DIGITAL ACCESS TO SCHOLARSHIP AT HARVARD
DASH.HARVARD.EDU

HARVARD LIBRARY

Young Children's Meta-Ignorance

Citation

Bartz, Deborah Teo. 2017. Young Children's Meta-Ignorance. Doctoral dissertation, Harvard Graduate School of Education.

Link

http://nrs.harvard.edu/urn-3:HUL.InstRepos:33051609

Terms of use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material (LAA), as set forth at
https://harvardwiki.atlassian.net/wiki/external/NGY5NDE4ZjgzNTc5NDQzMGIzZWZhMGFlOWI2M2EwYTg

Accessibility

https://accessibility.huit.harvard.edu/digital-accessibility-policy

Share Your Story

The Harvard community has made this article openly available.
Please share how this access benefits you. Submit a story

Young Children's Meta-ignorance

Deborah Teo Bartz

Advisors:
Paul L. Harris
Meredith Rowe
Catherine Snow

A Thesis Presented to the Faculty of the Graduate School of Education of Harvard University in Partial Fulfillment of the Requirements for the Degree of Doctor of Education

2017

© 2017
Deborah Teo Bartz
All Rights Reserved

Acknowledgements

I would like to thank Professor Paul Harris, Professor Meredith Rowe, and Professor Catherine Snow for their invaluable help in the research and writing process. I would especially like to thank Professor Harris for being my adviser. I am always amazed by his humility, kindness, and patience. I would not have been able to write this dissertation without his mentorship.

Additionally, I would like to thank Professor Susan Goldin-Meadow and Kristi for giving me access to their data from the Language Development Project at the University of Chicago. I am grateful for all the families who participated in this study. Ariya, Heather, and Kathleen, thank you for going out of your way to connect me with families in the area. I would like to thank Stony Brook Child Care Services, Suffolk County Community College's Campus Kids, Children's Community Head Start and Early Head Start, Port Jefferson Free Library, and Longwood Public Library for allowing me to recruit families on their premises. I am grateful to Natalie, Laura, and Mummy for assistance with coding. I am also thankful for Lynneth who graciously helped to translate my consent documents into Spanish.

Last, I would like to thank my family, especially my husband, Kevin, who believed in me and gave me the motivation and support to finish this dissertation. Papa, Mummy, Po-Ru, and Charis, thank you also for supporting, housing, and feeding me during my Cambridge visits. I am blessed to have such an amazingly supportive family.

Table of Contents

Acknowledgements i

Abstract iii

Introduction 1

Study 1 15

Study 2 41

Study 3 77

General Discussion 106

References 117

Abstract

Meta-ignorance is an awareness of one's own knowledge or lack of knowledge. The goal of this dissertation is to examine the development of children's meta-ignorance between 14 months and 42 months. I examine the hypothesis that children have some awareness of their own epistemic states, notably states of knowledge and ignorance.

In Study 1, eight children's use of the mental verb *know* was examined when they were between 18 and 36 months. Children (from the Child Language Data Exchange System) used *know* to affirm their own knowledge and that of their interlocutor. When they used *know* in the context of asking a question, they typically asked about their interlocutor's knowledge states and not their own. Conversely, they often denied their own knowledge but rarely their interlocutor's. Finally, they rarely referred to a third party's knowledge.

In Study 2, 64 children's production of the flip gesture (hold two hands palm up out to the side to communicate "I don't know") was examined when they were between 14 and 42 months. The video recordings were from the Language Development Project. Flip gestures were observed at 14 months, which is four months before a minority of children were first observed saying: "I don't know." Children often flipped following their interlocutors' comments and questions, suggesting that children used flips in a dialogic fashion. When children flipped, their interlocutors often interpreted flips as an expression of ignorance and responded accordingly.

Study 3 involved an experiment in which 52 children aged 16 to 37 months were presented with familiar and unfamiliar pictures and asked to label them. For familiar pictures, children mostly produced the correct name. For unfamiliar pictures, children

were more likely to display signs of uncertainty, including turning to gaze at an adult, producing a filled pause such as *Um*, asking for help, and saying *I don't know.*

Children's ability to produce I DON'T KNOW flips, to say *I don't know*, and to express uncertainty when asked to name unfamiliar objects indicates that they come to express a simple understanding of knowledge and ignorance in the course of the second and third year.

Introduction

Researchers studying early cognitive development are interested in when and how children come to reflect on their own knowledge states (Goupil, Romand-Monnier, & Kouider, 2016). This ability to reflect or "know what one knows" is "metacognition" (Beran, Brandl, Perner & Proust, 2012, p. 9). Metacognition is often seen as part of theory of mind (ToM) research, which investigates when the ability to attribute mental states to others develops (Beran et al., 2012). While there is some debate over the distinctions, metacognition research typically focuses on an individual understanding his or her own mind whereas ToM research focuses more on understanding other people's mental states (Beran et al., 2012). Understanding one's own knowledge and ignorance are essentially different sides of the same coin. This introduction focuses on meta-ignorance, which is knowing that one does not know (Marazita & Merriman, 2004) but references to meta-knowledge, knowing that one does know, will also be included.

When do children know that they are ignorant of a given piece of information? In a seminal study, Chouinard (2007) presented a model of the cognitive processes involved in children's early questions. She argues that when children encounter a new situation where their existing knowledge is incomplete, they experience disequilibrium, which is a state of mental uncertainty (Chouinard, 2007). This state is unsettling and it motivates children to ask questions to regain equilibrium (Chouinard, 2007). This dissertation looks at whether this state of disequilibrium may be more than an inchoate or tacit feeling of uncertainty. I examine the possibility that when young children experience disequilibrium, they are able to express their ignorance, especially to an interlocutor, via appropriate

comments and gestures. This dissertation examines the development of meta-ignorance between 14 months and 42 months.

How does meta-ignorance develop in early childhood? The next section reviews the existing evidence in three parts. The first part involves early signs of metacognition during infancy (six months to twenty-four months). The next section focuses on three- to four-year-olds. Finally, the intervening period, i.e., the period between two and three years will be discussed last because there are relatively fewer studies for this period.

Metacognition during infancy

In recent years, there has been significant interest in early signs of metacognition during infancy (Sodian, Thoermer, Kristen, & Perst, 2012). There is growing evidence that during the first year of life, infants are capable not just of identifying more knowledgeable informants (Begus & Southgate, 2012; Stenberg, 2009), or understanding others' mental states (Onishi & Baillargeon, 2005), but also of monitoring their own uncertainty (Goupil et al., 2016).

When preschool children are given the opportunity to choose between two informants, they often choose the more knowledgeable and accurate informant (Koenig & Harris, 2005; Koenig & Woodward, 2010). Recent findings indicate that they make these choices even in infancy. For instance, when 18- and 24- month-old children were tested in a laboratory setting, they preferred looking at the experimenter rather than their mothers for information about an unfamiliar toy (Walden & Kim, 2005), arguably because the experimenter was more familiar with the setting than their mother and not because the experimenter had presented the toy. To investigate this possibility more systematically, Stenberg (2009) conducted a study in which 12-month-old infants were

presented with an ambiguous toy dinosaur either by an experimenter or by their caregivers. In either case, infants preferred to look at the experimenter rather than their mothers when the toys were presented. By implication, infants looked to the 'local expert' for information rather than to the person who had presented the toy. Furthermore, they directed more puzzled looks at the experimenter. They also played more with the toy dinosaur in later free-play sessions when they received reassuring information from the experimenter as opposed to their mothers. These results suggest that the infants looked for information from the person they deemed to be most knowledgeable in that setting. The experimenter appeared as an expert to the child because, unlike the child's mother, he or she was familiar with the laboratory environment and testing procedures. Hence, Stenberg (2009) concluded that 12-month-old infants are capable of identifying a more knowledgeable informant.

This ability to identify more knowledgeable informants is observed again at 16 months. Begus and Southgate (2012) examined the connection between infants' pointing and the perceived abilities of their informants. They found that 16-month-olds were more likely to point to novel objects when they were interacting with a more knowledgeable experimenter than an ignorant experimenter. Infants assessed experimenters based on the manner in which they named novel objects. Experimenters either named the objects with confidence (e.g., "It's a [label]!") or with uncertainty (e.g., The experimenters looked puzzled and said "Hmm, I think it's a [label]."). Subsequently, infants pointed more when experimenters were perceived to be more knowledgeable or reliable. By implication, 16-month-olds are capable of assessing and remembering prior competence and they produce pointing gestures accordingly. These results also imply that the purpose of early

pointing is more than mere attention sharing; infants point to obtain information from knowledgeable others.

Further evidence for infants' abilities to understand mental states comes from a study on 15-month-olds. Onishi and Baillargeon (2005) tested infants' ability to predict an agent's behavior based on the agent's true or false belief about a toy's hiding place. As indexed by their gaze patterns, infants expected the actor to search for the hidden toy based on the actor's beliefs about the toy's location, no matter whether those beliefs were true or false. Infants looked longer when the actor searched in a way that was inconsistent with her beliefs. These results suggest that toddlers understand that other individuals act on their beliefs, and will do so even when those beliefs do not accurately represent reality (Onishi & Baillargeon, 2005).

In a recent study, toddlers' ability to monitor their own mental states was examined. Goupil et al. (2016) used a nonverbal monitoring paradigm to test if 20-month-olds are able to assess and communicate their own uncertainty. Infants had to remember the location of a hidden toy and after a delay, point to the box where the toy was located in order to receive help in recovering it. The infants in the experimental group were given the choice of asking for help when they forgot the toy's location. Experimenters trained infants to ask for help by turning to their caregivers to ask for assistance. Caregivers were told to establish eye contact with their children before indicating the correct box with the hidden toys. Infants in the control group were not taught to use this option of asking for help. The authors found that when given the opportunity, infants strategically used the option to request help in order to avoid making mistakes, especially when they were likely to have forgotten the location of the hidden

object (i.e.. in a delay condition where they were obliged to wait before searching). By implication, 20-month-old infants are able to monitor and communicate their own uncertainty to obtain information from their caregivers. In short, because uncertainty monitoring is a fundamental part of metacognition, these results clearly show that children possess some metacognitive abilities well before the age of four.

Overall, these studies suggest that infants are capable of identifying more knowledgeable informants and tailoring their communications accordingly. They are also capable of anticipating what an actor is likely to do, given her beliefs. Finally, the recent results from Goupil et al. (2015) strongly indicate that children are able to monitor and communicate their own uncertainty.

Metacognition between three and four years old

Having reviewed this cluster of infant studies, I now turn to studies on metacognition that have focused on children aged three years and upward. By this age, children are able to explicitly state who knows, for example, what is in a closed box, implying that they understand the link between seeing and knowing (Pillow, 1989; Pratt & Bryant, 1990). This matches Wellman and Liu's (2004) developmental scale, which places the understanding of seeing and knowing (also called the knowledge-ignorance task) as a precursor to false belief understanding (Wellman, Fang, Liu, Zhu, & Liu, 2006).

Three-year-old children are able to distinguish between being knowledgeable and being ignorant (Pratt & Bryant, 1990; Sodian, Thoermer, & Dietrich, 2006). In an experiment, children were asked to indicate who knew the color of a hidden object – themselves or another agent. Three- and four-year olds chose the puppet or person who had previously viewed the hidden object and not the puppet or person who had not

viewed it (Pillow, 1989). Thus, children did not respond egocentrically that the other agent's knowledge or ignorance was the same as their own. Even before they were able to pass the false-belief task, they were able to assess the other's knowledge when it was different from their own – they recognized that they might know what the other did not know and vice versa (Pillow, 1989).

Building on Pillow's (1989) work, Pratt and Bryant (1990) produced further evidence that children understand the link between seeing and knowing. In the first experiment, three- and four-year-old children were asked to judge which of two assistants knew what was inside the box. Children chose the assistant who had previously looked inside the box as opposed to the other assistant who had only lifted the box and not looked inside (Pratt & Bryant, 1990). In a second experiment, children were asked to state whether they or their friends knew what was hidden inside a box. Two children were involved in each session and the experimenter only showed what was inside the box to one child and not the other. Children were able to correctly state that the person who saw what was inside the box had knowledge of its contents. Findings from this study confirm that three-year-olds understand the difference between knowing and not knowing (Pratt & Bryant, 1990). Children understand that a person who has looked inside a box knows more about what is inside than someone who has not (Pratt & Bryant, 1990). Like the children in Pillow's (1989) study, these children do not respond egocentrically and are able to state when someone else's knowledge differs from their own. Three-year-olds are able to make explicit judgments about the links between visual access and knowledge.

At around three to four years of age, children typically pass the false-belief task. They understand that individuals can not only be ignorant of a given situation – for

example, which box contains an object – but can have a false belief about a given situation – for example, believing that an object that is actually in one box is in a different box. More specifically, children are able to predict how someone with a false belief will act on that false belief (Wimmer & Perner, 1983). In addition, children can explicitly talk about others' mistaken beliefs. For instance, a three-year-old was presented with a simple story: "Jane was looking for her kitten. This kitten was hiding under the chair. But Jane was looking under the piano. Why do you think she is doing that? 'She thinks it's under the piano.' Where is the kitten really? 'Under the chair'" (Bartsch & Wellman, 1995, p. 956). Thus, children are able to talk about the contrast between what someone falsely thinks is the case and what really is the case (Bartsch & Wellman, 1995). This developmental marker has been well documented and extensively studied in the research literature over the last two decades (Flavell & Miller, 1998; Wellman, Cross, & Watson, 2001). The classic example of a false-belief task is when a child watches Maxi put his chocolate in the kitchen cupboard (Wimmer & Perner, 1983). Maxi leaves the room and unbeknown to him, his mother moves the chocolate to a new location. The question of interest is whether the child is able to predict where Maxi will search for the chocolate. Most children between the ages of four and five years are able to judge that Maxi is unaware of the change and will search in the original location. Children who pass this false-belief task demonstrate that they understand that Maxi can have different beliefs and can act on those beliefs even when they are false.

There are many variations to this false-belief task. Another version involves objects with unexpected contents that are used to probe children's grasp of their own prior false beliefs (Wellman et al., 2001). In a seminal study by Gopnik and Astington

(1988), three-year-olds were shown deceptive objects where their true natures were revealed later: a closed Smarties box with small pencils instead of candies and a sponge painted to look like a rock. Children were asked about their past belief concerning the misleading box (e.g., “When you first saw the box, what did you think was inside? Did you think there were Smarties or pencils inside the box?”). Less than half of the three-year-olds answered this question correctly (i.e., “Smarties”). Instead, they were likely to answer as if they always knew there were pencils hidden in the Smarties box. They were unable to acknowledge that their past belief about the contents was different from their subsequent belief.

There are numerous studies establishing that children begin to consider alternative representation of objects and pass the false belief task around age four (Wellman et al., 2001). This body of research includes variations on the false-belief task, cultural differences in false-belief performances, explanations for why younger children fail it, and associations linking performance and other competencies (Wellman, 2014; Wellman et al., 2001).

Overall, these studies of three- and four-year-olds provide evidence of an age change. Three-year-olds understand that others can have knowledge that is different from their own and they understand the link between seeing and knowing. In contrast, four-year-olds have a more advance understanding of knowledge. They are able to predict that others will act on their false beliefs and they are able to distinguish between their own past beliefs and current beliefs.

Metacognition between late infancy and three years of age

The period after infancy and before three years of age has generally been overlooked in metacognitive studies. The few studies that do exist come from related research areas on children's responses to hiding events, their use of the mental verb *know*, and their ability to ask questions. In this section, these studies will be reviewed with a focus on how they relate to children's emerging ability to understand mental states.

O'Neill (1996) tested two-year-old children on their ability to assess the knowledge states of other people, notably their interlocutor, and to tailor their communications accordingly. If parents were absent when a desirable toy was hidden, children were more likely to address their parents by naming the toy, naming its location, and gesturing toward it than children whose parents had remained in the room and witnessed the hiding of the toy. These findings lend support to the claim that two-year-old children can understand that physical absence and concomitant lack of visual access limit a person's knowledge. They are able to use this understanding to adjust their communicative efforts accordingly.

The studies linking seeing and knowing reviewed in the previous section required children to give verbal responses during the experiments indicating who did or did not know a given piece of information. Because two-year-old children are still learning to speak, it is plausible that requiring such a verbal response may underestimate their metacognitive abilities. Note that such an explicit verbal attribution of knowledge versus ignorance was not required in the studies by O'Neill (1996). Rather, children indexed their awareness of their interlocutor's mental state by appropriate adjustments of their communication. With such considerations in mind, Call and Carpenter (2001) conducted

a nonverbal study in which two-year-olds were asked to find stickers located in one of three open-ended tubes. There was a "seen" condition in which children saw the experimenter hide stickers in one of the three tubes and an "unseen" condition in which a screen was placed in front of the tubes to block children from seeing the hiding event. They were taught to choose the tube that contained the stickers by touching it. After they had chosen, experimenters would either give them the stickers or show them where the stickers were if they had chosen incorrectly. Children used efficient search strategies when they were blocked from seeing the placements of the stickers. They looked into one tube at a time and only stopped looking when the stickers were found. At this point, they chose the tube by touching it. By implication, children knew when they were ignorant of the hidden stickers' location and they efficiently continued their search in order to locate them.

In addition to experimental studies, naturalistic studies show that two-year-olds are able to appropriately use the mental verb *know*. Harris, Yang and Cui (in press) examined the use of the verb *know* in daily conversations by three children (one Mandarin-speaking and two English-speaking). A majority of the *know* utterances was embedded in conversations. The three children used *know* to talk about their own knowledge and ignorance. In addition, they commented on and asked questions about their interlocutor's knowledge. Two-year-olds seemed to be cognizant of when they were ignorant and also when someone else had the knowledge that they sought. Two-year-olds' early use of *know* utterances suggests that they possess some degree of meta-ignorance, consistent with the fact that children of this age ask an increasing number of information-seeking questions.

Chouinard (2007) examined one- to five-year-old children's ability to ask questions to fill gaps in their knowledge. Children begin to ask questions using gestures and non-word vocalizations between 12 and 17 months. An example of a nonverbal question is when a child is unfamiliar with a kiwi fruit, picks it up, shows it to his or her parent, looks puzzled, and says "uh?" Thus, before they put questions into words, children may use vocalizations, especially with an appropriate intonation, to signal a request for information. Asking questions of more knowledgeable individuals is an effective way for young children to fill the gaps in their knowledge. Questions are particularly useful to cognitive development because they are asked at a time when children want information and are receptive to answers. They also suggest that children have some metacognitive awareness of their own ignorance. For example, when a child holds the kiwi up to a parent asking for its name, a plausible implication is that the child knows, at some level, that he or she does not know the name. While some might argue that this is evidence of uncertainty and not evidence of meta-ignorance, Chouinard (2007) found that children from one to five years of age persisted in repeating their questions when they received responses that did not contain the target information. Their persistence continued until they received the information they wanted. If the adults' answers were satisfactory, they would stop repeating their questions. By terminating their questions when they received the desired information, they show that they are able to monitor their changing knowledge states and judge whether the information given adequately fills the gap in their knowledge.

In a related study, Frazier, Gelman, and Wellman (2009) investigated two- to five-year-old children's questions and their reactions to adults' answers. Across both

naturalistic conversations and experimental laboratory conversations, children were motivated to seek out causal information. When they were given non-explanatory answers (e.g., answers such as "I don't know," "Because I said so," changing the topic, not responding, etc.), two-year-olds were more likely to re-ask questions and provide their own explanations. By contrast, when explanatory answers were given, children showed satisfaction and sometimes asked follow-up questions. These findings show that children are proficient at using conversational exchanges to obtain information. They are able to assess adults' answers and find causal explanations satisfying.

In sum, the studies reviewed suggest that children have some basic metacognitive abilities well before the age of four years when they typically pass the standard false belief task and indeed before the age of three years when children typically pass tasks probing their understanding of the link between knowledge and perceptual access. The studies are drawn from different areas of research but together, they support the possibility that children as young as two are capable of understanding mental states. These studies encompass a broad range of understanding. They show that children are able to assess others' knowledge and tailor their communication accordingly; they are able to acknowledge their own ignorance in daily conversations; and they persist in asking questions until their knowledge gaps are filled. This dissertation builds on this literature to further examine the early emergence of meta-cognition.

Research questions

In this dissertation, three different approaches are used to investigate children's metacognition between the ages of 14 and 42 months. In Study 1, I extend the work of Harris et al. (in press) by examining children's use of the epistemic verb *know.* I ask how

children between 18 months and 36 months use *know* to comment on their own knowledge and ignorance and their interlocutor's knowledge and ignorance. As noted previously, the original study by Harris et al. (in press) analyzed the spontaneous utterances of two English-speaking children and one Mandarin-speaking child. My study sought to reproduce their findings by analyzing a separate dataset of eight children from the Child Language Data Exchange System (CHILDES) recordings. I considered five research questions: When do children begin to use *know*? Do children produce *know* spontaneously or do they simply echo its use by their interlocutor? Is the use of *know* appropriately embedded in an ongoing conversation or activity? What are the pragmatic functions of children's *know* utterances? To whose knowledge does the child refer?

After analyzing these verbal utterances in Study 1, I examine children's non-verbal expressions of ignorance in Study 2. Because children often produce gestures before they produce verbal utterances, the main purpose of Study 2 is to investigate whether children's production of flips (i.e., a gesture involving the lifting and outward rotation of both hands and the shrugging of the shoulders to communicate "I don't know") emerges earlier than their production of *I don't know* utterances containing. I report an analysis of the video recordings and transcripts of a sample of 64 children from diverse backgrounds between 14 and 42 months of age from the Language Development Project at the University of Chicago. This project is a longitudinal study that began in 2002 under the direction of Dr. Susan Goldin-Meadow. The project's research goal is to explore the language-learning process in young children. Using this dataset, I examine children's production of *flip* gestures by investigating the context in which they are triggered, their apparent meaning, and the responses they elicit from interlocutors.

For the final study, I report an experimental investigation of children's meta-ignorance. A total of 52 children between 16 months and 37 months were asked to name pictures of familiar and unfamiliar objects. There were two primary questions: Are children aware of their own ignorance when they are asked to label an unfamiliar object? How do they express their ignorance? I analyze various indices -- both verbal and nonverbal -- of ignorance and uncertainty. Additionally, I examine whether specific expressions of ignorance change as children get older. I hypothesize that children between 16 months and 37 months will express ignorance or uncertainty more often when asked to label unfamiliar pictures than when asked to label familiar pictures. If they do, these expressions of ignorance and uncertainty support the claim that they have an early awareness of their own ignorance. Taken together, these three studies aim to describe the emergence and expression of early meta-ignorance during the understudied period of 14 to 42 months.

Study 1

What young children's use of *know* tells us about their metacognitive abilities

Introduction

Young children learn about the world around them not only through direct observation and exploration but also through communication. Communication is one of the primary channels through which they receive and give information (Chouinard, 2007; Kovács, Tauzin, Téglás, Gergely, & Csibra, 2014). How do children use verbal communication to signal their growing awareness of their own knowledge and ignorance? To begin to answer this question, the use of the mental verb *know* in naturalistic settings by 8 children between 18 to 36 months was analyzed. The next sections review the relevant literature on communication and knowledge, theory of mind, and epistemic verbs as background to this paper's analyses of children's use of *know*.

Early communication and knowledge

Young children understand that communication is a source of knowledge (Chouinard, 2007). They understand the purpose of pointing (Behne, Liszkowski, Carpenter, & Tomasello, 2012). Additionally, there is evidence that as early as 18 months, they are aware that false beliefs can be corrected via communication (Song, Onishi, Baillargeon, & Fisher, 2008).

As early as 12 months, infants are able to share interest with people around them using pointing gestures (Behne et al., 2012). They recognize that pointing communicates information. In a study by Behne et al. (2012), infants succeeded at inferring that adults pointed to let them know the location of a hidden toy. Furthermore, their understanding of communicative pointing was bidirectional (Behne et al., 2012). They were able to

reverse the roles and produce informative pointing gestures for the adults in the same game (Behne et al., 2012). Building on these early competencies, 16-month-old infants in a different study were able to point to obtain an information-laden response from more knowledgeable interlocutors (Begus & Southgate, 2012). When an interlocutor was perceived as ignorant, infants pointed less. This suggests that infants point to obtain information but only from people they perceive as competent (Begus & Southgate, 2012).

By 18 months, infants show evidence that they understand the intent of communication between two other individuals even when they are not directly involved. Infants observed while agent 1 hid a ball under a box and agent 2 looked on (Song, et al., 2008). While agent 2 was away, agent 1 moved the ball from under a box to a cup. When agent 2 returned, he was either told that the ball was now under the cup or told something irrelevant. Infants looked reliably longer when agent 2 was informed of the new correct location but continued to search in the old location under the box (Song et al., 2008). This result was reproduced even when agent 1 said nothing and merely pointed to the ball's new location (Song et al., 2008). Unlike the claims that children understand others' mental states starting around the age of four, these results suggest that infants have some understanding that agents can have false beliefs and that these false beliefs can be corrected by verbal and nonverbal communication.

In addition to false beliefs, children at the age of two are able to take their communicative partners' mental states into account when communicating with them (O'Neill, 1996). As reviewed in the introductory chapter, children witnessed an experimenter hiding a toy in a container on a high shelf. When asking for help in retrieving the toy, children were more likely to name the toy, name the location, and

gesture to its location when parents had not witnessed the hiding event than when they had (O'Neill, 1996). This evidence suggests that many two-year-olds have some basic metacognitive abilities and are able, at some level, to assess others' knowledge states and tailor their communication according to their assessments.

