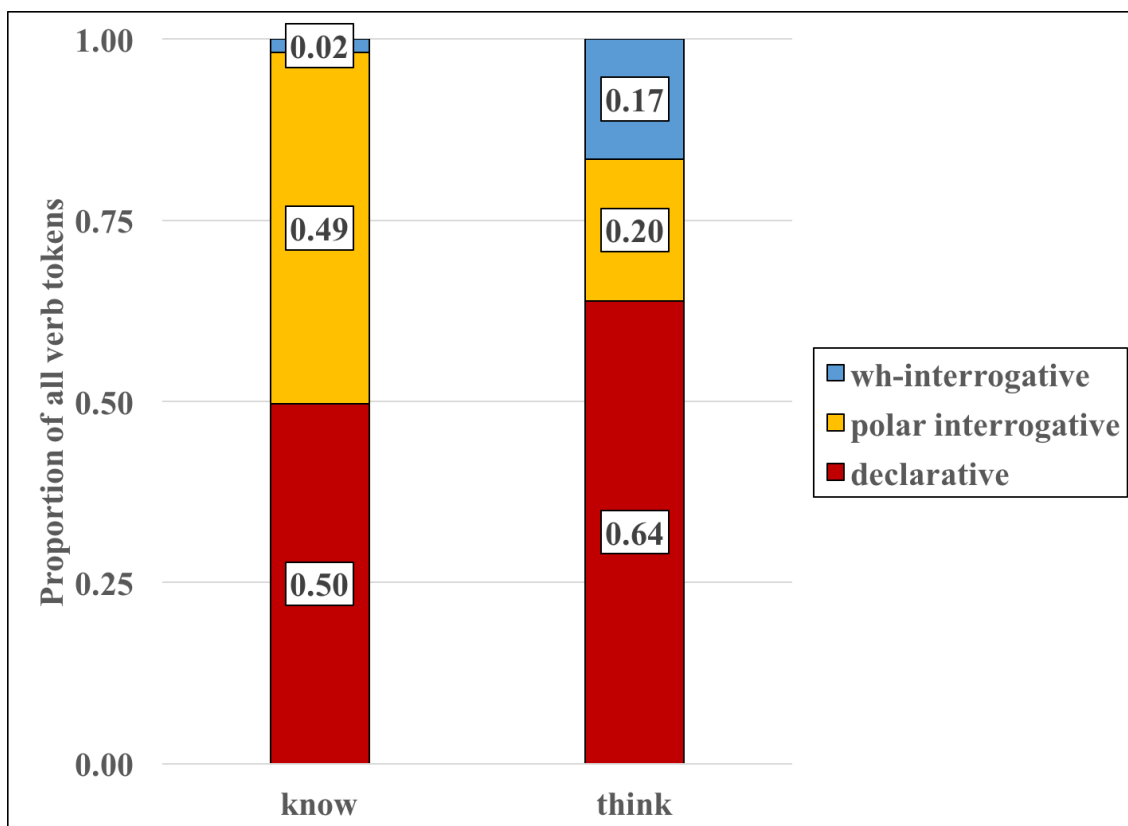


Figure 5.6: Clause-types within the Gleason sample, as a proportion of each verb

verify this relationship between clause-type and subject-type within our sample of belief verbs. The relation between these variables was significant, $\chi^2(2, N = 2387) = 1445.57$, $p < .00001$. In talking to children, we do tend to ask questions about the beliefs of others and assert things about our own beliefs, instead of interrogating our own beliefs and declaring others' beliefs.

The data presented here suggest that *know* is used typically with (i) second person subjects (Figure 5.1), (ii) interrogative clauses (Figure 5.6), and (iii) interrogative complements (Figure 5.5), while *think* is typically used with (i) first person subjects, (ii) declarative clauses, and (iii) declarative complements. This data is reflective of the kinds of indirect speech acts that *know* and *think* can be used to achieve. We know that there is

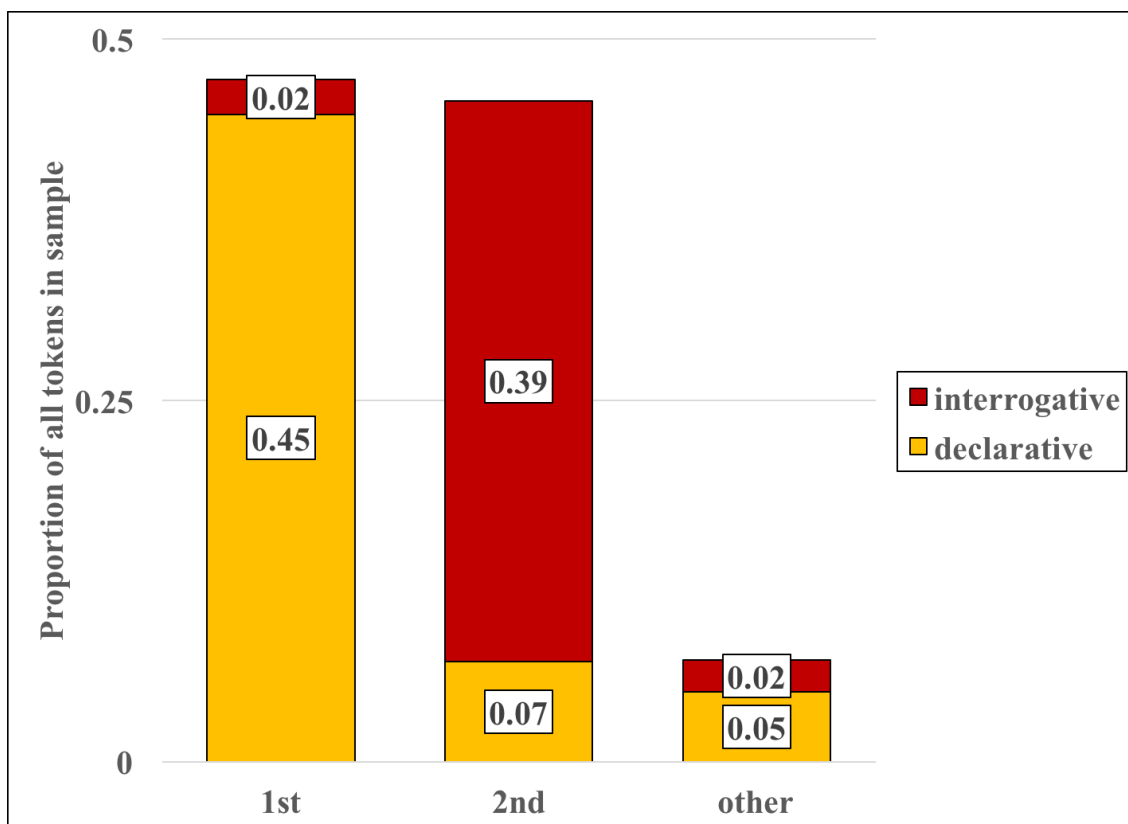


Figure 5.7: Clause-types by subject-types, as a proportion of entire Gleason sample

a relationship between subject-types and clause-types (Figure 5.7). 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 16a)? And how often do first person *think* assertions have declarative complements, compatible with indirect assertions (as in 17)?

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 (115) or to answer questions (33.5% of all *know* tokens are assertions with first person subjects) as in (116). 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, declara-

tive complements and no negation) as in (117). This suggests that, in speech to children, *know* is most often used to request information or to answer requests for information, while *think* is used to express commitment to some proposition.

(115) 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.

(116) 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)

(117) 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.

In addition to the kind of example in (115), 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, or they say *What?*, rather than expressing ignorance or saying that they do know:

(118) 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.

Now, to consider 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 5.7) in differentiating the verbs, the cue validity values remain higher than those discussed for the discourse status cues to factivity in Section 5.4.2. 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 indirect 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*.

5.5 Discussion

5.5.1 Discourse status cues

With this corpus study, we investigated the reliability of discourse status cues to the veridicality and factivity 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*.

To answer the first question, we find that *think* is most frequently used to discuss the speaker’s beliefs (see Figure 5.1). Moreover, these first person *think* sentences were rarely used in the past (Figure 5.2) or with negation (see Figure 5.4). Thus, in children’s experience, speakers are often committed to the truth of the complements of *think* (see also Diessel and Tomasello 2001, Lewis 2013, 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.

To answer the second question, we found that there was a difference in how often *know* vs. *think* was used to describe discourse-old vs. new information. But this difference (approx. a 40% - 60% split under the most generous estimates) was not of the kind that we would expect if children need to use the discourse status 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, and see studies reported in Chapter 4). And we find that projective contexts are rare with these *x knows p* tokens, suggesting that they might not be the most readily available contexts from which to learn about the factivity of *know*.

5.5.2 Syntactic cues

These results suggest that, in children’s experience, the overall syntactic distribution of *know* differs from that of *think*. Furthermore, these distributions would support the generalization underlying a syntactic bootstrapping approach to factivity given that *know* occurs with both declarative and interrogative complements while *think* does not take both kinds.

However, problematic to the generalization that factivity correlates with the ability to embed declarative and interrogative complements are its various counterexamples: Proffering verbs (*say, tell*) take questions but they are not factive (though, they can have “factive” uses, see Schlenker 2010, Spector and Egge 2014, Anand and Hacquard 2014); *decide* and *be certain* can also take questions, but they are not factive. Some of these counterexamples may not be too problematic since they are not verbs that children learn early on, and could thus 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.

5.5.3 Discourse function cues

We have seen that the way speakers use *think* and *know*, notable in the kinds of indirect speech acts these verbs are routinely used for can provide cues as to their underlying meaning. *Think* is mainly used for indirect assertions with 1st 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. In contrast, *know* is mainly used for indirect questions with 2nd person subjects. If the child understands that the speaker is indirectly asking the addressee *Q?* through these *Do you know Q?* questions, the child may infer that *know* relates the subject to the true answer to *Q*.

5.6 Comparing cues

With the corpus study described above, 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. 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.

As for discourse status cues to their (non-)veridicality and (non-)factivity, the 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 would be obscured by the fact that *x knows p* tokens are not systematically used in contexts where *p* is common knowledge.

In order to use the discourse status 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, whereas they aren't 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 can fail. We know that the relevant data is made available, but is very sparsely distributed across children's experience and the relative differences between *know* and its comparison case *think* are small. We know that these small differences are statistically significant, but we do not know if they are cognitively significant, or salient, to children. Speaker presuppositions are backgrounded such that children might fail to attend to them, and many speaker presuppositions are not candidates for conventional encoding in lexical representations. When children do attend to them and notice associations with particular words, they must then decide that this information needs to be conventionally encoded. While this is possible, much further work is needed to verify that the discourse status route is

taken, as opposed to the other possibilities that we lay out here. If the pragmatic view of the triggering problem is right for *know*, the pressure might be alleviated somewhat: perhaps all the child would need 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? We have growing support from other cases of attitude verb acquisition that syntactic bootstrapping is at play (see Harrigan et al. 2016, Lidz et al. 2016, more discussion in Chapter 3), 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 cues allow children to use pragmatic bootstrapping to discover the factivity contrast for *know* and *think*. 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. Do we have evidence that children can do this? In some ways, the information required for the pragmatic route is the most salient information, given that it has social importance. As mentioned in Chapter 3, there is some evidence that children are sensitive to the assertivity of *think* (Urmson 1952, Hooper 1975; Shatz et al. 1983, Diessel and Tomasello 2001, Lewis et al. 2012, 2017)

and to the speaker's intentions in performing other indirect requests, but we have not previously had the same evidence for *know*. This corpus suggests that children do do this, as in the example in (118). However, it is not unreasonable to think that children would be able to do so, especially if there are some constrained contexts with good extralinguistic and paralinguistic cues to their parents' intentions. However, over-weighting these cues could lead the children to make certain errors, like mapping desires meanings for *think* and *know*, when they are used to make indirect commands in parent-child dialogues (e.g., *I don't think you should touch that!*).

5.7 Remaining questions

We examined a corpus of child-directed speech to determine which direct and indirect cues to the (non-)factivity of *know* and *think* are made available to children. With respect to direct cues to presupposition, 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 when *p* is in the common ground, and when compared with *think p* sentences, the rates of known vs. new information differ, but not very starkly. As a result, the child may not have reliable opportunities to observe that *know* is used to talk about established information—or 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 could use these cues, it would 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 in children's experience, 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...*). Given that both types of cues (from syntactic distributions and discourse functions) are available to children, could they 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. Perhaps so, but the appropriate generalization may be more complicated than just embedded these two kinds of complements (White and Rawlins, 2017a, 2017b). Could pragmatic bootstrapping alone be sufficient? Probably not, because it might backfire. While indirect assertions and indirect questions are routine with *think* and *know* respectively, these verbs can also be used in other kinds of indirect speech acts. An utterance like *I think it's time for bed* can be used as an indirect command to send one's child to bed. From this, we wouldn't want the child to conclude that *think* expresses some kind of desire. But here is where the syntax might help constrain pragmatic bootstrapping. These two sets of cues might be made even stronger together (see Hacquard 2014, White et al. in prep, Hacquard and Lidz under review, as well as discussion in Chapter sec:developmental). The syntactic information could help by filtering out the unruly cases

when the embedded clause type does not match the indirect speech act.

5.8 Outlook

When we consider the types of representations that children might develop for *know* and *think*, what kind of outlook do these input analyses leave us with? The connection between evidence and representations may not be straightforward, but what could we infer about the underlying representations if we assumed that it was straightforward?

Direct cues to factivity are relatively sparse in the input, and we have reasons to doubt whether children would even try to use them in the first place. Direct cues to veridicality are also sparse, but potentially more informative given that less evidence is needed to make a decision about non-veridicality (in principle—on the assumption that children wouldn't just think the speaker was mistaken, one false complement would serve). As a result, children may not be able to develop representations of *know* that are factive, unless we have a theory that derives factivity from veridicality, such as a pragmatic theory. And preliminary statistics suggest that if they were to learn that *know* is factive, they would also conclude that *think* is factive. And this doesn't seem likely, given the behavioral results discussed in Chapter 4.

Direct cues to veridicality are very sparse, but one or two cases could help a child figure out that *think* is non-veridical. Given the sparsity of such cues, not all children would get the relevant evidence, so we might not want to endorse these cues as the route. Particular because a child with exclusively “assertive” uses of *think* would be likely to conclude that it is a veridical verb, which is a conclusion that they wouldn't necessarily

be able to back away from by the time that they are 4 years old.

Can these results inform the debate between semantic and pragmatic theories of factive presupposition? Again, we must assume that the connection between evidence and representations is straightforward. But, if we do, then these data place a higher burden on semantic accounts. Since there is no evidence for the factivity of *know* (but only evidence for its veridicality), semantic accounts seem less tenable.

Chapter 6

Investigating the relationship between input and understanding

What kind of evidence do children use to uncover the factivity distinction between *know* and *think*? If we can we put corpus methods and behavioral methods together, we can measure the relationship between linguistic inputs and behavioral outcomes which are proxies for underlying knowledge of the word meanings. This chapter lays out a novel corpus study that we conducted and an accompanying behavioral task which compare children's experiences with and understanding of *know* and *think*. While only preliminary analyses have been finished, the results suggest that pragmatic sources of evidence from discourse function cues, potentially when used in conjunction with syntactic cues from the verbs' distributions, are most related to children's understanding of the underlying distinction between the verbs.

While laid out in great detail in Chapter 1, we can review the potential routes and corresponding input cues that are available in principle: cues from the discourse status of the complement, from syntactic distributions, and from discourse functions.

- (119) **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, and infer that *know* but not *think* is factive.

- (120) **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 always common knowledge but not whenever *x thinks p* is uttered. Conclude that *p* is a presupposition triggered by *x knows p* but not *x thinks p*.
- (121) **Syntactic cues via syntactic bootstrapping:** Pay attention to the syntactic distributions of *know* and *think*. Notice that *know* is a responsive verb which embeds both interrogative and declarative complements, while *think* isn't. Conclude that *know* but not *think* is factive.
- (122) **Discourse function cues via pragmatic bootstrapping:** Pay attention to the discourse moves that speakers use *know* and *think* to achieve. Notice that *know* is regularly used to ask and answer questions, while *think* is used to proffer information. Conclude that *know* is a veridical verb which expresses a relation between the subject and the true answer to the embedded question, and infer that it is also factive. Conclude that *think* is a verb which expresses a commitment of the speaker to the embedded proposition, and is neither veridical nor factive.

Results from the Gleason corpus of child-ambient speech, discussed in Chapter 5 provide more support for the bootstrapping routes than for routes which focus on discourse status cues, but do not rule out the possibility that the learner uses these discourse status cues. When we match input and performance on an individual basis, can we get a clearer picture of the relationship between the two?

6.1 Relationships between input and outcome

Attitude verbs are relatively infrequent in naturalistic speech; they are produced in around 10% of utterances both cross-linguistically and in different types of conversational contexts (Adrián et al. 2007, Furrow et al. 1992, Slaughter et al. 2007, Tardif and Wellman 2000). However, out of this relatively infrequent class of verbs, *know* and *think* are two of the most common ones, occurring approximately 53 thousand and 35 thousand times respectively in the CHILDES database (MacWhinney 2000), which equates to about 1-2 tokens per 100 utterances.

Studies which look at the relationship between input and child productions of attitude verbs find that quantity of input is related to quantity of child productions (Jenkins et al., 2003). But we know that linguistic input can differ both in quantity and in “quality” (Hart and Risley 1995, Hoff 2003, Hoff 2006, Huttenlocher et al. 2007, Huttenlocher et al. 2010), and that aspects of input quality might ultimately relate to differences in acquisition outcomes, or ages of acquisition (Hoff and Naigles 2002). When we consider such analyses for attitude verbs, it seems that quality of the input is also related to children’s productions, both when we consider linguistic and non-linguistic measures. *Know* is first used to talk about the self and then about others, both in the input that children receive and in children’s own use of *know* (Booth et al. 1997) and other aspects of parent-child relationships, such as attachment style, can be related to the relative frequency of different attitude verbs during a goal-oriented interaction between mothers and their children (Becker Razuri et al., 2017). But these measures are coarse-grained and are not directly informative about the role of input in developing representations of the verbs’

(non-)factivity.

As a first step in the right direction, Howard et al. (2008) studied the relationship between aspects of input quality with *know* and *think* and children's understanding of differences between the verbs. The tasks that they used required the three-year-old participants to decide whether a *know* statement or a *think* statement was more informative when the two statements conflicted, similar to the methodology of Moore and colleagues (Moore et al. 1989, Moore and Davidge 1989):

(123) A toy is hidden in one of two boxes and the child 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.

While we have already discussed why this kind of measure is not necessarily informative about children's understanding of the factivity distinction between *know* and *think* (Chapter 4), there results are somewhat suggestive. They found that input with attitude verbs does differ between groups of children, and certain aspects of the input were related to performance on this kind of task. First, hearing *know* in questions predicted higher accuracy in the task. Second, hearing *know* occur with first person subjects lead to worse performance. While these are very coarse measures of input quality, they are suggestive that cues such as discourse function ones (*Do you know what time it is?*, see Chapter 5) are related to understanding distinctions between *know* and *think*.

Using finer-grained measures of distributional cues in input with *know* and *think* and a task designed to measure understanding of projection, is there evidence that individual

differences in quantity or quality of input lead to individual differences in understanding of factivity at three years? If so, can we determine the relative informativity of discourse status cues to factivity and veridicality vs. indirect cues from syntactic distributions and discourse functions?

6.2 Methodology

For our main input measure, families were asked to record conversations that they had with their children in the home. We recommended that they record during dinnertime, under the assumption that this would be a time when most members of the family were together and participating in conversation. But we allowed parents to record at other times if they were more convenient.

