The Role of Mental State Language on

Young Children's Introspective Ability

by

Christopher Ryan Gonzales

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved April 2018 by the
Graduate Supervisory Committee:

William V. Fabricius, Chair
Tracy Spinrad
Arthur Glenberg
Zachary Horne

ARIZONA STATE UNIVERSITY

May 2018

ABSTRACT

A cornerstone of children's socio-cognitive development is understanding that others can have knowledge, thoughts, and perceptions that differ from one's own. Preschool-aged children often have difficulty with this kind of social understanding, i.e., they lack an explicit theory of mind. The goal of this dissertation was to examine the role mental state language as a developmental mechanism of children's early understanding of their own mental states (i.e., their introspective ability). Specifically, it was hypothesized that (1) parents' ability to recognize and appropriately label their children's mental states and (2) children's linguistic ability to distinguish between their mental states shapes the development of children's introspective ability. An initial prediction of the first hypothesis is that parents should recognized differences in the development of children's self- and other-understanding in order to better help their children's introspective development. In support of this prediction, parents ($N = 400$, $M_{age} = 58$ months, Range = 28-93 months) reported that children's understanding of their own knowledge was greater than children's understanding of others' knowledge. A prediction of the second hypothesis is that children's linguistic ability to distinguish between and appropriately label their own mental states should determine their ability to make fined grained judgments of mental states like certainty. In support of this prediction, children's ($N = 197$, $M_{age} = 56$ months, Range = 36-82 months) ability to distinguish between their own knowledge and ignorance states was associated children's ability to engage in uncertainty monitoring. Together, these findings provide support for the association between children's linguistic environment and ability and their introspective development.

This dissertation is dedicated to Jolene and Michael Gonzales who taught me to always think deeply, and to always be kind.

ACKNOWLEDGMENTS

This dissertation would not have been possible without the mentorship of my graduate adviser William Fabricius and without the guidance and recommendations of my committee members Tracy Spinrad, Arthur Glenberg, and Zachary Horne. Their guidance throughout this process has helped shape me into a more thoughtful and diligent researcher. This project would not have been possible without the support of Melanie Martin, Kelley Fitzsimmons, Laura Marrocco and the numerous other staff members and visitors of the Children's Museum of Phoenix, as well as the administration of the National Living Laboratory. In addition, I am indebted to the Anne Kupfer and the other teachers, staff, and parents of the Child Study Lab preschool as well as the Child Development Lab preschool for their invaluable support. I would like to thank the numerous research assistants of the Child Study Lab and the research assistants Alex Gonzales, Quenten Benner, and Devon Wendtland from the Fabricius Lab for volunteering their time in order to help complete this project. Finally, I would like to thank Jenna Thomas, Andrew Allen, and all my other friends and family for the many kinds of support provided during this whole process.

TABLE OF CONTENTS

Page

LIST OF TABLES

Table Page

LIST OF FIGURES

The Role of Mental State Language on Young Children's Introspective Ability

> "It wasn't only wickedness and scheming that made people unhappy; it was confusion and misunderstanding; above all it was the failure to grasp the simple truth that people are as real as you. And only in a story could you enter these different minds and show how they have an equal value."
>
> — Ian McEwan, *Atonement*

A cornerstone of children's social and cognitive development is learning that others can have knowledge, thoughts, and perspectives that differ from one's own, and that these types of internal states ultimately motivate behavior. These abilities are central to developing a "theory of mind"—a critical understanding that facilitates making sense of and predicting one's own as well as others' behaviors. Research over the last 35 years on young children's explicit theory of mind development has revealed that over the toddler and preschool years, children go through a protracted period of development in which improvements in their ability to accurately predict and reason about their own and others' mental states and perspectives are clearly manifest in explicit behavioral responses and performance (Liu, Wellman, Tardif, & Sabbagh, 2008; Peterson, Wellman, & Liu, 2005; Wellman, Cross, & Watson, 2001; Wellman & Liu, 2004b). Children first learn to understand simpler internal states like desire and visual perception but take longer to understand other internal states such as knowledge and belief. However, a central topic of debate in theory of mind research has revolved around explaining how children develop these explicit mental state concepts and how children apply mental state concepts to themselves and others.

Much of the debate between the various theories of theory of mind development has focused on the developmental sequence of children's understanding of their own and others' mental states. Generally, two pathways for development have been proposed. One pathway begins with introspection. Children should be readily able to recognize their own mental states, and then, through a separate mechanism, must learn to attribute mental states to others. Under this proposal, children should demonstrate an understanding of mental states in themselves before being able to accurately attribute them to others. The second pathway begins not with introspection, but instead through the observation of one's own as well as others' outward behavior. From these observations, children should construct various mental state concepts as explanations for why various behaviors occur. Under this proposal, children's mental state concepts should be applied equally to themselves and others, and thus, children's understanding of their own and others' mental states should develop simultaneously.

One area that has received less attention is how children develop an understanding of their own mental states. The extant literature has either assumed that understanding one's own mind should be trivially easy or assumed that it should rely on the same processes used to understand others' minds. However, there has been renewed interest in whether these assumptions are valid. There is recent empirical evidence to suggest that children's understanding of their own mental states also develops during the preschool-years (Ghetti, Hembacher, & Coughlin, 2013), and that it likely relies on a different process than those used to understand others' mental states (Gonzales, Fabricius, & Kupfer, 2017). The purpose of this dissertation was to twofold: 1) to provide a novel theoretical account of children's introspective development which can explain current contradictions in the extant literature and 2), to further test assumptions of the theories of theory of mind development by beginning to examine possible developmental mechanisms of children's understanding of their own mental states, specifically focusing on preschool-aged children's ability to introspect their own knowledge and ignorance.

Theories of Theory of mind Development

The role of introspection in children's theory of mind development has been an area of contentious debate. There are several theoretical perspectives that either emphasize or deemphasize a role for introspection. Generally, three main perspectives of theory of mind development that have emerged from this debate; theory-theory (Gopnik & Wellman, 1992, 2012), Simulation-theory (Goldman, 1992, 2006; Harris, 2000), and modularity-theory (Scholl & Leslie, 1999). Both theory-theory and simulation theory have made specific claims and predictions about the role of introspection in theory of mind development which is discussed in further detail below; however, modularity theory typically only considers the development of children's understanding of others' minds and is not discussed further.

The Theory-Theory Account. Classically, the theory-theory account assumed that children's understanding of their own and others' mental states were derived from the same domain-general mechanism. Thus, children's self- and other-understanding should develop in parallel with one another. Theory-theorists posit that children construct abstract theories of different mental states from observations of their own and other people's outward behaviors. The classical accounts of theory-theory granted no unique role for self-experience in the development of mental state concepts (Gopnik, 1993). Evidence for parallelism in children's self- and other-understanding of mental states was found in both lab-based procedures such as the false belief task (Gopnik & Astington, 1988; Wimmer & Hartl, 1991), and in naturalistic observations of children's speech about the mind (Bartsch & Wellman, 1995). This lead some of the first theory-theorists to claim that feelings of a privileged introspective ability are an epiphenomenal illusion.