Once they start to use words, children ask a lot of questions. Chouinard (2007) found that four children from one to five years old asked 24,741 questions over 229.5 hours of conversations. This was an average of about 107 questions per hour. These children were also very persistent about getting the information they sought. Most of the questions (71%) were information seeking (rather than, for example, attention- or permission-seeking) and this pattern was consistent in children between one and five years of age (Chouinard, 2007). Taken together, these studies converge to show that preverbal infants and verbal children possess a clear and foundational understanding that knowledge can be received and given through communication. More specifically, they understand that a knowledgeable person can pass on information to an ignorant person (Harris & Lane, 2013). Following Harris et al.'s (in press) findings, it is expected that this ability would be manifest in daily speech. It is predicted that children would explicitly talk about their own knowledge and their interlocutor's knowledge between 18 and 36 months.

Spontaneous utterances of *know*: A precursor to the theory of mind

Having established that young children have some understanding of how individuals communicate their knowledge to one another, the next question is how this fits within the broader theory-of-mind literature. Prior to four, children display little explicit understanding of mental states, at least as indexed by their spontaneous

utterances (Bartsch & Wellman, 1995). Additionally, in the developmental progression of theory-of-mind understandings, children in Australia, United States, and China share a common sequence – their understanding of desires precedes understanding of knowledge and false belief – beginning at around three years of age (Wellman, Fang, Liu, Zhu, & Liu, 2006). Yet, it is difficult to reconcile these theory-of-mind findings with longitudinal evidence showing a marked increase in the use of epistemic verbs *know* and *think* in two-year-olds (Taumoepeau & Ruffman, 2008).

Harris et al. (in press) suggested a plausible middle ground. They found that existing studies of children's spoken utterances might be too conservative in how they measured children's understanding of epistemic states (Harris et al., in press). Using a less conservative measure that included all *know* utterances (which will be detailed in the next section), Harris et al. (in press) found that two-year-olds did show an explicit understanding of epistemic states in the way they used *know* in daily conversations. Similarly, this paper analyzed eight English-speaking children's spontaneous utterances of *know*. Building on the rationale of Harris et al. (in press), this study focused on *know* because it was the most frequently used epistemic verb by English-speaking children (Shatz, Wellman, & Silber, 1983). In the next section, studies on children's use of epistemic verbs will be reviewed.

Epistemic verbs

Children begin using the epistemic verb *know* as early as two. Shatz, Wellman, and Silber (1983) analyzed longitudinal data from one child, Abe, from two to four years of age. Abe's speech was recorded over a 20-month period for 20 to 30 minutes twice a week at mealtimes or playtimes when he was interacting with a parent. Abe's use of

mental terms such as *remember, know, think,* and *dream* were identified in the transcripts. With a total of 1483 mental verb utterances, the most frequent mental words were *know* (709 occurrences) followed by *think* (405 occurrences).

The mental verbs were coded in relation to their contextual function and meaning in the conversation in two main steps. First, the majority of Abe's mental words (1317) were classified in one of the seven coding categories: *mental state, modulation of assertion, directing the interaction, clarification, expression of desire, action-memory*. Only 408 (31% of 1317) were coded as *mental state*, which was an explicit reference to thoughts, knowledge, or memories of the speaker, interlocutor, or third person (e.g. "She doesn't know all of this"). Most of the *mental state* utterances (326 or 80%) were produced after Abe passed his third birthday.

Second, Abe's *mental state* utterances were coded for *contrastives.* Utterances coded in this way displayed an understanding of a difference between a mental state and observable reality (e.g., "Before I *thought* this was a crocodile; now I *know* it's an alligator."). This included person contrastives (e.g., "I was teasing you; I was *pretending* 'cept you didn't *know* that."). Similar to the pattern observed for *mental state* utterances, most of the *contrastive* utterances (78 of 97 or 80%) were produced after Abe's third birthday.

Shatz et al. (1983) obtained corroborating results when they analyzed the speech of 30 other two-year-olds over six months. These 30 children produced a mental verb at around the same time as Abe. The most frequent mental verbs used were *know* and *think. Know* made up 74% of all mental verbs compared to Abe's 66% and *think* made up 15% compared to Abe's 16%. Based on their strict coding system, they concluded that mental

verbs appear during the second part of the third year. They also cautiously proposed that mental verbs for conversational functions were precursors to *mental state* utterances.

Taking the next step, Harris et al. (in press) emphasized the potential significance of conversational uses of mental verbs. They noted that a majority of mental words were excluded from Shatz et al.'s (1983) *mental state* category. For instance, the phrase *I don't know* was omitted because Shatz et al. (1983) saw it as "merely an idiomatic negative expression" (p. 308). Yet, the phrase *I don't know* amounted to 20% (269 of 1317) of Abe's mental words and 56% of the 30 children's mental words. Additionally, it was notable that Abe often used the phrase *I don't know* in his second year. Between 28 and 32 months, *I don't know* made up 65% of his utterances. Subsequent studies followed this strict interpretation of *mental state* and did not include *I don't know* in their analyses (Bartsch & Wellman, 1995).

Harris et al. (in press) suggested that in order to determine if more conversational uses of *know* should be eliminated from analyses, they needed to examine the context of such utterances in a conversation. They looked at the preceding and subsequent utterances around the use of *know* (including *I don't know*). In doing so, they were able to examine whether *I don't know* was used correctly as an expression of ignorance or if it was used as an inflexible stock phrase to withdraw from or deflect the conversation. They found that children initiated most uses of *know*. References to *know* were not repetitions of their interlocutors' previous words. Instead, they were connected to a shared activity or topic and were used in the context of three pragmatic functions – children affirmed knowledge, denied their own knowledge, and asked their interlocutors questions about knowledge. Children rarely made references to a third party. Instead, they focused on the

knowledge or ignorance of the two parties involved in the conversation. Harris et al. (in press) believed that these early references to *know* were children's first steps toward the forming of explicitly mentalistic utterances at three years of age.

Research Questions

The goal of this study was to identify and analyze all naturally occurring uses of *know* by eight children from 18 months to 36 months. It aimed to extend Harris et al.'s (in press) findings with a larger sample of eight children. The original study only examined two English-speaking children and one Mandarin-speaking child. While these three children varied in their socioeconomic, racial, and cultural backgrounds, they displayed a similar profile and pattern in their use of *know.* They often used *know* to affirm knowledge, deny knowledge, and ask about knowledge related to the ongoing conversation. Additionally, they rarely referenced a third party's knowledge. This study extended Harris et al.'s (in press) work by analyzing the utterances of a larger sample of children. The five research questions were: When do children begin to use *know*? Do children spontaneously produce *know* on their own? Is *know* related to an ongoing conversation or activity? What are the pragmatic functions of the children's *know* utterances? To whose knowledge is the child referring?

Method

Participants

The Child Language Data Exchange System (CHILDES) contains transcribed audiotapes and videotapes of conversations between children and adults. The transcribed conversations of eight children (Laura, Lily, Naima, Naomi, Peter, Ross, Violet, and William) from five different corpora (Braunwald-Max Planck, Providence, Sachs, Bloom

1970, and MacWhinney) were used. Each of these eight children's conversations with his or her family was recorded longitudinally from around 18 months to 36 months. With the CHILDES database, it was possible to retrieve all *know* utterances as well as the comments made before and after them.

These eight children were chosen because they had transcripts throughout the appropriate age range and were recorded interacting with their families at home. The home setting was preferred because it captured children's naturally occurring and spontaneous *know* utterances. These children and information on their backgrounds are listed in Table 1.

Table 1

Children and their respective backgrounds from the CHILDES database

Child	Corpus	Background	Age Recorded	Visit
Laura	Braunwald-Max Planck	Child of a researcher	1;5.19 to 7;0.14	Irregular intervals, some recordings during mealtimes
Lily	Providence	Monolingual English-speaking child	1;1.2 to 4;0.2	Recorded for 1 hour every 1 to 2 weeks
Naima	Providence	Monolingual English-speaking child	0;11.27 to 3;10.10	Recorded for 1 hour every 1 to 2 weeks
Naomi	Sachs	Child of a professor	1;2.29 to 4;9.03	Irregular intervals
Peter	Bloom 1970	Firstborn child of upper-middle class white college-educated parents	1;9.08 to 3;1.20	Recorded every 3 weeks
Ross	MacWhinney	Child of a professor	1;4.11 to 7;5.18	Irregular intervals
Violet	Providence	Monolingual English-speaking child	1;2.0 to 3;11.24	Recorded for 1 hour every 2 weeks
William	Providence	Monolingual English-speaking child	1;4.12 to 3;4.18	Recorded for 1 hour every 2 weeks

Peter was the firstborn child of upper-middle class white college-educated parents. He lived in a university community in New York City. His speech was recorded for the work of Bloom, Hood, & Lightbown (1974) and Bloom, Lightbown, & Hood (1975) on language development. Peter was visited every three weeks by researchers. Laura was a child of a researcher, Susan Braunwald. Her speech was recorded by Braunwald (1976) to study native language acquisition. Ross was a child of a professor, Brian MacWhinney. His speech was recorded by MacWhinney (2000). Naomi was a child of a professor, Jacqueline Sachs. Her speech was recorded by Sachs (1983). Lily, Naima, Violet, and

William were four monolingual English-speaking children from the Providence corpus (Demuth, Culbertson, & Alter, 2006). Their speech was recorded for the purpose of studying early phonological and morphological development. Each of the four children was recorded for one hour every two weeks. The socioeconomic and ethnic backgrounds of seven of the eight children were not provided in CHILDES. However, it is possible to infer that three children of professors/researchers came from middle class families.

Data Coding

All children's utterances of *know* were coded using Harris et al.'s (in press) coding system. Each *know* utterance was assigned a total of four codes, one for each of four steps. The first step focused on whether or not the *know* utterance was a simple repetition or echo of what the child's interlocutor had just said. The second step examined the preceding context of the child's *know* utterances. The third step categorized whether *know* was used to affirm knowledge, deny knowledge, or ask a question about knowledge. The fourth step looked at whose knowledge or ignorance the child referenced. Cohen's kappas for the coding steps ranged from .63 to .79. These four steps will be outlined in greater detail in the following paragraphs.

Parroting or Spontaneous? The aim of the first step was to see if the *know* reference was initiated by the child or the interlocutor. This step involved allocating a *know* utterance to one of three codes: *exact repetition, partial repetition,* or *spontaneous*. An *exact repetition* code was assigned when the child repeated the interlocutor's previous words (e.g., Interlocutor: "I bet he doesn't know, cause he's a little bear." Child: "He doesn't know."). A *partial repetition* code was assigned when the child repeated some of the interlocutor's previous words, with an appropriate adjustment (e.g., Interlocutor:

"How do you know that she made the bread?" Child: "I don't know."). A *spontaneous* code was assigned when the child initiated the use of *know* on his or her own (e.g., Interlocutor: "And where's Mommy?" Child: "I don't know.").

Connected or Not? The second step examined the context preceding the child's use of *know.* This step involved assigning a *know* utterance to one of four codes: *replies to a question, replies to a comment, topical elaboration,* or *new topic.* The *replies to a question* code involved the interlocutor asking a question prior to the child's use of *know* (e.g., Interlocutor: "Who do you play with?" Child: "Um I don't know."). The *replies to a comment* code involved the interlocutor making a comment to which the child responded using *know* (e.g., Interlocutor: "It tickles." Child: "I know it tickles."). The *topical elaboration* code involved a shared discussion or activity between the interlocutor and child before the child used *know* (e.g., The interlocutor showed the child where Alaska was on the map. The child observed the water around Alaska and responded with: "I know the water is right here."). The *new topic* code involved the child's use of *know* in the context of a monologue, a solitary activity, or a pretend game (e.g., The child was looking at pictures of birds by herself and saying, "Those are ducks; I think that's a mallard and I don't know what the other ducks are called."). It also included instances when a child asked the interlocutor a question that was unrelated to the previous shared conversation or activity (e.g., in the middle of playing, the child asked: "Know [where] the stamps are, mommy?").

Pragmatic Function? The purpose of the third step was to analyze the pragmatic function of the child's *know* utterance. This step involved assigning one of three codes to the utterances: *affirmation of knowledge, denial of knowledge,* or *question about*

knowledge. The *affirmation of knowledge* code included instances when a child affirmed that a person had knowledge (e.g., "I know." or "You know."). The *denial of knowledge* code included instances when a child stated that a person was ignorant (e.g., "I don't know."). The *question about knowledge* code included instances when a child asked if a person had knowledge (e.g., "Do you know?" "Don't you know?").

Whose Knowledge? The goal of the last step was to see whose knowledge the child was talking about. This step involved assigning the utterance to four categories: *own knowledge, interlocutor's knowledge, third party's knowledge,* or indeterminate. The *own knowledge* code was for instances when the child was referring to his or her own knowledge (e.g., "I know!" or "I don't know"). The *interlocutor's knowledge* code was used for instances when the child was talking about the interlocutor's knowledge (e.g., "Do you know?"). The *third party's knowledge* code was for instances when the child was talking about someone else's knowledge rather than the interlocutor's or the child's. One example was when the child says: "Koala's a little kid who doesn't know." The indeterminate category was for instances in which it was unclear whose knowledge the child was discussing.

Taken together, these four levels of coding clarified the context and purpose of each of the *know* utterances used by the eight children. The coding system analyzed the spontaneity of children's production of *know* utterances, the conversational connectedness of *know* utterances, their pragmatic functions, and whose knowledge the child referenced.

Results

Information about the eight children and the total number of *know* utterances they produced between 18 months and 36 months are displayed in Table 2. Using 10,000 utterances as a base rate and prorating *know* utterances accordingly, Ross produced the highest number of *know* (68) per 10,000 utterances and William produced the lowest (20). Peter had the largest corpus (21,033) and Ross had the smallest (6,679). Children vary in when they begin saying *know*. Naima's first recorded *know* utterance was the earliest at 15 months. Naomi had the latest first *know* utterance at 29 months. The average age of children's first *know* and *I don't know* utterances was around 22 months. Despite this variation, it is noteworthy that all children produced *know* utterances.

Table 2

CHILDES children and their know utterances

Child	Corpus	Know	Utterance	Knows Per 10,000 Utterances	Age Range	Age of First Know[a] & First I Don't Know[b]
Laura	Braunwald-Max Planck	40	10,534	38	1;6.0 to 3;0.22	1;10.23[b]
Lily	Providence	116	17,999	64	1;6.11 to 3;0.26	1;11.7[b]
Naima	Providence	83	18,107	46	1;6.4 to 3;0.0	1;3.26[b]
Naomi	Sachs	47	12,221	38	1;6.16 to 2;11.24	2;5.5[b]
Peter	Bloom 1970	92	21,033	44	1;9.7 to 2;10.21	2;4.15[b]
Ross	Mac-Whinney	43	6,327	68	1;6.09 to 3;0.18	1;4.25[b]
Violet	Providence	24	6,679	36	1;6.3 to 2;11.27	2;0.27[a] & 2;5.28[b]
William	Providence	20	9,799	20	1;6.5 to 3;0.26	1;6.19[b]

Notes.
[a]Age of first know utterance includes any use of know by a child. This superscript is only used and indicated separately if the first know utterance is not I don't know.
[b]Age of first I don't know utterance, which if not indicated otherwise, is also the age of a child's first know utterance.

Parroting or Spontaneous?

The first step was directed at establishing whether *know* was generated spontaneously or simply echoed what the interlocutor previously said. Figure 1 shows the percentages of *know* utterances by the eight children falling into each of three coding categories. All eight children displayed the same pattern as Adam, Sarah, and Qiānqian in

Harris et al.'s (in press) study in that a majority of the *know utterances* – 82 percent and up – were spontaneous and only a few were exact or partial repetitions. Additionally, all of Laura's *know* utterances were spontaneous.

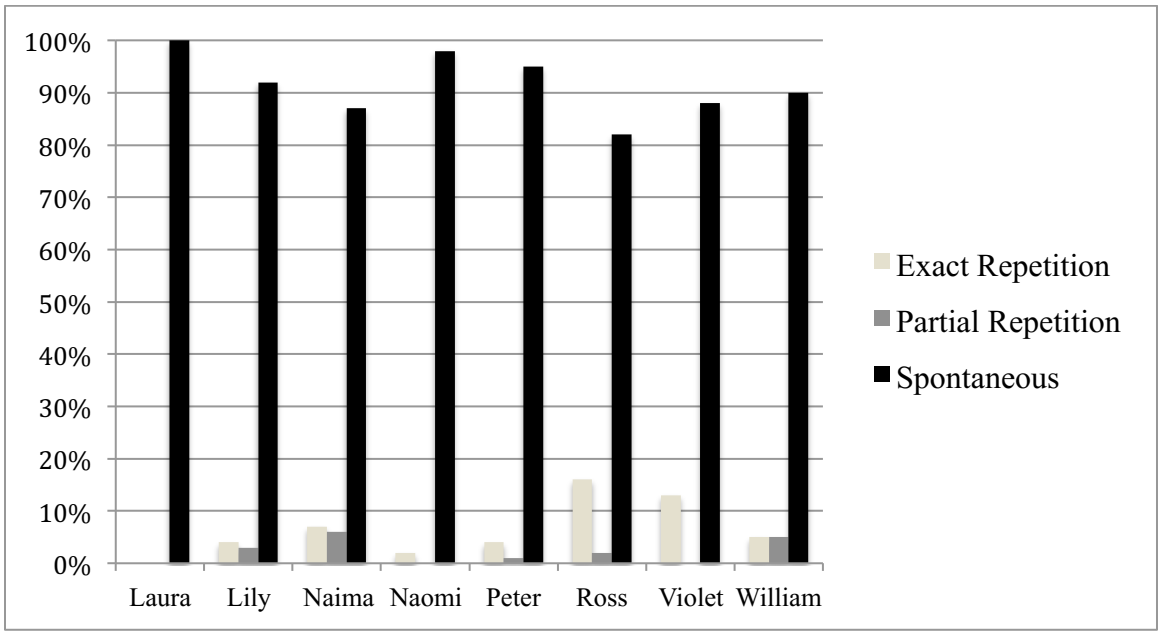


Figure 1: Percentages of exact repetitions, partial repetitions, and spontaneous uses of *know* by the eight children.

Connected or Not?

The objective for the second step was to determine if the *know* utterance was connected to an ongoing conversation or activity with the interlocutor. More specifically, it was important to establish if *know* utterances were used appropriately in conversations of previously introduced topics. Figure 2 displays the percentage of *know* utterances produced by each child falling into the four codes: *replies to question, replies to comment, topical elaboration,* or *new topic.* Figure 2 indicates that *replies to question* are the most

common context in which five of the eight children use *know.* This pattern mirrors the findings of Harris et al. (in press).

Although Naima, Peter, and Violet, did not share this pattern, it is important to note that a majority of their *know* utterances were on previously introduced topics when utterances that were *replies to question, replies to comment,* and *topical elaboration* are summed. Even Naima's tendencies to bring up new topics made up only 42 percent of all her *know* uses.

In sum, the majority of the eight children's uses of *know* were connected to the ongoing topic or activity with the interlocutor. They used *know* to reply to the interlocutor's question or comment. They also used it to elaborate on the topic or activity that was at hand. In a minority of cases, they used *know* to introduce a new topic of conversation.

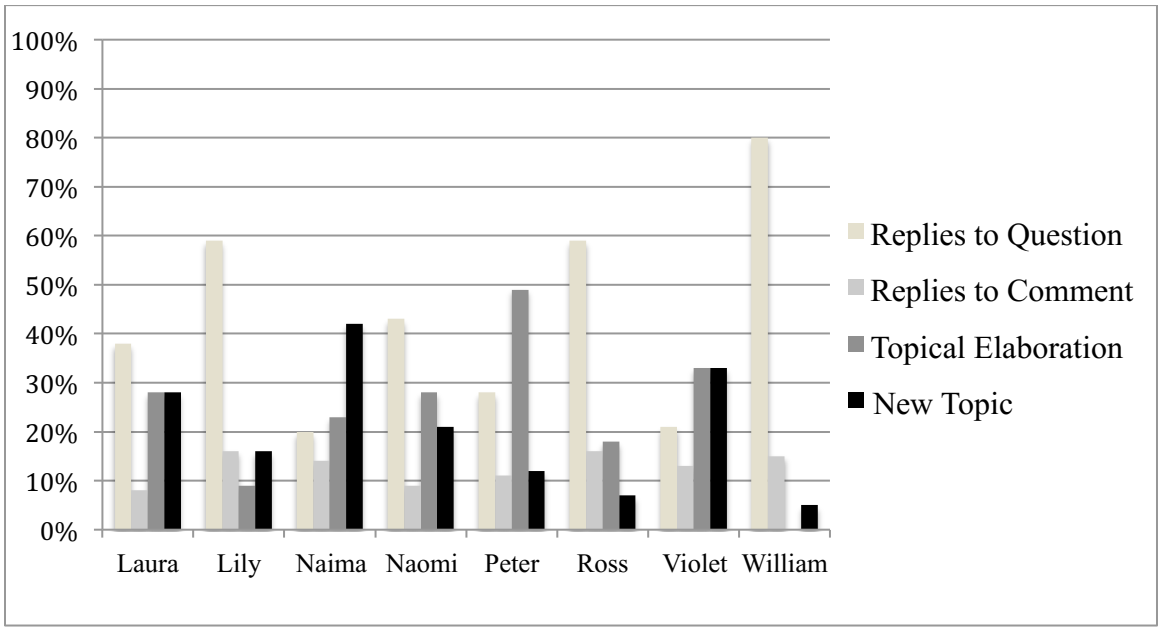


Figure 2: Percentages of replies to a question, replies to a comment, topical elaborations, and new topics by the eight children.

Pragmatic Function?

In the third step, the pragmatic function of the *know* utterances was examined. Figure 3 breaks down the percentage of *know* utterances produced by each child in terms of the three codes, *affirmation of knowledge, denial of knowledge,* or *question about knowledge.* The results differ slightly from those of Harris et al. (in press). They found that Adam, Sarah, and Qiānqian mainly used *know* to deny knowledge. Five of the children in the present study, Laura, Lily, Naomi, Ross, and William showed a similar pattern. They used *know* predominantly for denials, occasionally for affirmations, and rarely for questions. Thus, it is possible that using *know* to deny knowledge is the predominant pattern for most children but not all children. Further investigation is needed to examine possible sources of differences before more conclusions can be made.

Two other patterns were also observed. Unlike other children, Peter frequently used *know* to ask questions, occasionally to affirm, or to deny. The majority of Naima's and Violet's *knows* were to affirm knowledge. Despite the individual variations, the eight children used all three pragmatic functions, similar to the three children studied by Harris et al. (in press). Overall, the most common function was to deny knowledge.

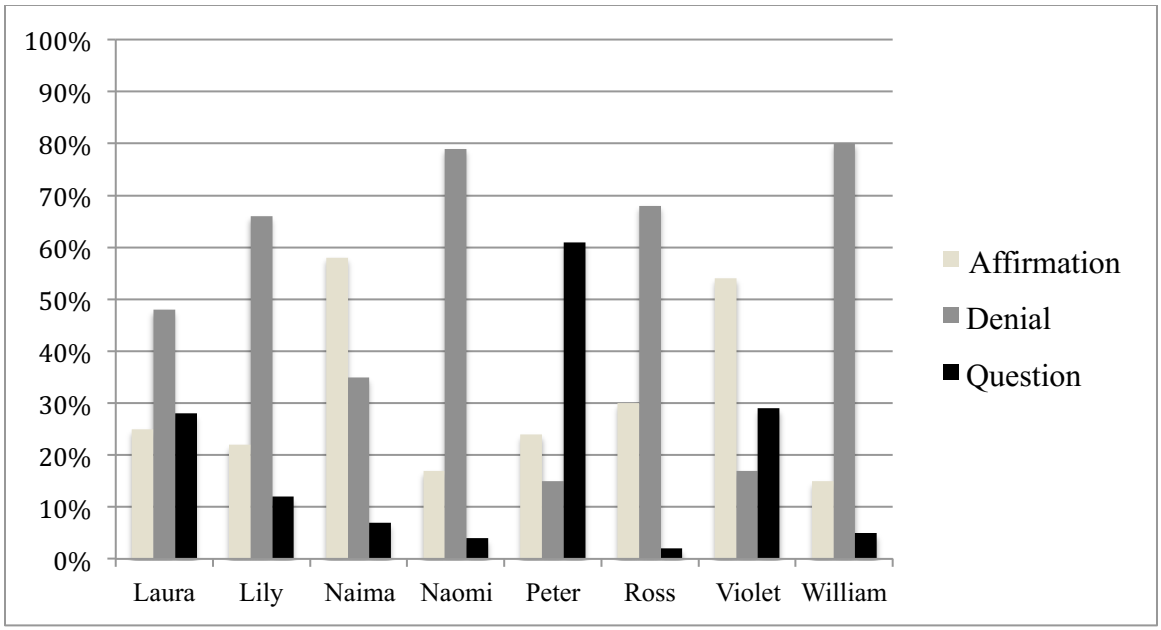


Figure 3: Percentages of affirmations, denials, and questions about knowledge by the eight children.

Whose Knowledge?

The purpose of the final step was to examine whose knowledge the child was referring to in the conversation. The utterances were allocated to the four coding categories displayed in Figure 4: o*wn knowledge, interlocutor's knowledge, third party's knowledge,* or indeterminate. With the exception of Peter, children mostly used *know* to refer to their own knowledge. They sometimes used it to refer to their interlocutor's knowledge and they rarely used it to refer to a third party's knowledge. Peter was the only child that seemed more interested in talking about the interlocutor's knowledge over his own. These results are similar to those of Harris et al. (in press).