In our lab, we collected two more input measures that were more controlled and therefore more comparable across different families. For these measures, we recorded conversations between the target child and one parent during two joint activities. The first activity was a goal-oriented puzzle task where children and parents were directed to use puzzle pieces (of different shapes, sizes, colors and patterns) to recreate images from flashcards (see Figure 5 in Appendix B for a picture of the puzzle board). Each parent-child dyad was given five flashcards with puzzles of increasing difficulty, but they were allowed to complete them in any order that they wished, or to use the puzzle set in a different way if they so desired. This activity was chosen because it provided an opportunity for parents to produce indirect speech acts in order to guide their child's behavior. The particular puzzles were chosen so that they were of different levels of

difficulty, but also so that there would be a mix of familiar objects (turtle, crab, train, bus). One puzzle in particular was chosen because it was more open to interpretation and could be viewed in multiple ways (e.g., giraffe, doll, robot, mask) and might thus encourage more belief- or opinion-centric discussion. The second activity was an open-ended play session with a set of cooking and food toys (see Figures 6 and 7 for sample pictures of the toys). Parents and children were directed to play with the toys as they saw fit, including pretend grocery shopping and pretend cooking.

These measures were chosen so that they would be comparable with previous corpus analyses (Chapter 5). Our input measures were chosen so that they would approximate three of the four interaction-types from the Gleason corpus. Our home conversations were picked to match Gleason's dinner conversations, our puzzle task was supposed to match Gleason's take-apart car game, and our cooking task was supposed to be similar to Gleason's grocery game. However, unlike Gleason, we did not include a picture-book context in this study.

6.3 Behavioral task

Between the two lab input activities, children participated in a behavioral task designed to assess their understanding of the (non-)factivity of *know* and *think*. This task was based on the paradigm developed for Study 2 (Chapter 4) with two adjustments: (i) the number of trials in the two matrix-negation critical conditions was increased to 9 (others left at 6 trials/condition), and (ii) we introduced a familiarization phase before the test phase where children were given trivial clues of the form *It's in the red/blue box*, in order

to familiarize them with the structure of a trial. The test items from the studies in Chapter 4 are repeated here in (124) for convenience.

- (124) a. No negation
- i. Chris thinks that it's in the red box (*think-none*)
 - ii. Chris knows that it's in the red box (*know-none*)
- b. Matrix negation
- i. Chris doesn't think that it's in the red box (*think-matrix*)
 - ii. Chris doesn't know that it's in the red box (*know-matrix*)
- c. Embedded negation
- i. Chris thinks that it's not in the red box (*think-embedded*)
 - ii. Chris knows that it's not in the red box (*know-embedded*)

As before, we will be most concerned with children's performance in the *know*-matrix and *think*-matrix conditions. In these two conditions, the target verbs occur in projective contexts so we can ask whether children understand that the truth of the complement should project with the factive *know*, but not the non-factive *think*. If they understand this, they should infer that the complement is true under *know* and search in the mentioned box. And they might tend to infer that the complement is false under *think*, assuming they trust Chris—the attitude holder—leading them to search in the box which is not mentioned.

6.3.1 Participants

Participants were 60 target children and their families. Target children were between 3 and 4.5 years of age, with an average age of 3 years and 8 months. 28 of the target children were female and 32 were male. All target children were reported to be monolingual speakers of English by their parents and all were recruited from the University of Maryland Infant Studies database, or at the University of Maryland Center for Young Children.

Some target children were excluded from preliminary analyses reported here: 9 children failed to achieve control criteria; 1 child failed familiarization trials; 2 children received parental direction during the task; 2 children demonstrated a clear color preference for one hiding location; for 5 children, preliminary coding of input measures has not been completed. These exclusions leave a final sample of 41 target children (21 males), mean age = 3;9 years;months, age range = 3;1-4;5.

6.3.2 Results

Children's performance as a group is represented in Figure 6.1. Children tend to pick the mentioned box when they hear *think*-none (91%) and *know*-none (92%) sentences. They tend to pick the other box when they hear *think*-matrix (74%), *think*-embedded (90%) and *know*-embedded (84%) sentences. In the *know*-matrix condition, children only picked the mentioned box on 48% of trials. Notice that these group means are approximately the same as those from Study 1 and Study 2 (Chapter 4). This suggests that adding extra trials in the critical condition did not have a great effect of per-

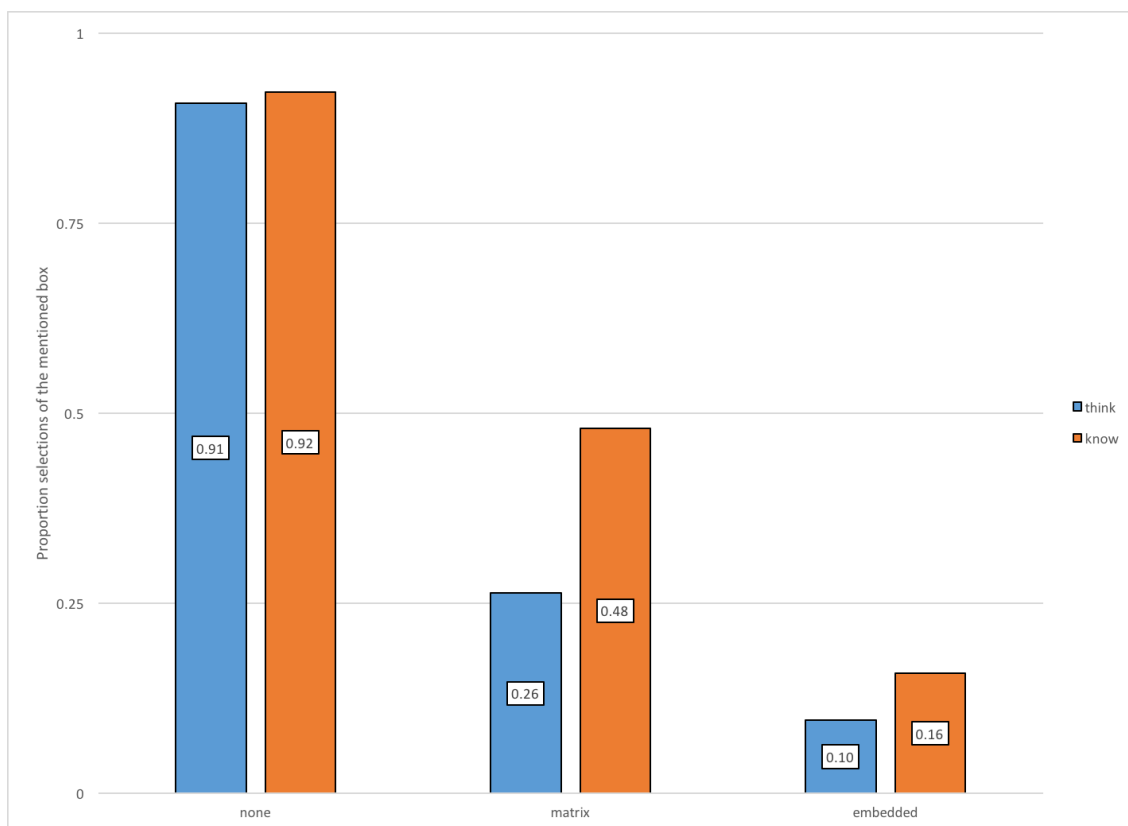


Figure 6.1: Children's performance across conditions, by negation-type

formance, and that the children in this study are drawn from a similar distribution of factivity-knowers vs. non-factivity-knowers as previous studies.

Now to turn to the critical trials, what kind of individual variation do we find? Individual performance in the *know*-matrix condition (e.g., *Chris doesn't know that it's in the red box*) is given in Figure 6.2 and individual performance in the *think*-matrix condition (e.g., *Chris doesn't think that it's in the red box*) is given in Figure 6.3.

Using age (continuous) and sentence-type (*think*-matrix/*know*-matrix) as predictors, multiple regression analysis indicated that the two predictors explained some of the variance ($R^2 = .1466$, $F_{2,79} = 6.784$, $p \ll .01$). Sentence-type significantly predicted performance ($\beta = -.217$, $p \ll .01$) and age marginally predicted performance ($\beta = -.145$, $p > .10$).

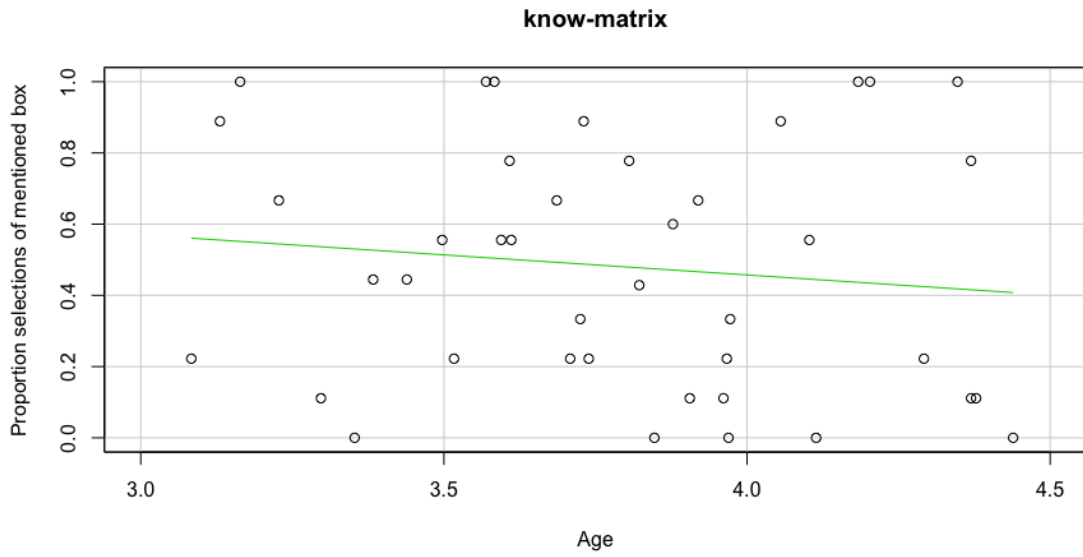


Figure 6.2: Children's performance on know-matrix trials

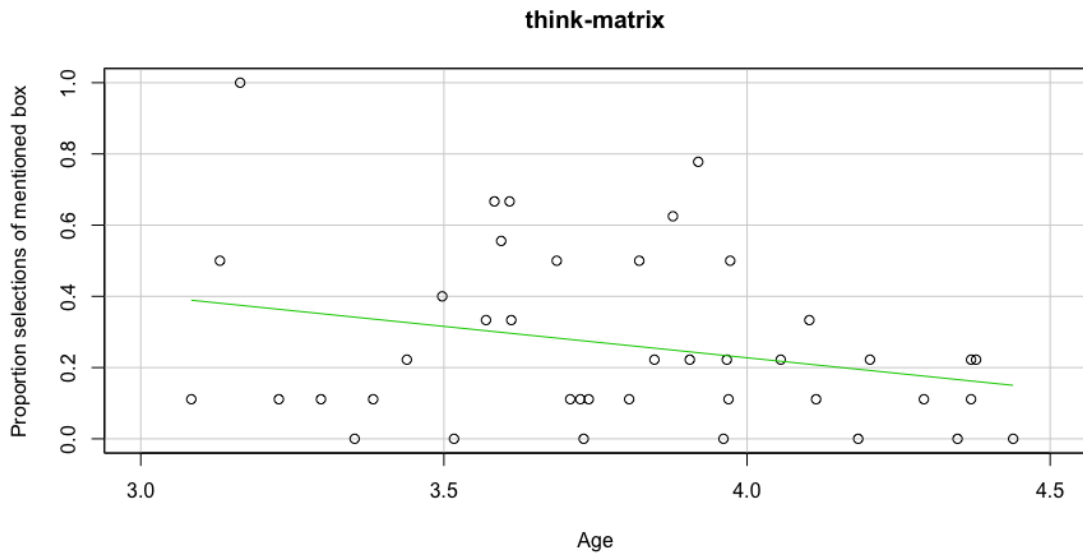


Figure 6.3: Children's performance on think-matrix trials

Children were more likely to pick the mentioned box when they heard *know*-matrix sentences than when they heard *think*-matrix sentences, and they were less likely to pick the mentioned box as they got older, across all 6 types of trials. Selections of the mentioned-

box were correlated with age in the *think*-matrix condition, but only with marginal significance ($r = -.27, p < .08$), and were not correlated with age in the *know*-matrix condition ($r = -.12, p < .45$).

These results are similar to those from Study 1 and Study 2 but suggest that the age effects which were found in previous studies were spurious. With a larger sample, we no longer have any evidence for age-related variation in *know*. This is suggestive that qualitative aspects of the input—which may vary across different families more than across different ages—are related to uncovering the distinction between *know* and *think*, in addition to quantitative aspects of input or other other factors that would be more related to age, such as executive function.

6.4 Input measures

When we look at the rate with which these two verbs occur in the input, we see that there are no age-related differences (Figure 6.4), but that the occurrence of verb tokens is well-related to the length of recordings which contribute to the input measures (Figure 6.5). Furthermore, the data in Figure 6.5 suggests that some parents use greater proportions of the verbs than others. However, some of the home recordings include long periods of silence when the families are in another room. In future analyses, we can control for this issue by considering how talkative parents are: once we factor out these periods of silence, do parents have similar rates of utterances that contain the verbs?

Average length of home recordings that contribute to home input measure is 114 minutes, or about 2 hours per family, although different families recorded between 22

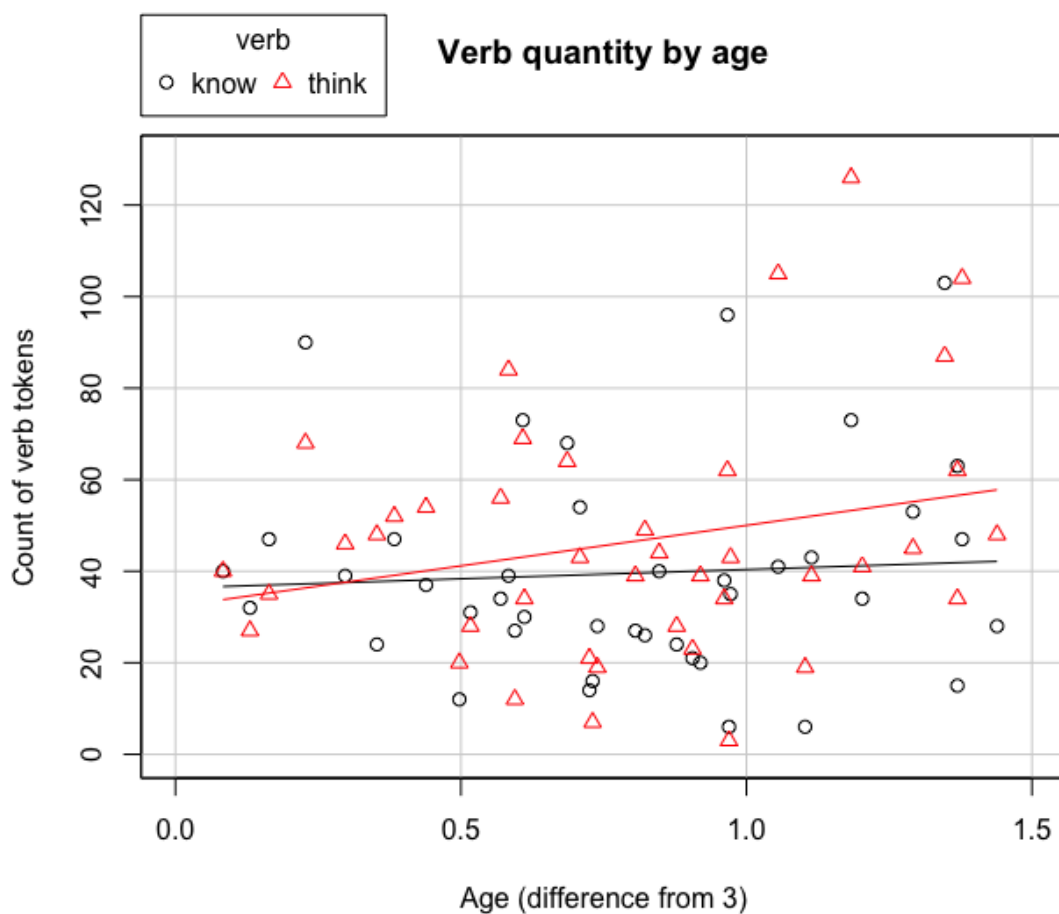


Figure 6.4: Count of verb tokens as a function of target child age

and 187 minutes. For lab activities that contribute to input measure, families were able to decide when they were ready to move on to the next task. Around 15-20 minutes into each activity, families were prompted to move on if they wanted to. All of these activities lasted around 5-30 minutes.

We do find interesting differences in use of the verbs across these different contexts (see Figure 6.6). Unsurprisingly, the verbs occur more frequently in home recordings, but these recordings are 8 times longer than the lab recordings on average. But, more surprisingly, we find that the verbs are used differently within the two contexts. A chi-square

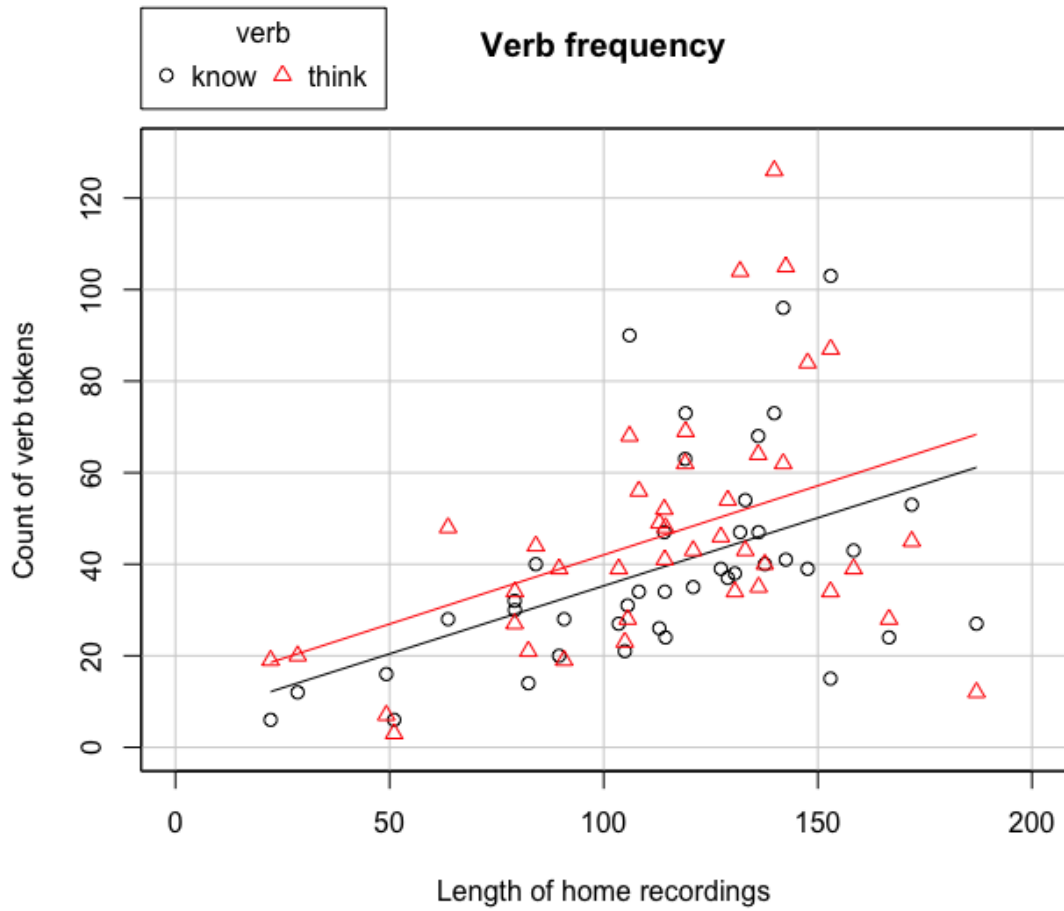


Figure 6.5: Count of verb tokens as a function of home recording length

Interaction	<i>know</i>	<i>think</i>	Total
home	1476 (91.1%)	1380 (72.6%)	2856 (81.1%)
puzzle-lab	145 (8.9%)	521 (27.4%)	666 (18.9%)
Total	1621 (100%)	1901 (100%)	3522 (100%)

Figure 6.6: Count of verb tokens by interaction context

Speaker	<i>know</i>	<i>think</i>	Total
mother	1042 (64.3%)	1410 (74.2%)	2452 (69.7%)
father	329 (20.3%)	341 (17.9%)	670 (19.0%)
other adult	84 (5.2%)	51 (2.7%)	135 (3.8%)
sibling	158 (9.7%)	93 (4.9%)	251 (7.1%)
media	8 (1.3%)	6 (0.3%)	14 (0.4%)
Total	1621 (100%)	1901 (100%)	3522 (100%)

Figure 6.7: Count of verb tokens by speaker

test of independence was performed to determine the relationship between interaction context and verb. The relation between these variables was significant, $\chi^2(2, N = 3522) = 194.5, p < .00001$. *Think* is used more within the puzzle context than *know*. This could be because the puzzle task encourages parents to use more indirect speech acts with *think* (which serve to provide information or direct behavior) than with *know* (which serve to request information or answer questions) because they are leading children through the activity.