Gopnik (1993) argued that feelings of privileged first-person knowledge largely stem from having a greater set of experiences with one's own behaviors than with other people behaviors. In this sense, any feelings of privileged self-knowledge could be ascribed to expertise with one's own behaviors rather than direct access to one's own phenomenally experienced mental states. Gopnik (1993) argued that expertise, in this sense, translates into a quasi-perceptual illusion even though it is entirely based on abstract theories derived from outward experiences. If one had a similar set of experiences with another person, one could feel a similar level of privileged feelings about another person's mental states as well, such as expertise of a parent's intuition about his or her child's emotional state.

These claims are in line with similar findings in the adult literature in which adults struggled to identify the true causes of their subjective experiences. In the classic series of studies by Nisbett & Wilson (1977), adults were unable to accurately identify the source of their preferences. Participants were unable to identify that their preference for a pair of stockings was determined by the stockings serial position in a line up and not through their actual tactile experiences with the objects. After choosing which their preferred stocking, almost all participants claimed that their preference for an object was based on its superior qualities. However, all objects in the lineup were physically identical. Participants were unaware of the effect of serial position on their preferences, but their theories of why they prefer some objects over others (i.e., superior quality) would lead them to provide such explanations. Thus, these findings make it seem likely that children similarly must construct theories of what leads them to their subjective experiences instead of being able to directly introspect those processes themselves.

However, a significant question for theory-theory is how children's theorizing leads them to postulate unobservable mental states. A criticism of the early accounts of theory-theory is that they were unable to deal with issues of indeterminacy. When reasoning about the relation between different behaviors, there would be an unsolvable number of possible relations for children to consider. Although the correlation between mental states and their associated behaviors would be significant (e.g., open eyes and correct behavior), there would also be a large number of other significant, but spurious correlations with no clear way for children to determine which one is the correct explanation.

The more contemporary accounts of theory-theory have refined their arguments of how children engage in theorizing, positing that children engage in a Bayesian-like analysis of their observations (Gopnik & Wellman, 2012) which helps resolve some of the issues with indeterminacy. A Bayesian approach allows children to construct a causal structure of the relation between different variables and rule out relations that are spurious. Children could accomplish this by looking longitudinally across instances of different combinations of variables, which, in a sense, sets up natural experiments where causation can be determined. A Bayesian approach could allow for causal inference about even unobserved variables (e.g., an unobserved mediation effect), which is applicable to how children observe their own and other actions to infer the concepts of mental states behind those actions.

These contemporary accounts have also have relaxed some of these stronger assumptions about children's introspective ability and now posit a limited role for self-experience in the development of mental state concepts. It is important to note, however, that these models still assume that children's self- and other-understanding should emerge in parallel, and that self-experience of different mental states is still largely theory-laden. Wellman (2014) recently argued that children must first develop a "conceptual framework" of different mental states to make sense of their large and immediate stream of first-person experiences, which affects both their attribution and interpretation of mental states in themselves. Once children establish a mental state concept, which is presumably the same one used for themselves and others, children can enhance their conceptual understanding by experimenting with their own states. For example, after children have a conceptual understanding of *seeing*, children supplement their theorizing about others' behaviors by manipulating and experimenting with being in and out of that state themselves to discover its consequences, e.g., having seen where something is leads to the ability to find it later. From these experiences, children can generate new hypotheses about different, and more complex mental states to better explain and predict behavior, for example, that the mental state of *seeing* leads to the mental state of *knowing*.

Both the original and contemporary accounts of theory-theory also posit that children should attribute some mental states before others, because some mental states are more conceptually complex. This would account for the observed developmental sequence of mental state understanding in young children (Wellman & Liu, 2004a), e.g., that children can attribute seeing before age three (Flavell et al., 1981) and later can attribute knowing around age four (Wimmer, Hogrefe, & Perner, 1988).

The Simulation-Theory Account. Simulation-theorists posit that there is no need to actively construct complex and abstract theories of mental states because one already has access to a perfect working model of different mental states, namely one's own mind (Goldman, 2006; Harris, 1991, 2000). Whereas some Simulation-theorists (e.g., Barsalou, 1999) posit a more explicit role for introspection in children's theory of mind development than others (Gallese & Goldman, 1998), in general, Simulation-theorists subscribe to a Cartesian Model of introspection in which mental state concepts are solely derived from experiences within one's own mind. To understand others' minds, children can wield their own mind through a process of pretense or imagination to directly model what mental states others' might be experiencing.

Many Simulation-theorists have characterized introspection as a perceptual, or at least quasi-perceptual, process turned inward toward the phenomenal experiences of one's mental activity. As a perceptual process, introspection should then also be a product of effortful attention (Goldman, 2006). Thus, much like it is possible for one to perceive external stimuli but not attend to them (e.g., having something within field of view that is not actually perceived), it is also possible to experience mental activity but not introspect it. In this view, introspection is limited to the capacity and duration of one's working memory and attentional focus. Thus, introspection in this view is effortful and sporadic and not an always ongoing or automatic process. As a process of effortful attention and working memory, it should be possible to shape one's introspective ability in the same way. Much like how repeated or evocative and repeated experiences with specific stimuli can make them much more salient to one's attention, experience should also be able to shape how easily or how readily one attends to certain mental activity.

Goldman (2006) has argued that mental state concepts are derived from the different phenomenological dimensions in which mental states are experienced. Much like models of visual perception (e.g., geons; Biederman 1985), Goldman postulates that different mental state concepts can be composed of independent base parts which vary in different ways. Goldman labeled these dimensions as the as the doxastic dimension (i.e., certainty vs doubt), the valence dimension (i.e., aversion vs attraction), and the bodily feeling dimension (i.e., pain vs pleasure). For example, the mental state of "hope" might be constructed of doubt or uncertainty in the doxastic dimension, desire or attraction in the valence dimension, and pleasure in the bodily-feeling dimension; "fear" might be constructed of uncertainty in the doxastic dimension, aversion in the valence dimension and pain in bodily feeling dimension. Thus, per Goldman's model, experiences of different mental states should be as easy to distinguish from one another as it is for one to distinguish between different external experiences such as red stimuli and blue stimuli.

Although not explicitly detailed, Goldman's model does provide a path for development in children's introspective ability. Variations in children's experiences of different mental states could lead them to attend to some mental states more readily than others. Some aspects of the different dimensions of mental states could also be more inherently salient to children's introspective ability. However, the model's predictions about the sequence of development of different mental state concepts is unclear. If the dimensions are completely independent of one another, the order in which children acquire different mental state concepts could vary depending on numerous factors specific to the experiences of individual children. In this account, there is no set order in which all children should acquire different mental state concepts. However, children do acquire mental state concepts in a set sequence (Wellman & Liu, 2004b), which is a problem for Goldman's model to explain.