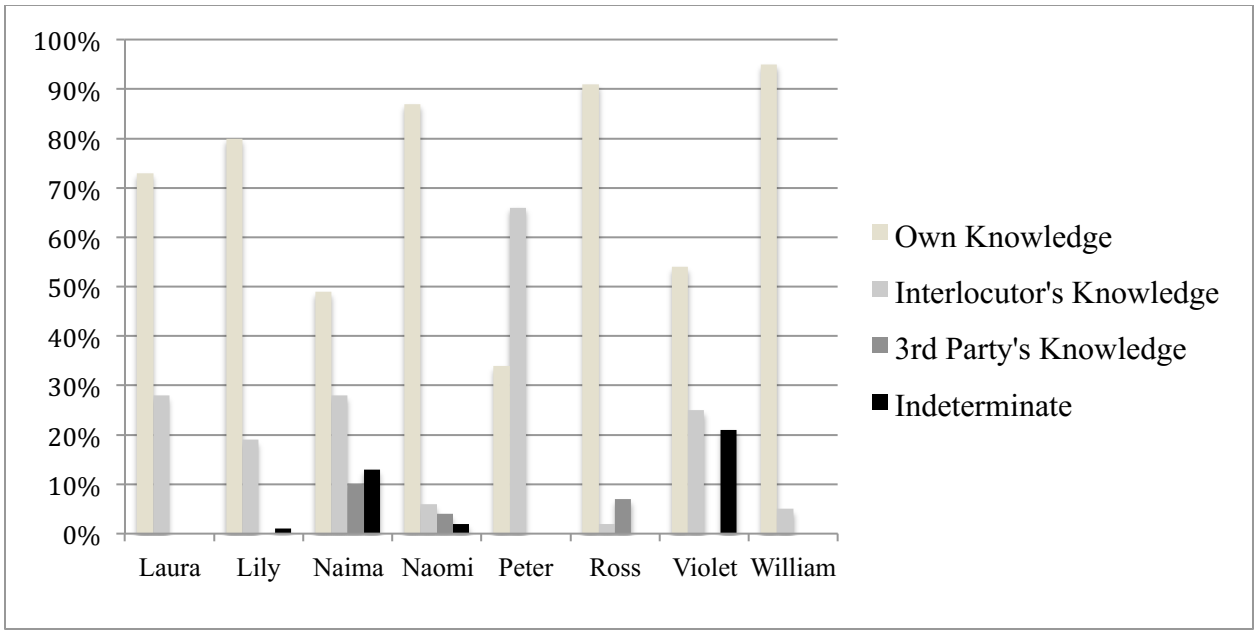


Figure 4: Percentages of references to the child's own knowledge, interlocutor's knowledge, and third party's knowledge by the eight children.

Intersection of Pragmatic Function and Person. Having analyzed the four steps in the coding system, the intersection of step three (the pragmatic function of the utterance) and step four (whose knowledge was being talked about) was examined. Figure 5 displays how the eight children used *know* to affirm, deny, or ask a question as a function of the person referenced. Given the paucity of references to a third party, this analysis focuses on references to the self as compared to the interlocutor. Figure 5 shows remarkable similarities to the findings of Harris et al. (in press). When children affirmed knowledge, they referred predominantly to themselves and occasionally to their interlocutor. When children denied knowledge, they almost invariably described their own ignorance rather than that of their interlocutor. By contrast, when they asked about knowledge, they almost exclusively asked about their interlocutor's knowledge state and

not their own. These findings were important because they revealed the possible limitations of two-year-olds' mental state talk. This limitation will be further examined in the discussion section.

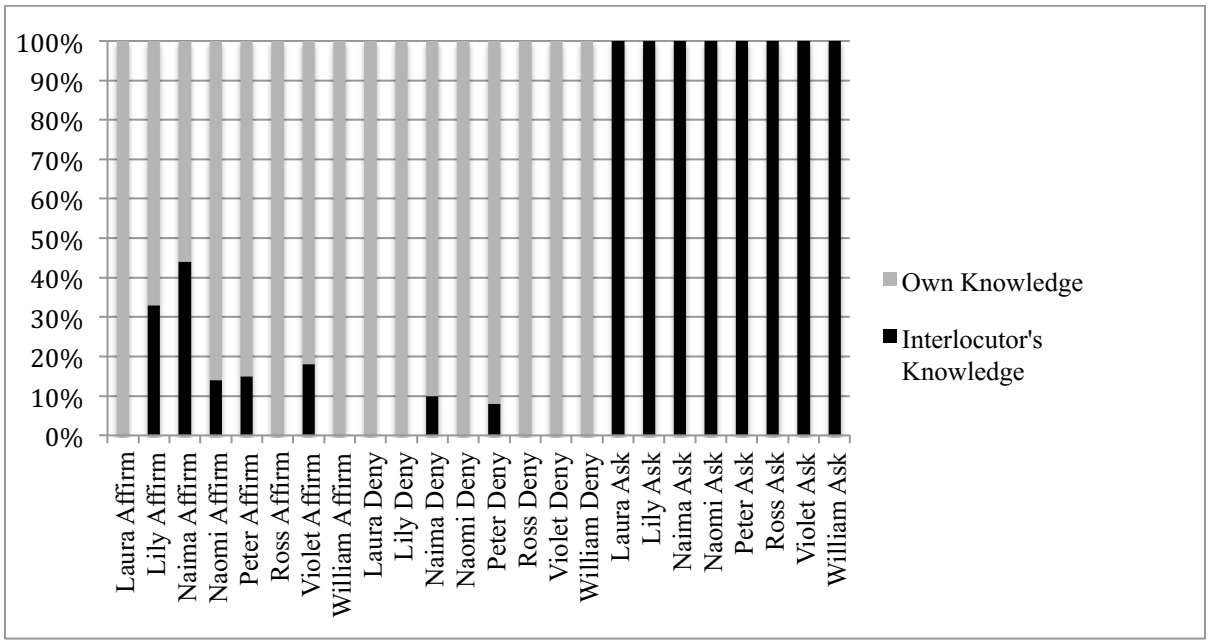


Figure 5: Percentages of references to the child's own knowledge as compared to the interlocutor's knowledge when the children produced affirmations of knowledge, denials of knowledge, and questions about knowledge by the eight children.

Discussion

The overall goal of this paper was to examine how children between 18 months and 36 months use *know* to comment on their own and other people's knowledge states. The five main findings will be reviewed along with a discussion on the implications for children's metacognition.

The first research question was at what age children begin to use *know.* The eight children's first recorded *know* utterances ranged from the earliest at 18 months to the latest at 29 months. The average age of first *knows* was around 23 months.

The second research question concerned the source of the child's production of *know*. Does the child spontaneously produce *know* or is it an echo of the interlocutor's previous statement? The data show that a majority of *know* utterances were spontaneous.

The third research question concerned the connectedness of the *know* utterance. Is the child using *know* to contribute to an ongoing conversation or activity? Alternatively, is the child using it as a way to bring up a new topic? Although there are exceptions, children predominantly use *know* in a connected way that is embedded in conversations.

The fourth research question concerned the pragmatic function of *know.* Is *know* used to affirm or deny knowledge? Is it used to ask questions about knowledge? Again, there are some variations among the eight children's utterances with *know.* Five children predominantly use *know* to deny knowledge. The other three children show different patterns. Despite this variation, the eight children do use all three pragmatic functions.

The fifth research question concerned whose knowledge the children were referring to when they used *know* in conversations. Children often use *know* to refer to their own knowledge.

Additionally, the intersection of the pragmatic function and person was examined. When children affirmed or denied knowledge, they mostly referred to their own knowledge state. They rarely affirmed or denied their interlocutor's knowledge. However, when they asked about knowledge, their *knows* were exclusively directed at their interlocutor's knowledge state and not their own.

In light of these findings, the five issues Harris et al. (in press) raised in their original paper will be re-examined with the aim of establishing that children show a limited metacognitive competence via early conversations.

First, how do these early conversational references to knowledge and ignorance fit into the theory of mind literature? Like Harris et al.'s (in press) work, this study highlights how analyzing children's early conversations with their interlocutors can provide insights into their metacognitive abilities. Conversations are important because they give children the opportunity to learn about and comment on knowledge. Children report what they know and what they do not know. They also ask questions of a more knowledgeable interlocutor. As a result, it is possible to infer that two-year-olds understand that people have different access to knowledge, that some people have more knowledge than others, and that this knowledge is sharable via conversations (Harris et al., in press).

Second, the results lend support to the continuity of awareness of mental states by young children (Harris et al., in press). Until recently, it was accepted that children's ability to attribute false beliefs to another person emerges only at around three to four years of age (Baillargeon et al., 2010; Wellman et al., 2001). However, recent studies using spontaneous-response tasks (e.g., tasks measuring how long children look or where they look for an anticipated action) show that the ability to understand false beliefs emerges as early as 13 months (Onishi & Baillargeon, 2005; Southgate, Chevallier, & Csibra, 2010; Surian, Caldi, & Sperber, 2007). There are two ways researchers interpret these recent findings with infants. On one side, some researchers argue that infants fully understand false beliefs so that there is no major developmental shift around four years of

age, i.e., when children typically pass the false-belief task (Apperly & Butterfill, 2009; Onishi & Baillargeon, 2005). According to this view, infants' early false-belief understanding is the foundation from which later explicit verbal reasoning about false beliefs emerges (Surian et al., 2007). On the other side, researchers argue that infants' success on theory-of-mind tasks can be explained away by their adoption of behavioral rules. According to this view, infants have no genuine understanding of beliefs (Apperly & Butterfill, 2009). Like Harris et al. (in press), the present findings lend some support to a more limited version of the first view. The results suggest that children have some awareness of epistemic states before four but that this understanding is limited. At the age of two, children are able to talk about their own and their interlocutor's knowledge and ignorance. Although these *know* comments are simple, they are appropriately used in conversation. These findings are in line with work by Hogrefe, Wimmer, and Perner (1986) who described a developmental lag in children's attribution of epistemic states. They found that children at the age of three were able to attribute ignorance but failed to attribute false beliefs to another person.

Third, although Shatz et al. (1983) argue that these early *know* utterances are not mentalistic, it is important to highlight the fact that these children nonetheless use *know* in meaningful ways that are connected to ongoing conversations. At the same time, it is clear that these *know* utterances do not meet Shatz et al.'s (1983) very strict qualification of a *mental state* term. For example, children did not make any explicit contrast between what they knew and what someone else believed or what they themselves currently knew and what they once thought. Rather, as Harris et al. (in press) propose, these utterances

can be viewed as a likely preceding metacognitive step before uncontested mentalistic references are produced.

Fourth, like the three children studied by Harris et al., all eight children in my study showed a bias towards talking about their own mental state. When two-year-olds talked about someone else's knowledge or ignorance, it was almost always their interlocutor's and rarely a third party's. This limitation is important because the false-belief task that children pass at around four years old requires them to report on a third party's belief or belief-based action (e.g., where will Maxi look for his chocolate once he returns?). Harris et al. (in press) emphasize that two-year-olds very rarely use *know* to refer to a third party's knowledge. They may be unable to pass the false-belief task because they are at an earlier stage where they can report on their own knowledge and their interlocutor's knowledge but not on a third party's knowledge. Evidence from O'Neill's (1996) study seems to back the claim. She finds that two-year-olds are able to accurately assess their interlocutor's knowledge state – not a third party's – when communicating with them. To be clear, the present results do not indicate that children have a fully developed theory of mind at the age of two. Rather, similar to Harris et al., (in press), the results suggest that it is plausible that two-year-olds understand mental states but only with regards to their own mental states and their interlocutors' mental states. This is plausibly a pre-theory-of-mind understanding of mental states.

Last, similar to the results from Harris et al. (in press), this study's eight children *know* utterances display similar patterns in their denials and questions (Harris, Ronfard, & Bartz, 2016). Most of the eight children's denials are directed at themselves (e.g., *I don't know)* rather than their interlocutors (e.g., *You don't know*). Conversely, most of the

children's questions are directed at their interlocutors (e.g., *Do you know?*) and not themselves (e.g., *I don't know?*). Harris et al. (2016) present three possible ways to interpret this asymmetry. First, this may be a pattern that is unique to the mental verb *know.* Second, this pattern may extend to other mental verbs such as *think* or *want*. If this is true, children will produce more denials directed at themselves (e.g., *I don't think*) rather than their interlocutors (e.g., *You don't think)* and the opposite pattern will be observed for questions. Third, this asymmetrical pattern may extend to all mental and non-mental verbs (e.g., *eating, drinking, playing,* etc.). Of the three, Harris et al. (2016) suggests that the second option may be the most likely. They hypothesize that the asymmetrical pattern may extend only to mental state verbs because of children's differential access to their own mental states compared to others' mental states. Children may have privileged access to what they themselves know, think, and want so they do not need to ask others on these matters. By contrast, they may not be able to deny what others may know, think, and want because they do not have the same privileged access to others' mental states.

To examine if this explanation is true, future studies could add other mental state verbs (e.g., think and want), action verbs (e.g., *eat*, *drink*, or *play*, etc.) and compare children's use of these verbs with the pattern of use for the epistemic verb *know*. In particular, it will be interesting to see if the pattern of focusing on oneself and the interlocutor is also observable in non-mental verbs. If the pattern is the same, it will weaken this incipient ToM claim. However, Harris et al. (2016) predicts that the pattern for action verbs will be different because conversations about observable external motor movements do not require privileged access to mental states. For instance, children may

equally be able talk about their own eating and drinking actions and others' eating and drinking actions.

Limitations

Further studies are needed to test whether children's understanding of other mental states are limited to themselves and their interlocutor. Harris et al. (in press) analyzed the speech of two English-speaking children of different social class and one Mandarin-speaking child. This study analyzed eight English-speaking children. The socio-economic backgrounds and ethnicities of most of the children are not disclosed in the CHILDES manual. However, it is known that three children are from academic families and one is from a white upper-middle-class family. With some exceptions, children in both Harris et al. (in press) and this study show similar patterns in their use of *know*. Future research that includes a wider range of socioeconomic and ethnic backgrounds will help establish whether the results in this study of eight children and Harris et al.'s (in press) study of three extend to other children.

Despite these limitations, this study extends the work of Harris et al. (in press) and provides converging evidence by showing that with a larger sample, children show similar patterns in their use of *know*. Together, the combined findings suggest that children's early use of *know* in conversations may be the missing middle step between infants' and four-year-olds' ability to understand false-beliefs. Children in their second year are able to appropriately affirm having knowledge, deny having knowledge, and ask questions when they need information. They show a simple understanding of knowledge.

Study 2

Gesture and Meta-ignorance: What young children's use of flip gestures tells us about what they don't know

Introduction

Metacognition is the ability to "know what one knows" (Beran et al., 2012, p. 9; Marazita & Merriman, 2004). There is converging evidence that children begin to show signs of metacognition during the first year of life (Sodian et al., 2012), yet there is still some debate among researchers as to when children first come to reflect on their own knowledge states (Goupil et al., 2016; Sodian et al., 2012). In this paper I examine children's early expressions of ignorance in gesture. Specifically, I look at whether children's use of the *flip* gesture provides evidence of early meta-ignorance.

Early metacognition

There has been increasing interest in investigating children's metacognitive capabilities during infancy (Sodian et al., 2012). Relevant studies focus on three related areas in children aged one- to two-years-old: 1) children's abilities to evaluate others' competencies and expertise, 2) children's abilities to assess others' knowledge states, especially concerning a recent event or situation, and 3) children's abilities to assess their own knowledge states. Since many of the studies were previously described in the introduction of this dissertation, they will only be briefly reviewed here.

Evidence for children's abilities to evaluate others' competencies and expertise comes from studies that ask whether infants are able to choose more competent informants. When 12-month-old infants were presented with an ambiguous toy dinosaur, they preferred to look at the experimenter rather than their caregivers (Stenberg, 2009).

Infants looked for information from the person they deemed to be more of an expert. Arguably, they perceived the experimenter to have more knowledge and expertise because he or she was familiar with the laboratory environment and testing procedures. The results suggest that when given the opportunity, 12-month-old infants are able to select the more competent and knowledgeable informant.

In addition to evaluating their informants, toddlers are also able to assess other individuals' knowledge states, especially with respect to a recent event or situation. When communicating with their caregivers, two-year-old children are able to assess their knowledge states and modify their communications based on their assessments (O'Neill 1996). If parents were initially not in the room when a desirable toy was hidden and they later returned, children were more likely to name the toy, state its location, and gesture towards it than children whose parents were in the room with them and saw the experimenter hiding the toy. These findings suggest that two-year-old children understand that physical absence and lack of perceptual access affect knowledge. They are able to assess their parents' knowledge states and modify their communications accordingly.

Not only are children able to take their parents' knowledge into account, they are also able to monitor and communicate their own uncertainty. Goupil et al. (2016) conducted an experiment in which 20-month-old toddlers had to remember where a toy was hidden and after a delay, point to the correct box in order to retrieve it. Children who were taught to ask for help were more likely to request assistance from their caregivers. These results suggest that 20-month-old toddlers can monitor their uncertainty and share their uncertainty with their caregivers to gain more information. Goupil et al. (2016)

write that in order to communicate uncertainty, children need to be consciously aware of their own metacognitive representations.

Additional evidence of children's early meta-ignorance comes from a naturalistic study by Harris et al. (in press) on two-year-olds' ability to appropriately use the mentalistic verb *know.* This study was extensively reviewed in Study 1. Harris et al. (in press) found that one Mandarin-speaking child and two English-speaking children started producing "know" utterances around two years old. Three important findings stand out. First, these "know" utterances were often child-initiated. Second, they were appropriately used and embedded in conversations. Last, the children used "know" to deny knowledge and to comment on their own knowledge. They also asked questions about their interlocutor's knowledge. The authors concluded that children's spontaneous and appropriate early use of "know" is evidence for a limited pre-theory-of-mind understanding of mental states in two-year-olds. Results from Study 1 adds to these findings. A similar pattern of findings emerged across eight English-speaking children. Children produced affirmations and denials but not questions regarding their own knowledge. The earliest observed *know* utterance was at 15 months while the latest was at 29 months. They average age of first *know* utterances was around 22 months.

Because children's use of gestures often precedes their production of verbal utterances, a natural next step is to examine if children express their meta-ignorance in gesture prior to speech. There is a gesture, the flip gesture (hold two hands palm up out to the side) that can be used to communicate "I don't know." In this study, I ask whether and when children use gestural communication to signal their awareness of their own ignorance.

Gestures

Cartmill, Demir, and Goldin-Meadow (2012) define a gesture as "a movement that is part of an intentional communicative act but is not functional in the real world" (p. 209). While gesture has been studied in many different ways, this section focuses on spontaneous gestures that young children use when communicating with their interlocutors (Cartmill et al., 2012). Young children typically spontaneously produce three types of gestures, deictic, conventional, and representational.

Young children's first gestures are deictic and conventional (Goldin-Meadow & Alibali, 2013). Deictic gestures indicate references and can direct attention towards something or someone in the surrounding context (Cartmill et al., 2012). *Pointing* gestures are deictic gestures. Pre-verbal children are able to point to draw an adult's attention to an object (Goldin-Meadow & Alibali, 2013). Additionally, deictic gestures are context-based, which means that the interlocutor needs to observe what the child is referring to in order to understand his or her gesture. Conventional gestures are also often context-based, yet have meanings that are culturally specific (Goldin-Meadow & Alibali, 2013). They include infants' *pick-me-up arm raise*, *head nod* meaning "yes" or signaling agreement, and *headshake* meaning "no" or signaling disagreement (Cartmill et al., 2012; Fusaro, Harris & Pan, 2011; Goldin-Meadow & Alibali, 2013). Most children begin producing head gestures at around 14 months, well before they are able to produce verbal "yes" and "no" utterances (Fusaro et al., 2011). The flip gesture, which can be used to express ignorance ("I don't know"), is also considered a conventional gesture.

Representational gestures are not as commonly observed in infants, unless they are explicitly taught (with baby signs, for example), but they begin to appear more frequently around two-years of age (Ozcaliskan, Gentner & Goldin Meadow, 2014). These representational gestures are typically actions recreating shape or movement. They are not as context-dependent and can be substitutes for words (Goldin-Meadow & Alibali, 2013). Two types of representational gestures are iconic and metaphoric. Iconic gestures reference physical objects and events (Cartmill et al., 2012). An example is when a child flaps her arms to indicate a bird flying (Goldin-Meadow & Alibali, 2013). Metaphoric gestures are used to express abstract ideas or concepts (Cartmill et al., 2012). An example is when a child moves his hands backward when talking about the past.

Flip gestures

There is limited research on the flip gesture. A flip gesture is a conventional gesture with two hands held out to the side, palms up. Flips can communicate uncertainty or ignorance, effectively serving as a nonverbal version of "I don't know." Additionally, a flip can be used to ask *where, what,* and *how* questions, such as "where did it go?"

One of the published references to the flip gesture comes from a case study of a girl named Kate (Acredolo & Goodwyn, 1985). Researchers followed the development of Kate's gestures from 12 to 17 months. They found that Kate's acquisition of the *I dunno* gesture (equivalent to the flip) began at 15 months. Her parents often routinely produced flips in combination with *where* questions. They modeled this gesture and Kate adopted it into her daily communication. Aside from this case study, flips have mostly been overlooked. Yet what makes the flip gesture especially interesting is that children appear to use it to deliberately communicate their ignorance to their interlocutors, potentially

implying some degree of metacognitive awareness. Hence, more research is needed to examine if the flip gesture is widely used and to identify the communicative contexts in which it is produced.

The current study

This study examines the production and the contextual use of flips from 14 to 42 months. The primary goal is to understand when flips emerge, contexts in which they are triggered, their intended meanings, and the responses they elicit from interlocutors. More specifically, I am interested in the following questions: 1) When do children's flips emerge? 2) Are flips spontaneous? 3) Are flips accompanied by verbal utterances? 4) What occurs immediately before the flip gesture? 5) How do interlocutors respond to children's flips?

Method

Participants

Participants included a group of 64 families with typically developing children from the Language Development Project (Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush, & Small, 2014). They were recruited from the greater Chicago area and selected to reflect the ethnic and racial makeup and family income of the Chicago area. All families spoke only English at home. There were 31 girls and 33 boys.

Procedure

Trained researchers visited families in their homes every four months when the children were between 14 and 58 months (Goldin-Meadow et al., 2014). A total of 12 visits were recorded for each child. This study used data from the first eight visits. At

each home visit, a researcher videotaped parent-child interactions for a 90-minute period. The video recordings focused on ordinary daily activities and interactions between the primary caregiver and the target child. The researchers were trained to limit their interactions with the families during these video recordings. All video recordings were transcribed for speech and gesture including flips. When it was possible, flips were coded for their communicative messages (e.g., flips meaning "I don't know" were coded as I DON'T KNOW flips, flips meaning "Where?" were coded as WHERE IS IT flips, flips that were ambiguous were coded as "X," etc.). Excluding the flips meaning "All done" or "All gone," there were nine different sub-groups of flips. I DON'T KNOW flips made up a sub-group within the broader categories of flips.

Transcription

All 64 target children and primary caregivers' utterances and gestures had been previously transcribed. Goldin-Meadow et al. (2014) reported that the interrater agreement for transcription exceeded 95% for speech and gesture. The reliability for coding categories exceeded 88% for speech and gesture. With this database, it was possible to search for all of the children's flip gestures, what was said before and after flips, and who made those comments.

Data coding

The coding system developed for the flip gesture was partially based on the coding system devised by Harris et al. (in press) for children's "know" utterances. All flip gestures in the database were coded with respect to eight coding categories: Was the flip child-initiated or interlocutor-initiated? What accompanied the flip? What occurred before the flip? Who spoke prior to the flip? What was the content of the pre-flip

questions (this consists of two coding categories)? Did the interlocutor respond to the child's flip by continuing or discontinuing the conversation? Did the interlocutor respond to the child's flip with a flip? These eight coding categories corresponded to research questions two to five mentioned earlier in the introduction. Cohen's kappas for all the coding steps excluding step five and six ranged from 0.642 to 1. Step five (0.48) and six (0.46) were difficult to code reliably because children's questions were often ambiguous. All eight steps will be described in greater detail in the next section.

Child-initiated or interlocutor-initiated? This coding category involved assigning the flip to one of three codes: "Interlocutor-initiated," "Child-initiated," or "Not applicable." The "Interlocutor-initiated" code was selected when the interlocutor produced a flip immediately prior to the child's flip (e.g., Interlocutor: "Do you have a bear?" Flip. Child: Flips.). The "Child-initiated" code was selected when the child spontaneously produced the flip gesture (e.g., Interlocutor: "What's in there?" Child: Flips.). The "Not applicable" code was selected when the interlocutor's hands were not visible in the video clip.

What accompanied the flip? This coding category was intended to provide a closer look at verbal utterances that accompanied a child's flip gesture. More specifically, each flip was assigned to one of five codes: "Alone," "I don't know," "Question," "Remark," or "Unknown utterance." The "Alone" code was chosen when a child made no verbal utterances with the flip. The "I don't know" code was chosen when a child produced a flip and made a comment containing the phrase "I don't know." The "Question" code was chosen when a child produced a flip paired with a question (e.g., Child flips and asks "What?"). The "Remark" code was chosen when a child produced a

flip paired with a remark (e.g., Child flips and says “I want to find it.”). The “Unknown utterance” code was chosen when a child produced a flip with unknown verbal utterances (e.g., Child flips and says “Haa?”).

What occurred before the flip? Did the child’s flip gesture have a meaningful relationship to the preceding conversation or activity? This coding category involved allocating the flip to one of four categories: “Question,” “Remark,” “Common ground,” or “No common ground.” The “Question” code was selected for flips that were produced after an interlocutor or the child had asked a question and the child answered with a flip. The “Remark” code was selected for instances when an interlocutor or child made a remark that a child answered with a flip. The “Common ground” code was for instances when a child and an interlocutor were jointly engaged in a nonverbal activity (e.g., They were drawing together) and the child flipped. The “No common ground” code was for instances when a child flipped while engaged in an autonomous monologue or activity.

Who spoke prior to the flip? There were three mutually exclusive coding categories: “Interlocutor,” “Child,” or “Not applicable.” The “Interlocutor” code was selected for instances when a child’s conversational partner spoke immediately prior to the child’s flip. The “Child” code was selected for instances when a child spoke immediately prior his or her own flip. The “Not applicable” category was selected for instances in which no one spoke prior to a child’s flip.