We also find differences in which kinds of speakers provide the most input to children (see Figure 6.7). Mothers supply two-thirds of the tokens within our sample. But without further analyses that look at speaker-talkativeness, we do not know whether this is because mothers use the verbs of interest more than other speakers, or because mothers are more involved in the recordings than other speakers. Another interesting fea-

ture of the mother's speech is that they use *think* more frequently than *know*, while all other input sources favor *know* over *think*. This difference may be related to the differences across interaction contexts (Figure 6.6) given that more mothers than fathers participated in lab tasks, and mothers have been found to speak differently to children (Gleason 1975, Tomasello et al. 1990, Rowe et al. 2004), including using more indirect language (McLaughlin et al. 1980).

6.4.1 Group input results

To get some idea of what kinds of input children receive on average, we applied the coding scheme developed for our Gleason corpus analyses to this dataset. For more details about the coding scheme, please see examples in Chapter 5. Full coding of the sample is not yet complete, but syntactic proxies for the other cues are reported here as preliminary data.

6.4.1.1 Proxies for discourse status cues

Discourse status of complement cues to factivity and veridicality come from observing the relationship between the discourse context and the propositions expressed by the complements of *know* and *think*. As a result, the utterances which will provide such cues are limited to those that embed declarative complements. As shown in Figure 6.8, there are more of such relevant utterances for *think* (74% of all *think* tokens) as compared to *know* (15% of all *know* tokens), which are similar amounts to those of the previous corpus. In order to determine whether these cues are informative about the

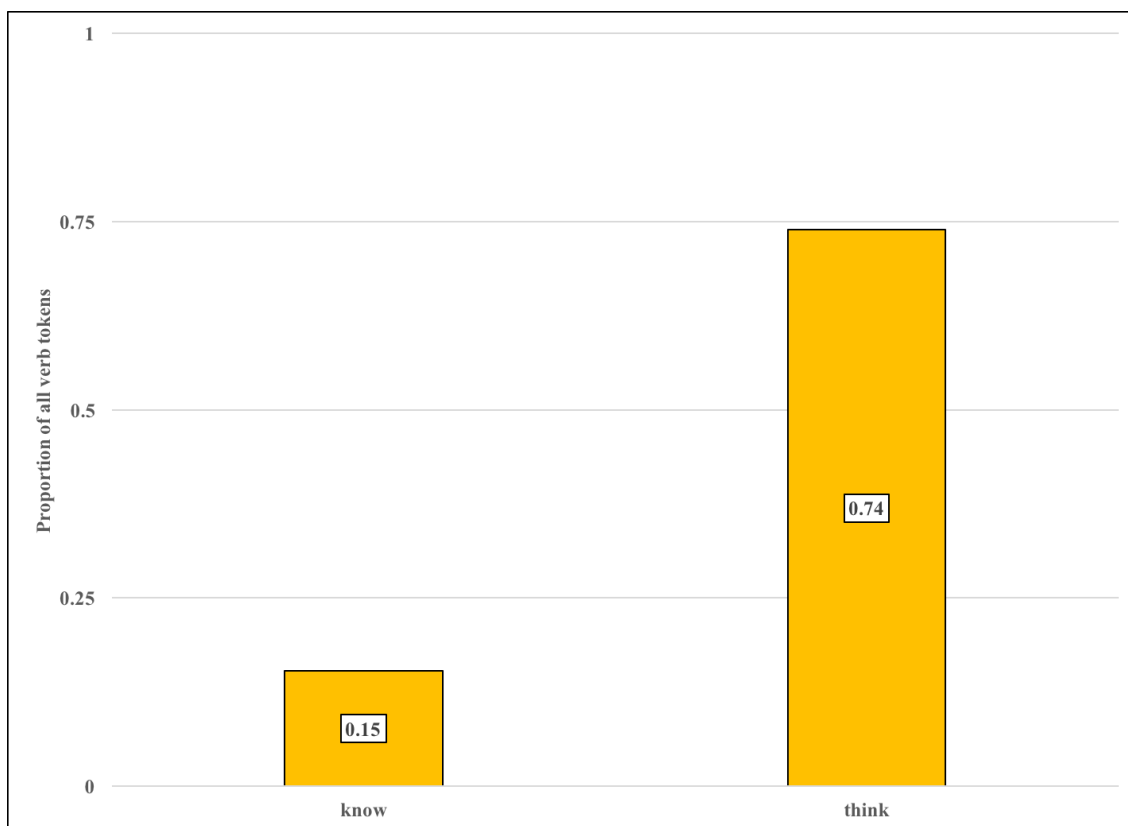


Figure 6.8: *X verbs p* tokens within the sample, as a proportion of each verb

verbs' (non-)factivity, there are no further proxies; we would have to code the status of the complement proposition with respect to what is known in the discourse.

But as reported in the previous corpus analysis, we can look at further proxies for discourse cues to veridicality. As discussed in Chapter 5, the kinds of utterances that would be informative about the non-veridicality of *think* are those that occur with 3rd person subjects or past tense (8-9). These kinds of utterances are informative because they could potentially describe beliefs which contrast with the beliefs of the interlocutors in the discourse context, and therefore signal that these beliefs might be ones that the interlocutors take to be false.

And similar to the conclusions drawn from the previous input sample, there would

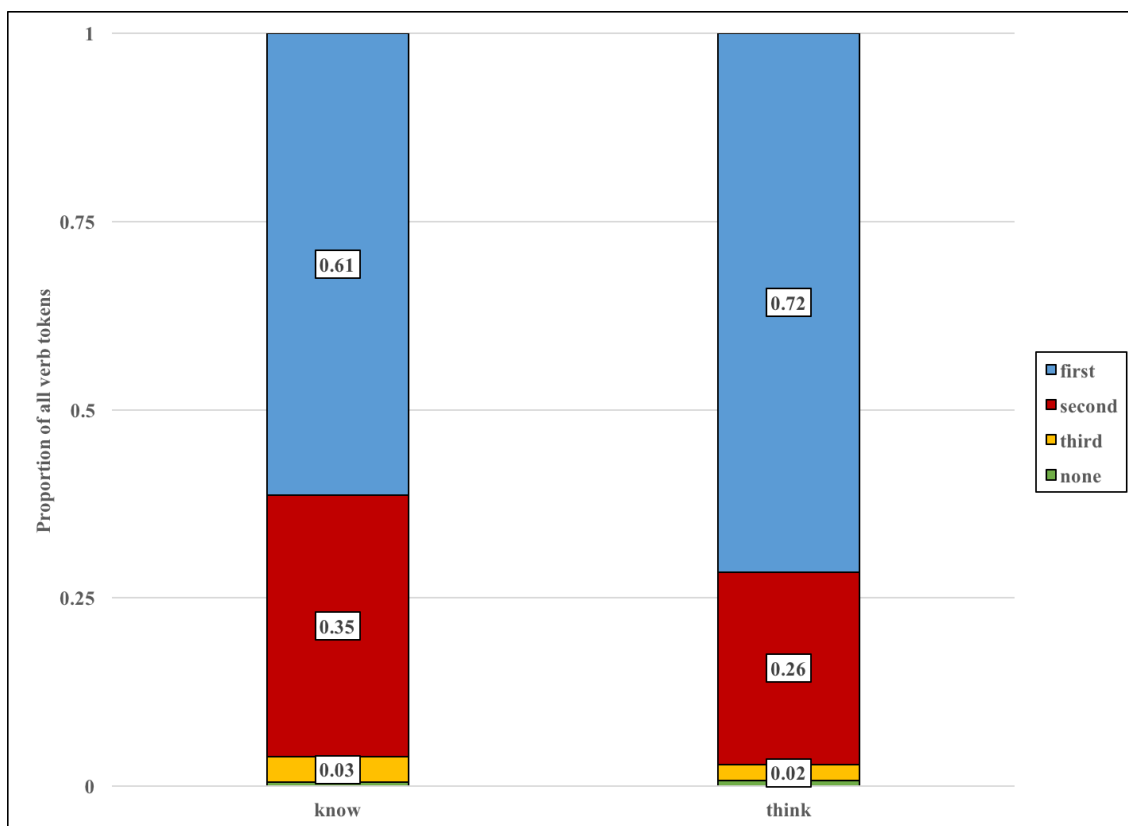


Figure 6.9: Subject-types within the sample, as a proportion of each verb

seem to be few cues to the non-veridicality of *think*. *Think* occurs most frequently with 1st person (72% of all *think* tokens) and 2nd person (26% of the tokens) subjects, suggesting that it is rarely used to contrast the beliefs of interlocutors with the beliefs of others. And it is rarely used in past tense form (10% of all *think* tokens), suggesting that it is not often used to contrast previously held beliefs with current beliefs.

6.4.1.2 Proxies for syntactic cues

We can also look at syntactic cues within this input sample (Figure 6.12). We find that *think* occurs most frequently with declarative complements (86% of all *think* tokens). In contrast, *know* occurs very rarely with declarative complements (16% of all *know* to-

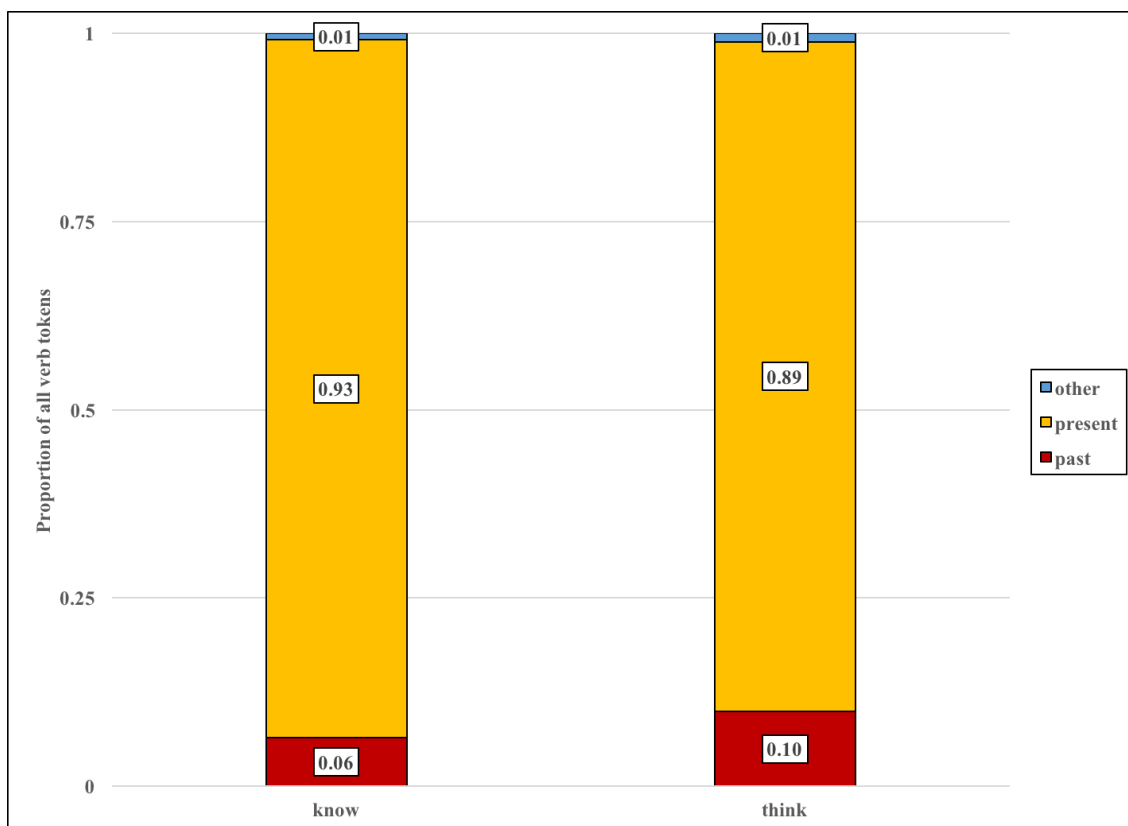


Figure 6.10: Tense-types within the sample, as a proportion of each verb

kens). Instead, the two most frequent complement-types for *know* are interrogatives and null complements, which both occur in 37% of *know* tokens. These results diverge from the previous sample from the Gleason corpus in that there are more null complements with *know*, and fewer interrogative complements.

6.4.1.3 Proxies for discourse function cues

The biggest difference between this sample and the Gleason sample can be seen in the data which serve as proxies for the availability of discourse function cues (data for this sample given in Figure 6.13). If we recall the findings from Chapter 5, there was a difference between *know* and *think* as far as the types of utterances that they tended

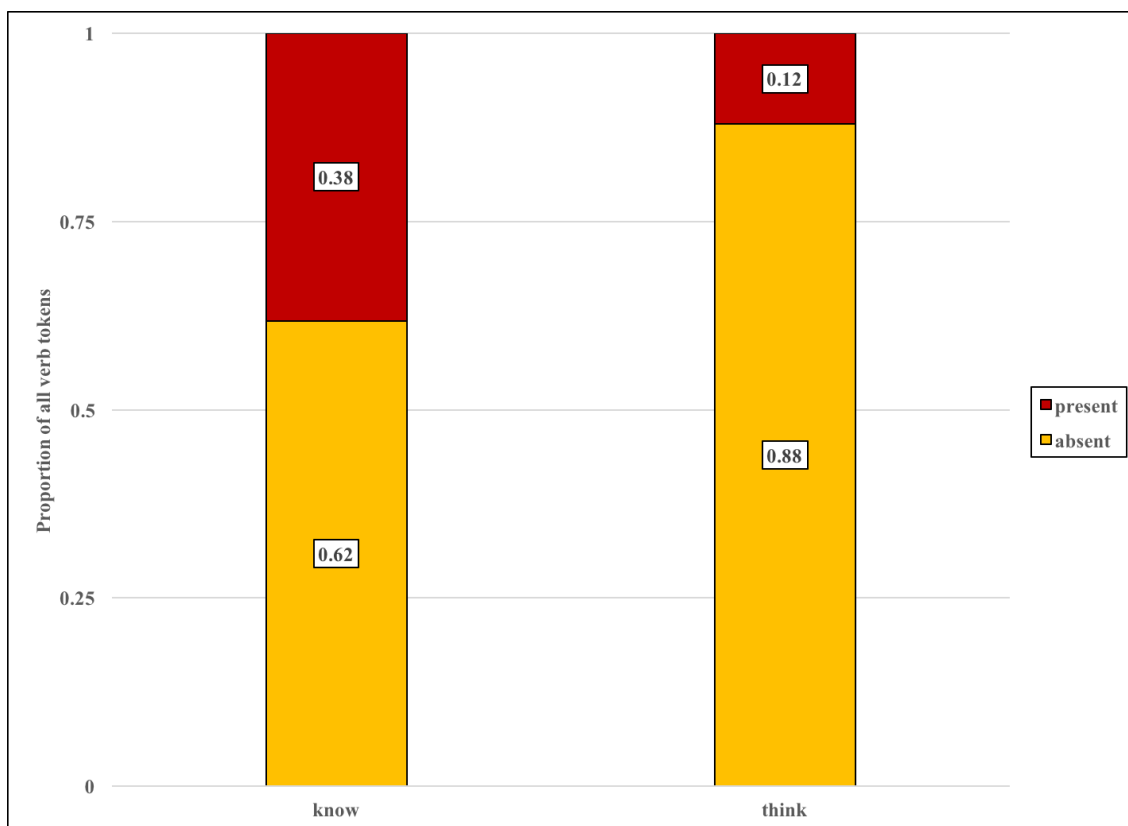


Figure 6.11: Negation within the sample, as a proportion of each verb

to occur in. *Know* occurred more frequently in questions while *think* occurred more frequently in assertions. In this sample of input, the difference in utterance-types between the two verbs is effectively neutralized. Both verbs occur most frequently in assertions and the proportions of assertions are comparable across the two verbs; 70% of *know* tokens were assertions while 74% of *think* tokens were assertions. This difference was also related to differences in whose beliefs were discussed with the two verbs (see Figure 6.14).