To reason about others' mental states, simulation-theorists argue that children do not rely on a set of theories of behaviors but instead can imagine themselves in the other's situation and can introspect how they would feel given that specific situation. However, this is not a perfect process and there are areas in which children can misunderstand others and make mistakes. Children and even adults can omit certain variables in their simulation or misunderstand the situation that a person is in, which could lead to inaccurate attributions to another person (Goldman & Sebanz, 2005). Although the most common errors within this model should be egocentric in nature (e.g., Saxe, 2005), it would be possible for children to make other types of errors. However, the model makes no specific claims about if these errors should be systematic in some way. Presumably, children forgetting to include certain variables within a simulation, or misunderstanding the situation should occur in a somewhat random fashion, which would result in no systematic errors beyond egocentrism.

Simulation theorists agree with the theory-theory account that there can be a lack of parallelism between different mental states, but for different reasons. For simulation theory, the more difficult states to attribute to others are those in which children must override their own current state, such as what they currently see and know. The more variables within a situation that children must change, the more likely the child is to make a mistake. However, this prediction is counter to the empirical evidence which demonstrate that children find mental states which require the same number of overrides more difficult to attribute over others (e.g. diverse desires versus diverse beliefs). Wellman and Liu (2004) demonstrated that children find attributing diverse-beliefs (e.g., "I think the object is in location A; You think the object is in Location B") more difficult than attributing diverse-desires (e.g., "I want the carrots, but you want the broccoli"). Both tasks only require children to override one state, but attributing beliefs is conceptually more complex than attributing desires. Thus, the empirical evidence does not support the classical simulation account.

My Theoretical Perspective

My own theoretical perceptive on the development of children's introspective ability and theory of mind borrows elements from both Theory-theory and Simulation theory. In my perspective, children's introspective ability maps onto genuine, phenomenally experienced mental states as suggested by Simulation-theory and is not the result of an epiphenomenal illusion as suggested by theory-theory. However, in my perspective, mental state concepts cannot be derived solely from the phenomenological experiences of mental states. Although different mental state types may vary along the dimensions outlined by Goldman, these differences might not be enough for children to form mental state concepts about them.

In my perspective, the central task for children is to learn how to distinguish between the large, ongoing, and immediate stream of phenomenological events that they experience. Children's mental state concepts should allow for the differentiation of mental states from the on-going stream of experiences but should develop gradually.

Unlike the model proposed by Goldman (2006), the phenomenological qualities of different mental states on their own are not be enough for children to distinguish among them. With the assistance of parents and other more advanced peers or adults, children can learn to apply different labels (i.e., mental state vocabulary) to their phenomenal experiences and can then start to distinguish singular mental states from other ongoing phenomenal and perceptual events.

Once children can identify their own states through introspection, they can then theorize about the causes and behavioral consequences of different mental states as suggested by Theory-theory. By grounding children's mental state concepts in phenomenological experiences, the referent problem and indeterminacy are greatly reduced. Whereas there will be many spurious relations between different behaviors, the only relations with the phenomenological experiences that will persist over time are the behaviors that cause them. Thus, children's mental state concepts emerge in two phases. The first begins by learning to identify the phenomenological features with mental state vocabulary, and the second begins by theorizing about the causal relations of these phenomenological events with different outward behaviors. Once children have theorized about the causal behaviors of different phenomenological events, they can recognize these behaviors in others and correctly attribute the unobservable phenomenological events to them.

Linguistic input on children's mental states has been a topic of much research (Pavarini, de Hollanda Souza, & Hawk, 2013). There is a commonly found relation between children's linguistic environment and their theory of mind development more broadly. Sociocultural perspectives of theory of mind development (Carpendale & Lewis,

2004) emphasize the relation between children's social interactions and exposure to talk about mental states and the development of their social understanding. In support of this argument, parental mind-mindedness (Meins et al., 2003), i.e., the extent to which caregivers talk about and appropriately label young children's mental states, is consistently found to be both a concurrent and longitudinal predictor of children's developing theory of mind (Devine & Hughes, 2016; Milligan, Astington, & Dack, 2007) as well as broader areas of socio-cognitive development (Brownell, Svetlova, Anderson, Nichols, & Drummond, 2013; Doan & Wang, 2010; Meins, Centifanti, Fernyhough, & Fishburn, 2013; Osório, Meins, Martins, Martins, & Soares, 2012; Taumoepeau & Ruffman, 2006, 2008).

In the sociocultural perspective, children also actively contribute to their own development by regularly eliciting mentalistic explanations in conversations with their parents (Sabbagh & Callanan, 1998) as well as their peers and siblings (Brown, Donelan-McCall, & Dunn, 1996). Direct causal evidence of the relation between exposure to mental state language and theory of mind is also found in behavioral experiments utilizing different types of training procedures. Training studies aimed at improving children's understanding of false belief often employ conversation or storybook-based interventions (see Hofmann et al., 2016 for a recent review) where children are exposed to or actively take part in discussions of mental states. For example, Lohmann and Tomasello (2003) found that 3-year-olds understanding of false belief was improved by perspective-shifting discussion of different types of deceptive objects (e.g., a pen that looked like a flower) but not by mere exposure to or experience with different types of deceptive objects.

Exactly how exposure to mental state language improves children's theory of mind has been a matter of some debate (Nelson, 2005; Olson, 1988), but in my theoretical perspective, it could help draw children's attention to their own internal states and helps calibrate their ability to effectively monitor them. Research on parental mind-mindedness has been refined to make the distinction between the quantity and quality of exposure to mental state language. For example, Ensor and Huges (2008) found that the connectedness between parent-child conversations (i.e., how well one utterance relates to the previous utterance) predicted children's later theory of mind development above and beyond the mere quantity of exposure to mental state terms. In addition, children's exposure to more cognitive-based terms (e.g., think, know, etc.) in connected conversations was a better predictor of children's theory of mind development than exposure to more emotional or desire-based terms (e.g., want, feel). The importance of connectedness in naturalistic parent-child conversations could be due to the fact that it provides a label for children's internal states as they are experienced (Hughes & Devine, 2015). Below I provide an account of how this type of process might work for children as they are learning about their visual-perceptual (i.e. *seeing*) and epistemic (i.e., *knowing*) states.

The first task of learning mental state vocabulary for *seeing* and *knowing* is realizing that mental state verbs refer to phenomenal experience and not to material objects or bodily actions. In my previous research (Gonzales et al., 2017), I found that most young 2-year-olds do not realize that the word "see" refers to directly to the experience of *seeing*. When asked, "Can [you—doll] see the [object]?" most children this age erred by responding "yes" for both themselves and others even when the target object was occluded behind a barrier. These children were answering a question more like, “Is the [object] there?” which reflects the commonly found realist bias where children report what is really true rather than what is perceived (e.g., Liben & Belknap, 1981). For example, when asking children to draw only what they can currently see of a partially occluded object (e.g., the handle part of a coffee mug with the rest hidden behind an opaque barrier), it is commonly found that young children will draw the full object that they know to be behind the barrier instead of the partial object that they can currently perceive.