A closer look at questions. If a question was asked prior to the flip gesture, the primary aim of the next two coding categories was to analyze the content of the question. These two coding categories – type of question and content of question – were taken from Chouinard’s (2007) study on children’s questions. For the type of question category,

each question was assigned to one of four codes: “Fact,” “Explanatory,” “Non-information seeking,” and “Not applicable.” These four codes were mutually exclusive. The “Fact” code was selected when a question involved a request for specific non-causal information (e.g., Where’s the blue balloon?). The “Explanatory” code was for questions that were requests for causal information (e.g., Why don’t you like that, Mama?). The “Non-information seeking” code was selected when a question involved seeking attention, clarification, action, or permission (e.g., Then you have to do this next okay?). The “Not applicable” category was selected for instances when a question was ambiguous or when there was no question.

The content of question category focused on the questions that were coded as “Fact” and “Explanatory” in the last step. These questions were sorted by content. I used the thirteen content coding categories developed by Chouinard (2007) and added a “Not applicable” code for non-questions and ambiguous questions. All fourteen codes were mutually exclusive and they are listed in Table 1.

Table 1

Chouinard's (2007) question content codes

Content Type	Asking About…	Examples
Label	The name for an object, or to what a name applies	*What's that? What's a jack-o-lantern?*
Appearance	A visible property of an object	*What color is it?*
Property	A permanent property of an object	*What is it made of? Is it soft?*
Function	The function of an object	*What does it do?*
Part	A part of an object	*Is that the donkey's ear?*
Activity	The activity of an object, person, or animal	*What is he doing? Is mom cooking?*
State	A temporary state of something	*Is it broken? Is he hungry?*
Count	The number of/the existence of something	*Is there any more milk? How many Legos are there?*
Possession	Who something belongs to, or if someone has possession of something	*Whose coffee is that? Do you have a cat at home?*
Location	Where something is or belongs	*Where is my ball?*
Hierarchy	How different category levels relate to one another	*Is that a poodle dog? What kind of car is that?*
Generalization	A category as a whole	*Do bats sleep upside down? Why do cats like milk?*
Theory of Mind	The beliefs, desires, knowledge, mental states, or personality of a person	*Do you want my milk? How does the pilot know where to fly the plane? Is he a mean dog?*
Not applicable	Unable to determine	

Notes: This table was taken directly from Chouinard (2007, p. 19) work on children's early questions.

Continuing or discontinuing the conversation? This coding category examined the interlocutor's response to the child's flip gesture. Each response by the interlocutor was allocated to one of 11 codes, which are presented in Table 2. The "Deny," "Know," "Don't know," and "Do you know" codes differentiated among responses containing the

word “know.” The “Flip” code was a gesture-only response. The “Answer,” “Related,” and “Follow up” codes were for responses that extended the conversation. The “Unrelated”, “No response,” and “No interlocutor” codes applied to situations when there were no responses or when flips were ignored.

Table 2

Interlocutor's response to the child's flip gesture

Response Type	Definition	Examples
Deny	Interlocutor does not accept the child's ignorance	*You know!*
Know	Interlocutor states possession of knowledge.	*I know.*
Don't know	Interlocutor states his or her own ignorance on the topic.	*Oh I don't know the names.*
Do you know	Interlocutor asks if the child has the knowledge.	*You don't know?*
Flip	Interlocutor responds only with a flip gesture. There is no verbal response. If the response contains both a flip and speech, code only the verbal response in this step.	
Answer	Interlocutor supplies the missing information or provides an explanation.	*Interlocutor: Whose hat is this? Child: Flips. Interlocutor: It's Daddy's hat.*
Related	Interlocutor makes a related on topic comment that is not an answer or an explanation.	*The child is looking for her blanket. Interlocutor: Where is it? The child finds it. Interlocutor: You found it!*
Follow up	Interlocutor asks a follow up question or asks for clarification. This includes the interlocutor's repeated questions or remarks.	*Child: Flips. Interlocutor: Where's the broom?*
Unrelated	Interlocutor makes an unrelated remark or asks an unrelated question.	*Interlocutor: Whose hat is this? Child: Flips. Interlocutor: Time for snack.*
No response	Interlocutor does not respond to the child's flip. If a child flips and the interlocutor is silent for a few seconds and then makes an unrelated comment, the video clip should be coded as "no response" and not "unrelated." This includes instances when the child talks to a silent videographer. It also includes occasions when the interlocutor is talking to someone else and does not respond to the child's flip.	
No interlocutor	Child is engaged in a monologue and the interlocutor is not present.	

Responding with a flip? The last coding category was used to examine whether or not the interlocutor answered the child's flip gesture with a flip. There were two mutually exclusive codes: "Flip" or "Not applicable." A "Flip" code was assigned when the interlocutor produced a flip gesture after the child's flip. Note that the "Flip" code in the previous step was created as an option for interlocutors who only provided nonverbal responses. This step's "Flip" code includes all instances of flips regardless of whether it was paired with verbal utterances or not. The "Not applicable" code was assigned when the interlocutor's response did not include a flip.

Results

Of the 64 children, 62 children produced the flip gesture at least once during the eight home visits conducted between 14 months and 42 months. Figure 1 displays the number of flips, I DON'T KNOW flips, and "I don't know" utterances by age. Note that this count of flips excludes ones that were directed to the videographer and ones that meant "all done" and "all gone"). Because this study was inspired by the work of Harris et al. (in press) on the mental verb "know" and by the follow-up study reported in the last chapter, I wanted to compare the developmental course of the flip gesture and "I don't know" utterances. The flip gesture emerged earlier. At 14 months, there were 35 flips (produced by 7 children), 12 I DON'T KNOW flips (produced by 6 children) but zero "I don't know utterances". At 18 months, there was only one child who used "I don't know" but 11 who produced I DON'T KNOW flips. It was only at 30 months that the number of "I don't know" utterances surpassed the number of gestural flips. Surprisingly, flips did not generally decline as "I don't know" utterances increased over time.

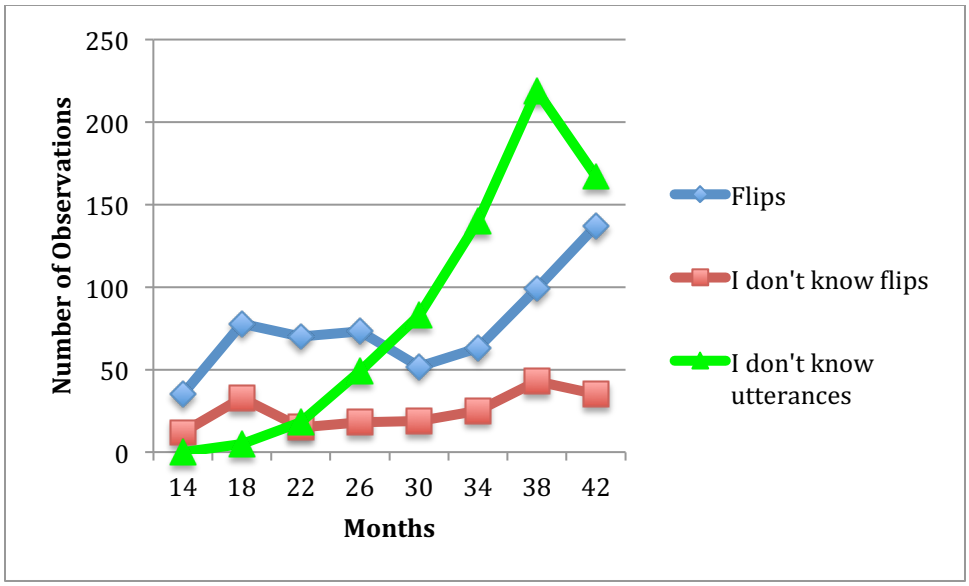


Figure 1: The total number of flips, I DON'T KNOW flips, and "I don't know" utterances by age for all 64 children.

The data were also analyzed to assess how many children produced each response type at least once during each of the eight home visits conducted between 14 months and 42 months. These data are shown in Figure 2. Inspection of Figure 2 shows that at 14 months, seven children produced flips, six produced I DON'T KNOW flips, and zero produced "I don't know" utterances. The number of children producing "I don't know" utterances surpassed the number of children producing flips only at 34 months.

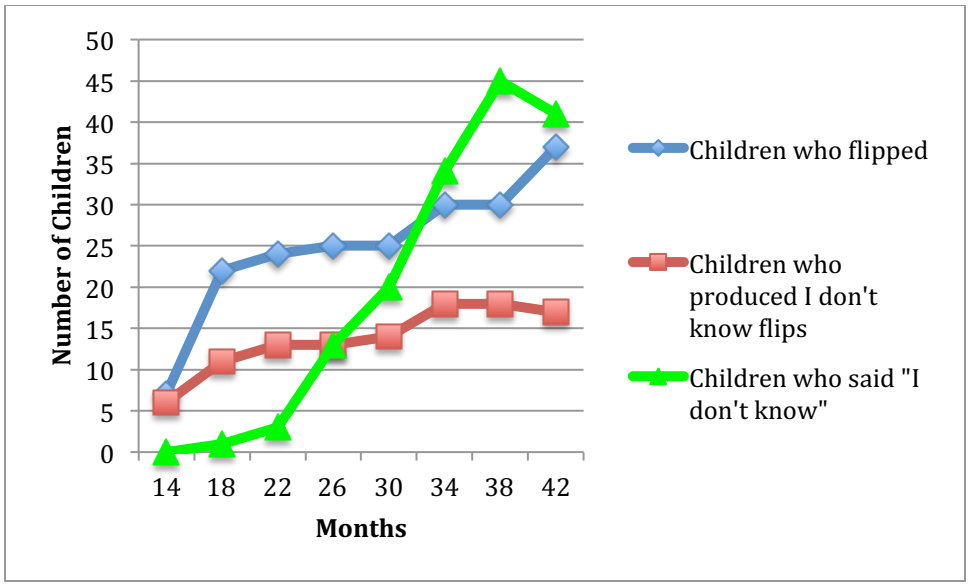


Figure 2 displays the number of children who produced flips, I DON'T KNOW flips, and "I don't know" utterances by age.

Figure 3 shows the cumulative number of children who ever produced flips, I DON'T KNOW flips, and verbal "I don't know" utterances by age. There were 62 children who produced flips, 48 children who produce I DON'T KNOW flips, and 60 children who said "I don't know" at least once between 14 and 42 months. Thus, almost all children in the sample produced flips in the period under study, and the majority of children (75%) produced I DON'T KNOW flips. On average, excluding children who did not produce I DON'T KNOW flips or say "I don't know," the difference between age of onset for I DON'T KNOW flips and age of onset for "I don't know" utterances was around four months. The I DON'T KNOW flips emerged earlier than verbal "I don't know" utterances.

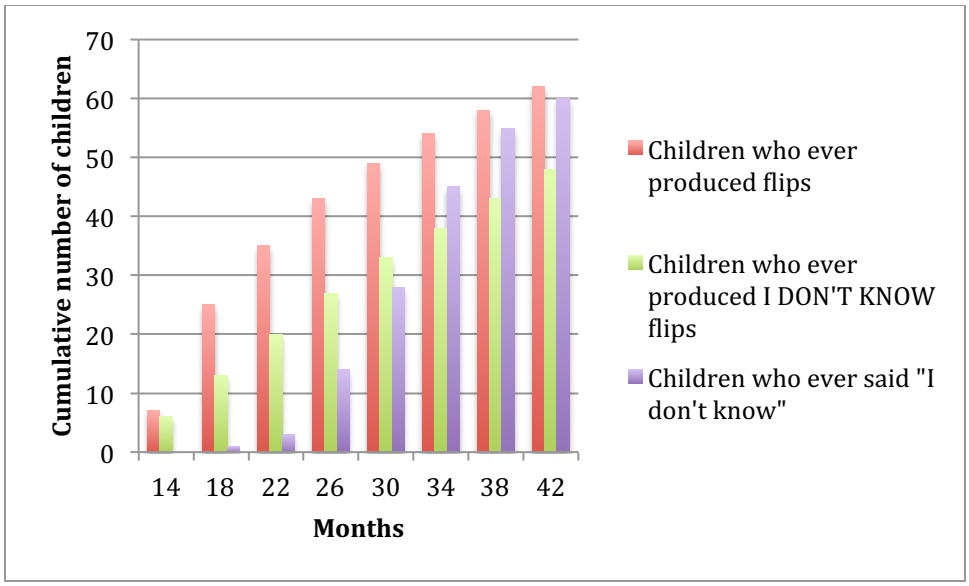


Figure 3 displays the cumulative number of children who ever produced flips, I DON'T KNOW flips, and "I don't know" utterances by age.

The breakdown of flips is presented in Table 3. Exclamation flips were the most common flips, followed by I DON'T KNOW flips. Because I was primarily interested in the metacognitive nature of flips, the ALL GONE and ALL DONE flips were excluded since they did not communicate an awareness of ignorance. EMPHASIS, EXCLAMATION, and OTHER flips were included because some of them were knowledge-related (e.g., a child asked, "In the fridge?" and emphasized his comment with an EXCLAMATION flip).

Table 3

Different types of flips

Flip Type	Count
I don't know	178
Emphasis	21
Exclamation	219
What	8
Whatever	16
Where	130
Who	1
Why	4
Other	30

Notes: The numbers exclude the all gone and all done flips

Child-initiated or Interlocutor-initiated?

All nine different categories of flips from Table 3 were combined and analyzed using the coding system described in the methods section. Was the flip gesture initiated by the child or copied from the interlocutor's prior gesture? Figure 4 displays an overview of the number of child-initiated and interlocutor-initiated flips from 14 months to 42 months. Inspection of Figure 4 shows that at each of the eight age points, the number of child-initiated flips exceeded the number of interlocutor-initiated flips.

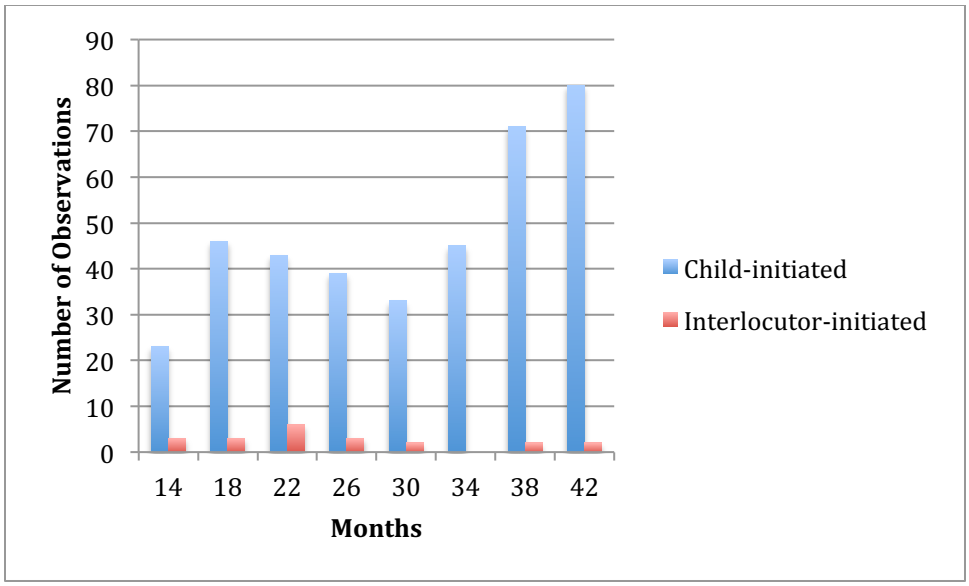


Figure 4: The number of flips that were initiated by the interlocutor or by the child for each age.

Figure 5 displays the number of children who produced more self-initiated flips and the number of children who produced more interlocutor-initiated flips at each of the eight age intervals. Sign tests confirmed that the number of children who produced self-initiated flips was greater than the number of children who produced more interlocutor-initiated flips at each age point (*p* ranged from 0.031 to <.0001). Additional analyses conducted using the paired-samples t-test produced similar results. Children's rate of self-initiated flips was greater than their rate of interlocutor-initiated flips (*p* ranged from 0.016 to 0.00022) from 18 to 42 months. At 14 months, a significant difference did not emerge, probably because only a small number of children (n=6) flipped at 14 months. In summary, there was consistent evidence at almost every age interval that child flips were typically initiated by the child rather than being copies of an interlocutor's immediately preceding flip.

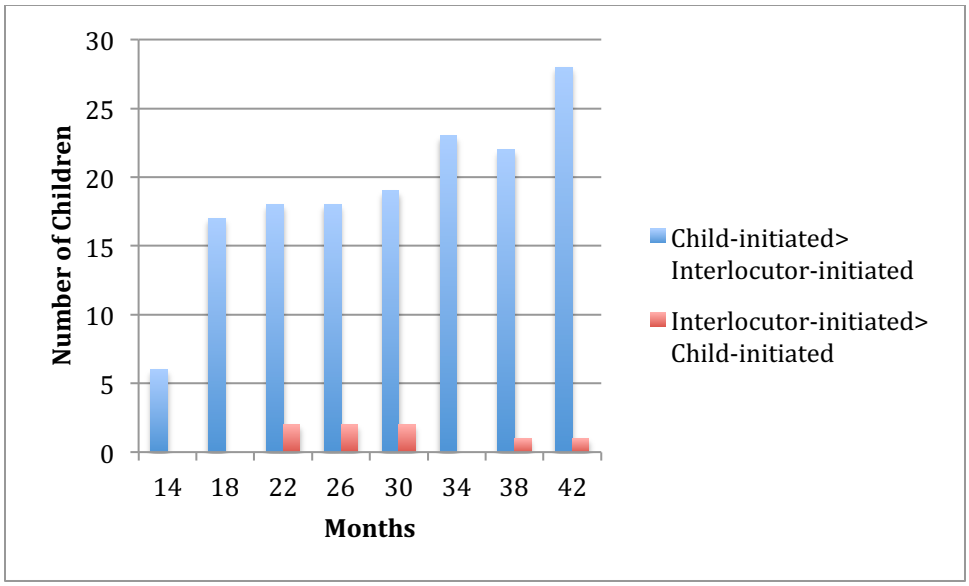


Figure 5: The number of children who produced more child initiated-flip gestures (child initiated > interlocutor initiated) compared with the number of children who produced more interlocutor-initiated flip gestures (interlocutor initiated > child initiated) by age.

What Accompanied the Flip?

This question differentiated flip gestures that accompanied speech from those that occurred alone. Of the original five codes ("Alone," "I don't know," "Question," "Remark," and "Unknown utterance") the latter four codes were combined under a broader "Verbal" code and the "Alone" code was left untouched. Figure 6 displays the number of flips occurring with and without speech from 14 months to 42 months. At 14 and 18 months, these numbers were similar but as children grew older, their flips were increasingly paired with speech.

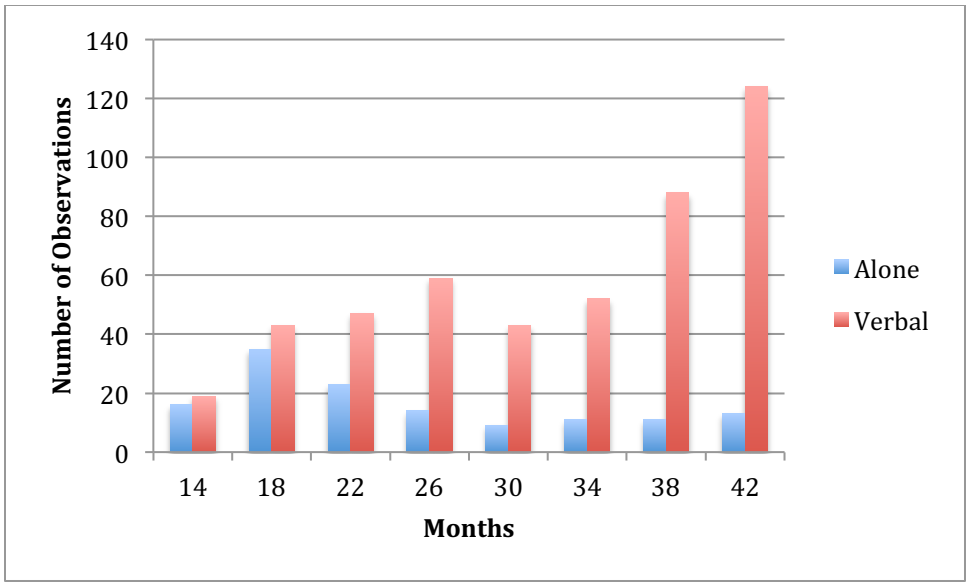


Figure 6: The number of flip gestures with and without verbal utterances by age.

Inspection of Figure 7 shows the number of children who produced more flips with verbal utterances than without and the number of children who produced more flips without verbal utterances than with by age. Sign tests were used to compare these numbers at each age group. The number of children who produced more accompanied flips exceeded the number of children who produced more unaccompanied flips from 26 months to 42 months (p ranged from 0.0015 to <.0001). At 14, 18, and 22 months, no significant difference was found. The results from the paired-samples t-test were identical. There was a significant difference between children's rate of accompanied flips and their rate of unaccompanied flips (p ranged from 0.0098 to <.0001) from 26 months to 42 months. At 14, 18, and 22 months, no significant difference was found. In summary, children were equally likely to produce flips with and without speech from 14 months to 22 months. From 26 months onwards, most of children's flips were accompanied by speech.

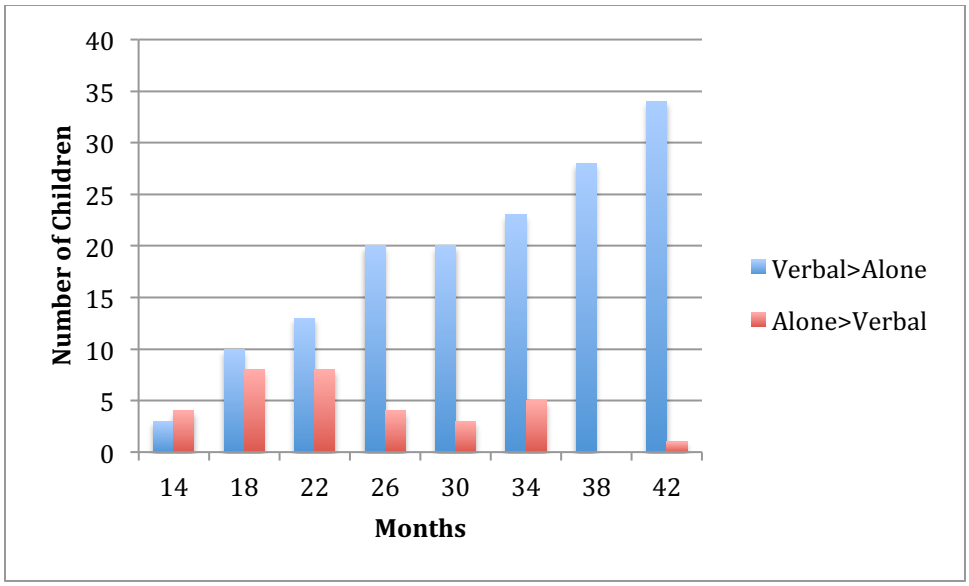


Figure 7: The number of children who produced more flip gestures with verbal utterances (Verbal>Alone) than without compared with the number of children who produced more flip gestures alone than accompanied (Alone>Verbal) by age.

What Occurred Before the Flip?

This coding category was used to examine what occurred immediately before the flip gesture. To present the results more effectively, the "Question" and "Remark" codes were merged under a new "Conversation" category. This category grouped together flips that were used in a conversational context. The "Common ground" and "No common ground" formed a new "Spontaneous" category. This category grouped together flips where there was no prior verbal dialogue. Figure 8 displays the number of flips produced in a conversational context and the number of flips produced spontaneously from 14 months to 42 months. A majority of flip gestures were conversational.

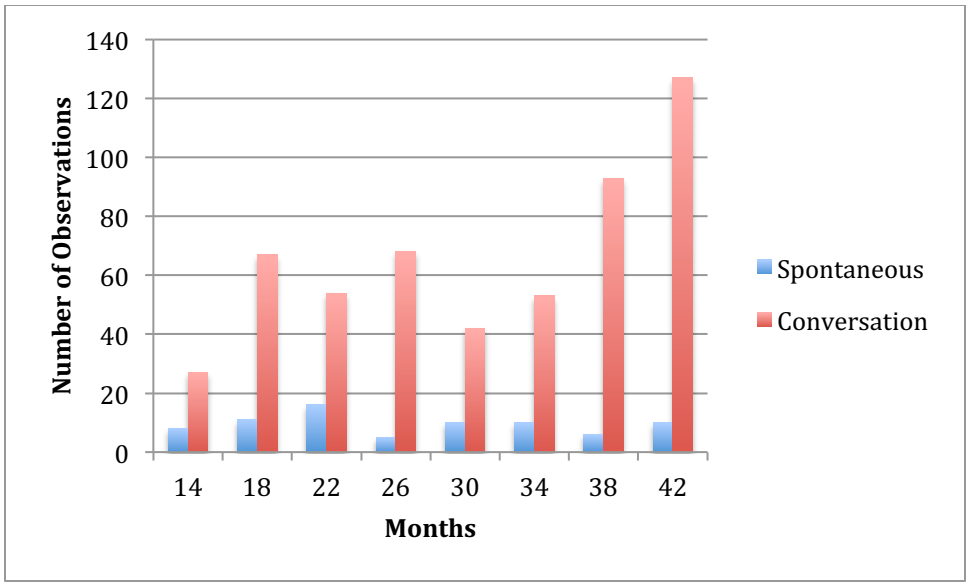


Figure 8: The number of flip gestures produced in a conversational context and produced spontaneously by age.