At first blush, these results suggest that discourse function cues to the distinction between *know* and *think* are not reliable within this new input sample. If true, this would call into question the tentative conclusions that we made at the end of Chapter 5 about

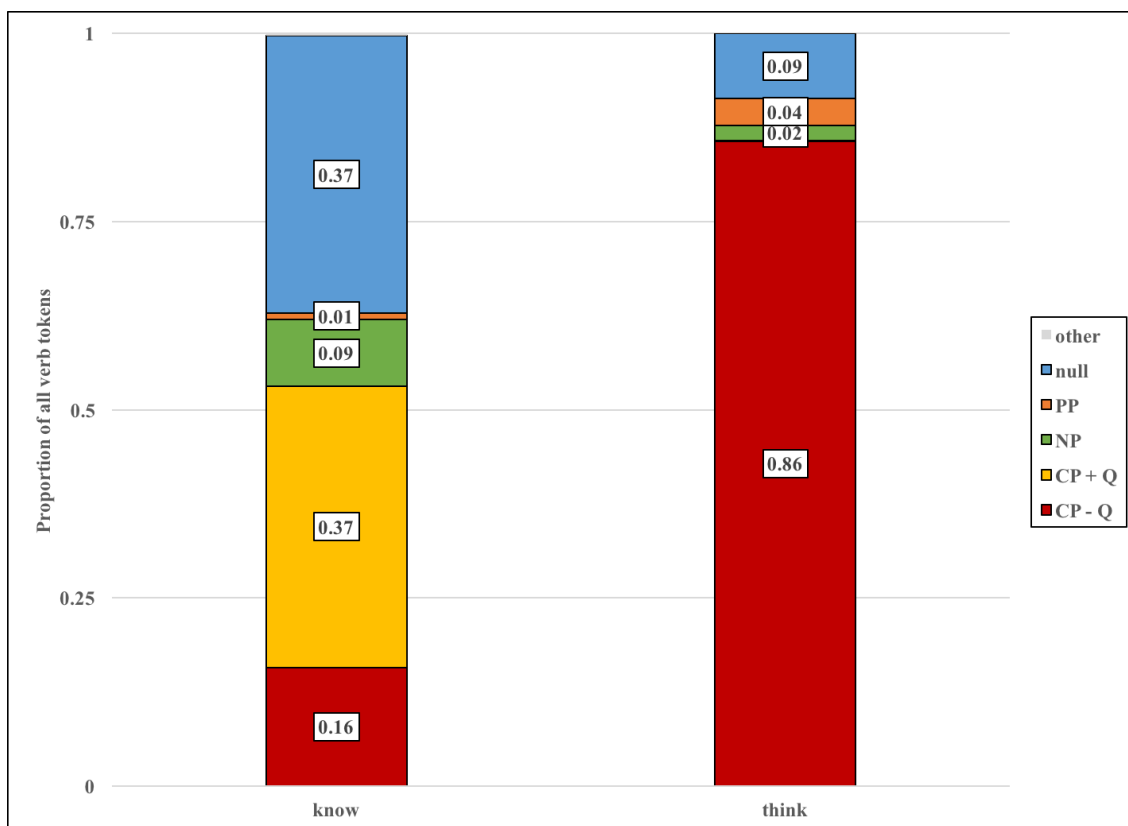


Figure 6.12: Complement-types within the sample, as a proportion of each verb

the relative importance of discourse function cues. Recall that we took *know* questions with 2nd person subjects to be indicative of the kinds of indirect speech acts that *know* should be used with under the pragmatic route (i.e, indirect questions such as *Do you know where the keys are*). While assertions with 1st person subjects would be most useful in learning to map *think* to THINK (i.e., indirect assertions such as *I think the keys are in the kitchen*). Within this sample of input, there are no difference between *know* and *think* with respect to these two different kinds of tokens. *Know* occurs in 2nd person questions 28% of the time while *think* occurs in such tokens 25% of the time. And *know* occurs in 1st person assertions 61% of the time while *think* occurs in such tokens 71% of the time. However, we should not be concerned about the availability of the pragmatic route

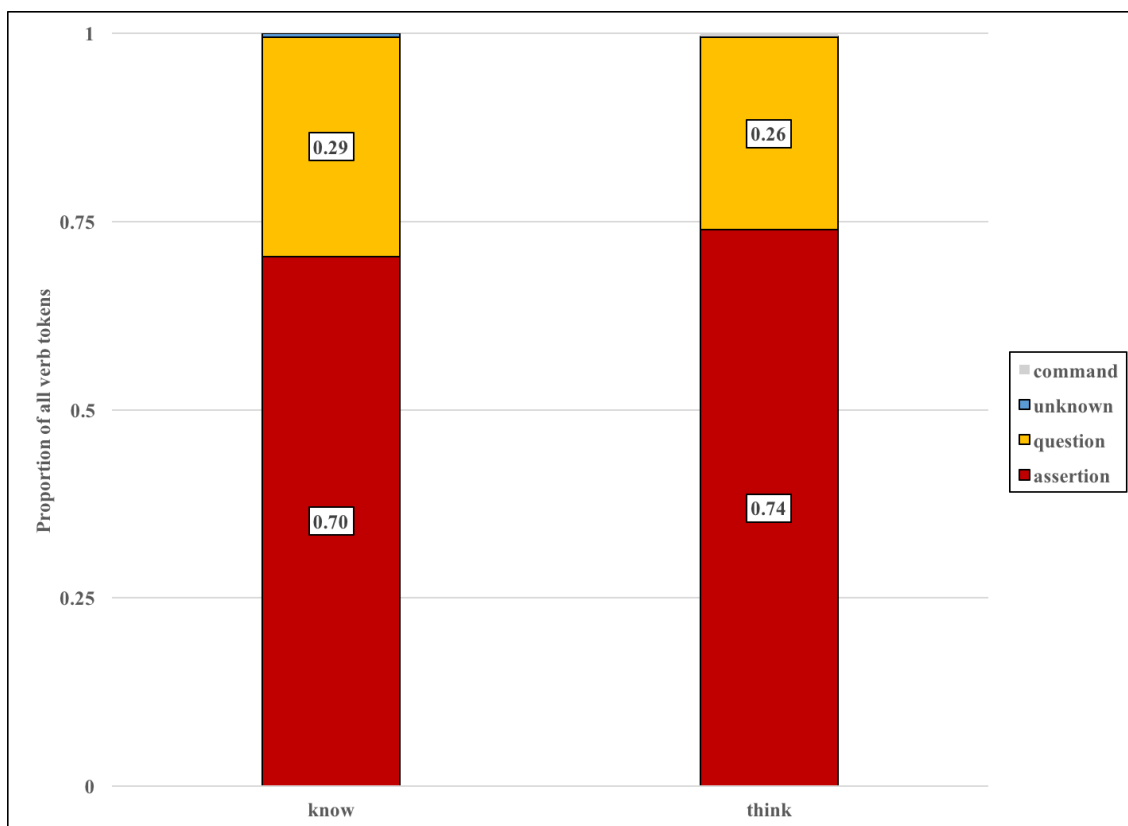


Figure 6.13: Utterance-types within the sample, as a proportion of each verb given these results. In fact, this data gives us a chance to re-evaluate the types of tokens that we take to be informative under the pragmatic route, and to generalize away from the particulars of one specific corpus.

To see this, consider the differences between the two corpora that we have seen so far. First, *know* occurs with more 1st person subjects and more assertions in this sample (Figures 6.9,6.13,6.14). These changes neutralize the distributional differences between *know* and *think*. But *know* also occurs in the presence of negation (Figure 6.11) more in this sample, and takes more null complements (Figure 6.12) in this sample. So, while there are fewer occurrences of tokens like *Do you know where the keys are?* in this sample, there are more occurrences of tokens like *I don't know* (see Figure 6.15). These *I don't*

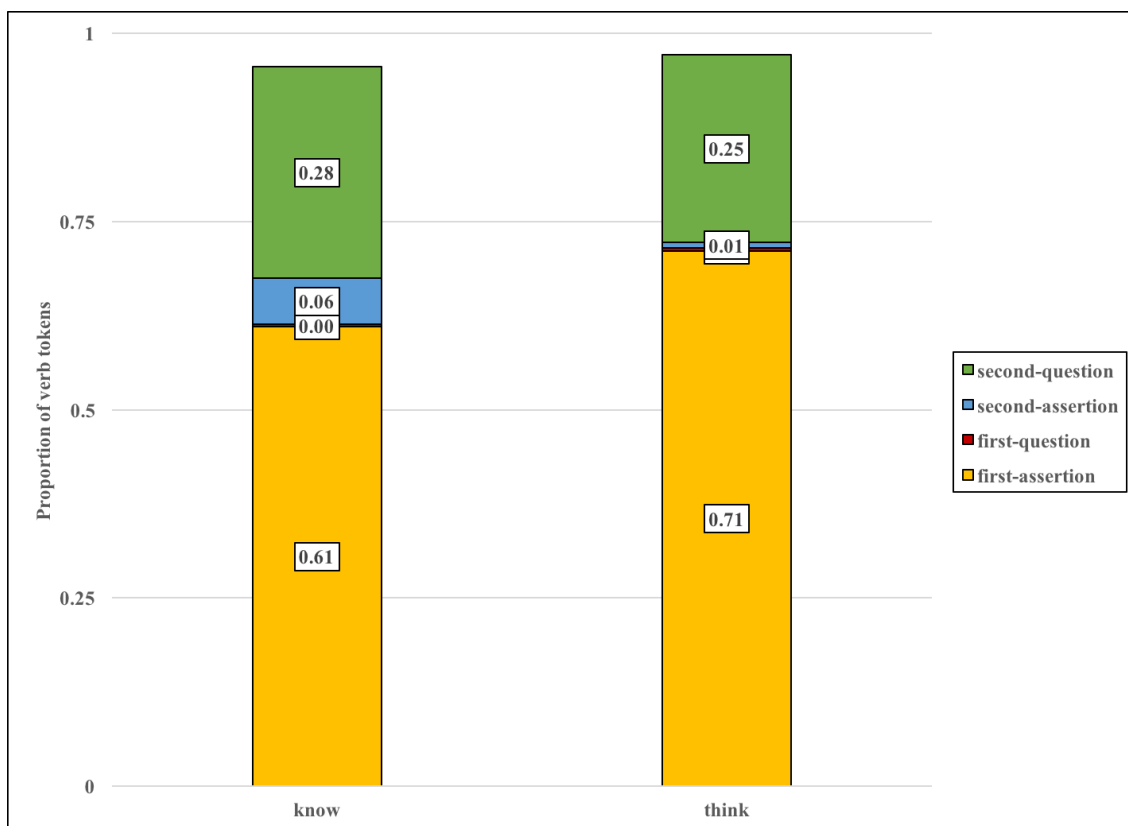


Figure 6.14: Subject-types by utterance-types within the sample, as a proportion of each verb

know tokens are informative under the discourse function because they allow children to observe that *know* is used to ask and answer questions. These *I don't know* tokens are used to express ignorance in answer to questions (125), so they are the complement to tokens like *Do you know where the keys are?* And if we compare the two input samples (Gleason from Chapter 5, and this sample) we see that decreases in the number of *Do you know where the keys are?* tokens are accompanied by increases in the number of *I don't know* tokens.

- (125) a. Where are the keys?
 b. I don't know where the keys are

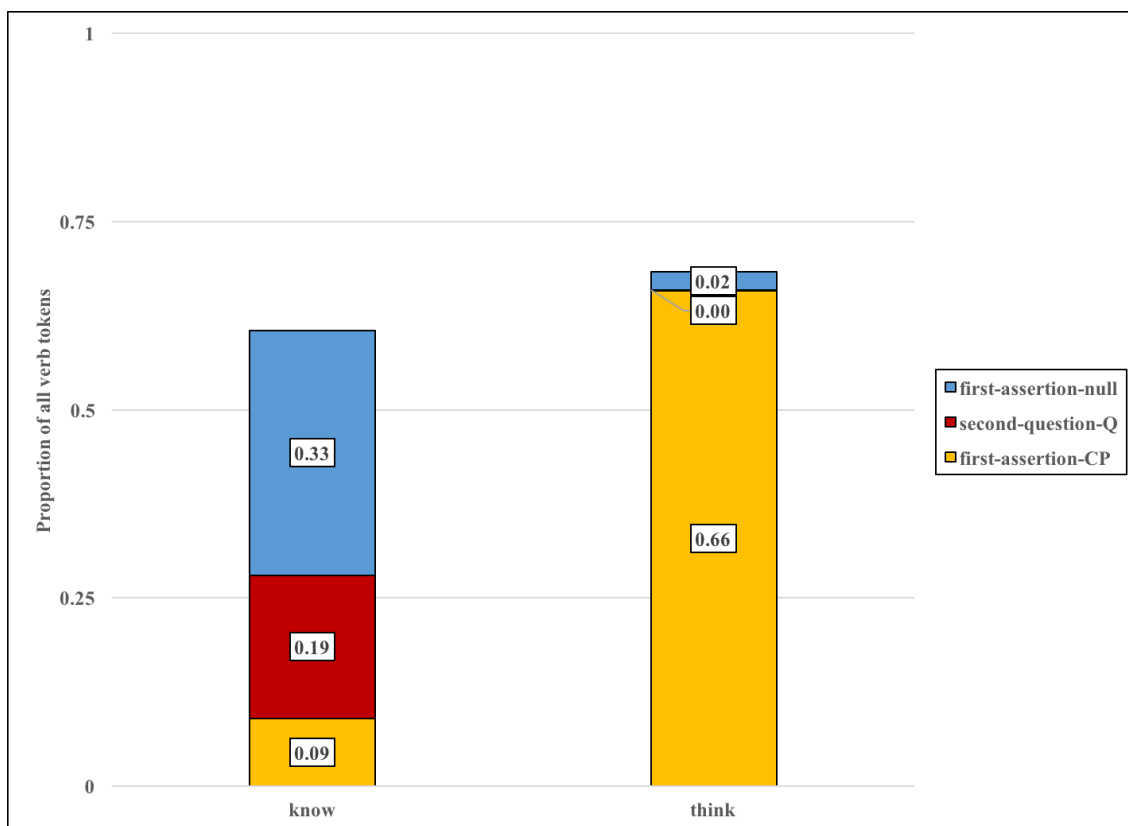


Figure 6.15: Indirect speech acts within the sample, as a proportion of each verb

6.4.2 Discussion

Zooming back out to take into consider the proxies for each route discussed here, what does our new input sample suggest about the cues that are available to children, on average? We saw that children have a similar amount of chances to look for discourse cues to factivity as they did in the Gleason corpus. If the distribution of those cues is anything like what we observed in the Gleason corpus, then we would expect those cues to be less useful. We also saw that discourse cues to veridicality are similar in the two samples. Finally, we saw differences in the distributions of the two verbs across the two samples. At first blush, these differences challenge the availability—and therefore the utility—of

syntactic, pragmatic and pragmatic-syntactic routes. But, upon consideration, the two superficially different distributions share deep similarities: for both samples, *know* clearly embeds both declarative and interrogative complements while *think* only embeds declaratives; and *know* is used primarily to answer or ask questions while *think* is used to proffer information. So, we have much the same perspective on direct vs. indirect routes that we did with the previous sample. But which routes are actually used by children? To address this question, we need to know more about the kinds of input distributions that individual children are exposed to, and their relationship to individual children's performance in the behavioral task.

6.5 Input-performance comparisons

6.5.1 Sample for comparison

For this preliminary analysis, children were sorted by their performance in the *know*-matrix condition. High-performing children regularly picked the blue box—the mentioned box—on trials where they heard the clue *Chris doesn't know that it's in the blue box*, and low-performing children regularly picked the other box, which was the red box, in this condition. With respect to their verb knowledge, we can assume that high-performing children are aware that *know* is a factive verb, and that low-performing children are either not aware of this fact or regularly make performance errors.

From this performance ranking, we separated the top quarter of participants and the bottom quarter of participants and analyzed small samples of their input, in order to compare the average input of high-performing children and low-performing children.

The high-performing group includes 13 children (age range: 3;1-4;5 years;month, mean age: 3;9, 6 boys). On average, these children picked the mentioned box on 92% of *know*-matrix trials, but the range was 78% to 100% selections of the mentioned box. The low-performing group includes 12 children (age range: 3;2-4;4 years;month, mean age: 3;10, 7 boys). On average, these children picked the mentioned box on 5% of *know*-matrix trials, but the range was 0% to 11% selections of the mentioned box. Preliminary analyses compared these groups based on age and gender and found no statistically significant differences, suggesting that these groups differ only in their understanding of the verbs and not in demographic dimensions as well.

For each of these children, we collected and coded all child-ambient tokens in the first 10-minute chunk of conversation that took place during the home recordings. More details on the coding scheme that was used are provided in the next two sections. It is important to note that this is a very small input sample, as compared to the whole corpus of speech that was collected. 10 minutes accounts for less than 10% of a family's recording time, on average, and we have only sampled 10 minutes from half of the families, so the data reported later on in this section is less than 5% of the entire sample which we will ultimately analyze.

6.5.2 Proposed composite variables for comparison

In order to better understand the role of input in uncovering the contrast between *know* and *think*, we need to move away from the proxies that this coding scheme provides us. What kinds of measures will help us disentangle discourse status of complement cues,

syntactic cues and discourse function cues?

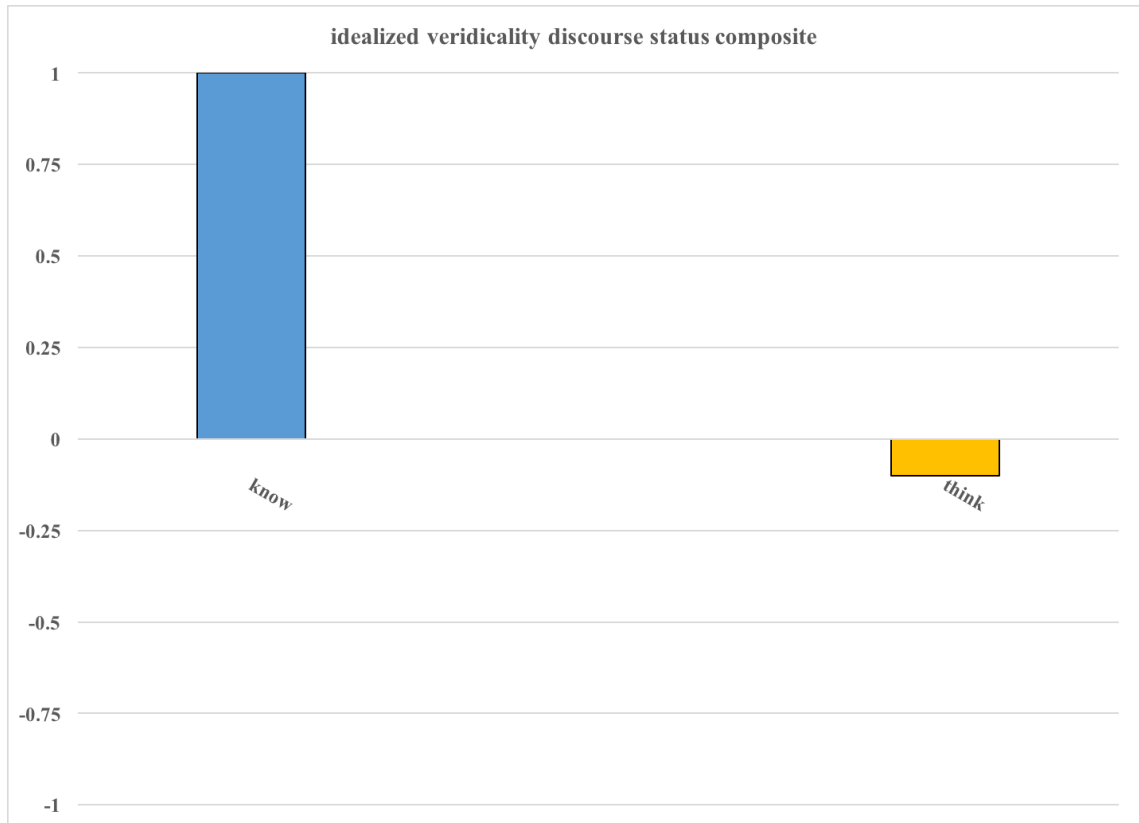


Figure 6.16: Expected composite score for discourse status of complement cues to veridicality, by verb

- **Veridicality discourse status of complement cue composite:** a measure of how often children could notice that the content of the reported belief is true. Discourse coding schemes from Chapter 5 will be extended to ask how often the complement proposition expresses information that is true in the discourse or false in the discourse. For this preliminary sample, we examined all *know p* and *think p* tokens and decided whether the proposition expressed by the complement seemed true within the conversation context, or whether it seemed false because of some disagreement or debate. To create the composite variable we computed a difference

score by subtracting the proportion of false complement tokens from the proportion of true complement tokens. We might expect *know* to score very high on this variable, with a value around 1, and we might expect *think* to score lower, with a value around 0 or a negative value. An idealization of these veridicality composite scores is given in Figure 6.16.