The dual challenge for young children is to learn that the word “see” refers to current visual experience, and to differentiate *seeing* from other ongoing phenomenal experiences. Because of certain functional characteristics of *seeing*, parents’ use of “see” and “don’t see” will generally covary more reliably with children being in those states. *Seeing* is largely dichotomous. An object is usually either visible or not visible due to eye blinks, head turns, or occlusion by other objects. In addition, line-of-sight is a reliable external indicator of when someone is seeing. This means that for *seeing*, parents can reliably use the mental state term when the child is clearly in that mental state. In addition, parents’ use of the mental state term and the target object together (e.g., see the cat) should draw children's attention to the object which would increase the likelihood of perceiving it. This would help children not only discover that the word “see” refers to their current visual experience but also differentiate *seeing* from other mental states.

Once children discover that the word “see” refers to visual experience, they then must learn how to attribute *seeing* to another person. When asked in my other-perception task “Does [the doll] see the [object]?” children who could label their own visual-states were equally likely to say that the doll either saw in both cases (i.e., when the doll saw and did not see) or could not see in both cases. Children have to construct the Level-1 rule that seeing depends on an unobstructed, straight line-of-sight (Flavell, Everett, Croft, & Flavell, 1981; Masangkay et al., 1974), which takes approximately seven months after the time they first succeed in using "see" correctly for themselves. Children have the means to theorize about the Level-1 rule because they already have introspective access to *seeing* and can experiment with transitioning between seeing and not seeing by manipulating their line of sight. Children's theorizing could also be facilitated by parent's reliable use of "see" to label other's states, including parent's own states as in a game of peek-a-boo.

Regarding children's understanding of *knowing*, most children under the age of 3 do not realize that "know" to refers to mental states. When asked, "Do [you—doll] know what's in the box?" the children in my study responded "yes" even for the box with the unknown contents. Previous studies have found that young children tend to overestimate their own abilities (Schneider, 1998; Shin, Bjorklund, & Beck, 2007; Yussen & Levy, 1975) and tend to ascribe knowledge to others depending on personal characteristics (e.g., age, expertise, etc.) rather than their informational access (Koenig & Jaswal, 2011; Marvin, Greenberg, & Mossler, 1976; Wimmer et al., 1988).

Children also face the dual challenge of learning that the word "know" refers to *knowing* and differentiating it from other ongoing phenomenal experiences. Because of certain functional characteristics of *knowing*, parents' use of knowledge vocabulary should covary less reliably than their use of seeing vocabulary with children being in those respective mental states. Even when a parent is aware of a child's prior informational access and assumes that the child knows, the child might have forgotten. Compounding the problem further, the child might know but feels uncertain. Preschoolers do have phenomenal experiences of uncertainty (Hembacher & Ghetti, 2014; Lyons & Ghetti, 2013), and they gradually learn terms referring to different levels of certainty well into and after the preschool years (e.g., know, think, guess; Moore, Bryant, & Furrow, 1989). Because parents' use of knowledge terms will not always exactly match children's knowledge states, parents are less able than with *seeing* to help children discover that the word "know" refers specifically to their mental state of *knowing*. This could explain the 10-month delay between children passing self-seeing tasks and the self-knowing tasks in my study.

Once children discover that the word "know" refers to a mental state for themselves, they must learn how to attribute *knowing* to another person. When asked in the other-knowing task "Does [doll] know what's in the box" children who passed the self-version of the task were also equally likely to say that the doll either knew in both cases or did not know in both cases. In order to attribute knowing to another person, children have to construct the rule that there is a causal relation between *seeing* and *knowing*. Once children are able to introspect both *seeing* and *knowing*, they are in a position to recognize that their concepts of the two states reliably covary with one another. As with seeing, children's theorizing could also be facilitated by parents' use of "know" to label others' knowledge states.

One additional challenge children face when learning mental state vocabulary is that mental state verbs are often used to refer to things other than mental states, such as usage in different cultural idioms or references to other things like conceptual clarity.

Parents use of mental state terms in this way should hurt children's ability to link them with phenomenological experiences mental states by reducing the correlation between children hearing the labels for a mental state and being in that state themselves. Thus, it is likely that a process of direct *semantic* bootstrapping (i.e., relying solely on the utterances of individual words in a stream) would not be enough for children to connect mental state verbs to their phenomenal experiences. However, at least regarding children's understanding of perceptual verbs, there is evidence to suggest that children engage in a process of syntactic bootstrapping to derive their meaning. Instead of relying on adults' use of individual words, children might be able to rely on how words are used within a sentence. Gleitman (1990) has argued that children pay attention to whole sentence structure to help them find verb meanings and found that parents typically only used perception verbs in specific syntactic forms when referring to actual visual perception (Landau & Gleitman, 1985). For example, parents most often used a perceptual verb followed by a noun phrase (e.g., "look, that's a cat!") when referencing an actual perceptual event and used other sentence structures when referring to non-perceptual events (e.g., "see where it belongs"). Such regularity could help children link their perceptual states to the correct mental verbs. Although there are no studies following similar procedures with other types of mental states verbs, it seems likely that they should also follow a similar pattern. However, these assumptions are purely speculative and should be the target of future research.

In sum, young children must develop an awareness of the phenomenally experienced mental states of *seeing* and *knowing*. I argue that learning mental state vocabulary facilitates their introspection and helps explain the developmental lag between introspective awareness of *seeing* and *knowing*. Additionally, I argue that young children are unlikely to have direct access to the processes that lead them to these states as suggested by Simulation-theory, but rather must theorize about how their mental states are related to the external world, and in turn how mental states are related to one another. Thus, when children attribute *seeing* and *knowing* to others, they are not theorizing about abstract concepts of mental states inferred from people's behaviors as suggested by Theory-theory; rather, the data that they theorize about and attribute to others are phenomenally experienced mental states.

Recent Empirical Evidence for Introspection

There are two areas of research that have provided recent empirical evidence for children's introspective ability. The first is the literature on children's developing metacognitive ability during early and middle childhood. The second is the literature on children's theory of mind development during the preschool years. It is important to look at the convergent evidence because there are noted limitations within each field. Several theorists (Gopnik, 1993; Perner, Kloo, & Stöttinger, 2007) have argued that self-report measures of mental activity alone do not provide strong enough evidence regarding whether children's introspective ability is distinct from their ability to attribute mental states to others. Self-report measures need to be paired with other-report measures to provide unambiguous tests of children's introspective ability relying on a second mechanism. However, many theorists (e.g., Harris, 1992) have also argued that many of the methods that are employed in self-other comparisons also have their flaws. In several cases, to make self- and other-tasks parallel to one another, it is only possible to ask children about their previous mental states, not ones that they are currently experiencing.

Asking children to recall previously held states is more difficult, and likely does not rely on the same mechanism as introspection itself (Schwitzgebel, 2014). Thus, it is important to look at both self- and other-report measures together, but also consider their individual limitations to understand any contradictions that might emerge.