Figure 9 displays the number of children who produced more conversational as opposed to spontaneous flips and the number of children who produced more spontaneous as opposed to conversational flips by age. Sign tests confirmed that the number of children who produced more conversational flips exceeded the number of children who produced more spontaneous flips from 14 to 42 months (*p* ranged from 0.0156 to <.0001). The results from the paired-samples t-tests were equivalent. Children's rate of conversational flips exceeded their rate of spontaneous flips (*p* ranged from 0.040 to 0.00021) at all eight age intervals. In sum, a majority of children's flips were embedded in a conversational context. If the reverse pattern had been observed, it would have suggested that children's flips were not conversational and that these flips were not meant to communicate ignorance or to request for more information. Still, caution should be exercised in drawing this conclusion. Most of the videos focused on

parent-child interactions. Although there were clips of children playing alone, they were less common. Hence, it is possible that fewer spontaneous flips were captured as a result of this focus on parent-child interaction.

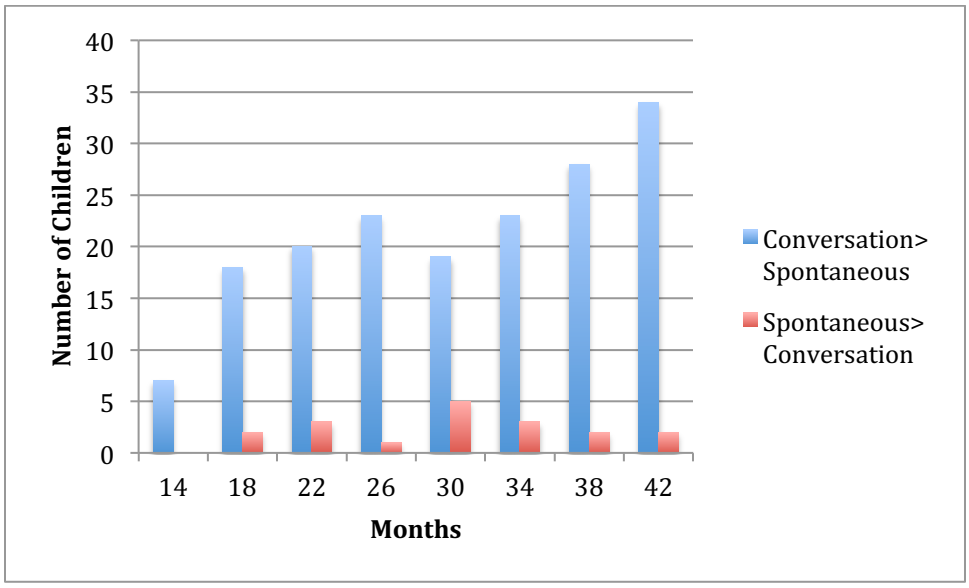


Figure 9: The number of children who produced more conversational flips (Conversation>Spontaneous) compared with the number who produced more spontaneous flips (Spontaneous>Conversation) by age.

Who Spoke Prior to the Flip?

To probe the question of who spoke prior to the child's flip, Figure 10 shows the number of times that the interlocutor or the child spoke immediately prior to a flip from 14 months to 42 months. Inspection of Figure 10 confirms that most of children's flips followed questions or remarks by their interlocutors rather than by children themselves.

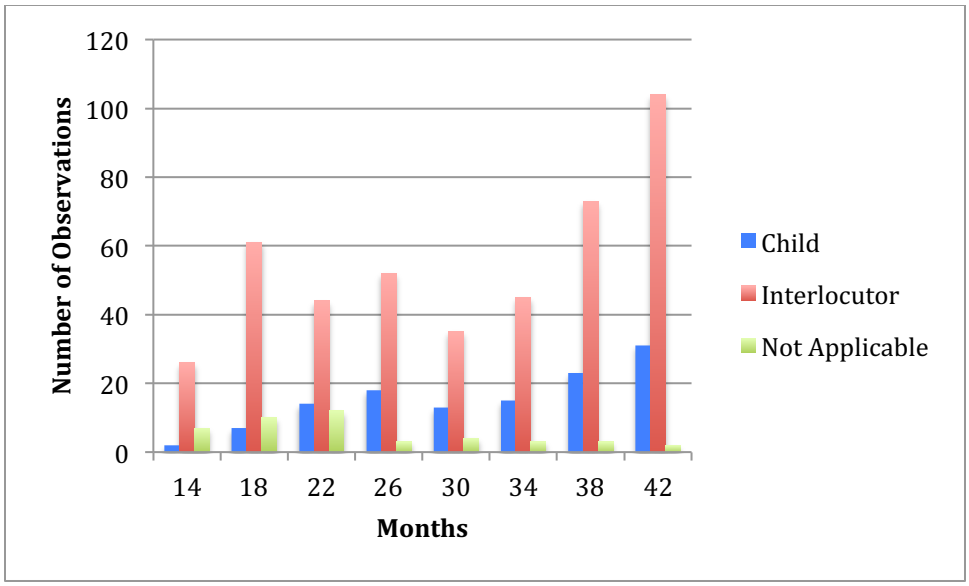


Figure 10: The number of times an interlocutor or a child spoke immediately prior to a flip by age.

Figure 11 displays the number of children whose flips were more often preceded by their interlocutors' utterances rather than their own compared with the number of children whose flips were more often preceded by their own utterances by age rather than their interlocutors'. Sign tests confirmed that the number of children whose flips were more often preceded by their interlocutors' utterances exceeded the number of children whose flips were more often preceded by their own utterances at all eight age periods (p ranged from 0.0313 to <.0001). The results from the paired-sample t-test were mostly similar. Children's rate of flips preceded by interlocutors' utterances was greater than their rate of flips preceded by their own utterances from 18 to 42 months (p ranged from 0.013 to 0.0002). At 14 months, no significant difference emerged. In summary, most of the children's flips were produced in response to the interlocutors' questions and remarks.

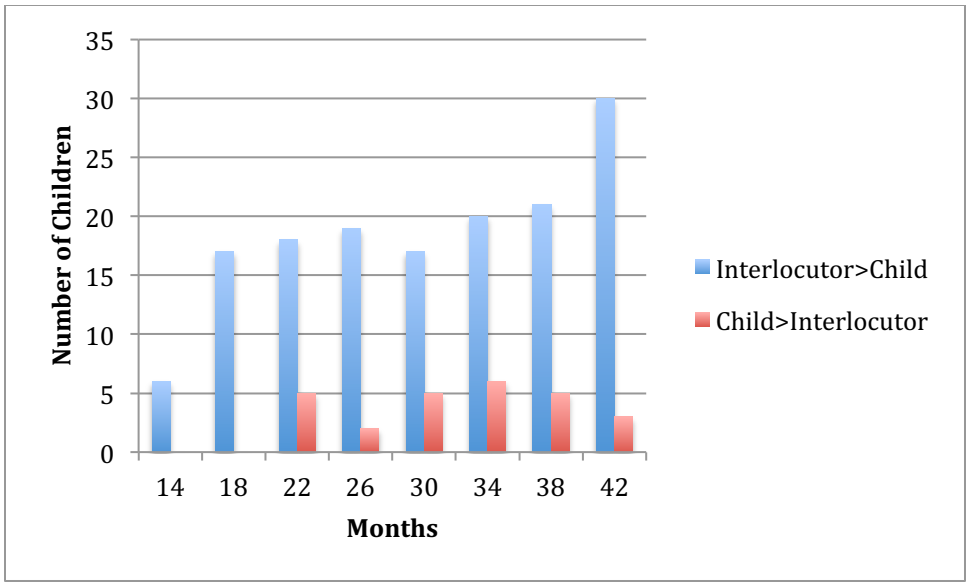


Figure 11: The number of children whose flips were more often preceded by their interlocutors' questions or remarks (Interlocutor>Child) compared with the children whose flips were more often preceded by their own questions or remarks (Child>Interlocutor) by age.

A Closer Look at the Questions.

The next two coding categories allowed a closer examination of the content of the questions that preceded children's flips. This set of questions included both interlocutors' and children's questions. The "Fact" and "Explanatory" codes were combined under a new "Information seeking" category. This broader category included questions that asked for simple factual information (e.g., concerning the location or identity of an object) and explanatory information. The "Non information-seeking" code remained the same. Figure 12 displays the number of non information-seeking questions and information seeking questions prior to a flip from 14 months to 42 months. Information-seeking questions were more commonly observed.

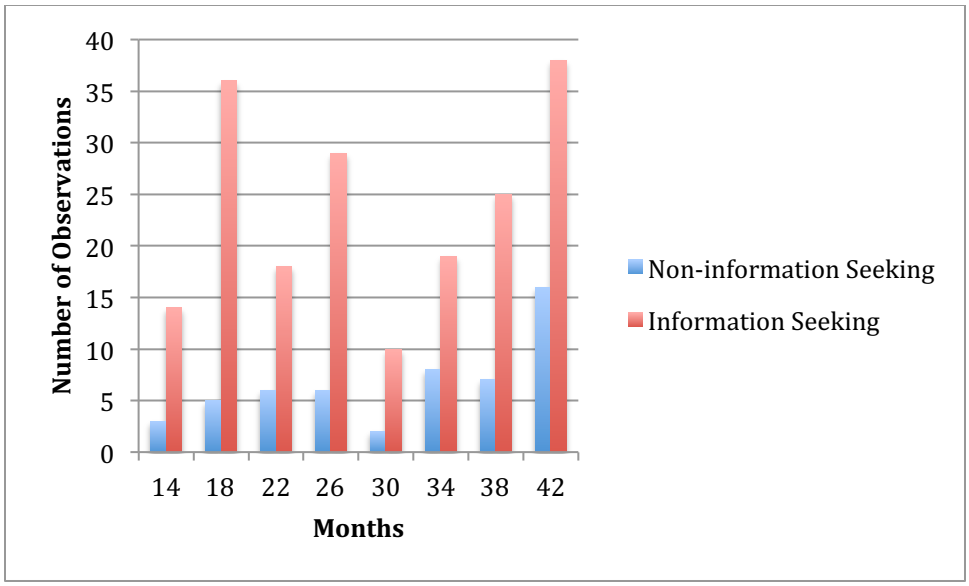


Figure 12: The number of non information-seeking questions and information-seeking questions that preceded a flip at each age point

Figure 13 displays the number of children whose flip gestures were more often preceded by information-seeking rather than non information-seeking questions compared with the number of children whose flip gestures were more often preceded by non information-seeking rather than information-seeking questions by age. Sign test revealed significant differences at 26 months ($p = 0.0213$) and 42 months ($p = 0.0266$). At 14, 18, 22, 30, 34, and 38 months, there were no significant differences. The paired-sample t-test results confirmed a significant difference between children's rate of flips that were preceded by information-seeking questions and their rate of flips that were preceded by non information-seeking questions at 18, 22, 26, 30, 34, and 42 months (p ranged from 0.045 to 0.0043). At 14 and 38 months, no significant differences were found. In summary, although the pattern was not consistently significant at each age interval, children's flips were generally more frequent when the interlocutor posed an

information-seeking question rather than a non information-seeking question. Thus, children were more likely to respond to a question such as "Where is it?" with a flip than to a question such as "Can you get the ball?"

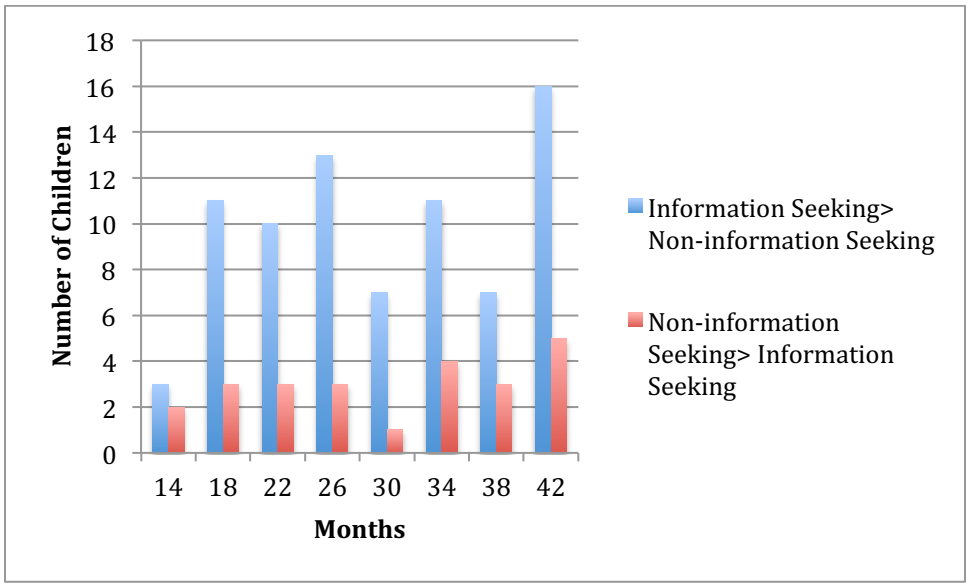


Figure 13: The number of children whose flips were more often preceded by information-seeking questions (Information-Seeking>Non information-Seeking) compared with the children whose flips were more often preceded by non information-seeking questions (Non information Seeking>Information-Seeking) by age.

The next coding category sought to classify the types of questions that were asked prior to flips. Similar to the previous coding step, these codes were difficult to use and the inter-rater reliability was low. Because there were fourteen categories, only the top four most frequently observed questions are presented in Figure 14. With the exception of the "Not applicable" code, the remaining ten categories were sparsely populated with five or fewer observations each. Inspection of Figure 14 shows that flips were often preceded by questions about location. No further analyses were conducted for this step.

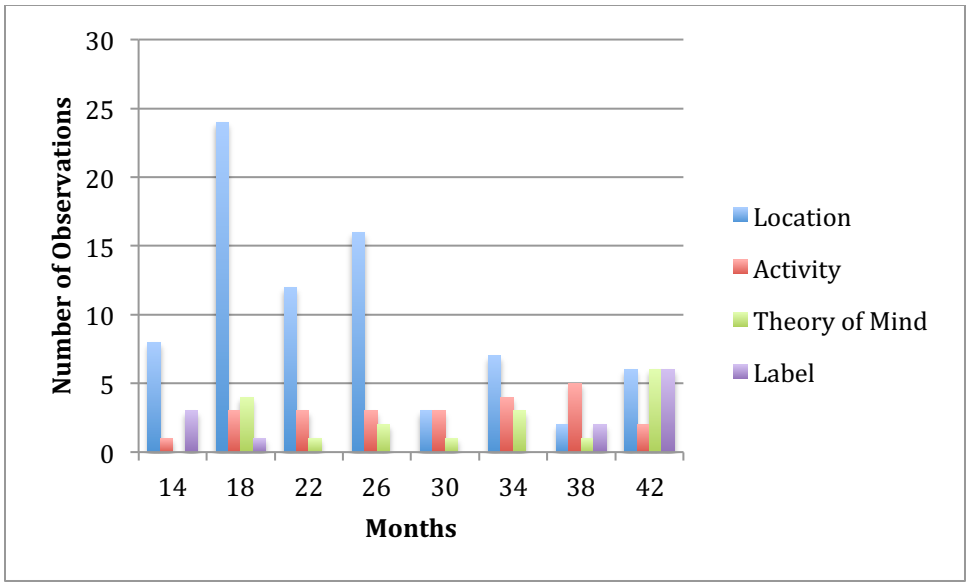


Figure 14: The four most frequent types of questions that preceded the flip gesture by age. (Note that the code "Not applicable" was the most common category but it is omitted from the figure).

Continuing or Discontinuing the Conversation?

The seventh step examined what occurred after the flip gesture. The thirteen codes were grouped into two larger categories of "Continue" and "Discontinue" (the "Not applicable" code was excluded). The new "Continue" category was used for responses that extended the interlocutor-child conversations. It incorporated the "Accept," "Deny," "Know," "Don't know," "Do you know," "Flip," "Answer," "Related," and "Follow up" codes. Conversely, if a flip response served as a terminus to the interlocutor-child conversation, it was classified under the new "Discontinue" category. The "Discontinue" category included "Unrelated," "No response," and "No interlocutor" codes.

Figure 15 shows the number of times interlocutors responded to the children's flip gestures by continuing the conversations or discontinuing the conversations from 14

months to 42 months. It is important to point out that the "Discontinue" category includes the "No response" code. A majority of these "No response" codes came from children talking to videographers who were trained not to respond. Effectively, this means that the distributions shown in Figure 15 are likely to be an over-estimate of the frequency with which interlocutors respond to children's flips by discontinuing the conversation.

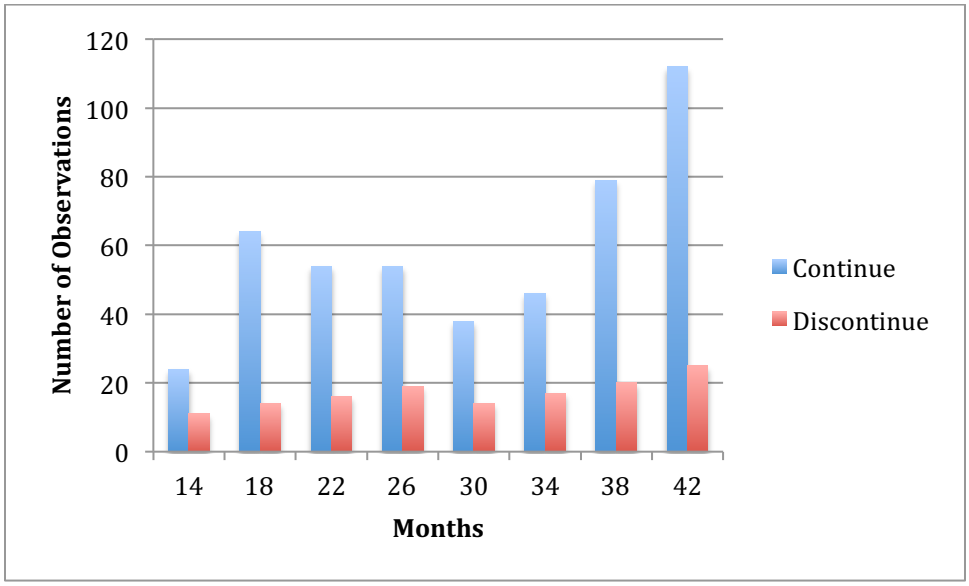


Figure 15: The number of times interlocutors responded to the children's flips by continuing the conversations or discontinuing the conversations from 14 months to 42 months.

Figure 16 displays the number of children whose flips were followed by more extended conversations compared with the number of children whose flips led to more discontinued conversations by age. I compared the totals using the sign test and found significant differences at 18, 22, 26, 34, 38, and 42 months (p ranged from 0.015 to < 0.0001). No significant differences emerged at 14 and 30 months. The results from the

paired-sample t-tests were identical. There was a significant difference between children's rate of flips leading to continued conversations and their rate flips leading to discontinued conversations at 18, 22, 26, 34, 38, and 42 months (*p* ranged from 0.011 to 0.00012). No significant differences emerged at 14 and 30 months. Thus, interlocutors mostly responded to the children's flip gestures by continuing the conversations.

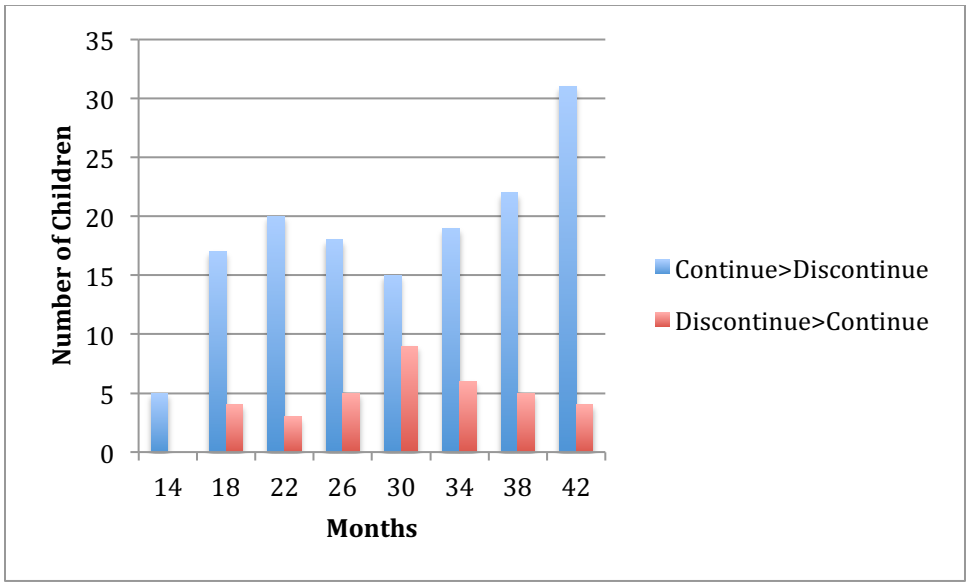


Figure 16: The number of children whose flips were followed by more extended conversations with their interlocutors (Continue>Discontinue) compared with the number of children whose flips were followed by more discontinued conversations (Discontinue>Continue) by age.

Responding with a Flip*?*

Figure 17 displays the number of times interlocutors flipped in response to children's flips from 14 months to 42 months. The interlocutors' flip responses peaked at 18 months and then declined.

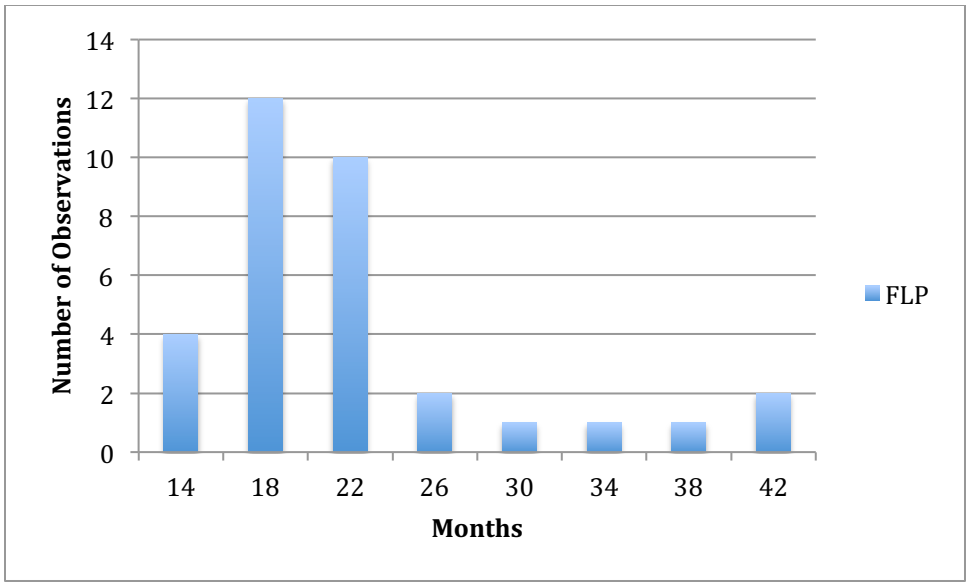


Figure 17: The number of times interlocutors responded to a child's flip gesture with a flip.

For the results presented up to this point, the whole sample of 607 flips (excluding ALL GONE and ALL DONE flips) was used. Similar analyses were conducted using only 178 I DON'T KNOW flips. The patterns found in Figures 4 to 17 were replicated with this smaller subset of I DON'T KNOW flips.

Discussion

The primary goal of this paper was to examine how children between 14 months and 42 months use flips. Flip gestures were observed at 14 months and increased in frequency over time. The number of children using and initiating flips also increased. Children were creative in their use of flips. The flip gesture was used to communicate a variety of meanings. Children used them not only to signal their ignorance but also to emphasize and highlight something they said (e.g., when a child's "Please" request was paired with a flip). They also produced them together with their *what, where, who*, and *why* questions. However, flip gestures were most commonly accompanied by verbal

exclamations (e.g., “That’s it!”) or by “I don’t know” utterances. The next sections will review the eight findings and discuss possible links with children’s metacognition.

Were flips initiated by children or copied from interlocutors? Most flips were child-initiated.

Next, children’s flips and accompanying verbal utterances were examined. Because a flip is a conventional gesture, it has meaning on its own and can be used communicatively with or without an accompanying verbal utterance. From 14 to 22 months, children produced flips with and without verbal utterances at approximately similar rates. By 38 and 42 months, most flips were accompanied by a verbal utterance.

What occurred immediately before children’s flips? At all eight age intervals, children often produced flips in the context of a conversation. This finding highlights the fact that even as early as 14 months, children are producing flips in response to preceding linguistic utterances.

Who spoke prior to children’s flips? Except at 14 months, children from 18 to 42 months often flipped following questions and remarks from an interlocutor rather than following their own remarks. Thus, by 18 months, children are able to use gestures to respond to an interlocutor in a dialogic fashion.

Next, the content of questions asked right before children’s flips were examined. Due to low inter-rater reliability, no firm conclusions were drawn. Nevertheless, two general observations were feasible based on a cautious examination of the data. First, from 18 months onward, there were significantly more information-seeking questions prior to flips than non-information seeking questions (as shown by t-tests) at all age

points except 38 months. Second, the most common type of question asked for the "location" of an object (e.g., "Where is my balloon?").

What happened after children's flips? Interlocutors at 18, 22, 26, 34, 38, and 42 months often interpreted children's flips as conversational and responded to them. They continued the conversations, provided answers, and asked follow-up questions. While no significant differences emerged at 14 and 30 months, these two age intervals still followed the same trends; more interlocutors responded by continuing rather than discontinuing the conversations.

Did interlocutors flip in response to children's flips? Interlocutors did sometimes flip in response and their flips peaked at 18 months and then decreased over time. Further research would be needed to understand why parents' flips sharply declined after 22 months. It is plausible that this was because interlocutors' answers become increasingly verbal as children matured and understood more verbal answers.