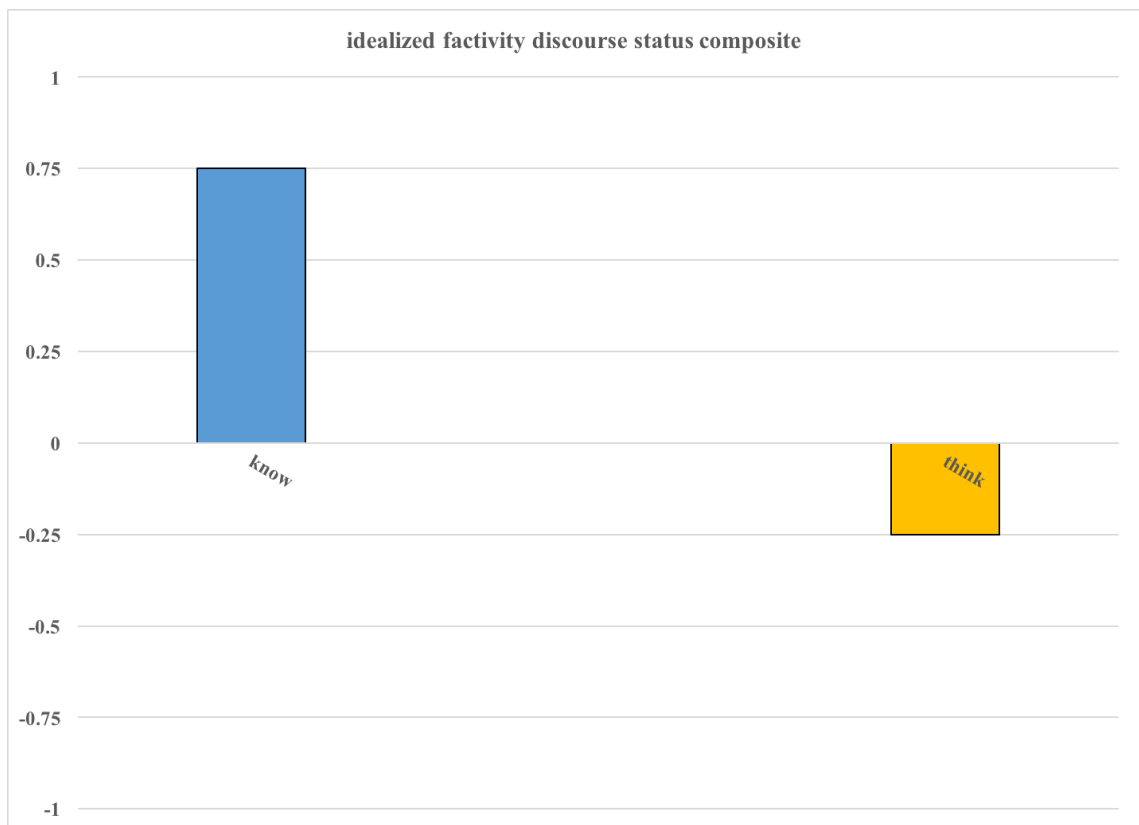


Figure 6.17: Expected composite score for discourse status of complement cues to factivity, by verb

- **Factivity discourse status of complement cue composite:** a measure of how often children could notice that the speaker presupposes the truth of the complement proposition. Discourse coding schemes that were developed for the corpus analysis

in Chapter 5 will be used for this variable. For this preliminary sample, we examined all *know p* and *think p* tokens and decided whether the proposition expressed by the complement was part of the common ground—either because it was established in or inferable from the previous discourse, or because it was the kind of information that an average parent and child would share—or whether it expressed new information within the discourse. To create the composite variable we computed a difference score by subtracting the proportion of new complement tokens from the proportion of established complement tokens. We might expect *know* to score relatively high on this variable, with a value around 1, and we might expect *think* to score lower, with a value around 0 or a negative value. An idealization of these factivity composite scores is given in Figure 6.17.

- **Syntactic cue composite:** a measure of the variation in syntactic distributions that children are exposed to. Existing syntactic codes will provide the basis for this measure, but we would need to take into account the relative contributions of different complements that *know* and *think* embed. For example, interrogative complements are only informative when they occur in addition to declarative complements. If children only had experience with declarative complements, they would not be able to distinguish the distribution of *know* from that of *think*. And only observing interrogative complements would make it difficult to distinguish the distribution of *know* from the distribution of *wonder*. To create the composite variable we computed a difference score by subtracting the proportion of tokens with declarative complements from the proportion of tokens with interrogative complements. We

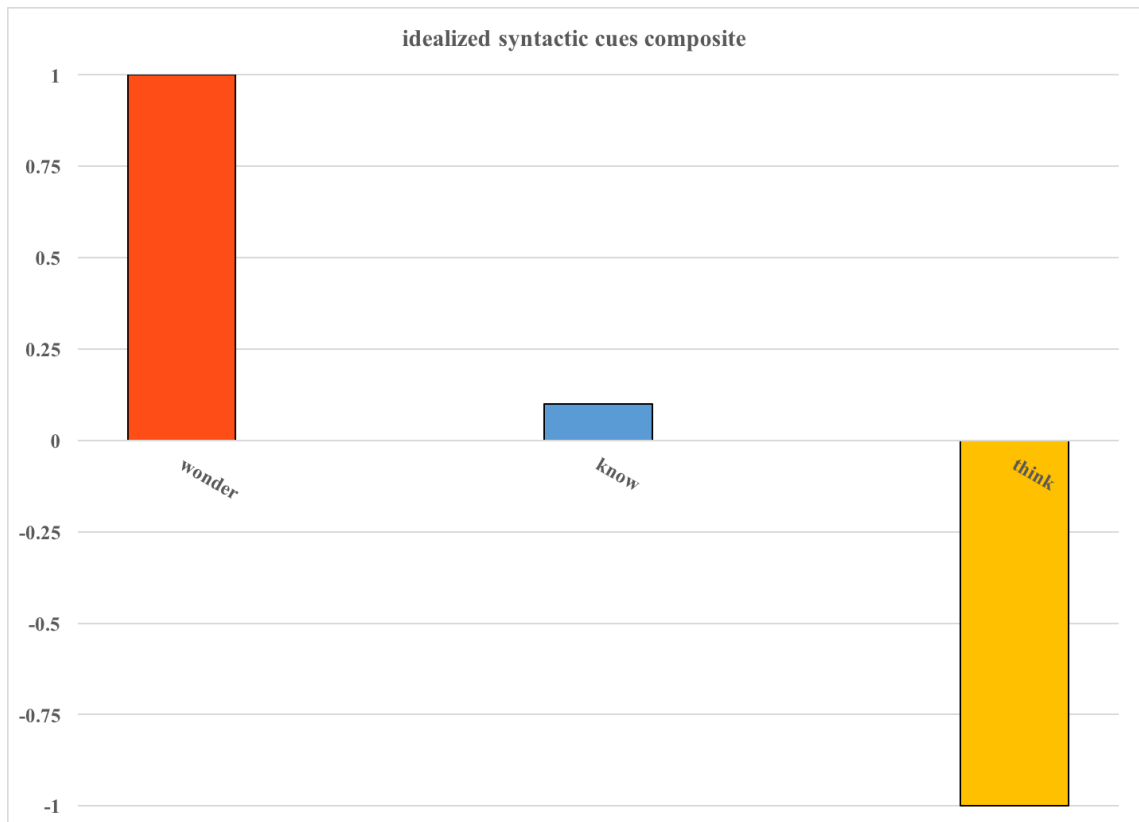


Figure 6.18: Expected composite score for syntactic cues, by verb

might expect a verb like *wonder* to score high on this variable, with a value around 1, while a verb like *know* would have a small positive value or one around 0, and a verb like *think* would score very low, around -1. An idealization of these syntactic composite scores is given in Figure 6.18.

- Discourse function cue composite:** a measure of the kinds of conversational goals that parents use *know* and *think* utterances to achieve. Based on discourse coding, we will need to distinguish between utterances that are intended to (i) request information, (ii) provide information, or (iii) direct behavior. Existing syntactic proxies do not provide enough information because one utterance can be used for multiple

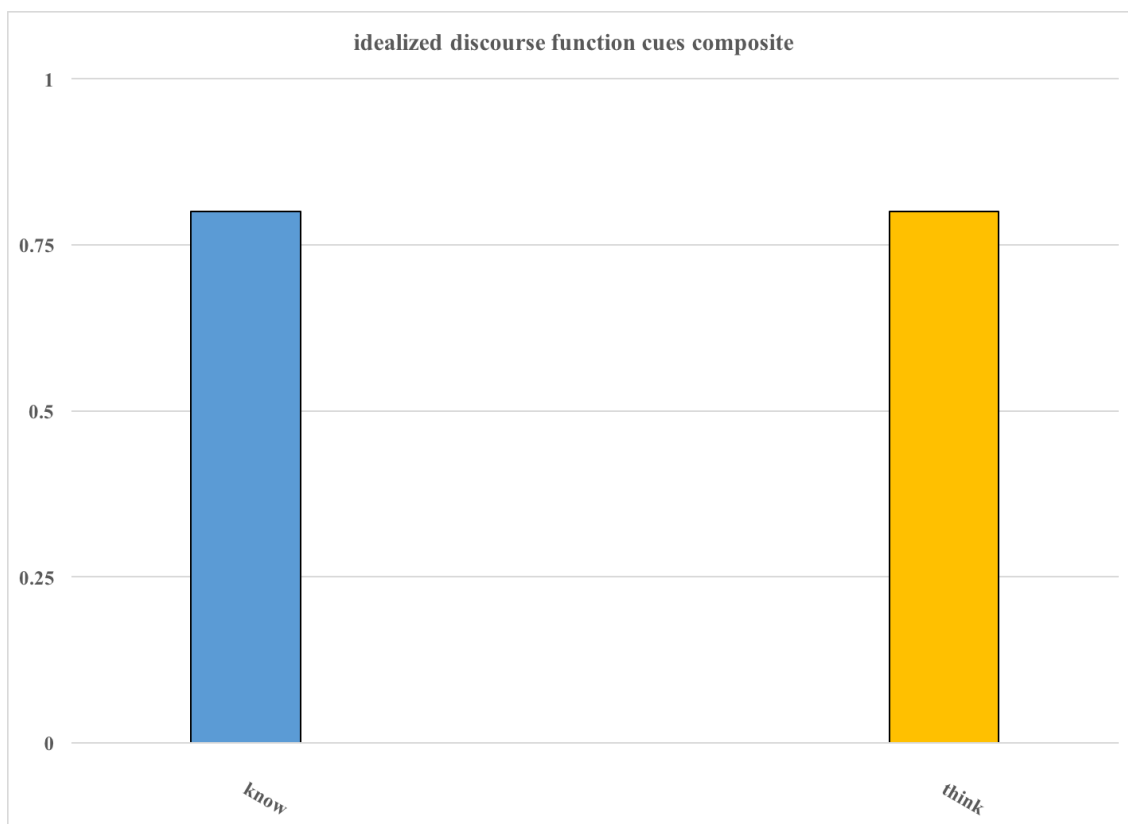


Figure 6.19: Expected composite score for discourse function cues, by verb

purposes. For example, *Don't you know where the keys are?* could be used to request information about the keys or to direct the addressee to retrieve the keys. And *I think it's time for bed* can serve as a direction to go to bed as well as a statement about the time. For *know*, we computed this variable by calculating the proportion of tokens that speakers used to request or provide information, and for *think* we calculated the proportion of tokens that speakers used to proffer information. We would expect *know* and *think* to both score relatively high for this pragmatic composite variable. An idealization of these scores is given in Figure 6.19.

6.5.3 Average input by group

In this sample, there are relatively few tokens; just 45 *know* and 48 *think* tokens occur in the sample for the high-performing group, and 27 *know* and 39 *think* tokens in the sample from the low-performing group. But even with this small sample, preliminary analyses might start to provide suggestions of what we will see with the full sample. For all these tokens, we coded that discourse status of the proposition expressed by the complement clause with respect to veridicality and factivity, the syntactic frames, and the discourse functions of the verbs. The average number of times that each of these things occurred is given in Figure 6.20.

Veridicality cues from discourse status of complement: from this sample, we find that no children hear *know p* tokens where *p* expresses information that is false, because they all express information that seems true, or non-controversial in in the context. In contrast, *p* expresses both true and false information in *think* tokens for both groups. Under the hypothesis that children need to observe true *p* tokens for *know* and false *p* tokens for *think*, we might expect to see more false *p* tokens than true *p* tokens for *think*. However, our high-performing group receives the opposite kind of distribution, where true *think p* tokens are more prevalent than false *think p* tokens. If this is representative of the larger sample, it suggests that children do not directly learn about the veridicality distinction between the two verbs by observing direct consequences of it.

Factivity cues from discourse status of complement: from this sample, we see that both groups are exposed to *know p* tokens where *p* expresses established information

Figure 6.20: Average tokens in 10-minute window, by verb, performance group, and cue-type

Type of cue		High-performers		Low-performers	
		<i>know</i>	<i>think</i>	<i>know</i>	<i>think</i>
veridicality	true p	2.0	2.8	1.6	2.0
	false p	–	1.5	–	3.2
factivity	established p	1.7	1.7	1.6	1.5
	new p	1.0	3.0	–	3.7
syntactic	CP +Q	1.9	*	1.7	*
	CP -Q	1.9	3.8	1.8	4.4
discourse function	question	1.6	1.0	1.5	2.3
	assertion	2.2	3.4	1.7	2.5

as well as new information, and that the same holds for *think p* tokens. Furthermore, the distribution of established *p* tokens vs. new *p* tokens skews in the right direction for both groups. But, since there are no big differences between the input for the two groups, these data suggest that children do not uncover the factivity contrast between the verbs by observing its direct consequences either.

Syntactic cues from distributions: from this sample, both groups of children are exposed to distribution of syntactic frames for the two verbs that would allow them to conclude that *know* is a responsive verb while *think* is not. For both groups, *know* oc-

curs in tokens with interrogative and declarative complements, while *think* only occurs in tokens with declarative complements. However, if these cues played a central role in learning about the differences between the two verbs, we might expect to see more of a difference between the values for the high-performing and the low-performing group, which we do not see.

Pragmatic cues from discourse functions: from this sample, we can see that the high-performing group is exposed to more *know* tokens in questions than in assertions, and more *think* tokens in assertions than in questions. Under the hypothesis that discourse functions like asking and answering questions are related to having a *know*-like semantics, while discourse functions like proffering information are related to having a *think*-like semantics, the high-performing group gets exactly the right distribution of discourse functions in their input. In contrast, the low-performing group has no chance to observe that there is a difference in the kinds of discourse functions that *know* and *think* play, because they occur in equal numbers for the two verbs in that group. This suggests that pragmatic bootstrapping from discourse function cues may play a central role in uncovering the contrast between the verbs. In addition, it may be possible that good distribution of discourse function cues that the high-group receives comes at the cost of veridicality cues from the discourse status of the complement; since *think* is mostly used to proffer the complement proposition in this group, there is also less debate about the controversiality of that proposition within the discourse.

6.5.4 Results for composite variables

We also compute our composite variables from the group averages in Figure 6.20. these scores are presented below in Figures 6.21, 6.22, 6.23, and 6.24. Mann-Whitney tests were performed comparing each of these composite variable scores for the high-performing vs. low-performing samples. None of the scores for the two groups were statistically significantly different (all $p > .15$), but this may be due to small sample sizes.

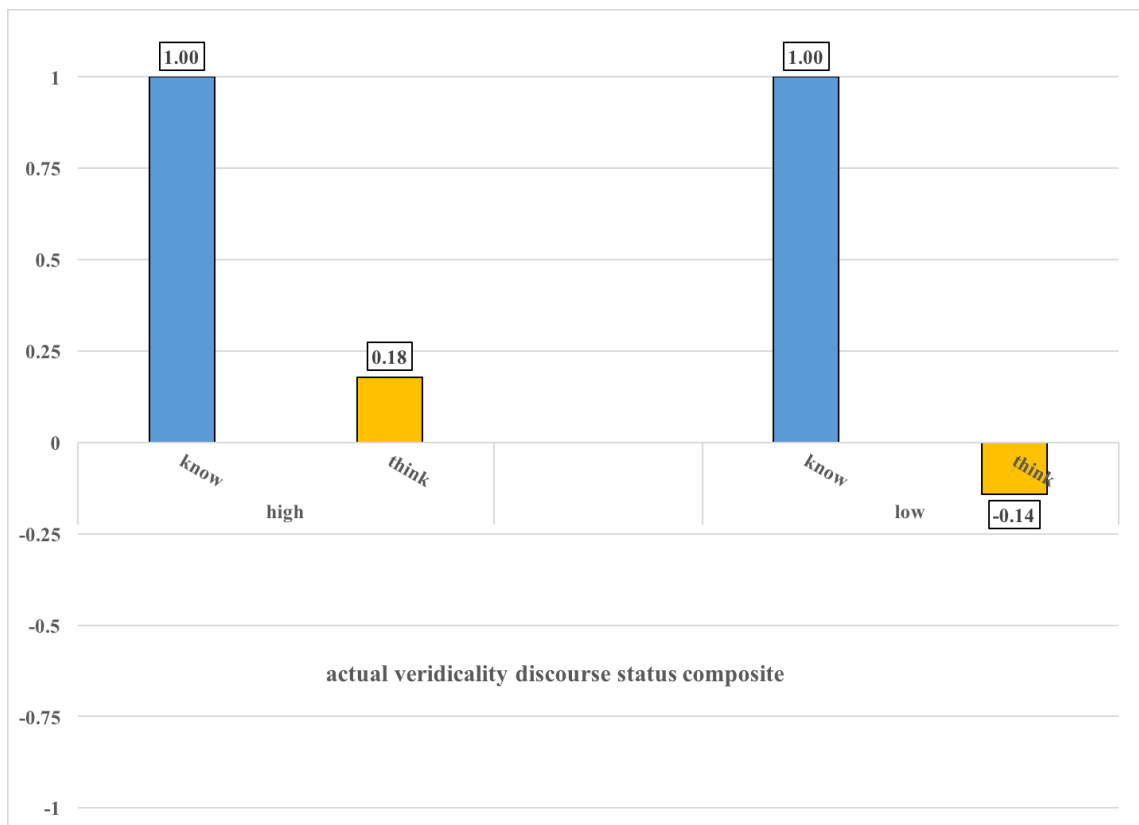


Figure 6.21: Composite score for discourse status of complement cues to veridicality, by performance level in behavioral task and verb

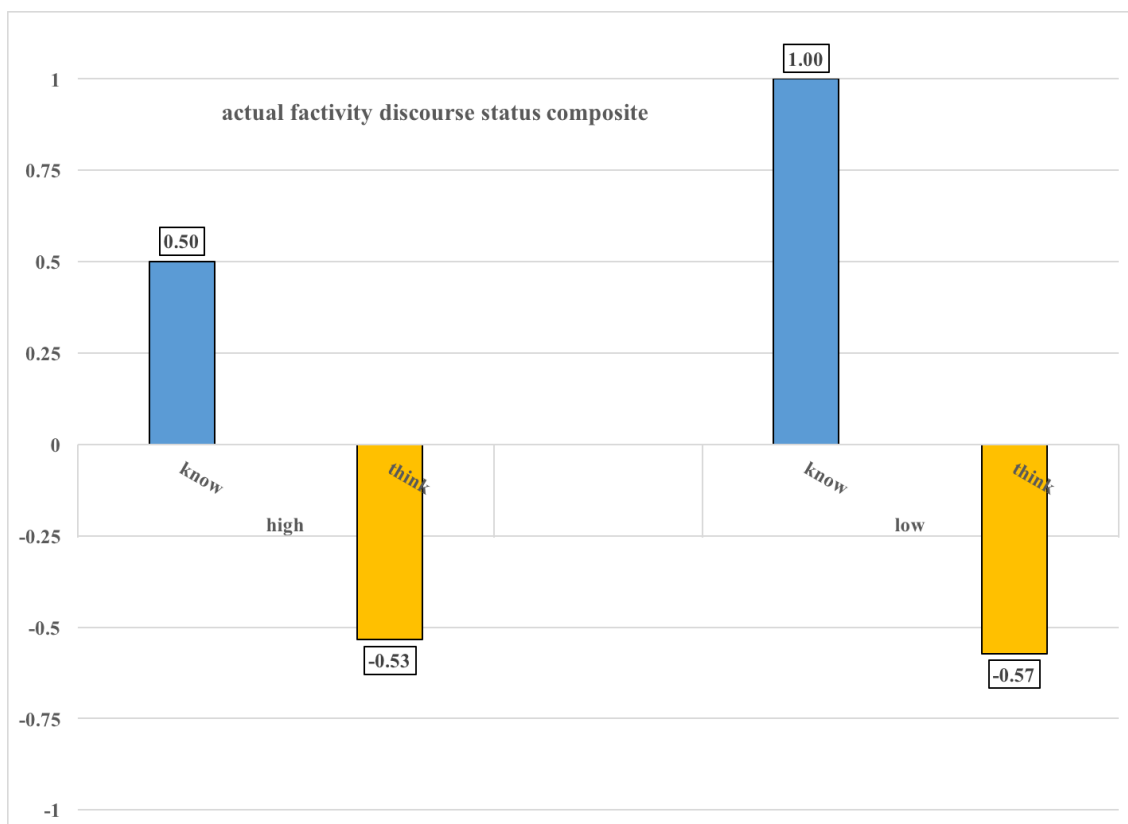


Figure 6.22: Composite score for discourse status of complement cues to factivity, by performance level in behavioral task and verb