Metacognition Studies. The literature in children's metacognitive ability started with John Flavell's classic studies on metacognitive monitoring. Flavell (1979) argued that a child's metacognitive ability is not only an important aspect of children's cognitive development, but also has an important function within broader categories of development such as a child's ability to effectively communicate with others and a child's ability to engage in more efficient education strategies. Children's ability to monitor how well they are communicating in the way they intend or monitoring how well they understand a set of material when studying for a test all rely on their ability to introspect their ongoing mental activity. More recently, it has been suggested that children's ability to engage in metacognitive monitoring is the likely mechanism behind children's information seeking behavior, and sparks their curiosity about the world more broadly (Ronfard, Bartz, Cheng, Chen, & Harris, 2017).

The study of metacognition can be broadly divided into two different areas, children's beliefs about their own cognitive ability which is often referred to as their metacognitive knowledge, and children's ability to actively monitor their ongoing mental activity which is often referred to as metacognitive monitoring. Children's introspective ability is explicitly assumed in their ability to engage in metacognitive monitoring. Although there was a wealth of research on the development of metacognitive monitoring during middle-childhood and later stages of development, it was initially believed that children's ability to engage in metacognitive monitoring was severely limited during the preschool years (Lyons & Ghetti, 2010). However, there is a growing body of literature suggestive of a more positive alternate view of children's ability.

There are a few early studies in metacognitive monitoring (Cultice, Somerville, & Wellman, 1983; Wellman, 1977) that showed that preschool age children are able to engage in select introspective activities like feeling-of-knowing judgments (i.e., tip of the tongue phenomena). Wellman (1977) initially found children's ability to judge whether they would recognize the name of familiar and unfamiliar objects increased during early and middle childhood. Kindergartners struggled to demonstrate metacognitive monitoring (i.e., feeling of knowing judgments) whereas third-graders did not. However, the study by Cultice et al (1983) found better performance with 4- and 5-year-old children when using stimuli that were more salient to young children. Wellman (1977) used line drawings of different objects, whereas Cultice et al (1983) used color photographs of familiar and unfamiliar peers. These findings suggested that preschool children do have some ability to engage in metacognitive monitoring if the information is salient enough for young children.

More recently, Ghetti and her colleagues (Coughlin, Hembacher, Lyons, & Ghetti, 2014; Hembacher & Ghetti, 2014; Lyons & Ghetti, 2013) have conducted several studies on young children's ability to monitor their uncertainty of both perceptual information and epistemic information (i.e., memory judgments) which expand upon the earlier studies on children's feeling-of-knowing judgments. In these studies, Ghetti has found that 3- and 4-year-old children's certainty judgments are strongly related to their ability to correctly modulate strategic behavior. For Example, children were shown two degraded pictures (e.g., line drawings with a significant proportion of pixels removed) in which one picture showed a target object and the other showed a similar looking distractor object. Children were asked to judge which of the two pictures contained the target object. Children were then asked to rate if they were certain about their choice, and then allowed to ask for help with their choice if they wanted it. It was found that even for 3-year-old children, their choices were rated as less certain across trials when children made the incorrect picture choice versus in the picture correct choice (Lyons & Ghetti, 2013), and children were more likely to ask for help from an adult when they rated their response as uncertain versus certain (Coughlin et al., 2014).

Children's certainty judgments about their memory states appears to be more difficult. In a separate study, Hembacher and Ghetti (2014) asked children to memorize a short series of pictures and then showed one of the pictures from the memorized set and a new, but similar looking distractor picture. Children were asked to choose which picture they had seen before, and then made a certainty judgement about their choice. Hembacher and Ghetti (2014) found that 3-year-olds certainty judgments were equally high across correct and incorrect choices, whereas 4- and 5-year-olds certainty judgments were higher for correct choices than incorrect choices. Across these series of studies, it appears that three-year-old children are not be able to accurately judge their certainty of memory states whereas they can do so with their perceptual states.

Findings from these studies are in line with my theoretical perspective on the development of introspection. Although the differences that Ghetti and her colleagues found between children's judgments of their perceptual and epistemic states could simply reflect variation in the domain-general demands between the two types of tasks, a conceptual difference between the two abilities is also compelling. The difference could reflect children's ability to identify and label their *seeing* and *knowing* states which is facilitated by parent's ability to help children with each type of understanding. Because parents can more easily label *seeing* states than *knowing* states, it is expected that children's introspective access to one state would emerge before another. The fact that similar findings were found across different types of task procedures aids the argument that there are more than just domain-general differences between the two abilities.

Theory of Mind Studies. Initially, research in theory of mind was framed within the philosophical account of the "problem of other minds" which can be attributed to a Cartesian model of the mind. Thus, research has focused on whether typically developing preschool children (Wimmer & Perner, 1983), children with autism (Baron-Cohen, Leslie, & Frith, 1985), and non-human primates (Premack & Woodruff, 1978) could understand the representational aspects of perspective taking. Early researchers assumed children should have no problem understanding their own mental states. In this view, difficulty in attributing mental states to others arose from having to override one's own current state to figure out others mental states and perspectives. In studies of egocentrism, questions about children's own mental states were used as a control to ensure children could meet general task demands and were not the primary interest of study. Thus, there are several studies in early theory of mind research that include self and other questions but have no direct or parallel comparison between the two. Many other studies within more contemporary theory of mind research have simply not asked self-questions. The most commonly used scales of theory of mind development in use today contain no self-questions at all (e.g., Wellman & Liu, 2004). Thus, there is a limited literature with self-other comparisons within the wider theory of mind research, and findings from studies that do include such analyses have been often been underreported and inconsistent.

One of the largest areas in the literature that has included self-other comparisons is the literature on the false belief task. As the different theories of theory of mind development emerged, there were more tests of the Cartesian assumption that children should easily understand their own mind. In one of the first studies of children's understanding of their own false beliefs, Gopnik and Astington (1988) demonstrated that children under four-years-old found recalling their own immediately prior false belief (e.g., "I thought there was candy in the Smarties box and not pencils") rather difficult, which was around the same level of difficulty similar aged children had with understanding others' current false beliefs. Wimmer and Hartl (1991) ruled out several alternative explanations for why children might have problems recalling their own false-beliefs, finding that children's difficulties could not be explained by general memory problems, misunderstanding the test-question, or by embarrassment of having thought something false. Including all these separate controls, Wimmer and Hartl (1991) were able to demonstrate that children still found recalling their own false-beliefs as difficult as attributing false beliefs to others. Since these foundational studies, a large meta-analysis of children's understanding of their own and other's false beliefs, Wellman, Cross, and Watson (2001) found that the self- and other-tasks were equal in difficulty.

However, there are issues with making claims about children's introspective ability when asking them to recall and report on prior mental states. Gopnik and Slaughter (1991) found that children's difficulties with reporting past states is not limited just to their understanding of belief, demonstrating that children also find it difficult to report other prior states, such as desires and intentions. Because measuring children's understanding of their own false-belief requires asking about previous states, it is beneficial to see if self-other parallelism persists in children's understanding of other mental states where there is no such requirement to ask about previous states.