These findings on children's use of the flip gesture provide insight into early communication and metacognitive skills. How are they related to metacognitive research? While pointing has been studied as a precursor to theory of mind (Colonnesi, Rieffe, Koops, & Perucchini, 2008), similar connections have not been made for the flip gesture. Building on recent findings for "know" utterances (Harris et al., in press), this gestural study analyzed how children's early conversations with their interlocutors reveal their emerging metacognitive abilities. Children produced flips appropriately in conversation. For example, a mother asked, "Do you know a horse?" and her 18-month-old child produced an isolated (i.e., no accompanying verbal utterance) I DON'T KNOW flip in response. The mother's interpretation of the flip is informative. She observed the

flip and followed up by asking, “You don’t know?” The child responded with a head nod. Such interactions imply that children can successfully assess their own epistemic states and communicate their own lack of knowledge to their interlocutors. Most importantly, this ability started to emerge at 14 months, which is four months before children first produce verbal utterances with “know.” Only a very small minority of children verbally produced “know” at 18 months. Excluding children who did not produce I DON’T KNOW flips or say “I don’t know,” the average lag between age of their first I DON’T KNOW flips and first “I don’t know’ utterances was around four months with flips emerging earlier. The average age of children’s first I DON’T KNOW flips was 26 months. The average age of their first verbal “I don’t know” utterances was 30 months. These averages were calculated by taking the sum of when each child in the sample was first observed producing I DON’T KNOW flips or “I don’t know” utterances and dividing it by the number of children (excluding children who did not produce them at all). Note that these numbers are approximate estimates of when children began flipping and saying “I don’t know” because the data were collected in four-month intervals and also children may not have made use of their full gestural or oral repertoire during any given recording. Despite this limitation, it is clear that on average, I DON’T KNOW flips emerge earlier than verbal expressions of ignorance. Previous work on other conventional gestures has connected early communicative use of head nods and headshakes to more pragmatic flexibility in verbal language skills later on (Fusaro et al., 2011). Future studies could examine whether children’s early use of flip gestures predicts later verbal language skills.

This chapter provides a portrait of the flip gesture's development and insights into young children's emerging communication skills. A majority of the children produced a flip gesture at least once between 14 months and 42 months. Even though verbal "I don't know" utterances surpassed I DON'T KNOW flips at 30 months, children's production of flips generally increased in frequency between 14 months and 42 months. This pattern is similar to the one Fusaro et al. (2011) found for conventional head gestures. The increasing use of flip gestures suggests that children are learning to use them more appropriately in conversations as they mature (Fusaro et al., 2011). Children were learning to coordinate their flip gestures with verbal utterances during this developmental period. Children produced isolated flips at 14 months. By 18 months, children's flip gestures were often paired with verbal utterances. Future studies could make a closer examination of when children are able to master their coordination of flip gestures and speech.

In sum, these results suggest that children between 14 months and 42 months are able to use flip gestures appropriately in conversations to convey multiple messages. They use flips to highlight and emphasize their verbal utterances. They also use them to ask what, where, who, and why questions. And of particular importance to this study, they use flips to communicate, "I don't know." Thus, young children are able to communicate via I DON'T KNOW flip gestures their states of ignorance, which is an important metacognitive achievement.

Study 3

Two-year-old Children's Meta-ignorance:

An Experimental Study

An important intellectual achievement occurs when young children begin to recognize their own knowledge or ignorance (Kominsky, Langthorne, & Keil, 2015). Metacognition is "thinking about thinking" or, more formally, awareness and management of one's own cognitive activity (Flavell, Miller, & Miller, 1993; Flavell & Ross, 1981; Misailidi, 2010; Sodian et al., 2012). While knowledge and ignorance are two sides of the same coin, this paper focuses on meta-ignorance or children's awareness of their own ignorance (Marazita & Merriman, 2004). Meta-ignorance has not been extensively studied in early childhood. When it is mentioned, there is a general assumption in the theory-of-mind literature, as discussed in the introduction, that meta-ignorance emerges at around four years of age when children pass the false belief tasks (Rohwer, Kloo, & Perner, 2012).

Young children's understanding of people's cognitive states appears to undergo an important shift around the age of four. Children's performance on false-belief tasks improves - they exhibit an awareness that people can hold, express and act on beliefs that are mistaken (Wellman et al., 2001). Prior to the age of four, there is evidence that three-year-old children understand that looking leads to knowing (Pillow, 1989; Pratt & Bryant, 1990). For example, children are able to infer that a person's knowledge or ignorance of the color of a hidden object depends on whether he or she has previously seen the hidden object.

Comparatively little is known about children's metacognition between the ages of two and three years (Sodian et al., 2012). There is evidence that two-year-olds take another person's knowledge state into account when communicating with that person (O'Neill, 1996). A related question is whether children can accurately assess their own knowledge states and at what age this occurs. The primary goal of this study is to understand nascent stages of meta-ignorance by exploring children's assessments of what they know and do not know, especially in the context of children's responses to familiar and unfamiliar items. The next section briefly reviews the literature on early metacognition from one to four years (for a more in-depth review, please refer to the introduction of this dissertation). I review studies on infants' abilities to predict behaviors based on false beliefs, studies demonstrating their understanding of the link between seeing and knowing at around three years old, and numerous studies on children's understanding of false beliefs at around four years of age.

Metacognition research from one to four years old

Over the last decade, research on early forms of metacognition in infancy has increased (Sodian et al., 2012). One-year-old infants readily interpret an agent's actions as goal-directed (Brandone & Wellman, 2009; Kuhlmeier, Wynn, & Bloom, 2003; Sodian et al., 2012; Woodward, 1998). In addition, 15-month-olds can predict an agent's actions based on an appreciation of his or her true or false belief about a toy's hiding place (Onishi & Baillargeon, 2005). These results suggest that toddlers possess some rudimentary awareness of an agent's knowledge, ignorance, and belief (Baillargeon, Scott, & He, 2010; Sodian et al., 2012). They seem able to make inferences about how others' knowledge or beliefs affect their actions (Sodian et al., 2012). Nevertheless, it is

important to underline the fact that studies with infants rely on behavioral indices – they do not call for any ability to explicitly attribute knowledge or belief. Furthermore, they do not require children to judge their own knowledge and ignorance.

A different body of evidence concerning metacognition focuses on the age at which children demonstrate that they understand the link between seeing and knowing (Pillow, 1989; Pratt & Bryant, 1990). Typically, three-year-olds can state whether a puppet who has seen an object hidden in box, knows more about the contents of the box than a puppet that did not see the hiding. This finding is reinforced by Wellman and Liu's (2004) developmental scale showing that seeing and knowing (also known as the knowledge-ignorance task) is understood before false belief (Wellman et al., 2006).

Thus, by age three, there is convincing evidence that children understand the distinction between knowing and not knowing (Pratt & Bryant, 1990; Sodian et al., 2006). When children were asked to choose between their own knowledge and a puppet's knowledge of a hidden object's color, three-year-olds chose the person that had seen the hidden object and not the person who had not seen it (Pillow, 1989). Similarly, when asked to judge which of two assistants knew what was hidden inside a box, children chose the assistant who had looked inside as opposed to the assistant who had only lifted the box without looking inside (Pratt & Bryant, 1990). Thus, three-year-olds can make explicit judgments of knowledge and ignorance both in their own case and with respect to other people (Pillow, 1989; Pratt & Bryant, 1990).

Another major body of research in the theory-of-mind tradition focuses on the period from three to five years when children begin to pass the false-belief task. A large collection of studies has accumulated around variations on this task, explanations for

children's errors, and the task's relationship to other cognitive competencies (Wellman et al., 2001). At around four years, children are able to explicitly recognize that other individuals can have false beliefs. More specifically, they talk about what someone mistakenly thinks and contrast it with what is actually the case (Bartsch & Wellman, 1995). Most ToM research assumes that, prior to this age, children have an explicit understanding of desires but, at most, an implicit understanding of beliefs (Wellman, 2014; Wellman & Liu, 2004). With the notable exception of studies study linking visual access and knowledge in three-year-olds, there are few studies directly examining two- to three-year-olds' reflective and explicit access to their own epistemic states.

Evidence of metacognition among two-year-olds

The few studies on this age period that do exist come from proximate areas of research ranging from children's verbal and nonverbal responses after a hiding event, their trust in testimony, their use of the mental verb *know* as revealed in studies of natural language, and their questions. The following paragraphs examine how these studies point to children's developing ability to understand knowledge and ignorance even before they are able to pass the false-belief task.

O'Neill (1996) conducted a pioneering study of two-year-olds' ability to understand another's knowledge state and to tailor their communication accordingly. She found that children whose parents did not witness where an attractive toy was placed were likely to name the toy, name its location, and gesture to it significantly more often than children whose parent co-witnessed the hiding of the toy (O'Neill, 1996). By implication, children are able to take a communicative partner's knowledge state, or at

least her co-presence versus absence, into account when communicating about retrieving a hidden toy or sticker.

Most of the studies on the connection between seeing and knowing involve children giving verbal answers to an experimenter's questions. Because children between the ages of two to three are still learning to communicate, and to understand and produce mental verbs such as *know* and *think*, these studies could underestimate children's metacognitive abilities (Call & Carpenter, 2001). In a nonverbal study involving two-year old children, the young participants were asked to locate stickers in one of three open-ended tubes (Call & Carpenter, 2001). When blocked from seeing the hiding process, children used efficient search strategies. They looked into each tube before choosing the one containing the sticker, implying that they knew they were ignorant of the sticker's location. Children stopped looking into the other tubes after seeing the sticker but continued searching upon finding an empty tube. There are two possible ways of interpreting these findings. First, one may argue for a more reductive interpretation. Children may simply want stickers and stop searching after they obtain them. While it is debatable if the results count as strong evidence towards early metacognitive awareness, children are aware that their desire for stickers has been satisfied and they stop searching. An awareness of desire is an early step towards metacognition. A second interpretation is that these findings suggest that two-year-old children have some metacognitive abilities because continued seeking is an early index of meta-ignorance. It is plausible that children are able to monitor their own knowledge of the sticker's location since they only pointed at a specific tube and stopped looking when they found the hidden sticker. They were systematic in their search and they did not randomly point at all the tubes until they

happened to choose the right one. They know when they do not know the sticker's hidden location. Furthermore, they know that they can act to obtain information that they lack. A recent study by Neldner, Collier-Baker, and Nielsen (2015) seem to consolidate this claim that three-year-old children know when they are ignorant. Children either observed an experimenter bait a large reward into one of four cups or were blocked from seeing the baiting process. Half of the trials included an additional distinctive escape cup that was baited with a small reward. When the baiting process was hidden and children were uncertain about large reward's location, they often chose the escape cup's small reward. However, when they were able to observe the hiding procedure, children were proficient at choosing the correct baited cup with the large reward and they did not opt for the escape cup's small reward. These results seem to consolidate the claim that children are able to assess their own knowledge and ignorance because they more often chose the escape cup's small reward when they did not know the location of the large reward.

In addition to experiments involving hiding events, an indication of early metacognition comes from trust in testimony. When presented with two informants who differ in accuracy, children choose the informant with a history of greater accuracy. This selective trust in an accurate informant occurs even during infancy. As early as the beginning of their second year, infants faced with uncertainty, for example about whether to approach or retreat from an unfamiliar toy, are able to take in information from a knowledgeable informant (Harris & Lane, 2014). Harris et al. (2012) suggest that this choice could be guided by a metacognitive inference because children seem to be able to assess which informant has more familiarity with the toy. Stenberg (2009) tested 12-month-old infants by having either the experimenter or the caregiver present an

ambiguous toy dinosaur to them. Children responded with puzzled looks and directed these looks more often at the experimenter than their mothers. They also were more likely to act on the experimenter's encouragements rather than their mothers'. A plausible implication is that infants turned to the experimenter because she was linked with the novel testing environment and might therefore be more familiar with the toy than their mothers (Harris et al., 2012).

In line with the experimental findings so far, naturalistic studies show that children as young as two years can produce and use the mental state verb *know.* This study by Harris, Yang, and Cui (in press) was extensively reviewed in Study 1. The authors found that *know* references occurred primarily in the context of an ongoing exchange of information via conversation. Children used k*now* (and *not know*) to report their own knowledge and ignorance of topics mentioned in the conversation and sometimes that of their interlocutor. Furthermore, analysis of the production of *know* utterances by eight English-speaking children in Study 1 revealed a similar pattern. Children from Study 1 started to say "I don't know" at around 23 months. In Study 2, children first produced I DON'T KNOW flips at around 26 months and said, "I don't know" at around 30 months. Together, these findings suggest that young children are aware of their own ignorance and the interlocutor's ability to provide them with knowledge (Harris et al., in press). They provide evidence that early meta-ignorance exists and indeed may be the source of and motivation for children's questions.

In a seminal naturalistic study, Chouinard (2007) investigated young children's questions as a mechanism for cognitive development. She established that children begin asking (nonverbal) questions in the course of the second year of life. As they explore

their environment and encounter gaps in their knowledge, young children seek to fill those gaps by posing nonverbal and/or verbal questions to more knowledgeable individuals (Chouinard, 2007). Insofar as the majority of children's questions are aimed at obtaining a piece of information, questions also imply that children have some metacognitive awareness of their own lack of knowledge – regarding, for example, the name or location of an object or the reason for a person's ongoing activity. Although it could be argued that children ask questions because they have, at most, a vague sense of uncertainty the evidence that children persist by repeating their questions when they do not get a satisfactory answer and only stop questioning when they finally receive the answer, points to a relatively precise metacognitive ability to diagnose their current state of uncertainty and to monitor incremental reductions in that state (Chouinard, 2007).

Further underlining the metacognitive significance of questions and children's capacity for monitoring gaps in their knowledge, children care about the answers they receive. In the context of both a naturalistic and an experimental study, Frazier et al. (2009) examined two- to five- year-olds' causal questions and their reactions to adults' answers. When an adult answered a child's question with an explanation, the child was more likely to stop questioning and react with satisfaction. Conversely, when an adult did not give an explanation (e.g., saying "I don't know," saying "Because I said so," not responding, etc.), the child was more likely to re-ask the question or provide his or her own explanations. These findings again show that children are motivated to seek information via questions and use conversational strategies to probe for satisfactory explanations.

Taken together, the evidence suggests that children may have some basic metacognitive abilities between two and three years that have not been extensively studied. They adjust their communication depending on what a caregiver does or does not know; they comment appropriately on their knowledge and ignorance as well as that of an interlocutor; and they either persist or desist in information-seeking – via visual inspection or question-asking – depending on their current state of knowledge. The purpose of the study described in this chapter was to conduct an experimental investigation of children's developing metacognitive ability by analyzing their responses when asked to name pictures of familiar and unfamiliar objects. Do children spontaneously give any indication of their own ignorance of the object's name? If so, what do these indications of ignorance look like?

To answer these questions, children were asked to name six pictures of familiar objects and six pictures of unfamiliar objects. Various potential indices of ignorance and uncertainty – both verbal and non-verbal – were monitored. It was predicted that children between 16 months and 37 months would express ignorance or uncertainty more often when asked to name unfamiliar pictures than when asked to name familiar pictures. Whether specific expressions of ignorance change over development was also examined.

Method

Participants

Participants were 52 children (33 boys and 19 girls, mean age = 27 months, range = 16 to 37 months, SD = 5.68) from an East Coast suburb. The participants were recruited from university childcares, Head Start facilities, public libraries, and by word of mouth. There were 34 Caucasian children, 5 Hispanic, 1 Asian American, 1 African

American, 10 multi-racial children, and 1 child whose parent did not state a racial background. The children came from a mix of working class and middle class backgrounds. Maternal education ranged from less than a high school diploma to a professional/graduate degree. There were 39 children from monolingual English-speaking homes and 13 children from bilingual English-speaking homes. For purposes of analysis, children were divided into a younger (16 months to 27 months) and an older (28 months to 37 months) group. There were 26 young children (17 boys and 9 girls, mean age = 22 months) and 26 older children (16 boys and 10 girls, mean age = 32 months). Data from an additional 10 children were dropped from the final sample due to excessive fussiness, lack of verbal and nonverbal responses, recording equipment error, or parental interference.

Materials

Materials used in this experiment included 14 pictures (two familiar warm-up pictures, six familiar test pictures and six unfamiliar test pictures). The eight familiar pictures were black-and-white line drawings taken from items listed in the MacArthur Short Form Vocabulary Checklist: Level 1, which is designed for children between 8 and 18 months (Fenson et al., 2000). The pictures were of a book, bird, car, socks, dog, spoon, chair, and shoe. Similarly, the unfamiliar pictures were black-and-white line drawings developed by Johnson (1992) and used by Marazita and Merriman (2004) in a word familiarity judgment study. Figure 1 shows an example of each picture type. Pictures were presented one at a time, in random order, on a laptop screen using PowerPoint slides.

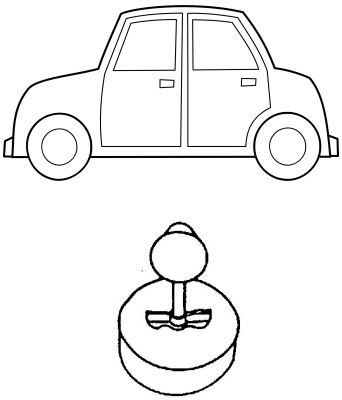


Figure 1: A familiar picture (car) and unfamiliar picture used in the naming task.

Procedure

Children were tested at a location that was most convenient for their parents. They were tested individually – a majority with one parent sitting beside them – in a quiet room or quiet area of childcare centers, homes, libraries, or parks. Sessions were recorded using a video camera mounted on a tripod in front of, and in view of, the child. All parents provided consent prior to the interview. When the parent was in the room (43 parents were present and 9 were not present), the experimenter played with the child while the parent read and signed the consent form. When the parent was finished, the experimenter asked the parent to say as little as possible during the subsequent naming task.

Warm-up trials. The first two pictures were warm-up pictures used to model the question-and-answer format and build rapport with the child. The first warm-up picture depicted a book and the second depicted a bird. The experimenter began by asking the child, "What is this?" while pointing at the picture shown on the laptop screen. She briefly paused and waited for an answer. If the child answered correctly, she said "Yes,

that is a book!" and she proceeded to the next picture. If the child provided no answer or an incorrect answer, she answered her own question and said, "I know! It is a book!" She then tried to further engage the child by asking if he or she had read a book before. The experimenter went through this process for both of the warm-up pictures.

Experimental trials. After the two warm-up pictures, the participant was presented with a familiar picture of a car, the beginning of the experimental set. All 11 pictures following the car were presented in random order. For each picture, the experimenter asked the child, "What is it?" and pointed to the picture on the laptop screen. The experimenter paused briefly to allow the child to answer. If the child did not respond, the experimenter repeated the question again. After a pause of approximately 3 seconds, the experimenter moved on to the next picture.

Coding. Children's verbal and nonverbal responses were coded from the video recordings. The coding system comprised 13 categories that could be applied to both familiar and unfamiliar items. For each of the 12 pictures, if the child displayed a behavior that fitted the description for a coding category, the child was given one point. If the behavior was not displayed for that picture, the child was assigned a zero. Thus, a child could score between zero and six points in each coding category for each item type (familiar and unfamiliar).

The 13 categories were as follows: silence, asks adult, says *I don't know*, says *no*, produces a filled pause such as *um*, word misapplications (e.g., calling a car a train), word inventions (e.g, *starda*), says *yes*, flip gesture of one or both hands, gazes at adult, headshake, head nod, and pointing. Note that the first eight of these coding categories involved either the absence or the presence of a vocal or verbal response whereas the

remaining five categories involved a non-verbal behavior or gesture. In addition, two mutually exclusive supplementary codes ("correct" and "incorrect") were used for familiar items. By definition, these could not apply to the unfamiliar items because these items had no name. Table 1 provides a more detailed description of the coding categories. The purpose of these categories was to provide a fine-grained portrait of children's responses to the six familiar pictures as compared to the 6 unfamiliar pictures. Cohen's kappas for each coding category ranged from .62 to 1. Reliability was conducted on 20% of the video interviews.

Table 1

Familiar Pictures Codes and Unfamiliar Pictures Codes

Response	Definition
Familiar correct	When a child correctly names a familiar picture. This code does not exist for an unfamiliar picture.
Familiar incorrect	When a child incorrectly names a familiar picture and is not silent. This code does not exist for an unfamiliar picture.
Silence	When a child remains silent. If a child utters a filled pause without a correct answer, his or her speech is coded as incorrect.
Asks adult	When the child asks an adult for help in naming the picture.
I don't know	When the child explicitly says "I don't know."
No	When a child says "No."
Filled pause	When a child produces "Um," "Ah," or "Hmm."
Misapplication	When a child misapplies a real word to the picture. When there is a mix of actual words and unintelligible words, the child's speech will be coded only as a misapplication.
Word invention	When a child invents unintelligible words for the picture.
Yes	When a child says "Yes."
Flip	When a child raises his or her hands palms up to the side.
Gazes at adult	When the child looks at an adult after seeing the picture and before giving his or her final answer.
Headshake	When the child shakes his or her head.
Head nod	When the child nods his or her head.
Pointing	When a child points at the picture.

Results

Descriptive statistics for all responses

The pattern of children's responses was different for familiar as compared to unfamiliar items. Children named 82 percent of the familiar pictures correctly; they named 15 percent of the familiar pictures incorrectly (word misapplication and word invention were included here); and they stayed silent for the remaining three percent of the familiar pictures. Beyond these responses to familiar pictures, children sometimes gazed at an adult or pointed at the picture, but they rarely did or said anything else. On the other hand, unfamiliar pictures tended to elicit a wider range of responses.

Figure 2 shows the average proportion of trials out of a maximum of six on which children's behavior fell into each of 15 categories for familiar pictures and into 13 categories for unfamiliar pictures

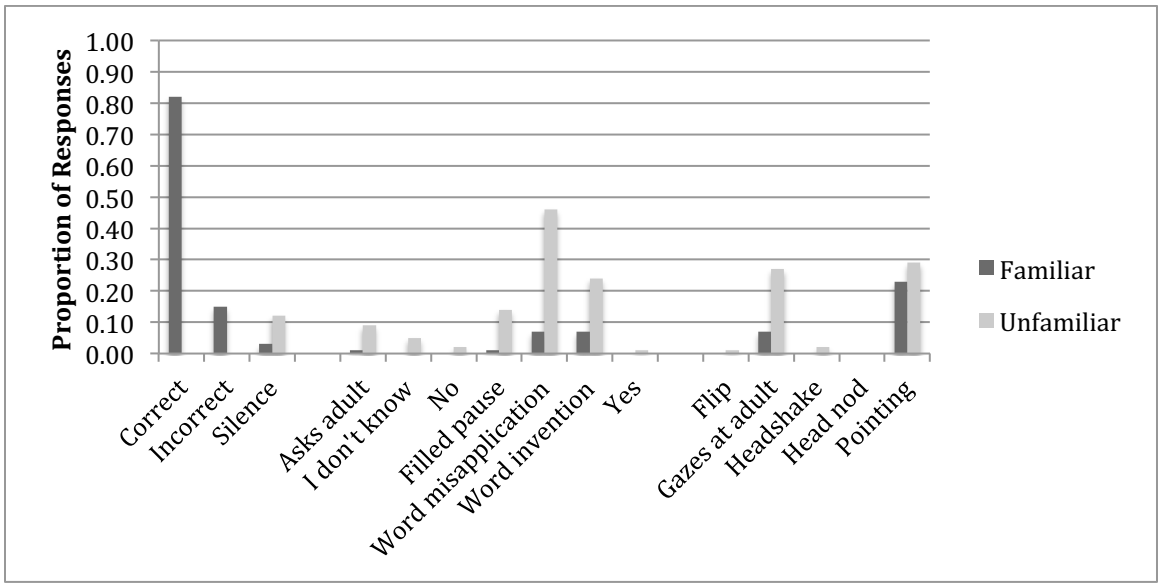


Figure 2: Proportion of trials on which children produced a response falling into each of 15 categories for familiar pictures and into 13 categories for unfamiliar pictures.

Sign tests were used to compare children's responses to familiar and unfamiliar pictures. When shown an unfamiliar rather than a familiar picture, children were significantly more likely to produce the following verbal responses: asks adult for help ($p = .0002$), say *I don't know* ($p = 0.03$), produce filled pauses such as *Um* and *Ah* ($p = .0001$), misapply actual words (e.g., "a duck") to the picture ($p < .0001$), and invent unintelligible words (e.g., "a starda") for the picture ($p < .0001$).

As compared to familiar items, unfamiliar pictures also elicited more nonverbal responses. Children gazed at an adult ($p < .0001$) significantly more often for unfamiliar pictures. Finally, they were more likely to stay silent ($p = 0.0018$) for unfamiliar pictures. Three other types of non-verbal response (hand flips, head shakes, and head nods) were rarely produced for either familiar or unfamiliar pictures. Finally, points occurred quite often but with a similar frequency for familiar and unfamiliar pictures. The majority of pointing behaviors (100% of points at familiar pictures and 92% of points at unfamiliar pictures) occurred together with verbal utterances.

In summary, when presented with a familiar picture and asked to name it, children mostly produced the correct name but they occasionally produced an incorrect name or remained silent. However, when presented with an unfamiliar as opposed to a familiar picture, children were more likely to stay silent or to produce an incorrect name. In addition, they were more likely to display signs of uncertainty by producing a filled pause, asking for help, explicitly saying *I don't know*, and turning away from the picture to gaze at an adult.

Correctly identified familiar responses and unfamiliar responses

Arguably, when a child was shown a familiar picture and was unable to name it, it is not appropriate to treat children's response to that picture as equivalent to their response to other familiar pictures. To address this possibility, a more conservative coding system was adopted. Children's responses to correctly identified (i.e., correctly named) familiar pictures were examined and compared with their responses to the full set of unfamiliar pictures.