6.5.5 Discussion

As discussed above, even with such a small sample, the differences in average input for the two groups is suggestive about which routes are most likely used by the learner. The data discussed above suggest that children in the low-performing sample receive input that more clearly signals the (non-)veridicality and (non-)factivity of the two verbs; the discourse status cues do vary across the two groups, but the kids who get the better distribution of these cues actually perform worse in the behavioral task, suggesting that these routes are not the ones that children use to uncover the distinction. However, children in

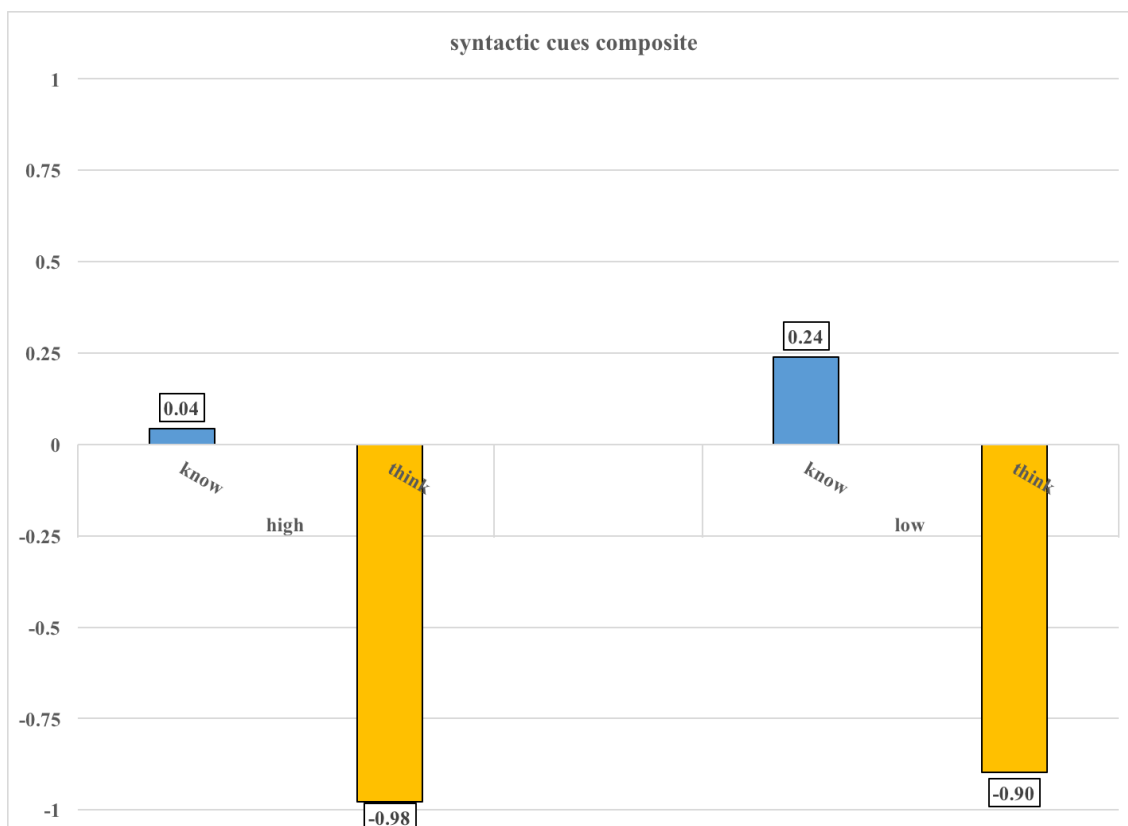


Figure 6.23: Composite score for syntactic cues, by performance level in behavioral task and verb

both samples receive clear syntactic cues which differentiate the verbs, and children in the high-performing sample receive very clear signals about the different discourse functions of the two verbs, suggest that a bootstrapping approach to uncovering the contrast is most likely, either pragmatic or pragmatic-syntactic bootstrapping.

However, we cannot conclude too much from these preliminary results, because our statistical tests indicate that the differences in the sample were not reliable. Perhaps this comes from not having enough power, given that we have analyzed less than 5% of the whole sample. Alternatively, because this preliminary sample is so small, it might not be representative of the distributions in the entire sample.

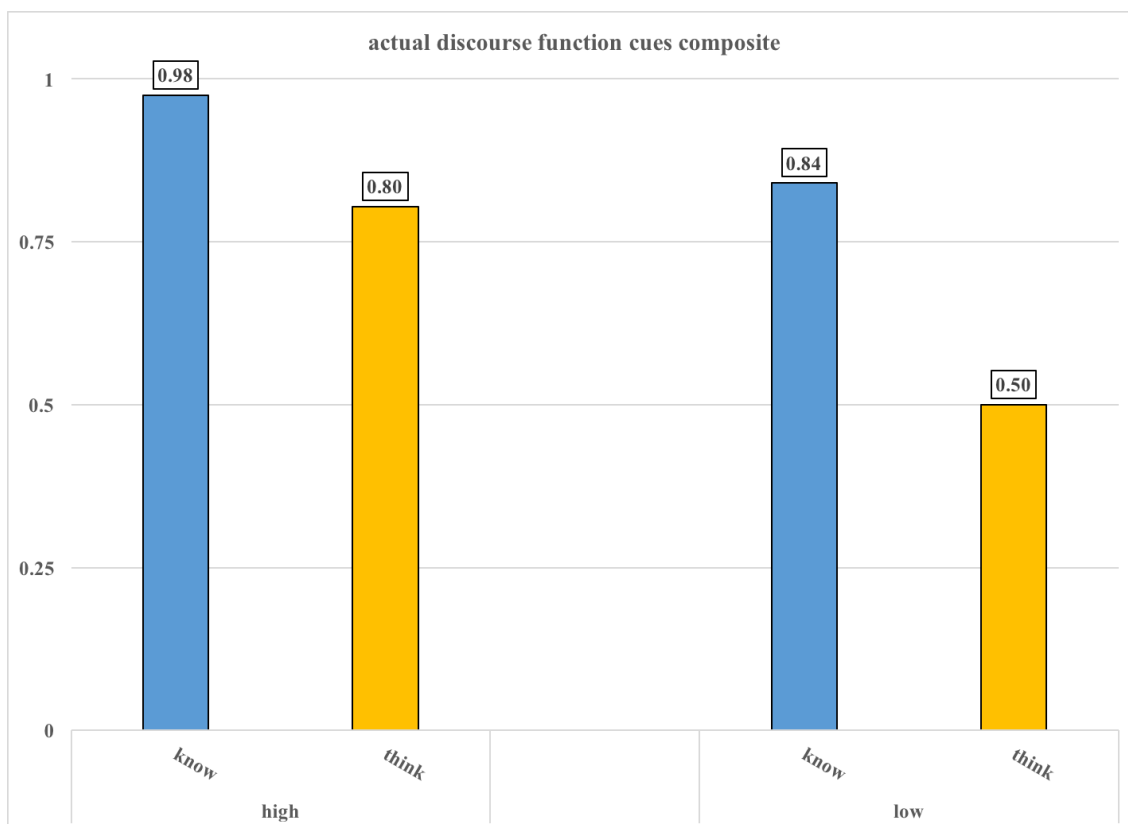


Figure 6.24: Composite score for discourse function cues, by performance level in behavioral task and verb

If we continue to find no statistically significant differences between groups after analyzing the full sample, we will have to go back to the drawing board and consider some alternative ways of addressing the relationship between experience and word learning. For one, our behavioral measure might not be as reflective of underlying word knowledge as we hope. It is likely that other factors like attention play a role in succeeding at this task, and they may outweigh the effects of word knowledge. It's also possible that we have not measured enough child-centric or parent-centric variables, in order to be able to control for the effect that these other variables play on language development. For example, two children might receive the exact same linguistic input but have different understanding

of the verbs because they are at different stages in the acquisition process. It's likely an extended process where different information matters at different points. And there might be non-linguistic aspects of parent-child interactions which help to mask or to highlight different linguistic aspects of experience. For example, differences in joint attention or parental engagement might lead children to make different conclusions about whether a proposition was established within a discourse, or what their parents are trying to achieve by talking to them. Additionally, it may be that there is a more complex interplay between aspects of the linguistic input that we have been able to measure thus far, meaning that we would need to develop new ways of calculating our input variables.

Chapter 7

Conclusion

7.1 Contributions of the dissertation

This dissertation took the first few steps to answering when and how children figure out that *know* is a presupposition trigger, while *think* isn't, as well as what the acquisition path can tell us about the presuppositions of *know*. Chapter 1 laid out the possible routes that children might use to solve the *know-think* mapping problem, and what kinds of input these routes would require. Chapter 2 discussed the semantic, syntactic and pragmatic properties of *know* and *think* that underlie the routes from Chapter 1, as well as semantic and pragmatic theories of presupposition. Chapter 3 reviewed findings from the developmental literature which suggest that children have in place all the representational abilities and mechanisms to take the routes laid out in Chapter 1. Chapter 4 demonstrated that children figure out the factivity contrast between 3-5 years. Chapter 5 presented a corpus analysis which addressed which kinds of routes from Chapter 1 are most likely, given the types of input that children receive. Chapter 6 developed a method for testing the relationship between input and comprehension of the verbs. This chapter concludes the dissertation by reviewing what this tells us about *know* and *think* and their acquisition.

7.1.1 Methodological implications

With respect to addressing **when** questions in the development of semantic and pragmatic abilities, we should take care to choose behavioral methods which are sensitive to the right distinctions. Truth-value judgment tasks are an important methodological tool because they are sensitive to asserted content, which is what is at issue in judgments of truth. But there are other dimensions of meaning, such as implicated or presupposed content, which have different properties and for which there may be different trajectories of acquisition. Implications from implicated or presupposed content need not arise on every use of a sentence, the way that implications from asserted content might, because they are more defeasible. As a result, particular contextual factors contribute to these implications, and those factors should be controlled for, such as in inference-based paradigms.

When addressing **how** questions in language acquisition, corpus methods should be part of the toolkit of developmentalists, experimentalists and theoreticians. When taken together with behavioral methods, corpus methods can help us to have a more nuanced understanding of the types of evidence that are available to a language learner and this can inform which ones of a theoretical set of representations children would be likely to develop. In particular, corpus methods are mandatory for addressing poverty of the stimulus cases for semantics. We are able to start addressing such cases, but addressing them requires an understanding of the kinds of evidence that children are exposed to in the input. Theoretical advances might suggest what stock of possible representations are available (e.g., as in semantic vs. pragmatic theories of presupposition), but corpus analyses can help us start to rule out some of the possibilities.

7.1.2 Empirical implications

Children have non-factive representations of *think* as early as 3 years. There is either minimal individual variation in figuring this out, or it comes well before 3. Children develop adult-like representations of *know* between 3-5 years. There is a lot of individual variation in this development and it is not well-related to age.

Linguistic experience is implicated in children's developing representations of *know*. While the quantity of such experience plays a role, the quality of such experience may also be crucial, insofar as particular uses of *know* are more informative about its underlying meaning. Direct, discourse status cues to distinctions of factivity and veridicality are available, but only sparsely so. These cues require observing that the propositions expressed in the complement of *know* are true or express information that is part of the common ground in order to observe that *know* entails its complement or places restrictions on the common ground when it is uttered, but that *think* places neither of these requirements on its complement.

However, much of the contrast in veridicality and factivity between *know* and *think* is effectively neutralized, because (i) children rarely have the chance to observe the status of *know*'s complement propositions; (ii) *know* is often used 'informatively' when the complement proposition is not part of the common ground, since it is a soft trigger; and (iii) *think* is often used to proffer the truth of its complement proposition, such that these complements are not clearly false in the context of utterance.

On the other hand, indirect, distributional cues are readily available. Assuming a principled link between attitude verb meanings and the syntactic distributions that they

occur in, children can infer that these verbs are doxastic verbs because they embed sentential complements—which express propositions—and they do not take the same kinds of subjects and objects as communicative verbs. They can observe that *know* is a responsive verb because it embeds both interrogative and declarative complements, while *think* does not. They can also infer that *know* is veridical because it can be used to ask or answer questions, while *think* is not because it occurs in different kinds of speech acts.

7.1.3 Conceptual implications

The data discussed here suggests that the contrast between *know* and *think* may not be learned directly through discourse status cues about their (non-)factivity. If not, then understanding of *know* is developed through distributional cues which are informative about its veridicality (and not its factivity).

The learning theory laid out here does not preclude the use of discourse status cues or the direct route to discovering presupposition triggers. The literatures described in Chapter 3 suggest that children could in principle notice the kind of information that is relevant to veridicality, to factivity, and to understanding speaker presuppositions more generally. Instead, the learning theory advocated here would argue that this information may not be widely used for another reason. These conceptual arguments suggest that concepts like belief, knowledge and truth are so ubiquitous that children it might be hard for children to clearly see when they are relevant for the meaning of specific words. So the use of such routes might be restricted in practice.

7.2 Broader outlook

7.2.1 Theories of presupposition

This dissertation presents the first body of evidence about children’s linguistic experiences with a presupposition trigger and arguments about how they might develop an adult-like representation from that experience. Different theories of presupposition contrast the kinds of representations of triggers that children would need to develop in order to capture their presuppositional nature. Semantic accounts stipulate that a trigger’s presupposition is in its representation (Karttunen 1974 and following), whereas pragmatic accounts aim to avoid such a lexical stipulation (Stalnaker 1974 and following).

If we assume a straightforward relationship between evidence and the representations that are developed, then semantic accounts—by definition—require a higher burden of proof for representation of presuppositional phenomena than pragmatic accounts. And one of the empirical contributions of this dissertation is to demonstrate that this high burden of proof might not be met for a soft trigger like *know*. Instead, pragmatic accounts of factive presupposition allow the learner to arrive at *know*’s factivity via its veridicality. But that isn’t to say that semantic presuppositions are un-acquirable.

Consider the presupposition trigger *too*. Its presuppositional status is acquired at roughly the same age as *know* (Dudley et al. 2017), but the evidence for it is different in kind. Discourse status cues to the presupposition are very available, given that *too*’s presupposition rarely goes unsupported within a discourse, and these cues often come from salient aspects of a discourse such as propositions that have recently been expressed verbally or visual stimuli that is present (Dudley et al. 2017). Furthermore, there do not

seem to be any clear indirect cues to the presupposition of *too*. This all suggests that triggers like *too* would meet the burden of proof required for semantic presuppositions, and supports the view that only the hardest or least accommodatable triggers (i.e., focus particles such as *too*) will provide best cues for semantic representations and thus be the limited set of triggers for which children develop semantic representations.

7.2.2 Precocious preschoolers?

This dissertation contributes to a growing body of research which suggests that children develop Theory of Mind and associated pragmatic abilities early than was once assumed. Theorists might have been reluctant to attribute sophisticated pragmatic abilities to children because it was assumed that (i) children could not attribute the beliefs or intentions to others (either in principle or in practice) that serve as inputs to pragmatic reasoning (Perner et al. 1987, Gleitman 1990), and that (ii) they did not have the requisite cognitive abilities to perform the complex steps of logic involved in theories of such reasoning (Grice 1975). But, in fact, children can recognize mental states like beliefs and their content as early as the first year of life (Scott and Baillargeon 2017). And the reasoning mechanisms and steps that children employ to understand a speaker's message need not be as complicated as those written down by theorists (Geurts and Rubio-Fernández 2015). Young children can even master some presupposition triggers by 2-3 years of age (Syrett et al. 2009, Jasbi 2015, Dudley et al. 2015).

7.2.3 Acquisition of “hard” words

But children’s pragmatic sophistication and their abilities to parse environmental cues, including socio-pragmatic ones about speakers intentions, should not be taken to indicate that the environment and children’s experience of it are the only contributors to word learning. This evidence is generally only helpful in light of some expectations about possible meanings. In fact, a child who was purely motivated by their experiences of the world around them (with no antecedent hypotheses about what words could mean) would not be able to learn the meanings of hard words.

To illustrate why, let us consider the learning perspective advocated in this dissertation. This perspective is most closely related to that of Gleitman (1990) but differs in that the explanation of difficulty with hard words is not due to their elusive nature, but rather their quotidian or ubiquitous nature. Children engage in spontaneous belief tracking and they constantly use what they know about other people’s beliefs/desires to explain their behavior. Consequently, the difficulty with these verbs cannot be due to the unobservability of beliefs and desires. They are hard because they are related to concepts which are not salient hypotheses which we readily entertain for word meanings; they have low informational value since that are always part of the explanation of what people mean when they say something. The problem is particularly insidious for “hard” words that token belief concepts. Because they are able to attribute beliefs to those around them, and use those beliefs in figuring out what others mean to say, children are factoring such beliefs out of literal meaning all the time. So they need extra evidence to help them factor belief concepts back in when they are learning belief verbs. The kind of evidence that

cues children into the right answer are distributional cues, for example from the syntax.

But this information is only useful in light of principled links between meaning and distribution, because there are all kinds of possible meanings which we do not see attested. Consider two possible words: the factive, veridical and responsive verb *know* and its hypothetical non-factive counterpart *shknow*. Children would not get the necessary evidence to distinguish between the two hypotheses, because their experiences do not give away the factivity of *know*. Instead they can only observe that *know* is veridical, and they must have some principles which help them derive factivity from veridicality. Do children even entertain a word meaning like that of our hypothetical *shknow*?

7.3 Extensions

Future work can be done to provide support for this conceptual arguments laid out in this dissertation. The force of such claims should extend across lexical categories within a language, across different communities of speakers within a language and across languages. This work would involve verifying that the signal for discourse status cues is clear in the case of hard triggers, and noisy in the case of soft triggers; as well as verifying that indirect cues are available the case of soft triggers and not in the case of hard triggers. And this perspective on learning would predict that if differences in the types of cues available are found across triggers, communities or languages, then these differences should lead to different acquisition paths.

How will KNOW and THINK be mapped in other languages or cultures? The availability of these cues might differ across different communities, either due to cultural

differences in how we speak to children or to linguistic differences. Discourse status cues might be more prevalent in communities where beliefs or truth are more often salient topics of conversation. Factives embed interrogatives and declaratives cross-linguistically, but are both types of complements available in the input? And the use of speech acts with *know* and *think* are likely to differ across speech communities. But there might be other pragmatic reflexes of the contrast which are superficially different but underlyingly similar in that they reflect the information-seeking nature of *know* and the assertivity of *think*.

How will other cognitive factives be mapped? These discourse function cues do not extend straightforwardly to the use of other cognitive factives like *realize* (e.g., *Do you realize where the keys are?* can not be easily understood as a request for information), but the syntactic ones do (e.g., *John realizes that Mary is home/where Mary is*). Perhaps *know* is learned first, given its frequency in speech to children (often orders of magnitude more than other cognitive factives) and factivity is generalized to the others through overlap in their syntactic distributions with *know*'s.

How are other presuppositional meanings mapped? Alternative cues play a role when discourse status cues are unreliable. Alternative cues will be important in learning other soft triggers, and maybe even hard triggers, but not for anaphoric triggers. For anaphoric triggers, discourse status cues are likely to be extremely reliable and potentially salient.