There are comparatively much fewer studies outside the literature on children's understanding of false-belief that have looked at children's self- and other-understanding with different types of mental states. Two mental states that are important prerequisites for understanding false belief are children's understanding of *seeing* and children's understanding of *knowing*. In my own previous research (Gonzales, et. al. in press), I have reviewed the small body of literature on children's self- and other-understanding of these states. No prior studies had adequately compared children's self- and other-understanding with *seeing* states, and only five studies had tested children's self- and other-understanding with *knowing* states (C. Pratt & Bryant, 1990; Ruffman & Olson, 1989; Tardif, Wellman, Fung, Liu, & Fang, 2005; Wimmer et al., 1988; Woolley & Wellman, 1993). Of the other five studies that tested children's understanding of *knowing*, three found better performance for self than other (Ruffman & Olson, 1989; Tardif et al., 2005; Wimmer et al., 1988), and two found no difference between self and other (C. Pratt & Bryant, 1990; Woolley & Wellman, 1993).

Low statistical power might account for the inconsistent findings in studies of children's understanding of *knowing*. Four studies had sample sizes between 32 and 45; the outlier was Tardif et al. (2005; Study 1) with 144. As would be expected with low power (Egger et al., 1997) the number of children who passed the self-task and failed the other-task varied widely, from 6% in Pratt and Bryant (1990) to 48% in Ruffman and

Olson (1989). Maxwell, Lau, and Howard (2015) have recently argued that to replicate a true effect, statistical power needs to exceed the traditional .80 benchmark. In the five previous studies of *knowing,* the average percentage of children who passed the self-task and failed the other-task was approximately 20% with less than 5% of children in the opposite pattern, which means that among the four smaller studies the highest statistical power (Wimmer et al., 1988) was only .55. To achieve a .95 level of power, at least 113 children would be needed (Connor, 1987).

After addressing these concerns in my own study (Gonzales, et. al., in press), we found that children's understanding of their own *seeing* and *knowing* states was better and developed sooner than their ability to attribute each state to others. We found evidence that 2- and 3-year-olds could introspect *seeing* and that 3- and 4-year-olds could introspect *knowing*. For both mental states, the age at which 50% of children could introspect the mental state was seven months younger than the age at which 50% could attribute the mental state to another person. These findings have shaped my theoretical perspective to explain why children would be able to introspect one state before another, as no prior models of the development of introspection have predicted such a finding.

In sum, examining whether children demonstrate parallelism in their self- and other-understanding in theory of mind development requires incorporating results from a wide range of mental state concepts. With the findings reviewed above, it is possible that the parallelism in children's self- and other-understanding of false belief might be an outlier when examining the full scope of children's mental state concepts. There is convergent evidence that children's explicit understanding of their own *seeing* and *knowing* states emerges early in the preschool years which is typically before children can attribute these states to others. Such findings are reflected in the positions of my own theoretical perspective that that children's developing introspective ability is central to their understanding of other's mental states. Children must first be able to identify their own states before they can theorize about the behaviors that cause them, and attribute them to others.

The current study.

The purpose of the current study was to test two different hypotheses derived from my theoretical perspective on the development of children's introspective ability. The first hypothesis involved an initial, but important test of the assumption that it is caregivers linguistic input about children's mental states that helps calibrate their introspective ability. The second hypothesis involved a test of children's own linguistic ability specifically regarding mental states which provides an important distinction between the model of introspection proposed by Goldman (2006) and the model from my own theoretical perspective.

Hypothesis One: Parents' sensitivity to self-other differences. A key assumption of my theoretical perspective on the development of children's introspective ability is that caregivers' linguistic input regarding children's mental states plays a causal role in the development of children's introspective ability. Parental influences on children's theory of mind development are well established (Pavarini et al., 2013), however the exact mechanism regarding how they influence theory of mind development has been a matter of some debate (Nelson, 2005; Olson, 1988). In my theoretical perspective, it is the connectedness between parents' use of words like "see" and "know" and children actually being in those mental states (Hughes & Devine, 2015; Taumoepeau

& Ruffman, 2008) that helps children's segment their on-going stream of phenomenological experiences and establish the conceptual boundaries between different types of mental states. Repeated exposure to talk about children's own mental states from their parents should also draw children's attention to different types of mental states more reliably, and thus make them more salient as predictors of one's own as well as other's behaviors.

However, in the extant literature, it is unclear whether parents are sensitive to differences in children's understanding of their own and others' mental states. Given that there has only recently been renewed focus on preschool-aged children's privileged introspective ability (Ghetti et al., 2013; Gonzales et al., 2017), few studies have made the distinction between children's (or parents') talk about the child's own and others' mental states. In order for parents to talk about their child's mental state in a connected fashion with children's actual experiences of mental states, it would seem necessary, or least crucially helpful, for parents to recognize differences in their children's conceptual understanding. Caregivers should be more inclined to comment on or children should be more likely to elicit conversations about their own mental their own mental states if it is a topic of active conceptual development (Brown et al., 1996; Harris, 2006). Testing whether parents recognize self-other differences in children's mental state understanding also provides an opportunity to establish convergent external-validity between more naturalistic and laboratory-based measures of self-other differences in children's mental state understanding.

One avenue to explore this relation is to utilize recently developed parent report measures (Hutchins, Prelock, & Bonazinga, 2012; Tahiroglu et al., 2014) of children's language production regarding mental states (e.g., "my child talks about their uncertainty"), their conceptual understanding of different types of mental states in social settings ("my child recognizes that experts are more knowledgeable than non-experts"), and their specific behavior indicative of mental state understanding (e.g., "my child is good at playing hide and seek"). The Children's Social Understanding Scale (CSUS; Tahiroglu et al., 2014) provides separate subscales for children's understanding of different types of mental states, and crucially, includes questions in the knowledge subscale about both children's self- and other-understanding. Whereas the scales were originally designed and found to be adequately represented by a single latent factor, it was hypothesized that that the parent report data would be better represented by a two-factor model separating self- and other-understanding. Such a finding would indicate that parents are sensitive to self-other differences in children's mental state understanding.

Hypothesis Two: Children's own mental state talk and introspective ability. The models of children's' introspective ability reviewed above posit different relations for children's verbal ability regarding mental states. Perspectives ascribing to Theory-theory (Carruthers, 2009; Gopnik & Wellman, 1992, 2012) would predict that children's introspective ability should be no different than their understanding of other's mental states. Thus, performance on introspective tasks should primarily be predicted by their performance on tasks measuring their understanding of others' mental states. Goldman's model of introspection coming from simulation-theory (Goldman, 2006) is not completely incompatible with my own theoretical perspective on how children's introspective ability develops; however, they do make different predictions about the mechanisms that guide children's learning about their mental states. Goldman's model proposes that children's mental state concepts are completely derived from the phenomenological dimensions in which mental states are experienced (i.e., the dioxic, valiance, and bodily feeling dimensions). My perspective sees children as learning to differentiate between different phenomenal aspects of mental states; however, I do not see children as learning to differentiate between mental states based solely on the merit of the independent phenomenal dimensions of mental states themselves. Instead, with the assistance of their parents, children learn to use mental state vocabulary to segment the stream of ongoing phenomenological experiences and to establish the conceptual boundaries between different types of mental states.