Children's responses to correctly identified familiar pictures and to unfamiliar pictures are presented in Figure 3. Inspection of Figure 3 again reveals a sharp contrast in their pattern of responding to the two types of pictures. For the correctly identified pictures, children did little else other than name the picture. They sometimes also pointed at the picture. For the unfamiliar items, by contrast, children responded in a variety of verbal and nonverbal ways. Figure 3 shows the mean proportion of correctly identified familiar pictures and unfamiliar pictures for which children's behavior fell into each of 14 categories for familiar pictures and into 13 categories for unfamiliar pictures

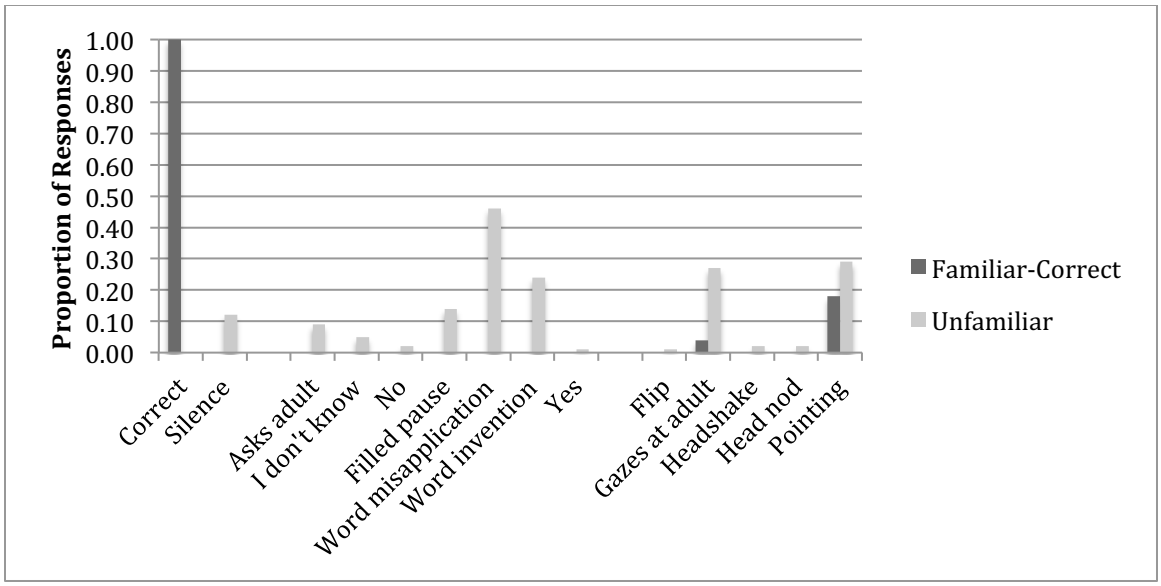


Figure 3: Proportion of trials on which children produced a response falling into each of 14 categories for familiar pictures that were correctly named and into 13 categories for unfamiliar pictures

Sign tests confirmed that when shown an unfamiliar picture as opposed to a familiar and named picture, children were more likely to produce the following verbal responses: asks adult for help ($p = .0002$), say *I don't know* ($p = 0.03$), produce filled pauses such as *Um* and *Ah* ($p < .0001$), misapply actual words (e.g., "a duck") ($p < .0001$), and invent unintelligible words (e.g., "a starda") ($p < .0001$). As compared to familiar and named pictures, unfamiliar pictures also elicited more nonverbal responses. Children gazed at an adult ($p < .0001$) and pointed ($p = .01$) significantly more often for unfamiliar pictures. Additionally, they were more likely to stay silent ($p < .0001$) for unfamiliar pictures. As in the previous analysis, three other types of non-verbal response (hand flips, head shakes, and head nods) were rarely produced for either familiar or unfamiliar pictures.

Age changes in children's responses

In this section, we asked whether the different pattern of responding to unfamiliar pictures, as compared to correctly named pictures, was evident throughout the age period under scrutiny or more evident for older children than younger children.

The responses of younger children (aged 16 to 27 months) were examined first. Figure 4 shows the mean proportion of responses falling into 14 categories for correctly identified familiar picture and into 13 categories for unfamiliar pictures produced by younger children. For the correctly identified pictures, younger children named the pictures and often pointed at them. They also sometimes gazed at the adult. By contrast, the unfamiliar pictures elicited a range of responses.

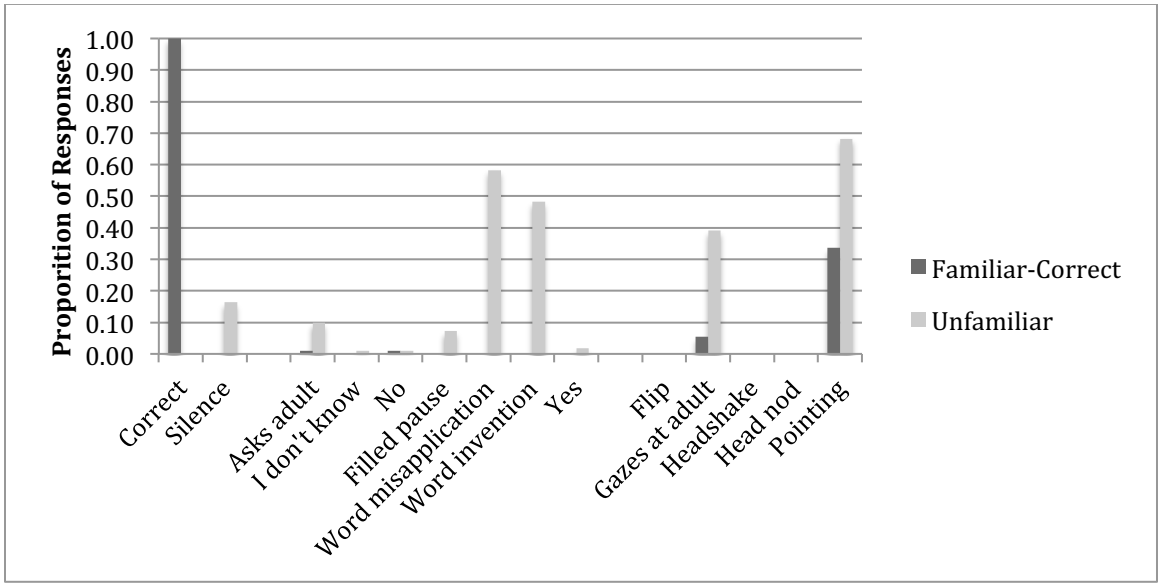


Figure 4: Proportion of trials on which younger children (16 months to 27 months) produced a response falling into each of 14 categories for correctly identified familiar pictures and into 13 categories for unfamiliar pictures.

Sign tests confirmed that there were differences in younger children's responses to correctly identified familiar as compared to unfamiliar pictures. Younger children were

more likely to misapply actual words (e.g., “a duck”) ($p < .0001$) and invent unintelligible words (e.g., “a starda”) ($p < .0001$) for unfamiliar pictures. They also responded nonverbally by gazing at an adult ($p < .0001$) and pointing ($p = .0044$) significantly more often for unfamiliar pictures. Additionally, they were more likely to stay silent ($p = 0.0039$). The remaining verbal and nonverbal categories were not significantly different for the two types of picture.

Next, Figure 5 shows the mean proportion of responses falling into 14 categories for correctly identified familiar picture and into 13 categories for unfamiliar pictures produced by older children (28 months to 37 months). Older children’s responses to correctly identified familiar pictures and to unfamiliar pictures are presented in Figure 5. Figure 5 shows that for the correctly identified pictures, children do little else other than name the pictures. In a few instances, they sometimes gaze at an adult and/or point at the picture. For the unfamiliar pictures, there is a wide range of responses.

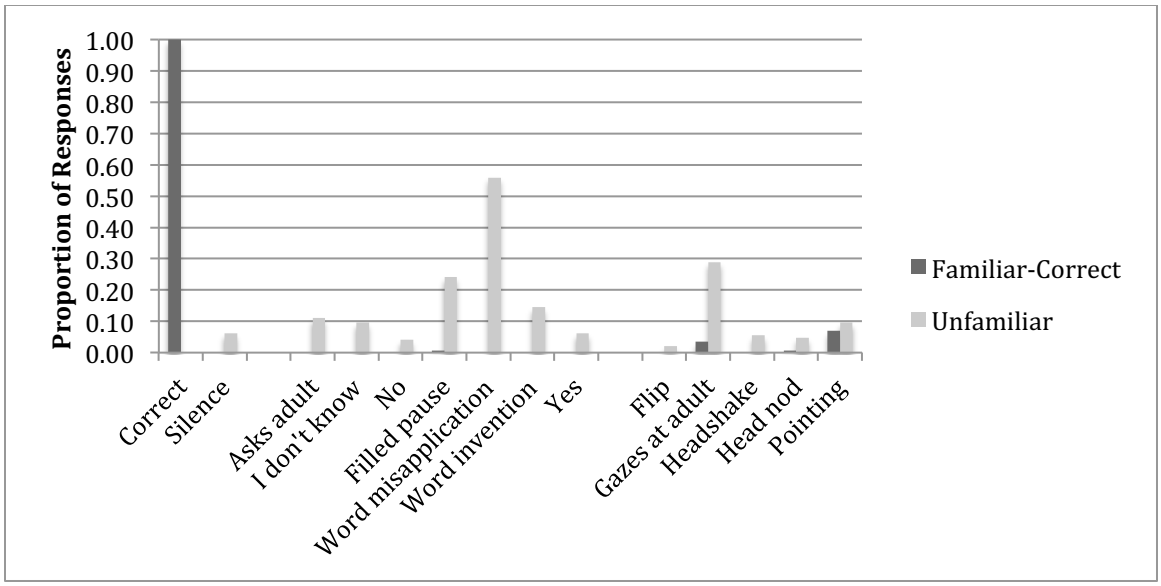


Figure 5: Proportion of trials on which older children (28 months to 37 months) produced a response falling into each of 14 categories for correctly identified familiar pictures and into 13 categories for unfamiliar pictures.

Sign tests were used to compare the differences between correctly identified familiar and unfamiliar pictures. Older children were more likely to produce the following verbal responses for unfamiliar pictures: asks adult for help (p = .0078), produced filled pauses such as *Um* and *Ah* (p = .001), misapply actual words (e.g., "a duck") (p < .0001), and invent unintelligible words (e.g., "a starda") (p = .002). The only nonverbal response observed more frequently for unfamiliar pictures was gazing at an adult (p = .0023). Additionally, they were more likely to stay silent (p = 0.031). All the other types of verbal (saying *I don't know*, *No*, *Yes*) and nonverbal (hand flip, headshake, head nods, and pointing) responses were not significant.

Taken together, these findings show that both younger and older children misapplied actual words, invented unintelligible words, gazed at an adult, and remained

silent more often for unfamiliar pictures. The two age groups also showed some differences in the way they express their uncertainty. Younger children were more likely to communicate nonverbally; they pointed when presented with unfamiliar pictures. Older children more often communicated verbally; they asked questions or produced filled pauses when they were asked to identify unfamiliar pictures.

Other age-related relationships include a positive correlation between age and familiar correct responses, $r = 0.57$, $p < .0001$. Thus, as expected, naming accuracy increases with age. Older children were significantly less likely than younger children to point ($U = 200$, $p = .01$) at the correctly identified familiar pictures. There was also a negative correlation between age and word inventions to familiar pictures $r = -0.34$, $p = .014$. Similarly, there was a negative correlation between age and word inventions to unfamiliar pictures, $r = -0.43$, $p = .0015$. Thus, as compared to their older counterparts, younger children were more likely to create word inventions for both familiar and unfamiliar pictures.

Supplementary Results

Finally, as a supplement to the core results reported above, various additional analyses were conducted. First, children's responses to the relatively small subset of familiar pictures that they could not name were identified and examined. Second, developmental changes in responses to familiar pictures were analyzed. Third developmental changes in responses to unfamiliar pictures were analyzed. Finally, the potential contribution of maternal education was briefly examined

Responses to incorrectly identified familiar pictures

The responses to the familiar pictures that were discarded in Figure 3 were analyzed. Figure 6 shows children's responses to the familiar pictures that they failed to name correctly and compares them with their responses to correctly named familiar pictures as well as their responses to the full set of unfamiliar pictures. Inspection of Figure 6 reveals that children's responses were different across the three types of pictures: correctly named, incorrectly named, and unfamiliar.

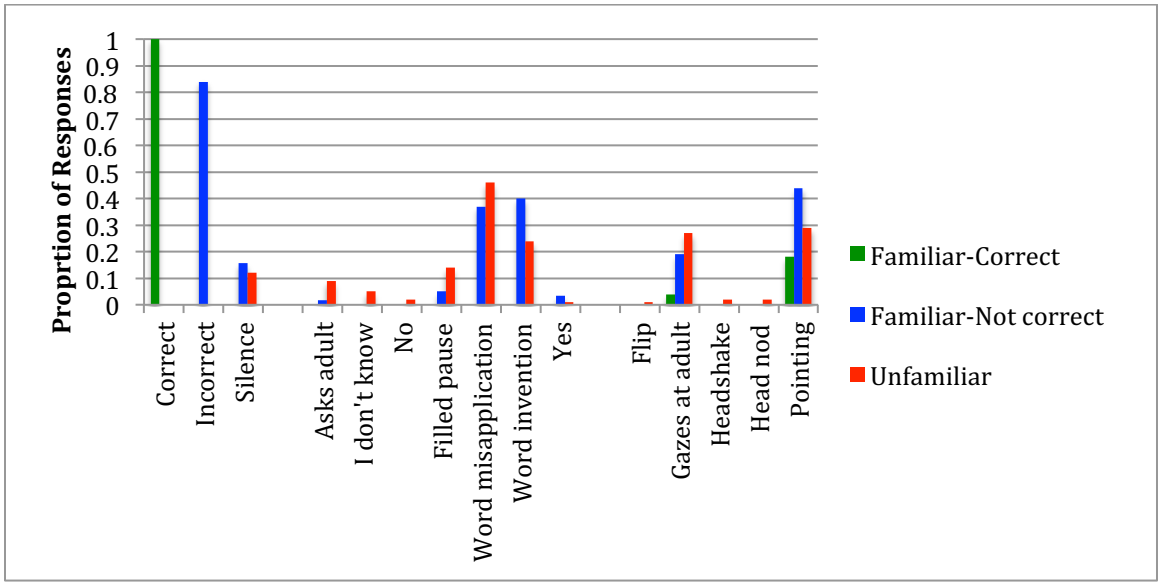


Figure 6: Proportion of trials on which children produced a response falling into each of 14 categories for familiar pictures that were correctly named, into each of 14 categories for familiar pictures that were incorrectly named, and into 13 categories for unfamiliar pictures.

Although it was anticipated that children's responses to familiar pictures that they failed to name correctly would resemble their responses to unfamiliar pictures, there were some notable differences. Sign tests confirmed that when shown an unfamiliar picture as opposed to a familiar picture that they failed to name correctly, children were more likely

to produce the following verbal responses: ask adults for help (p = .0002), say *I don't know* (p = 0.031), produce filled pauses such as *Um* and *Ah* (p =.0002), misapply actual words (e.g., "a duck") (p < .0001) but less likely to invent unintelligible words (e.g., "a starda") (p < .0001). Additionally, for nonverbal responses to unfamiliar pictures as opposed to familiar pictures that they failed to name correctly, children were more likely to gaze at an adult (p < .0001) but less likely to point (p < .0001) or stay silent (p = 0.0018). These findings suggest that in various ways, children were more likely to express uncertainty when they were unable to name a pictured item that was unfamiliar to them and therefore unfamiliar as compared to a pictured item that was familiar to them but one whose name they could not successfully retrieve. Thus, children may have had a stronger sense that they were truly ignorant for unfamiliar pictures since, beyond not knowing the name of the item, they did not even know what was being depicted.

Developmental changes in responses to familiar pictures

In the next step of the analysis, the responses of younger and older children were compared for familiar pictures. Figure 7 shows the mean percentage of familiar pictures for which the behavior of younger and older children fell into each of 15 categories.

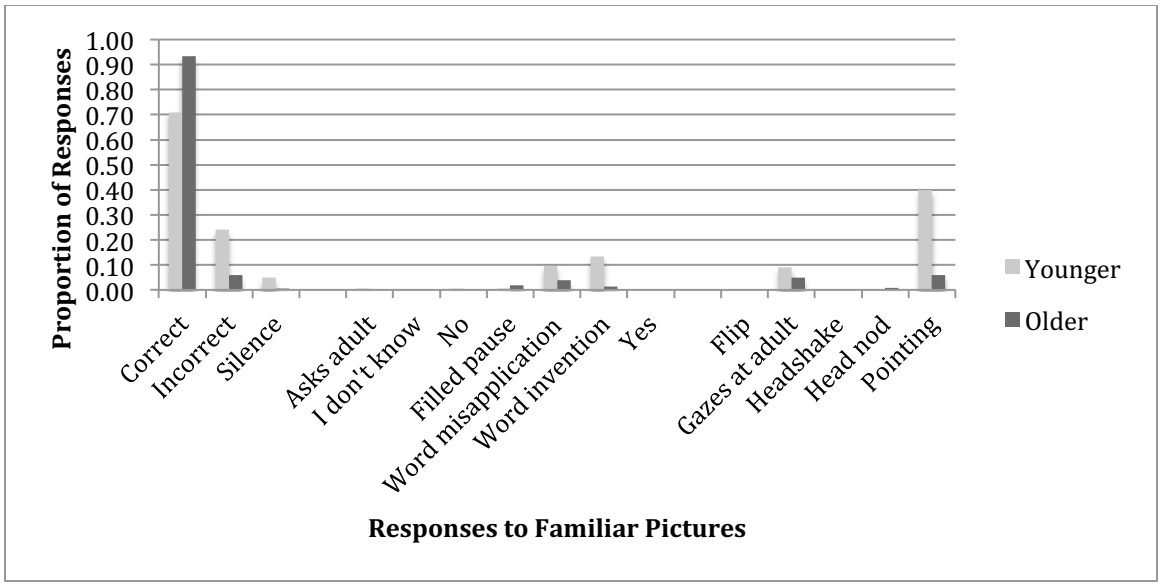


Figure 7: Proportion of responses to all familiar pictures by 26 younger children and 26 older children.

Mann-Whitney tests were used to compare the responses of the two age groups. As displayed in Figure 7, older children more often correctly identified the familiar pictures than younger children ($U = 138$, $p = .0003$). By contrast, younger children were significantly more likely to give incorrect answers ($U = 164$, $p = .002$), invent unintelligible names ($U = 203$, $p = .01$) and to point ($U = 184.5$, $p = .005$) at familiar pictures. In other respects, the pattern of responding by older and younger children was similar.

Unfamiliar responses by age

In the next step of the analysis, the responses of younger and older children were compared for unfamiliar pictures. Figure 8 shows the mean proportion of responses by younger and older children that fell into each of 13 categories.

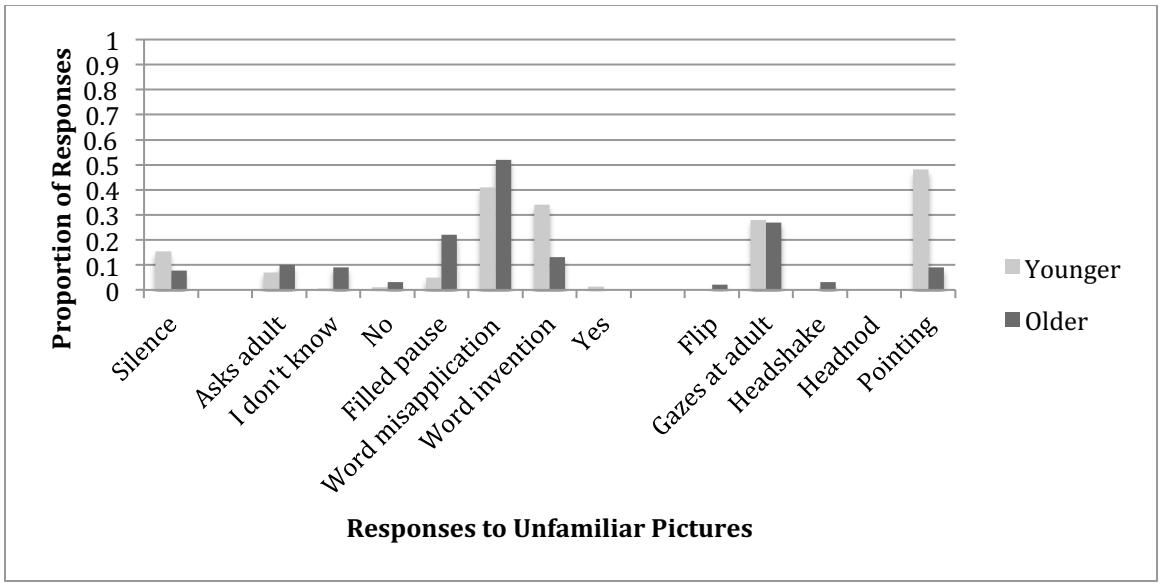


Figure 8: Proportion of responses to unfamiliar pictures by 26 younger children and 26 older children falling into each of 13 categories.

There were only two significant differences between the two age groups. Younger children were significantly more likely than older children to invent unintelligible names for (U = 174, p = .003) unfamiliar pictures. They also pointed more often at (U = 143, p = .0004) them.

Responses by maternal education

Finally, we asked if children's response pattern varied depending on their mother's level of education. Mothers were divided into those with no college education (N = 12), those with a college education (N = 10) and those with graduate education (N = 30).

A two-way ANOVA was used to assess the effect of maternal education and age group on children's responses. The null hypothesis was not rejected for any of the

familiar item responses, correctly identified familiar item responses, and unfamiliar item responses at the $\alpha = 0.05$ significance level. In sum, children's pattern of responding was quite similar across all three maternal education groups controlling for age.

Discussion

The purpose of this paper was to examine whether and how young children express ignorance or uncertainty when asked to name unfamiliar pictures. We found that young children between 16 and 37 months expressed ignorance in various ways. The main findings will be reviewed along with a discussion of the implications for children's meta-ignorance.

When asked to name a familiar picture, children were often able to do so. Thus, they produced the correct name on 82% of the trials. This was an expected result because the six familiar items had been deliberately chosen on the basis of past findings to be familiar. Nevertheless, older children were more often able to produce the correct name than younger children. Compared to the older group, younger children were more likely to point and to invent unintelligible names for the familiar pictures.

When asked to name an unfamiliar picture, children produced a variety of verbal and nonverbal responses. They expressed uncertainty or ignorance by asking for help, looking to an adult for help, saying *I don't know*, and producing filled pauses such as *Um* and *Ah*. Additionally, they stayed silent more often for unfamiliar pictures. Together, these findings suggest that even one- and two-year-olds display signs of uncertainty.

Children were also inventive. They misapplied known words and invented unintelligible words when they did not know the name of the unfamiliar pictures. Although such responses can be interpreted as a lack of meta-ignorance, the

overwhelming evidence in this study shows that children display several signs of uncertainty when confronted with unfamiliar pictures. One possible explanation for the production of such misapplications and inventions is that children overestimate their own competence (Flavell, 1999; 2016; Taylor, Esbensen, & Bennett, 1994). For instance, children around four and five year olds will claim they always knew a piece of information that they just learned moments ago (Taylor et al., 1994). A different explanation is that these young children were simply exhibiting a strong social desirability bias. Most children saw the experiment as a game and were excited to name the pictures. It is plausible that, in their eagerness to please and to participate, children misapplied words and invented unintelligible words for the unfamiliar pictures.

Few studies have explored how children between 16 and 37 months understand their own ignorance. It is a common assumption in the theory-of-mind literature that meta-ignorance emerges in the preschool years when children are able to attribute ignorance to others and when they pass knowledge-access tasks and false-belief tasks (Hogrefe et al., 1986). Prior to those developmental markers, children understand only desires and intentions but not cognitive mental states (Wellman, 2014; Wellman & Liu, 2004).

In this study, children conveyed uncertainty when they were asked to identify unfamiliar pictures. A few children were able to explicitly say *I don't know* but most children communicated their uncertainty by other verbal and gestural means. This suggests that children are developing a consciousness of their own uncertainty. Thus, our results indicate that children have some meta-ignorance abilities at the age of two – in advance of the markers that have been focused on within theory-of-mind research.

These findings are in line with recent studies that show that infants as young as 13 months have some understanding of false beliefs (Onishi & Baillargeon, 2005; Southgate et al., 2010; Surian et al., 2007). They further support the proposal that children at the age of two have some awareness of their own epistemic states given that they are able to talk about their own knowledge and ignorance as shown in Chapter 2 of this thesis and also by Harris et al. (in press).

Limitations

Further studies are needed to test children's awareness of their ignorance in a context that reduces the social desirability bias. Children in this study often wanted to produce names and this may have led them to invent names for unfamiliar pictures. If there were a way to reduce this bias, researchers might observe even more expressions of uncertainty such as turning to adults for help or saying *I don't know*. In future studies, a potentially useful modification would be to have a parent ask his or her child to name the pictures. Children are likely to feel more comfortable expressing uncertainty when interacting with familiar caregivers.

Additionally, this study found that children in this study were more likely to express uncertainty when they were unable to name an unfamiliar picture than a familiar picture they had seen before but whose name they had trouble retrieving from memory. It is plausible that children may have had a stronger sense of their ignorance for unfamiliar pictures since in addition to not knowing the picture's name, they had not seen the item before. Building on these results, future studies may vary the experimental design by adding a third group of pictures. These new pictures will depict items that children frequently see but may have not learned names for (e.g., rearview mirrors, colanders,

etc.). It would then be possible to investigate if children have different responses to unfamiliar items compared to familiar objects that they are unable to name.

Despite these limitations, this study provides evidence that young children have some understanding of their own ignorance. This early meta-cognitive ability may serve as a developmental stepping-stone, positioned in between younger infants' non-verbal monitoring of others' knowledge and belief – as indexed via the direction and duration of their gaze and preschoolers ability to make correct, verbal judgments in theory-of-mind tasks. Children's ability to convey to another individual via speech or gesture that they do not know the name of an object is a simple but significant metacognitive achievement.