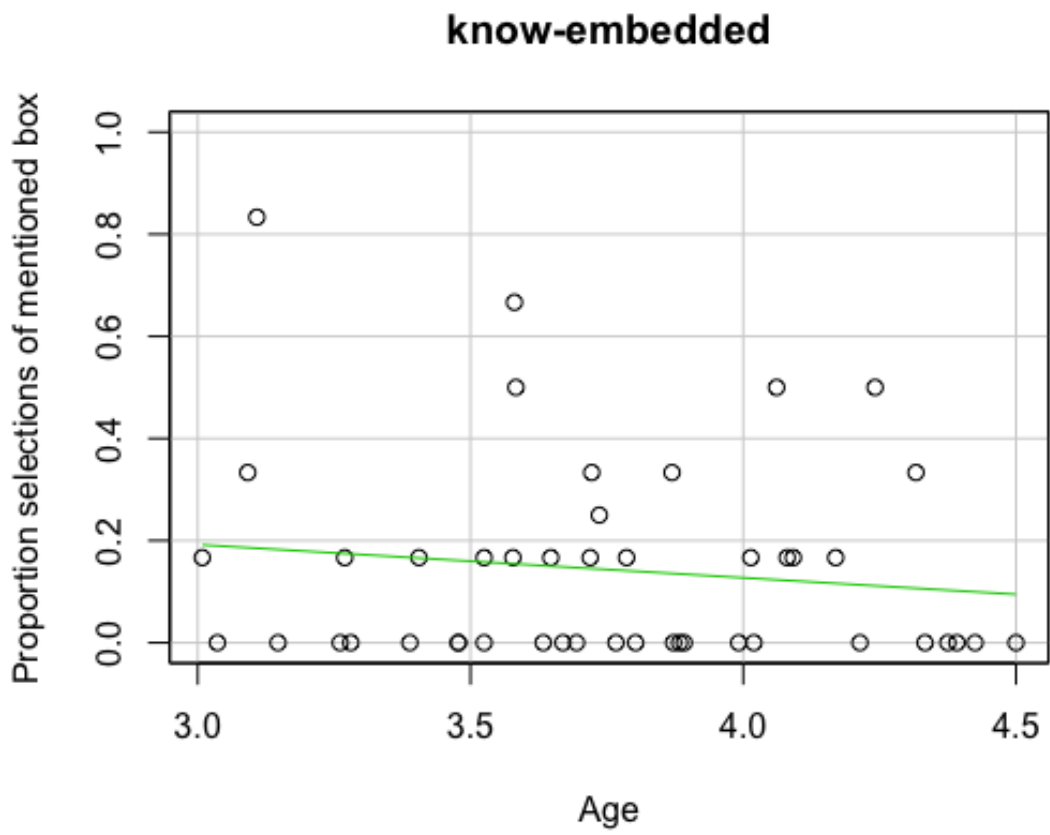


Figure 4: Individual performance in *know*-embedded condition, Study 2

Appendix B



Figure 5: Puzzle set used in puzzle task



Figure 6: Stove toy used in cooking toy set



Figure 7: Type of food toys used in cooking toy set

Bibliography

- Abbeduto, L. and Rosenberg, S. (1985). Children's knowledge of the presuppositions of know and other cognitive verbs. Journal of Child Language, 12(03):621–641.
- Abbott, B. (2000). Presuppositions as nonassertions. Journal of pragmatics, 32(10):1419–1437.
- Abbott, B. (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, pages 1–20.
- Abrusán, M. (2011). Predicting the presuppositions of soft triggers. Linguistics and philosophy, 34(6):491–535.
- Abusch, D. (2002). Lexical alternatives as a source of pragmatic presuppositions. In Proceedings of SALT, volume 12, pages 1–19.
- Abusch, D. (2010). Presupposition triggering from alternatives. Journal of Semantics, 27(1):37–80.
- Adrián, J. E., Clemente, R. A., and Villanueva, L. (2007). Mothers' use of cognitive state verbs in picture-book reading and the development of children's understanding of mind: a longitudinal study. Child development, 78(4):1052–1067.
- Anand, P. and Hacquard, V. (2013). Epistemics and attitudes. Semantics and Pragmatics, 6(8):1–59.
- Anand, P. and Hacquard, V. (2014). Factivity, Belief and Discourse. In Crnič, L. and Sauerland, U., editors, The Art and Craft of Semantics: A Festschrift for Irene Heim, volume 1, pages 69–90. MIT Working Papers in Linguistics, Cambridge, MA.
- Apperly, I. A., Samson, D., and Humphreys, G. W. (2005). Domain-specificity and theory of mind: evaluating neuropsychological evidence. Trends in cognitive sciences, 9(12):572–577.
- Asplin, K. N. (2002). Can complement frames help children learn the meaning of abstract verbs? PhD thesis, University of Massachusetts, Amherst.
- Babelot, G. and Marcos, H. (1999). Comprehension of directives in young children: influence of social situation and linguistic form. First Language, 19(56):165–186.
- Baillargeon, R., Scott, R. M., and Bian, L. (2016). Psychological reasoning in infancy. Annual Review of Psychology, 67:159–186.
- Baldwin, D. A., Markman, E. M., Bill, B., Desjardins, R. N., Irwin, J. M., and Tidball, G. (1996). Infants' reliance on a social criterion for establishing word-object relations. Child development, 67(6):3135–3153.

- Baron-Cohen, S., Leslie, A. M., and Frith, U. (1985). Does the autistic child have a “theory of mind”? Cognition, 21(1):37–46.
- Barrett, H. C., Broesch, T., Scott, R. M., He, Z., Baillargeon, R., Wu, D., Bolz, M., Henrich, J., Setoh, P., Wang, J., et al. (2013). Early false-belief understanding in traditional non-western societies. Proceedings of the Royal Society of London B: Biological Sciences, 280(1755):20122654.
- Bates, E. (1971). The development of conversational skill in 2, 3 and 4 year olds.
- Beaver, D. (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, pages 65–99.
- Becker Razuri, E., Hiles Howard, A. R., Purvis, K. B., and Cross, D. R. (2017). Mental state language development: The longitudinal roles of attachment and maternal language. Infant Mental Health Journal.
- Begus, K. and Southgate, V. (2012). Infant pointing serves an interrogative function. Developmental science, 15(5):611–617.
- Behne, T., Liskowski, U., Carpenter, M., and Tomasello, M. (2012). Twelve-month-olds’ comprehension and production of pointing. British Journal of Developmental Psychology, 30(3):359–375.
- Berger, F. and Höhle, B. (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.
- Bill, C., Romoli, J., Schwarz, F., and Crain, S. (2014). Indirect scalar implicatures are neither scalar implicatures nor presuppositions (or both). In Poster presented at the 27th Annual CUNY Conference on Human Sentence Processing, Ohio State University, Ohio.
- Bloom, P. (2002a). How children learn the meaning of words. The MIT Press.
- Bloom, P. (2002b). Mindreading, communication and the learning of names for things. Mind & Language, 17(1-2):37–54.
- Bolinger, D. (1968). Postposed main phrases: an English rule for the Romance subjunctive. Canadian Journal of Linguistics, 14(1):3–30.
- Booth, J. R., Hall, W. S., Robison, G. C., and Kim, S. Y. (1997). Acquisition of the mental state verb know by 2-to 5-year-old children. Journal of Psycholinguistic Research, 26(6):581–603.
- Bretherton, I. and Beeghly, M. (1982). Talking about internal states: The acquisition of an explicit theory of mind. Developmental psychology, 18(6):906.

- Butler, L. P. and Markman, E. M. (2014). Preschoolers use pedagogical cues to guide radical reorganization of category knowledge. Cognition, 130(1):116–127.
- Buttelmann, D., Carpenter, M., and Tomasello, M. (2009). Eighteen-month-old infants show false belief understanding in an active helping paradigm. Cognition, 112(2):337–342.
- Buttelmann, D., Over, H., Carpenter, M., and Tomasello, M. (2014). Eighteen-month-olds understand false beliefs in an unexpected-contents task. Journal of experimental child psychology, 119:120–126.
- Buttelmann, F., Suhrke, J., and Buttelmann, D. (2015). What you get is what you believe: Eighteen-month-olds demonstrate belief understanding in an unexpected-identity task. Journal of experimental child psychology, 131:94–103.
- Carlson, S. M., Claxton, L. J., and Moses, L. J. (2015). The relation between executive function and theory of mind is more than skin deep. Journal of Cognition and Development, 16(1):186–197.
- Carlson, S. M. and Moses, L. J. (2001). Individual differences in inhibitory control and children’s theory of mind. Child development, 72(4):1032–1053.
- Charlow, S. (2009). StrongãÏ predicative presuppositional objects. In Proceedings of ESSLLI 2009 Workshop: New Directions in the Theory of Presupposition.
- Chemla, E. (2009). Similarity: Towards a unified account of scalar implicatures, free choice permission and presupposition projection. Under revision for Semantics and Pragmatics.
- Chierchia, G. and McConnell-Ginet, S. (2000). Meaning and grammar: An introduction to semantics. MIT press.
- Ciardelli, I., Groenendijk, J., and Roelofsen, F. (2013). Inquisitive semantics: a new notion of meaning. Language and Linguistics Compass, 7(9):459–476.
- Ciardelli, I., Groenendijk, J., and Roelofsen, F. (2015). On the semantics and logic of declaratives and interrogatives. Synthese, 192(6):1689–1728.
- Clements, W. A. and Perner, J. (1994). Implicit understanding of belief. Cognitive development, 9(4):377–395.
- Crain, S., Fodor, J., and Dromi, E. (1993). Competence and performance in child language. Journal of Phonetics, 14:99–104.
- Csibra, G., Biró, S., Koós, O., and Gergely, G. (2003). One-year-old infants use teleological representations of actions productively. Cognitive Science, 27(1):111–133.
- Dayal, V. and Grimshaw, J. (2009). Subordination at the interface: the Quasi-Subordination Hypothesis.

- de Villiers, J. G. (1995). Questioning minds and answering machines. In Proceedings of the 19th Boston University Conference on Language Development, pages 20–36.
- de Villiers, J. G. (2005). Can Language Acquisition Give Children a Point of View? In Astington, J. W. and Baird, J. A., editors, Why language matters for theory of mind, pages 186–219.
- De Villiers, J. G. and De Villiers, P. A. (2000). Linguistic determinism and the understanding of false belief. Children’s Reasoning and the Mind, pages 191–228.
- De Villiers, J. G. and Pyers, J. E. (2002). Complements to cognition: A longitudinal study of the relationship between complex syntax and false-belief-understanding. Cognitive Development, 17(1):1037–1060.
- Delin, J. and Oberlander, J. (1995). Syntactic constraints on discourse structure: the case of it-clefts. Linguistics, 33(3):465–500.
- Diessel, H. and Tomasello, M. (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, R., Orita, N., Hacquard, V., and Lidz, J. (2015). Three-year-olds’ understanding of know and think. In Experimental Perspectives on Presuppositions, pages 241–262. Springer.
- Egré, P. (2008). Question-embedding and factivity. Grazer Philosophische Studien, 77(1):85–125.
- Egyed, K., Király, I., and Gergely, G. (2013). Communicating shared knowledge in infancy. Psychological science, 24(7):1348–1353.
- Evans, A. D., Stolzenberg, S. N., Lee, K., and Lyon, T. D. (2014). Young children’s difficulty with indirect speech acts: Implications for questioning child witnesses. Behavioral sciences & the law, 32(6):775–788.
- Falmagne, R. J., Gonsalves, J., and Bennett-Lau, S. (1994). Children’s linguistic intuitions about factive presuppositions. Cognitive Development, 9(1):1–22.
- Farkas, D. (1985). Intensional descriptions and the Romance subjunctive mood. Taylor & Francis.
- Fillmore, C. J. (1969). Verbs of judging: An exercise in semantic description. Research on Language & Social Interaction, 1(1):91–117.
- Fillmore, C. J. (1970). The Grammar of Hitting and Breaking. In R.A. Jacobs and P.S. Rosenbaum, editors, Readings in English Transformational Grammar, pages 120–133. Ginn, Waltham, MA,.
- Fisher, C., Gertner, Y., Scott, R. M., and Yuan, S. (2010). Syntactic bootstrapping. Wiley Interdisciplinary Reviews: Cognitive Science, 1(2):143–149.

- Fisher, C., Hall, D. G., Rakowitz, S., and Gleitman, L. (1994). When it is better to receive than to give: Syntactic and conceptual constraints on vocabulary growth. Lingua, 92:333–375.
- Fox, D. (2012). Presupposition projection from quantificational sentences: trivalence, local accommodation, and presupposition strengthening. In MS the Hebrew University of Jerusalem. J. ROMOLI Gajewski, J. Citeseer.
- Frege, G. (1948). Sense and reference. The Philosophical Review, 57(3):209–230.
- Furrow, D., Moore, C., Davidge, J., and Chiasson, L. (1992). Mental terms in mothers' and children's speech: Similarities and relationships. Journal of child Language, 19(03):617–631.
- Ganea, P. A. and Saylor, M. M. (2007). Infants' use of shared linguistic information to clarify ambiguous requests. Child Development, 78(2):493–502.
- Garnham, W. A. and Ruffman, T. (2001). Doesn't see, doesn't know: is anticipatory looking really related to understanding or belief? Developmental Science, 4(1):94–100.
- Garvey, C. (1975). Requests and responses in children's speech. Journal of child language, 2(1):41–63.
- Gauker, C. (1998). What is a context of utterance? Philosophical Studies, 91(2):149–172.
- Gelman, R. and Shatz, M. (1977). Appropriate speech adjustments: The operation of conversational constraints on talk to two-year-olds. Interaction, conversation, and the development of language. New York: Wiley.
- Gergely, G., Nádasdy, Z., Csibra, G., and Bíró, S. (1995). Taking the intentional stance at 12 months of age. Cognition, 56(2):165–193.
- Geurts, B. and Rubio-Fernández, P. (2015). Pragmatics and processing. Ratio, 28(4):446–469.
- Giannakidou, A. (1997). The landscape of polarity items. PhD thesis, University of Groningen.
- Ginzburg, J. (1995). Resolving questions, I & II. Linguistics and Philosophy, 18(6):459–527, 567–609.
- Gleason, J. B. (1975). Fathers and other strangers: Men's speech to young children. Developmental psycholinguistics: Theory and applications, pages 289–297.
- Gleitman, L. (1990). The structural sources of verb meanings. Language acquisition, 1(1):3–55.
- Goodman, N. (1955). Fact, fiction and forecast, volume 74. JSTOR.

- Grice, P. (1975). Logic and conversation. In Syntax and semantics, volume 3, pages 41–58. Academic Press.
- Grimshaw, J. (1979). Complement selection and the lexicon. Linguistic inquiry, 10(2):279–326.
- Grimshaw, J. (1990). Argument structure. MIT Press, Cambridge, MA.
- Grimshaw, J. (1994). Lexical reconciliation. Lingua, 92:411–430.
- Groenendijk, J., Stokhof, M., et al. (1984). On the semantics of questions and the pragmatics of answers. Varieties of formal semantics, 3:143–170.
- Grosse, G., Moll, H., and Tomasello, M. (2010). 21-month-olds understand the cooperative logic of requests. Journal of Pragmatics, 42(12):3377–3383.
- Grosse, G. and Tomasello, M. (2012). Two-year-old children differentiate test questions from genuine questions. Journal of child language, 39(01):192–204.
- Hacquard, V. (2014). Bootstrapping attitudes. In Semantics and Linguistic Theory, volume 24, pages 330–352.
- Halberda, J. (2006). Is this a dax which i see before me? use of the logical argument disjunctive syllogism supports word-learning in children and adults. Cognitive psychology, 53(4):310–344.
- Hamblin, C. L. (1973). Questions in montague english. Foundations of language, 10(1):41–53.
- Hamburger, H. and Crain, S. (1982). Relative acquisition. Language development, 1:245–274.
- Hamburger, H. and Crain, S. (1984). Acquisition of cognitive compiling. Cognition, 17(2):85–136.
- Harrigan, K., Hacquard, V., and Lidz, J. (2016). Syntactic bootstrapping in the acquisition of attitude verbs: think, want and hope. In Proceedings of WCCFL, volume 33.
- Harris, R. J. (1975). Children’s comprehension of complex sentences. Journal of Experimental Child Psychology, 19(3):420–433.
- Hart, B. and Risley, T. R. (1995). Meaningful differences in the everyday experience of young American children. Paul H. Brookes Publishing Co., Baltimore.
- Heim, I. (1983). On the projection problem for presuppositions. Formal semantics—the essential readings, pages 249–260.
- Helming, K. A., Strickland, B., and Jacob, P. (2014). Making sense of early false-belief understanding. Trends in cognitive sciences, 18(4):167–170.

- Helming, K. A., Strickland, B., and Jacob, P. (2016). Solving the puzzle about early belief-ascription. Mind & Language, 31(4):438–469.
- Heyman, G. D., Sritanyaratana, L., and Vanderbilt, K. E. (2013). Young children’s trust in overtly misleading advice. Cognitive Science, 37(4):646–667.
- Hintikka, J. (1975). ‘different constructions in terms of the basic epistemological verbs: A survey of some problems and proposals. The Intentions of Intensionality, pages 1–25.
- Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. Child development, 74(5):1368–1378.
- Hoff, E. (2006). How social contexts support and shape language development. Developmental Review, 26(1):55–88.
- Hoff, E. and Naigles, L. (2002). How children use input to acquire a lexicon. Child development, 73(2):418–433.
- Hooper, J. B. (1975). On Assertive Predicates. In Kimball, J. P., editor, Syntax and Semantics, volume 4, pages 91–124.
- Hooper, J. B. and Thompson, S. A. (1973). On the applicability of root transformations. Linguistic inquiry, 4(4):465–497.
- Hopmann, M. R. and Maratsos, M. P. (1978). A developmental study of factivity and negation in complex syntax. Journal of Child Language, 5(02):295–309.
- Howard, A. A., Mayeux, L., and Naigles, L. R. (2008). Conversational correlates of children’s acquisition of mental verbs and a theory of mind. First Language, 28(4):375–402.
- Hurewitz, F., Brown-Schmidt, S., Thorpe, K., Gleitman, L. R., and Trueswell, J. C. (2000). One frog, two frog, red frog, blue frog: Factors affecting children’s syntactic choices in production and comprehension. Journal of Psycholinguistic Research, 29(6):597–626.
- Huttenlocher, J., Vasilyeva, M., Waterfall, H. R., Vevea, J. L., and Hedges, L. V. (2007). The varieties of speech to young children. Developmental psychology, 43(5):1062.
- Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., and Hedges, L. V. (2010). Sources of variability in children’s language growth. Cognitive psychology, 61(4):343–365.
- Jackendoff, R. (1972). Semantic interpretation in generative grammar. MIT press Cambridge, MA.
- Jasbi, M. (2015). Mapping projective content: An investigation of too in english. Unpublished manuscript.

- Jaswal, V. K. (2010). Believing what you're told: Young children's trust in unexpected testimony about the physical world. Cognitive psychology, 61(3):248–272.
- Jaswal, V. K., Croft, A. C., Setia, A. R., and Cole, C. A. (2010). Young children have a specific, highly robust bias to trust testimony. Psychological Science.
- Jaswal, V. K. and Kondrad, R. L. (2016). Why children are not always epistemically vigilant: Cognitive limits and social considerations. Child Development Perspectives, 10(4):240–244.
- Jenkins, J. M., Turrell, S. L., Kogushi, Y., Lollis, S., and Ross, H. S. (2003). A longitudinal investigation of the dynamics of mental state talk in families. Child development, 74(3):905–920.
- Johnson, C. N. and Maratsos, M. P. (1977). Early comprehension of mental verbs: Think and know. Child Development, pages 1743–1747.
- Kampis, D., Parise, E., Csibra, G., and Kovács, Á. M. (2015). Neural signatures for sustaining object representations attributed to others in preverbal human infants. In Proc. R. Soc. B, volume 282, page 20151683. The Royal Society.
- Karttunen, L. (1971). Some observations on factivity. Paper in Linguistics, 4(1):55–69.
- Karttunen, L. (1974). Presupposition and linguistic context. Theoretical linguistics, 1(1-3):181–194.
- Karttunen, L. (1977). Syntax and semantics of questions. Linguistics and philosophy, 1(1):3–44.
- Kiparsky, P. and Kiparsky, C. (1970). Fact. In Manfred Bierwisch and Karl Erich Heidolph, editors, Progress in Linguistics: A Collection of Papers, pages 143–173. Mouton, The Hague.
- Király, I., Csibra, G., and Gergely, G. (2013). Beyond rational imitation: Learning arbitrary means actions from communicative demonstrations. Journal of Experimental Child Psychology, 116(2):471–486.
- Klinedinst, N. (2010). Totally hardcore semantic presuppositions. Unpublished manuscript.
- Knudsen, B. and Liszkowski, U. (2012). 18-month-olds predict specific action mistakes through attribution of false belief, not ignorance, and intervene accordingly. Infancy, 17(6):672–691.
- Koenig, M. A. and Echols, C. H. (2003). Infants' understanding of false labeling events: The referential roles of words and the speakers who use them. Cognition, 87(3):179–208.
- Kovács, Á. M., Téglás, E., and Endress, A. D. (2010). The social sense: Susceptibility to others' beliefs in human infants and adults. Science, 330(6012):1830–1834.