One way to test this distinction is to examine the relation between tasks that require the correct, contrastive use of mental state vocabulary (e.g., "I know this, but I don't know that"), like the tasks used in my own prior research, and tasks that rely on more nonverbal measures of children's introspective ability, like that tasks used by Ghetti and her colleagues (Coughlin et al., 2014; Ghetti et al., 2013; Lyons & Ghetti, 2013). Ghetti and her colleagues' findings of children's ability to introspect their certainty of perceptual information and their memory is in line with my own findings of children's ability to introspect their *seeing* and *knowing* states. In both cases, children found it harder to make judgments about what they could currently see versus what they knew or could recall from memory. However, the age trends across studies were close enough together that it is ambiguous as to whether better performance emerges on one task prior to the other. In Ghetti's studies, children could engage in metacognitive monitoring with their perceptual states by three years of age (Coughlin et al., 2014; Lyons & Ghetti, 2011, 2013), whereas children could not do so with their knowledge (i.e., memory) states by four years of age (Hembacher & Ghetti, 2014). This is slightly older than the ages I found in which children could correctly label their perceptual and knowledge states using theory of mind procedures, 2½-years-old and 3½-year-old respectively (Gonzales et al., 2017).

It was hypothesized that if children's introspective ability relies on their correct usage of mental state vocabulary when applied to their own mental states as predicted by my theoretical perspective, then only children who pass the self-knowing task should be able to engage in metacognitive monitoring. If children's introspective ability relies on their understanding of others' mental states as predicted by theory-theory, then only children who pass the other-knowing task should be able to engage in metacognitive monitoring. Finally, if children's introspective ability is derived solely from the phenomenological dimensions of mental states, then children should be able to engage in metacognitive monitoring prior to passing either the self-knowing or other-knowing tasks.

Methods

Participants and Recruitment.

Data for this study were gathered from children and their parents while visiting the Children's Museum Phoenix during the spring, summer, and fall of 2017. Data collection took place on the exhibit floor at the Children's Museum of Phoenix as part of the Living Lab initiative (i.e., Corriveau et al., 2015) which is designed to connect developmental researchers with public in community spaces. A total of 430 children between 2- and 8-years-of-age were recruited. To be included in the study, children had to have a parent or legal guardian present and had to be native speakers of English. Sixteen children were excluded from analyses because they were not native speakers of

English and 14 children were excluded because they did not finish the any of the tasks or questionnaires during the testing session. A total of 400 children were retained in the study (217 female, Mage = 58 months, SD = 15 months). Because there were only a few 2-year-olds (N =14), and 7- and 8-year-olds (N = 15) in the study, two-year-olds were grouped with the 3-year-old age group, and 7 and 8-year-olds were grouped with the 6-year-old age group when evaluating age groups (preliminary analysis revealed no differences in results if the younger or older children were excluded from group analyses). Thus, there were 116 children between two and three years of age (55 female, Mage = 41 months, SD = 4 months), 106 four-year-olds (61 female, Mage = 53 months, SD = 4 months), 87 five-year-olds (52 female, Mage = 66 months, SD = 4 months), and 91 children between six and eight years of age (51 female, Mage = 79 months, SD = 6 months).

Parents answered a series of demographic questions about their children. Parents indicated their child's race as Caucasian (77%), African American (3%), Asian (3%), Native American, (2%), Other (3%), more than one race (9%), or did not indicate their child's race (4%). Parents indicated their child's ethnicity as either Hispanic or Latino (22%), non-Hispanic or non-Latino (76%), or did not indicate their child's ethnicity (3%). Parents also indicated their household income on a 7-point scale ranging from (1) Less than $15,000 a year to (7) More than $100,000 a year. The median household income was (6) between $75,000 and $100,00 a year. Parents also indicated the highest level of education achieved for both the child's mother, and the child's father on a 7-point scale ranging from (1) a grade school education to (7) a Ph.D. or M.D. The median level of education was (5) a four-year college degree for both mothers and fathers.

Of the larger sample of 400 children, only a subset of the sample (*N* =197) completed and contributed data to the certainty rating task described below. Approximately the first half of the total sample children in the study (*N* = 171) were used in the construction, evaluation, and piloting of the certainty rating task. Additionally, the age of children who were given the certainty rating task was further restricted to only include children between 3- and 6-years of age. An additional 11 children were excluded due to this restricted age range. Finally, 8 children completed the task, but data were not recorded due to equipment failure, and 13 children started, but did not complete the task either due to distractibility or wanting to stop the session early. Preliminary analyses revealed that children from the smaller subset of the sample performed no differently on the other tasks in the session.

Materials and Procedures

All materials and testing procedures received approval from the Institutional Review Board at Arizona State University. Participants were tested individually at an open exhibit in the Children's Museum of Phoenix with two testing stations available. For most testing days, I was accompanied by either a male or female undergraduate research assistant. Approximately half the participants were tested by myself at one testing station and the other half were tested by at the second testing station by the research assistant. Research assistants received extensive training before the beginning of data collection and were routinely monitored during data collection to ensure compliance to the procedures described below.

Participants completed a modified picture-identification task (Lyons & Ghetti, 2013) on an Apple iPad using the Paradigm Stimulus Presentation software (Perception

Research Systems, 2007). Participants also completed the self- and other-knowledge tasks (Gonzales et al., 2017) using plastic dolls and small wooden boxes with hinged lids and different objects hidden inside. Parents were allowed and encouraged to sit next to their children during the assessment to ensure that their child was comfortable, but parents were asked to not engage with or help their children during the assessments themselves. Parents filled out all the consent materials and questionnaires while children went through the assent process and a short warm -up period with the experimenter. The order of the two child assessments described further below were counterbalanced. Testing sessions on average took approximately 10 to 15 minutes to complete, and children received a small sticker at the end of the session as token for completing the assessments. Parents were not compensated for their child's participation.

Self and Other Knowledge Tasks. Children's ability to label their own and other's knowledge states was measured using a set of self- and other-knowing tasks (Gonzales et al., 2017). The self- and other-knowledge tasks measure participants' ability to report on a person's knowledge after being allowed to look in one box and ignorance after not being allowed to look into a second box. Two separate tasks were used to measure participants' ability to report this for themselves (self) and for another person (other) which are detailed below. To be scored as passing each task, participants were required to respond that the person (either the participant themselves or the doll) knew the contents of the box they looked into but did not know the contents of the box they did not look into to be scored as passing each task. The order of the self- and other-versions of the task and the order of the knowledge and ignorance questions were counterbalanced across participants.

In the self-knowledge task, the experimenter started by placing two boxes on the table and asking the participate to name the color of each box. The experimenter then told the participant "I'm going to show you what is in the [color of the first] box, but not what is in the [color of the second] box" and then opened the first box to show the participant the contents inside. Participants were asked to look into the box, identify the object, and hold it briefly before placing it back in the box. The experimenter then closed the box and said, "I'm going to ask you if you know what is in each of these boxes. Tell me "yes" if you know or "no" if you don't know." This was followed by either the knowledge-question, "Do you know what is in the [first] box?" or the ignorance-question, "Do you know what is in the [second] box?" The order of the knowledge and ignorance questions were counter balanced. If the participant did not give a discernibly affirmative or negative response to either question, the instructions to answer with "yes" or "no" and the question were repeated once. If the participant did not give a discernable response after this, it was counted as an incorrect response, and the participant was scored as not passing the task.