General Discussion

The goal of this dissertation was to examine the development of meta-ignorance between 14 months and 42 months. I examined the hypothesis that children have some awareness of their own epistemic states, notably states of knowledge and ignorance. This awareness enables children to signal their knowledge or ignorance to others, for example, by producing flip gestures, by saying *I don't know* or by saying *I know.* While some may argue that there is a difference between expressing ignorance and being aware of ignorance, Goupil et al. (2016) argue that the fact that infants in their study were able to "communicate metacognitive information" to their caregivers suggests that they were able to "consciously experience their own uncertainty" (p. 4). There is a general assumption that for ignorance to be communicated verbally and nonverbally, children must consciously access mental representations (Dennett, 1991; Frith, 2010; Shea et al., 2014 as cited in Goupil et al., 2016). In light of this, my results suggest that because young children are able to express their ignorance or knowledge they are able to consciously access their states of ignorance or knowledge.

Three primary questions have been addressed in three different studies:

1. When and how do children between 18 months and 36 months use *know* to comment on their own knowledge and ignorance and their interlocutor's knowledge and ignorance?
2. When do children begin to produce non-verbal expressions of ignorance, notably flip gestures? Do children between 14 months and 42 months ever use flips to communicate their own ignorance? When do they start to do so? And

to what extent are such non-verbal gestures used in isolation or in communication with spoken utterances?

3. Can toddlers' expressions of ignorance be studied in an experimental context? More specifically, how do children between 16 months and 37 months respond when they are asked to name unfamiliar and unfamiliar as compared to familiar and familiar objects? In the former case, do they signal their ignorance, and if so, how.

The results pertaining to these three questions will be discussed in the next sections.

Children's Use of *Know*

How do children between 18 months and 36 months use *know* to comment on their own and other people's knowledge and ignorance? To answer this question, I examined children's utterances that included the word *know* as well as their immediately preceding and subsequent utterances. Eight children (Laura, Lily, Naima, Naomi, Peter, Ross, Violet, and William) were chosen from the Child Language Data Exchange System (CHILDES). They were drawn from five different corpora (Braunwald-Max Planck, Providence, Sachs, Bloom 1970, and MacWhinney). These children were chosen because their conversations with their families at home were recorded and transcribed from the time they were around 18 months to 36 months. Study 1 showed that children initiated most uses of *know*. In other words, their *know* utterances were not echoes of their interlocutors' previous speech. Children used *know* during shared conversation and activities with their interlocutors. Their *know* utterances had three primary pragmatic functions – children affirmed knowledge, denied knowledge, and asked questions about

knowledge. Children rarely made references to a third party. Instead, they focused on the knowledge or ignorance of the two parties involved in the conversation.

Nevertheless, in focusing on the self and the interlocutor, children adopted a distinctive stance toward each. When children affirmed or denied knowledge, they referred to their own knowledge states whereas they rarely affirmed or denied their interlocutors' knowledge. On the other hand, when they used *know* to ask questions, their *knows* referenced their interlocutors' knowledge states and not their own. For example, they asked questions such as: "You know what I got in my backpack?" or "Don't you know Mom?" but they did not pose equivalent questions about themselves, e.g., "Do I know?" or "I don't know?"

Importantly, these results suggest that children used *I don't know* in an appropriate fashion as an expression of their own ignorance. For example, a mother asked, "What kinds of flowers are those?" and her child responded by saying, "I don't know." What is important here is that the mother does not interpret her child's response as a mindless response or stock phrase, contrary to the implications of the conservative coding system adopted by Shatz et al. (1983). Instead, the mother responded by providing a hint in her follow-up question ("Are they roses?"). Her answer indicates that she interpreted her child's "I don't know" as a profession of ignorance.

These early references to *know* suggest that two-year-olds are able to report on mental states but primarily in regards to their own mental states and their interlocutors' mental states and in the context of an ongoing conversation. This ability to report on mental states suggests that young children possess a limited degree of meta-cognition.

Children's Flip Gestures

When do children begin producing flips? To answer this question, I analyzed video recordings and transcripts of a longitudinal sample of 64 children between 14 and 42 months of age. These children came from diverse backgrounds and were part of the Language Development Project at the University of Chicago. Researchers visited children in their homes every four months and each interaction was videotaped for a 90-minute period. The videos focused on daily parent-child activities and interactions. I used a modified version of the coding system developed by Harris et al. (in press) for children's "know" utterances. There were eight steps to the coding system for flips. These steps examined the preceding and subsequent contexts for the flip gestures.

Flips were observed at 14 months. The frequency of flips and the number of children producing them increased over time. Initially, children from 14 to 22 months produced flips with and without verbal utterances at approximately similar rates. By 38 months, most children's flips were accompanied by verbal utterances.

Using the eight coding steps mentioned previously, I examined the contexts in which children produced flips. Children initiated most flip gestures. Thus, their flips were not copied from interlocutors' immediately prior gestures. Instead, even as early as 14 months, children flipped during shared interactions with their interlocutors. Children from 18 months often flipped following their interlocutors' questions and remarks rather than their own speech, suggesting that children were able to use flips to respond to their interlocutors in a dialogic fashion. When children flipped, interlocutors often interpreted flips as conversational and responded to them. Interlocutors continued the conversations, provided answers, and asked follow-up questions. Interlocutors also sometimes flipped in response and their flips peaked at 18 months and then decreased over time.

Furthermore, children specifically produced I DON'T KNOW flips to comment on their own ignorance and to signal their need for more information from their interlocutors. For example, a mother asked, "Do you know a horse?" and her 18-month-old child flipped (there was no accompanying verbal utterance) in response. The mother's interpretation of the flip is informative. She observed the flip and followed up by asking, "You don't know?" The child responded with a head nod. Their interactions illustrate how a child can successfully use a flip to signal a lack of knowledge. More typically, toddlers frequently coupled their flips with verbal utterances of "I don't know" which made it clear that they were using flips to express their ignorance.

Together, these results suggest that children produced flips appropriately in conversation. Flip gestures were observed at 14 months, which is four months before a minority of children were first observed producing utterances with *know.* Thus, the results for flip gestures further consolidate the claim that children are aware of, and able to communicate, their knowledge states, or at least their states of ignorance, at a very young age.

Children's Responses to Familiar and Unfamiliar Objects

The first two studies – of children's *know* utterances and flip gestures – were based on naturalistic data. Thus, it is not easy to ascertain the mental state that led children to produce the utterances or gestures. The third study involved an experimental design in which children were presented with a mix of pictures, some depicting familiar objects that they knew the names of and some depicting unfamiliar objects that they did not know the names of. Thus, Study 3 enabled us to assess how far children would express ignorance under two different conditions – one in which ignorance of the relevant

name was relatively unlikely and one in which ignorance of the relevant name was almost certain. More specifically, we asked how children between 16 months and 37 months respond when they are asked to label familiar and unfamiliar objects? When children were shown a familiar object, they often produced the correct name (82 percent of children correctly identified familiar pictures). This was expected because the six familiar items were carefully chosen to be words children used in this age range. Nevertheless, there was also an age difference. Older children were more likely to produce the correct name than younger children. Compared to the older group, younger children pointed and invented more unintelligible names for the familiar pictures.

When children's pattern of behavior was compared across the familiar and unfamiliar conditions, several significant differences emerged: For familiar pictures, children mostly produced the correct name and they less frequently produced an incorrect name or remained silent. In contrast, when presented with an unfamiliar as opposed to a familiar picture, children were more likely to remain silent or to produce an incorrect name. Additionally, they were more likely to display signs of uncertainty. Signs of uncertainty include turning away from the picture to gaze at an adult, producing a filled pause such as *Um* or *Ah*, asking for help (e.g., a child turned to his parent and asked, "Daddy, what is this?"), and explicitly saying *I don't know.* These results again imply that young children have some awareness of their own ignorance.

Children were also inventive in their answers. When they were unable to name an unfamiliar object, they misapplied names and invented unintelligible words. While it is possible to interpret these findings as evidence for a lack of meta-ignorance in children, I suggest that there are other plausible explanations. First, there was an age difference:

younger children (16 months to 27 months) were more likely to misapply actual words and invent unintelligible words for unfamiliar pictures than older children (28 months to 37 months). The younger children in my study were less verbal and were still unable to explicitly state their ignorance when asked. Children 28 months and older were more able to state their uncertainty and presented a stronger case for meta-ignorance.

A second possibility is that these young children were simply exhibiting a strong social desirability bias. The experiment was set up as a game and most children were excited to participate and name pictures. In their eagerness to answer questions, they may have misapplied words and invented unintelligible words for unfamiliar pictures.

Concluding Comments

Together the results from three studies suggest that children between 14 months and 42 months display a limited form of meta-ignorance. How do these findings fit into the research literature? I look at how early meta-ignorance is linked with conversations. Next, I argue that meta-ignorance begins in infancy and develops over time to eventually merge with children's competence, as displayed in various assessments of their theory of mind. Third, I discuss the limitations to young children's early meta-ignorance. Finally, I underline some of the limitations to the three studies and ways in which future research might consolidate and extend their conclusions.

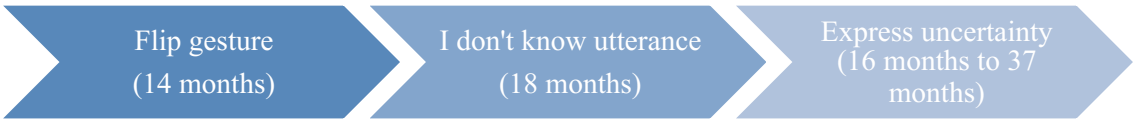
Meta-ignorance and conversations. In Studies 1 and 2, I found that children produced meaningful expressions of their knowledge and ignorance very early in their conversations with adults. Conversations are important because they provide children with opportunities to communicate – via gesture and/or speech – their ignorance and their desire for more information. They also cue children to reflect on their own knowledge

and their interlocutors' knowledge. Studies 1 and 2 found that children were able to report what they knew and did not know in the context of an ongoing conversation. When they did not know something, they asked more knowledgeable interlocutors for answers. They were also able to affirm their interlocutors' knowledge or ask them questions about their knowledge. Thus, it is possible that children as young as 14 months are able to understand that people vary in what they know and realize that a person's knowledge can be transferred from speaker to hearer via conversations (Harris et al., in press).

Continuity of meta-ignorance. Taken together**,** Studies 1-3 suggests that children have some awareness of their mental states, especially their states of knowledge versus ignorance, well before the age of four. It is true that researchers have recognized that young children have some understanding of diverse desires, diverse beliefs, and variation in knowledge access before four years of age (Wellman, 2014). I will briefly discuss children's understanding of variation in knowledge access because it is most relevant to my findings. The knowledge access task described by Wellman (2014) is similar to the task derived by Pratt and Bryant (1990) and Pillow (1989) in which a child is shown a box with a drawer and asked to guess what is inside. After answering, the drawer is opened and a toy dog is revealed. Next, the drawer is closed with the toy dog inside and the child is asked if Polly (a toy figure of a girl) knows what is inside the drawer and if Polly has seen what is inside. To pass the knowledge access task, the child must state that Polly does not know what was in the drawer. Wellman and Liu (2004) found that U.S. preschoolers generally passed the knowledge access task before the false belief task. Still, the average age that children passed the knowledge access task was quite late – at four years and six months (Wellman & Liu, 2004). To be clear, I am not

arguing that two-year-olds would be able to pass the knowledge access task. However, my results suggest that there needs to be a more nuanced understanding of children's capacity for meta-ignorance because from the age of approximately 14 months, children are able to express their own ignorance.

My results suggest a tentative developmental progression:



Children's early awareness of their own ignorance is evident when they produce flip gestures at 14 months. Their interlocutors interpreted these flip gestures as meaning "I don't know" and responded by providing the requested information. At 18 months, a few children begin to verbally use *know.* By two years of age, most children were able to explicitly talk about their own and their interlocutors' knowledge and ignorance. They used "I don't know" appropriately in conversations and their interlocutors responded with answers and explanations. Children between 16 months and 37 months display their uncertainty about the name of an object in several different ways (e.g., turning to gaze at an adult, producing a filled pause, asking for help, or explicitly saying *I don't know*). Taken together, these findings suggest that children have an early awareness of their own ignorance and uncertainty and they use various means – conventional gestures, explicit statements, and non-verbal signals and request – to convey that to their interlocutors.

In sum, these three studies contribute new information on meta-ignorance in early childhood. Children are able to assess their own knowledge states well before the age of four. A child's ability to produce I DON'T KNOW flips, to say *I don't know*, and to express uncertainty when asked to name unfamiliar objects is meta-ignorance.

Limitations

Further studies are needed to probe why children's communication about mental states is limited to themselves and their interlocutors. Although young children's most frequently used mental verb is *know*, future research could include an analysis of other mental verbs, such as *think* or *hope* or *suppose*. It will also be informative to examine how children use action verbs (such as eat, drink, or play, etc.) and to compare action verb usage patterns with mental verb usage patterns. Such comparisons will allow researchers to examine if the children's restricted reference to their own knowledge and their interlocutors' knowledge extend to non-mental verbs. Once the scope of children's restricted references to the self and to the interlocutor is established, it will also be informative to study adults' talk to young children. When adults talk to very young children, do they also only refer to the states of individuals participating in the conversation? Children could be picking up on this pattern and reproducing it in their own speech. Arguably, this limited pattern marks the beginning of a path toward the broader range of references that children begin to produce around their third year.

Additionally, Study 1 analyzed a sample of eight English-speaking children whose socioeconomic backgrounds and ethnicities were not systematically indicated in the CHILDES manual. What is known is that three of the children came from academic families and one from a white upper-middle class family. A future study could include a wider range of socioeconomic and ethnic backgrounds to check whether the pattern of results extends to other children.

For Study 2, children were first videotaped at 14 months in the Language Development Project. Future studies could examine the possibility that flips emerge

earlier. It would also be interesting to examine when parents begin producing flip gestures in their communications with their infants.

Building on the results in Study 3, future studies could test children in a way that reduces the implication that they should supply a name – any name. Children enjoyed answering the questions and they seemed to invent names for unfamiliar pictures because they wanted to respond. Researchers might find children produce more *I don't know* responses if this bias were reduced. In future studies, it would also be helpful to ask caregivers to assess their own children. It is possible that when a caregiver asks his or her child to name unfamiliar pictures, the child will feel more comfortable expressing uncertainty.

Despite these limitations, the evidence from these three studies suggests that children possess a simple understanding of knowledge and ignorance in early childhood. Children's early ability to express via speech and gesture their own knowledge and ignorance is a limited but important metacognitive achievement.

References

Acredolo, L. P., & Goodwyn, S. W. (1985). Symbolic gesturing in language development: A case study. *Human Development*, *28*, 40-49.

Apperly, I. A., & Butterfill, S. A. (2009). Do humans have two systems to track beliefs and belief-like states? *Psychological Review*, *116*, 953-970.

Bartsch, K., & Wellman, H. M. (1995). *Children talk about the mind*. New York, NY, US: Oxford University Press.

Begus, K., & Southgate, V. (2012). Infant pointing serves an interrogative function. *Developmental Science*, *15*, 611-617.

Baillargeon, R., Scott, R. M., & He, Z. (2010). False-belief understanding in infants. *Trends in Cognitive Sciences, 14*, 110-118.

Behne, T., Liszkowski, U., Carpenter, M., & Tomasello, M. (2012). Twelve‐month‐olds' comprehension and production of pointing. *British Journal Of Developmental Psychology*, *30*, 359-375.

Beran, M. J., Brandl, J. L., Perner, J., & Proust, J. (2012). *Foundations of metacognition*. New York, NY, US: Oxford University Press.

Bloom, L., Hood, L., & Lightbown, P. (1974). Imitation in language development: If, when and why. *Cognitive Psychology, 6*, 380–420.

Bloom, L., Lightbrown, P., & Hood, L. (1975). Structure and variation in child language. *Monographs Of The Society For Research In Child Development*, *40*, 1-97.

Brandone, A. C., & Wellman, H. M. (2009). You can't always get what you want. Infants understand failed goal-directed actions. *Psychological Science, 20*, 85-91.

Braunwald, S. R. (1972). Mother-child communication: The function of maternal language input. In R. von Raffler-Engel (Ed.), *Child language—1975*. Great Britain: International Linguistics Association, pp. 28-50.

Call, J., & Carpenter, M. (2001). Do apes and children know what they have seen? *Animal Cognition, 3*, 207-220.

Cartmill, E. A., Ece Demir, Ö. and Goldin-Meadow, S. (2012) Studying Gesture, in Research Methods in Child Language: A Practical Guide (ed E. Hoff), Wiley-Blackwell, Oxford, UK.

Chouinard, M. M. (2007). Children's questions: A mechanism for cognitive development: I. Introduction. *Monographs of the Society for Research in Child Development*, *72*, 1-13.

Chouinard, M. M. (2007). Children's questions: A mechanism for cognitive development: II. Analysis of the CHILDES database. *Monographs of the Society for Research in Child Development*, *72*, 14-44.

Colonnesi, C., Rieffe, C., Koops, W., & Perucchini, P. (2008). Precursors of a theory of mind: A longitudinal study. *British Journal of Developmental Psychology*, *26*, 561-577.

Demuth, K., Culbertson, J. & Alter, J. (2006). Word-minimality, epenthesis, and coda licensing in the acquisition of English. *Language & Speech*, *49*, 137-174.

Dennett, D. C. (1991). *Consciousness explained*. New York, NY, US: Little, Brown and Co.

Fenson, L., Pethick, S., Renda, C., Cox, J. L., Dale, P. S., & Reznick, J. S. (2000). Short-form versions of the MacArthur Communicative Development Inventories.

Applied Psycholinguistics, *21*, 95-115.

Flavell, J. H. (1999). Cognitive development: Children's knowledge about the mind. *Annual Review Of Psychology*, *50,* 21-45.

Flavell, J. H., & Miller, P. H. (1998). Social cognition. In W. Damon, W. Damon (Eds.), *Handbook of child psychology: Volume 2: Cognition, perception, and language* (pp. 851-898). Hoboken, NJ, US: John Wiley & Sons Inc.

Flavell, J. H., Miller, P. H., & Miller, S. A. (1993). *Cognitive development*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Flavell, J. H., & Ross, L. (1981). *Social and cognitive development*. New York, NY: Cambridge University Press.

Frazier, B. N., Gelman, S. A., & Wellman, H. M. (2009). Preschoolers' search for explanatory information within adult-child conversation. *Child Development*, *80*, 1592-1611.

Frith, C. (2010). What is consciousness for? *Pragmatics & Cognition*, *18*, 497-551.

Fusaro, M., Harris, P. L., & Pan, B. A. (2012). Head nodding and head shaking gestures in children's early communication. *First Language*, *32*, 439-458.

Goldin-Meadow, S., & Alibali, M. W. (2013). Gesture's role in speaking, learning, and creating language. *Annual Review Of Psychology*, *64,* 257-283.

Goldin-Meadow, S., Levine, S. C., Hedges, L. V., Huttenlocher, J., Raudenbush, S. W., & Small, S. L. (2014). New evidence about language and cognitive development based on a longitudinal study: Hypotheses for intervention. *American Psychologist*, *69*, 588-599.

Gopnik, A., & Astington, J. W. (1988). Children's understanding of representational

change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Development*, *59*, 26-37.

Goupil, L., Romand-Monnier, M., & Kouider, S. (2016). Infants ask for help when they know they don't know. *PNAS Proceedings of the National Academy of Sciences of the United States of America*, *113*, 3492-3496.

Harris, P. L., Corriveau, K. H., Pasquini, E. S., Koenig, M., Fusaro, M., & Clément, F. (2012). Credulity and the development of selective trust in early childhood. In M. J. Beran, J. L. Brandl, J. Perner, & J. Proust (Eds.), *Foundations of metacognition* (pp. 193-210). Oxford, UK: Oxford University Press.

Harris, P., & Lane, L. (2014). Infants Understand How Testimony Works. *Topoi, 33*, 443-458.

Harris, P.L., Ronfard, S., & Bartz, D. (2016).Young children's developing conception of knowledge and ignorance: Work in progress. *European Journal of Developmental Psychology.* Advance online publication.

Harris, P. L., Yang, B., & Cui, Y. (in press). *"I don't know": Children's early talk about knowledge. Mind and Language*.

Hogrefe, G., Wimmer, H., & Perner, J. (1986). Ignorance versus false belief: A developmental lag in attribution of epistemic states. *Child Development*, *57*, 567-582.

Johnson, C. J. (1992). Cognitive components of naming in children: Effects of referential uncertainty and stimulus realism. *Child Development, 61*, 973–982.

Koenig, M. A., & Harris, P. L. (2005). Preschoolers mistrust ignorant and inaccurate speakers. *Child Development*, *76*, 1261-1277.

Koenig, M. A., & Woodward, A. L. (2010). Sensitivity of 24-month-olds to the prior inaccuracy of the source: Possible mechanisms. *Developmental Psychology*, *46*, 815-826.

Kominsky, J. F., Langthorne, P., & Keil, F. C. (2015). The better part of not knowing: Virtuous ignorance. *Developmental Psychology, 52,* 31-45.

Kovács, Á. M., Tauzin, T., Téglás, E., Gergely, G., & Csibra, G. (2014). Pointing as epistemic request: 12-month-olds point to receive new information. *Infancy*, *19*, 543-557.

Kuhlmeier, V., Wynn, K., & Bloom, P. (2003). Attribution of dispositional states by 12-month-old infants. *Psychological Science, 14*, 402-408.

MacWhinney, B. (2000). The CHILDES Project: Tools for analyzing talk. 3rd Edition. Vol. 2: The Database. Mahwah, NJ: Lawrence Erlbaum Associates.

Marazita, J. M., & Merriman, W. E. (2004). Young children's judgment of whether they know names for objects: The metalinguistic ability it reflects and the processes it involves. *Journal Of Memory And Language*, *51*, 458-472.

Misailidi, P. (2010). Children's metacognition and theory of mind: Bridging the gap. In A. Efklides & P. Misailidi (Eds.), *Trends and prospects in metacognition research.* (pp. 279-291). New York, NY, US: Springer Science + Business Media.

Neldner, K., Collier-Baker, E., & Nielsen, M. (2015). Chimpanzees (Pan troglodytes) and human children (Homo sapiens) know when they are ignorant about the location of food. *Animal Cognition*, *18*, 683-699.

O'Neill, D. K. (1996). Two-year-old children's sensitivity to a parent's knowledge state when making requests. *Child Development, 67*, 659-677.

Onishi, K. H., & Baillargeon, R. (2005). Do 15-Month-Old Infants Understand False Beliefs? *Science, 308*, 255-258.

Özçalişkan, Ş., Gentner, D., & Goldin-Meadow, S. (2014). Do iconic gestures pave the way for children's early verbs?. *Applied Psycholinguistics*, *35*, 1143-1162.

Pillow, B. H. (1989). Early understanding of perception as a source of knowledge. *Journal of Experimental Child Psychology, 47*, 116-129.

Pratt, C., & Bryant, P. (1990). Young children understand that looking leads to knowing (so long as they are looking into a single barrel). *Child Development, 61*, 973-982.

Rohwer, M., Kloo, D., & Perner, J. (2012). Escape from meta-ignorance: How children develop an understanding of their own lack of knowledge. *Child Development, 83*, 1869-1883.

Sachs, J. (1983). Talking about the there and then: The emergence of displaced reference in parent–child discourse. In K. E. Nelson (Ed.), *Children's language, Vol. 4,* Hillsdale, NJ: Lawrence Erlbaum Associates.

Shatz, M., Wellman, H. M., & Silber, S. (1983). The acquisition of mental verbs: A systematic investigation of the first reference to mental state. *Cognition, 14*, 301-321.

Shea, N., Boldt, A., Bang, D., Yeung, N., Heyes, C., & Frith, C. D. (2014). Supra-personal cognitive control and metacognition. *Trends In Cognitive Sciences*, *18*, 186-193.

Sodian, B., Thoermer, C., & Dietrich, N. (2006). Two- to four-year-old children's differentiation of knowing and guessing in a non-verbal task. *European Journal of Developmental Psychology*, *3*, 222-237.

Sodian, B., Thoermer, C., Kristen, S., & Perst, H. (2012). Metacognition in infants and young children. In M. J. Beran, J. L. Brandl, J. Perner, J. Proust, M. J. Beran, J. L. Brandl, J. Proust (Eds.) , *Foundations of metacognition* (pp. 119-133). New York, NY, US: Oxford University Press.

Song, H., Onishi, K. H., Baillargeon, R., & Fisher, C. (2008). Can an agent's false belief be corrected by an appropriate communication? Psychological reasoning in 18-month-old infants. *Cognition*, *109*, 295-315.

Southgate, V., Chevallier, C., & Csibra, G. (2010). Seventeen-Month-Olds Appeal to False Beliefs to Interpret Others' Referential Communication. *Developmental Science, 13*, 907-912.

Stenberg, G. (2009). Selectivity in infant social referencing. *Infancy*, *14*, 457-473.

Surian, L., Caldi, S., & Sperber, D. (2007). Attribution of beliefs by 13-month-old infants. *Psychological Science*, *18*, 580–586.

Taumoepeau, M., & Ruffman, T. (2008). Stepping Stones to Others' Minds: Maternal Talk Relates to Child Mental State Language and Emotion Understanding at 15, 24, and 33 Months. *Child Development, 79*, 284-302.

Taylor, M., Esbensen, B. M., & Bennett, R. T. (1994). Children's understanding of knowledge acquisition: The tendency for children to report that they have always known what they have just learned. *Child Development*, *65*, 1581-1604.

Walden, T. A., & Kim, G. (2005). Infants' social looking toward mothers and strangers. *International Journal of Behavioral Development*, *29*, 356-360.

Wellman, H. (2014). *Making minds : How theory of mind develops* (Oxford series in cognitive development).

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development*, *72*, 655-684.

Wellman, H. M., Fang, F., Liu, D., Zhu, L., & Liu, G. (2006). Scaling of theory-of-mind understandings in Chinese children. *Psychological Science*, *17*, 1075-1081.

Wellman, H. M., & Liu, D. (2004). Scaling of theory-of-mind tasks. *Child Development, 75*, 523-541.

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

Woodward, A. L. (1998). Infants selectively encode the goal object of an actor's reach. *Cognition, 69*, 1-34.