- Kovács, Á. M., Téglás, E., Gergely, G., and Csibra, G. (2016). Seeing behind the surface: communicative demonstration boosts category disambiguation in 12-month-olds. Developmental Science.
- Kripke, S. A. (1982). Wittgenstein on rules and private language: An elementary exposition. Harvard University Press.
- Kuczaj, S. A. (1978). Children's judgments of grammatical and ungrammatical irregular past-tense verbs. Child Development, pages 319–326.
- Lahiri, U. (2002). Questions and answers in embedded contexts. Oxford University Press.
- Landau, B. and Gleitman, L. R. (1985). Language and experience: Evidence from the blind child, volume 8. Harvard University Press.
- Lasnik, H. (1989). On certain substitutes for negative data. In Learnability and linguistic theory, pages 89–105. Springer.
- Léger, C. (2008). The acquisition of two types of factive complements. In Language Acquisition and Development: Proceedings of GALA 2007, pages 337–347.
- Leslie, A. M. (1994). Tomm, toby, and agency: Core architecture and domain specificity. Mapping the mind: Domain specificity in cognition and culture, pages 119–148.
- Leslie, A. M., Friedman, O., and German, T. P. (2004). Core mechanisms in 'theory of mind'. Trends in cognitive sciences, 8(12):528–533.
- Leslie, A. M. and Polizzi, P. (1998). Inhibitory processing in the false belief task: Two conjectures. Developmental Science, 1(2):247–253.
- Levin, B. (1993). English verb classes and alternations: A preliminary investigation. University of Chicago Press.
- Lewis, D. (1979). Scorekeeping in a language game. Journal of philosophical logic, 8(1):339–359.
- Lewis, S. (2013). Pragmatic enrichment in language processing and development.
- Lewis, S., Hacquard, V., and Lidz, J. (2013). The semantics and pragmatics of belief reports in preschoolers. In Proceedings of SALT, volume 22, pages 247–267.
- Lewis, S., Hacquard, V., and Lidz, J. (2017). "Think" pragmatically: Children's interpretation of belief reports. Language Learning and Development, pages 1–23.
- Lidz, J. (2006). Verb learning as a probe into children's grammars. Action meets word: How children learn verbs, pages 429–449.
- Liebal, K., Behne, T., Carpenter, M., and Tomasello, M. (2009). Infants use shared experience to interpret pointing gestures. Developmental science, 12(2):264–271.

- Liszkowski, U. (2005). Human twelve-month-olds point cooperatively to share interest with and helpfully provide information for a communicative partner. *Gesture*, 5(1):135–154.
- Locke, J. (1948). *An essay concerning human understanding*, 1690.
- Macnamara, J., Baker, E., and Olson, C. L. (1976). Four-year-olds' understanding of "pretend", "forget", and "know": Evidence for propositional operations. *Child Development*, pages 62–70.
- MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk. transcription format and programs*. Lawrence Erlbaum Associates, Mahwah, NJ, third edition.
- Mascaro, O. and Morin, O. (2014). Gullible's travel: How honest and trustful children become vigilant communicators. In *Trust and skepticism: Children's selective learning from testimony*, pages 69–83. Psychology Press.
- Mascaro, O. and Morin, O. (2015). Epistemology for beginners: Two-to five-year-old children's representation of falsity. *PloS one*, 10(10):e0140658.
- Mascaro, O., Morin, O., and Sperber, D. (2016). Optimistic expectations about communication explain children's difficulties in hiding, lying, and mistrusting liars. *Journal of Child Language*.
- Mascaro, O. and Sperber, D. (2016). Pragmatic inference in infancy. *Pre-proceedings of Trends in Experimental Pragmatics*, page 95.
- Masur, E. F. and Gleason, J. B. (1980). Parent–child interaction and the acquisition of lexical information during play. *Developmental Psychology*, 16(5):404.
- McLaughlin, B., Schutz, C., and White, D. (1980). Parental speech to five-year-old children in a game-playing situation. *Child Development*, pages 580–582.
- Moll, H., Kane, S., and McGowan, L. (2015). Three-year-olds express suspense when an agent approaches a scene with a false belief. *Developmental Science*.
- Moll, H., Khalulyan, A., and Moffett, L. (2017). 2.5-year-olds express suspense when others approach reality with false expectations. *Child Development*, 88(1):114–122.
- Moll, H. and Tomasello, M. (2006). Level 1 perspective-taking at 24 months of age. *British Journal of Developmental Psychology*, 24(3):603–613.
- Moore, C., Bryant, D., and Furrow, D. (1989). Mental terms and the development of certainty. *Child Development*, pages 167–171.
- Moore, C. and Davidge, J. (1989). The development of mental terms: Pragmatics or semantics? *Journal of Child Language*, 16(03):633–641.
- Moore, C., Jarrold, C., Russell, J., Lumb, A., Sapp, F., and MacCallum, F. (1995). Conflicting desire and the child's theory of mind. *Cognitive Development*, 10(4):467–482.

- Naigles, L. (1990). Children use syntax to learn verb meanings. Journal of child language, 17(2):357–374.
- Naigles, L., Gleitman, H., and Gleitman, L. (1993). Syntactic bootstrapping and verb acquisition. Language and cognition: a developmental perspective. Norwood, NJ: Ablex.
- Naigles, L. R. (1996). The use of multiple frames in verb learning via syntactic bootstrapping. Cognition, 58(2):221–251.
- Ninio, A. (1983). Joint book reading as a multiple vocabulary acquisition device. Developmental Psychology, 19(3):445.
- Onishi, K. H. and Baillargeon, R. (2005). Do 15-month-old infants understand false beliefs? science, 308(5719):255–258.
- Papafragou, A., Cassidy, K., and Gleitman, L. (2007). When we think about thinking: The acquisition of belief verbs. Cognition, 105(1):125–165.
- Pea, R. D. (1982). Origins of verbal logic: Spontaneous denials by two-and three-year olds. Journal of child language, 9(03):597–626.
- Perner, J., Leekam, S. R., and Wimmer, H. (1987). Three-year-olds' difficulty with false belief: The case for a conceptual deficit. British Journal of Developmental Psychology, 5(2):125–137.
- Perner, J., Sprung, M., Zauner, P., and Haider, H. (2003). Want That is Understood Well before Say that, Think That, and False Belief: A Test of de Villiers's Linguistic Determinism on German-Speaking Children. Child development, 74(1):179–188.
- Pesetsky, D. (1991). Zero syntax: vol. 2: Infinitives.
- Pham, K., Bonawitz, E., and Gopnik, A. (2012). Seeing who sees: Contrastive access helps children reason about other minds. In CogSci.
- Pinker, S. (1989). Learnability and cognition: The acquisition of argument structure. The MIT press.
- Pinker, S. (1994). How could a child use verb syntax to learn verb semantics? Lingua, 92:377–410.
- Poulin-Dubois, D. and Chow, V. (2009). The effect of a looker's past reliability on infants' reasoning about beliefs. Developmental Psychology, 45(6):1576.
- Premack, D. and Woodruff, G. (1978). Does the chimpanzee have a theory of mind? Behavioral and brain sciences, 1(04):515–526.
- Quine, W. (1960). Word and object.
- Rakoczy, H., Warneken, F., and Tomasello, M. (2007). "this way!" "no! that way!" 3-year olds know that two people can have mutually incompatible desires. Cognitive Development, 22(1):47–68.

- Reeder, K. (1980). The emergence of illocutionary skills. Journal of Child Language, 7(01):13–28.
- Repacholi, B. M. and Gopnik, A. (1997). Early reasoning about desires: evidence from 14- and 18-month-olds. Developmental psychology, 33(1):12.
- Roberts, C. (2012). Accommodation in a language game. A Companion to David Lewis, pages 345–366.
- Rooryck, J. (2001). Evidentiality, part I. Glott International, 5(4):125–133.
- Rooth, M. (1985). Association with focus.
- Rowe, M. L., Coker, D., and Pan, B. A. (2004). A comparison of fathers' and mothers' talk to toddlers in low-income families. Social Development, 13(2):278–291.
- Rubio-Fernández, P. and Geurts, B. (2013). How to pass the false-belief task before your fourth birthday. Psychological science, 24(1):27–33.
- Rubio-Fernández, P. and Geurts, B. (2016). Don't mention the marble! the role of attentional processes in false-belief tasks. Review of Philosophy and Psychology, 7(4):835–850.
- Salomo, D., Lieven, E., and Tomasello, M. (2010). Young children's sensitivity to new and given information when answering predicate-focus questions. Applied Psycholinguistics, 31(01):101–115.
- Saylor, M. M. and Ganea, P. (2007). Infants interpret ambiguous requests for absent objects. Developmental psychology, 43(3):696.
- Schlenker, P. (2010). Local contexts and local meanings. Philosophical Studies, 151(1):115–142.
- Scholl, B. J. and Leslie, A. M. (2001). Minds, modules, and meta-analysis. Child development, 72(3):696–701.
- Schulz, P. (2003). Factivity: Its nature and acquisition, volume 480. Walter de Gruyter.
- Scott, R. M. and Baillargeon, R. (2009). Which penguin is this? attributing false beliefs about object identity at 18 months. Child development, 80(4):1172–1196.
- Scott, R. M. and Baillargeon, R. (2017). Early false-belief understanding. Trends in Cognitive Sciences, 21(4):237–249.
- Scott, R. M., Baillargeon, R., Song, H.-j., and Leslie, A. M. (2010). Attributing false beliefs about non-obvious properties at 18 months. Cognitive psychology, 61(4):366–395.
- Scott, R. M., Richman, J. C., and Baillargeon, R. (2015). Infants understand deceptive intentions to implant false beliefs about identity: New evidence for early mentalistic reasoning. Cognitive psychology, 82:32–56.

- Scoville, R. P. and Gordon, A. M. (1980). Children's understanding of factive presuppositions: An experiment and a review. Journal of Child Language, 7(02):381–399.
- Searle, J. R. (1975). Indirect speech acts. na.
- Senju, A., Southgate, V., Snape, C., Leonard, M., and Csibra, G. (2011). Do 18-month-olds really attribute mental states to others? a critical test. Psychological science, 22(7):878–880.
- Shatz, M. (1978a). Children's comprehension of their mothers' question-directives. Journal of Child Language, 5(01):39–46.
- Shatz, M. (1978b). On the development of communicative understandings: An early strategy for interpreting and responding to messages. Cognitive Psychology, 10(3):271–301.
- Shatz, M., Wellman, H. M., and Silber, S. (1983). The acquisition of mental verbs: A systematic investigation of the first reference to mental state. Cognition, 14(3):301–321.
- Siegal, M. and Beattie, K. (1991). Where to look first for children's knowledge of false beliefs. Cognition, 38(1):1–12.
- Simons, M. (2001). On the conversational basis of some presuppositions. In R. Hasting, B. Jackson, and Z. Zvolensky, editors, Proceedings of Semantics and Linguistic Theory 11, pages 431–448, Ithaca, NY. Cornell University.
- Simons, M. (2003). Presupposition and accommodation: Understanding the stalnakerian picture. Philosophical Studies, 112(3):251–278.
- Simons, M. (2007). Observations on embedding verbs, evidentiality, and presupposition. Lingua, 117(6):1034–1056.
- Simons, M., Beaver, D., Roberts, C., and Tonhauser, J. (2017). The best question: Explaining the projection behavior of factives. Discourse Processes, 54(3):187–206.
- Slaughter, V., Peterson, C. C., and Mackintosh, E. (2007). Mind what mother says: Narrative input and theory of mind in typical children and those on the autism spectrum. Child development, 78(3):839–858.
- Smith, L. B. (1995). Self-organizing processes in learning to learn words: Development is not induction. In Basic and applied perspectives on learning, cognition, and development. The Minnesota Symposia on Child Psychology, volume 28, pages 1–32. Lawrence Erlbaum Associates Mahwah, NJ.
- Song, H.-j. and Baillargeon, R. (2008). Infants' reasoning about others' false perceptions. Developmental psychology, 44(6):1789.

- Song, H.-j., Onishi, K. H., Baillargeon, R., and Fisher, C. (2008). Can an agent's false belief be corrected by an appropriate communication? psychological reasoning in 18-month-old infants. Cognition, 109(3):295–315.
- Southgate, V., Senju, A., and Csibra, G. (2007a). Action anticipation through attribution of false belief by 2-year-olds. Psychological Science, 18(7):587–592.
- Southgate, V., Van Maanen, C., and Csibra, G. (2007b). Infant pointing: Communication to cooperate or communication to learn? Child development, 78(3):735–740.
- Southgate, V. and Verneti, A. (2014). Belief-based action prediction in preverbal infants. Cognition, 130(1):1–10.
- Sowalsky, E., Hacquard, V., and Roeper, T. (2009). Is pp opacity on the path to false belief. In Generative Approaches to Language Acquisition North America (GALANA), volume 3, pages 263–261.
- Spector, B. and Egré, P. (2015). A uniform semantics for embedded interrogatives: An answer, not necessarily the answer. Synthese, 192(6):1729–1784.
- Spenader, J. (2003). Factive presuppositions, accommodation and information structure. Journal of Logic, Language and Information, 12(3):351–368.
- Stalnaker, R. (1973). Presuppositions. Journal of philosophical logic, 2(4):447–457.
- Stalnaker, R. (1974). Pragmatic presuppositions. Semantics and Philosophy, pages 197–214.
- Stowell, T. A. (1981). Origins of phrase structure. PhD thesis, Massachusetts Institute of Technology.
- Strawson, P. F. (1950). On referring. Mind, pages 320–344.
- Sullivan, K. and Winner, E. (1993). Three-year-olds's understanding of mental states: The influence of trickery. Journal of experimental child psychology, 56(2):135–148.
- Surian, L., Caldi, S., and Sperber, D. (2007). Attribution of beliefs by 13-month-old infants. Psychological science, 18(7):580–586.
- Surian, L. and Leslie, A. M. (1999). Competence and performance in false belief understanding: A comparison of autistic and normal 3-year-old children. British Journal of Developmental Psychology, 17(1):141–155.
- Syrett, K., Kennedy, C., and Lidz, J. (2009). Meaning and context in children's understanding of gradable adjectives. Journal of semantics, pages 1–35.
- Tardif, T. and Wellman, H. M. (2000). Acquisition of mental state language in mandarin and cantonese-speaking children. Developmental Psychology, 36(1):25.

- Theiler, N. (2014). A multitude of answers: embedded questions in typed inquisitive semantics. PhD thesis, Universiteit van Amsterdam.
- Theiler, N., Roelofsen, F., and Aloni, M. (2016). Truthful resolutions: A new perspective on false-answer sensitivity. In Semantics and Linguistic Theory (SALT), volume 26, pages 122–141.
- Tomasello, M., Conti-Ramsden, G., and Ewert, B. (1990). Young children's conversations with their mothers and fathers: Differences in breakdown and repair. Journal of child language, 17(01):115–130.
- Tomasello, M. and Haberl, K. (2003). Understanding attention: 12- and 18-month-olds know what is new for other persons. Developmental psychology, 39(5):906.
- Tonhauser, J., Beaver, D., Roberts, C., and Simons, M. (2013). Toward a taxonomy of projective content. Language, 89(1):66–109.
- Topál, J., Gergely, G., Miklósi, Á., Erdőhegyi, Á., and Csibra, G. (2008). Infants' perseverative search errors are induced by pragmatic misinterpretation. Science, 321(5897):1831–1834.
- Träuble, B., Marinović, V., and Pauen, S. (2010). Early theory of mind competencies: do infants understand others' beliefs? Infancy, 15(4):434–444.
- Trueswell, J. C., Sekerina, I., Hill, N. M., and Logrip, M. L. (1999). The kindergarten-path effect: Studying on-line sentence processing in young children. Cognition, 73(2):89–134.
- Uegaki, W. (2015). Interpreting questions under attitudes. PhD thesis, Massachusetts Institute of Technology.
- Urmson, J. O. (1952). Parenthetical verbs. Mind, 61(244):480–496.
- Van der Sandt, R. A. (1992). Presupposition projection as anaphora resolution. Journal of semantics, 9(4):333–377.
- Villalta, E. (2008). Mood and gradability: an investigation of the subjunctive mood in Spanish. Linguistics and Philosophy, 31(4):467–522.
- Vouloumanos, A., Onishi, K. H., and Pogue, A. (2012). Twelve-month-old infants recognize that speech can communicate unobservable intentions. Proceedings of the National Academy of Sciences, 109(32):12933–12937.
- Walker, K. and Armstrong, L. (1995). Do mothers and fathers interact differently with their child or is it the situation which matters? Child: Care, health and development, 21(3):161–181.
- Warneken, F. and Tomasello, M. (2006). Altruistic helping in human infants and young chimpanzees. science, 311(5765):1301–1303.

- Warneken, F. and Tomasello, M. (2007). Helping and cooperation at 14 months of age. Infancy, 11(3):271–294.
- Wellman, H. M., Cross, D., and Watson, J. (2001). Meta-analysis of theory-of-mind development: the truth about false belief. Child development, 72(3):655–684.
- Westra, E. (2016). Pragmatic development and the false belief task. Review of Philosophy and Psychology, pages 1–23.
- Westra, E. and Carruthers, P. (2017). Pragmatic development explains the theory-of-mind scale. Cognition, 158:165–176.
- White, A. S. (2015). Information and incrementality in syntactic bootstrapping. PhD thesis, University of Maryland.
- White, A. S., Dudley, R., Hacquard, V., and Lidz, J. (2014a). Discovering classes of attitude verbs using subcategorization frame distributions. In Hsin-Lun Huang, Ethan Poole, and Amanda Rysling, editors, Proceedings of the 42nd annual meeting of the North East Linguistic Society.
- White, A. S., Hacquard, V., and Lidz, J. (2014b). Projecting attitudes.
- Wimmer, H. and Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children’s understanding of deception. Cognition, 13(1):103–128.
- Woodward, A. L. (1998). Infants selectively encode the goal object of an actor’s reach. Cognition, 69(1):1–34.
- Yazdi, A. A., German, T. P., Defeyter, M. A., and Siegal, M. (2006). Competence and performance in belief-desire reasoning across two cultures: The truth, the whole truth and nothing but the truth about false belief? Cognition, 100(2):343–368.
- Yont, K. M., Snow, C. E., and Vernon-Feagans, L. (2003). The role of context in mother-child interactions: An analysis of communicative intents expressed during toy play and book reading with 12-month-olds. Journal of Pragmatics, 35(3):435–454.
- Yott, J. and Poulin-Dubois, D. (2012). Breaking the rules: Do infants have a true understanding of false belief? British Journal of Developmental Psychology, 30(1):156–171.
- Yu, C. and Smith, L. B. (2011). What you learn is what you see: using eye movements to study infant cross-situational word learning. Developmental Science, 14(2):165–180.
- Yuan, S. and Fisher, C. (2009). “Really? She Blicked the Baby?” Two-Year-Olds Learn Combinatorial Facts About Verbs by Listening. Psychological Science, 20(5):619–626.
- Zwicky, A. M. (1971). In a manner of speaking. Linguistic Inquiry, 2(2):223–233.