In the other-knowledge task, the experimenter placed two new boxes on the table and had the participant name their colors. Then the experimenter placed a doll on the table and said to the participant, "This is [the doll's name]." After introducing the doll to the participant, the experimenter said, "I'm going to show [the doll] what is in the [first] box, but not what is in the [second] box" The experimenter then opened the box away from the participant to not let them see inside, and acted out the doll looking into the box and saying, "Okay I see what's in the box," Before asking each of the test questions in the other-version of the task, the experimenter reminded the participant of the doll's perceptual access by saying "[Doll] looked in the [first] box" or "[Doll] did not look in the [second] box," The knowledge and ignorance test questions are asked by the experimenting saying, "Does [the doll] know what is in the [first] box?" and "Does [the doll] know what is in the [second] box?" respectively.

Certainty Monitoring Task. Children's ability to monitor their certainty was measured using a modified version of the picture-identification task used by Ghetti and her colleagues (Coughlin et al., 2014; Lyons & Ghetti, 2011, 2013). In the original task, children answered two questions: a picture identification question, and a certainty question. For the picture-identification question, children were asked to choose which of two pictures was the target object for the trial (e.g., "which of these is the turtle?"). All pictures consisted of line drawings of objects that preschool-aged children readily recognize (e.g., Snodgrass & Vanderwart, 1980). Children were given no corrective feedback on their answers; however, to ensure children would feel unsure about some of their answers, the pictures were partially degraded by randomly removing different blocks of pixels. The proportion of pixels removed from the pictures varied by age group (between 20% and 40% of pixels removed) so that all children, on average, answered approximately 70% of the picture-identification questions correctly. After choosing a picture, children answered the certainty question using a two-point pictogram scale (and in later studies a three-point pictogram scale; Coughlin et al., 2014; Hembacher & Ghetti, 2014) depicting a gender-neutral child with increasing levels of positive facial expressions and body posture. The original measure consisted of 20 trials, and children's certainty monitoring ability was quantified as a difference score between their average certainty rating on trials where they passed the picture-identification question and their average certainty rating on trials where they failed the picture-identification question.

Individual differences in children's certainty scores has predicative value for both their strategic choices (Lyons & Ghetti, 2013) and help-seeking behaviors (Coughlin et al., 2014); however, basing children's certainty scores on their performance on the picture-identification question has two problems that potentially reduces the overall accuracy of the measure. First, children will often not know, but guess correctly on the picture-identification question, but still (correctly) give a low certainty rating. Thus, children's observed certainty scores are expected to be smaller than their true ability. Second, the number of times children fail the picture-identification question will be variable between participants. Some children might answer all the picture-identification questions correctly, making it impossible to calculate their certainty score, and other children might be no better than chance on the picture-identification question, making their certainty scores uninterpretable. Thus, not all children will obtain a useable certainty score.

To address these issues, I made several modifications to the current task which also made the task shorter and more appropriate for the testing setting. First, the stimuli were modified to manipulate the general level of difficulty of the picture-identification question. Children received three easy trials where they were expected to almost always choose the correct picture and three hard trials where they were expected to be no better than chance at choosing the correct picture. How the stimuli were manipulated is further described below. Second, the scoring procedures were changed to no longer rely solely on children's performance on the picture identification question. Instead of comparing children's certainty ratings on trials with correct or incorrect picture choices, children's certainty scores were quantified as the difference between their average certain ratings on easy picture-identification questions and their certainty ratings on hard picture-identification questions.

Stimuli. The stimuli for each trial consisted of two black and white line drawings from the same database of objects used in previous studies (e.g., Snodgrass & Vanderwart, 1980). Each picture was presented in the top right and left corners of the computer-screen, and the word for the target object appeared in the middle of screen in plain text. For the test trials, each line drawing was digitally cropped to show only a small portion (approximately 12% of the total area) of the complete picture. The portion shown of each picture was chosen intuitively so it contained readily identifiable portions of the target object (e.g., handle bars or bunny ears), or only ambiguous portions of both the target object and distractor picture (e.g., diagonal lines). The position of the cropped portion of the pictures were always in the same location for both the target and distractor images within each trial but varied between trials (See Figure 1). Pilot testing confirmed that children showed near ceiling performance on the easy picture-identification questions, and near-chance performance on the hard-picture-identification questions.

Training Procedures. To start, the experimenter told the child that they were going to play a picture game together on the iPad. The experimenter said he was going to show the child two pictures on the iPad and tell the child the word in the middle of the screen. The experimenter then told the child that he or she should pick the picture on the screen that goes with the word. The experimenter demonstrated how to choose a picture by tapping one on the screen, and then children received three practice trials where they were shown full pictures. For each trial, the experimenter stated, “Which of these is the (target object)?” and stated, “Is this the (target object) or is this the (target object)?” while pointing to each of the objects on the screen. If children chose the correct picture, the experimenter praised the child, and a smiley face was displayed on the screen while the background turned green and a happy and positive tone played. If children chose the incorrect picture, a frowny face was displayed on the screen while the background turned red and a sad and negative tone played. The experimenter then reminded the child to try and choose the picture that went with the word.

After the three full picture practice trials, children were told that they were only going to be shown parts of the pictures for the rest of the game, but they should still try to choose the picture that went with the word. Children were given two practice trials with easy picture judgments where they received the same feedback as above, and one practice trial with a hard picture judgment. For the hard picture judgment, even if they guessed correctly, children were always told they picked the incorrect picture. This was done to ensure that some children would not overestimate their performance on the hard picture judgment trials later in the game. If children tried to select or verbalized that they thought it could be both pictures, they were told that only one of the pictures was the target object, and they should choose which one they thought it was.

Next, the experimenter told the child that they were no longer going to be told if they chose the correct picture or not. Instead, for the rest of the game, the experimenter wanted the child to say how much he or she had to think about their answer. The experimenter then introduced the three-point pictogram scale to the children and told them that they were going to use the pictures to say how much they had to think. During this introduction, the scale was presented by itself on the bottom of the screen such that the low confidence picture was presented in the bottom left corner of the screen, the middle confidence picture was presented in the bottom of the middle part of the screen, and the high confidence picture was presented in the bottom right corner of the screen. The experimenter then pointed to the high confidence picture and stated to tap that picture if they "knew it right away." The experimenter pointed to the middle confidence picture and stated to tap that picture if they "had to think a little bit." Finally, the experimenter pointed to the low confidence picture and stated to tap that picture if they "had to think a lot." The experimenter then tested the children's understanding of the scale by asking which picture meant they "knew it right away," which picture meant they "had to think a little bit," and which picture meant they "had to think a lot." If a child chose the wrong picture for any of the questions, the experimenter re-explained the whole scale to the child, and re-asked the questions until the child answered all three questions correctly. These descriptors for the confidence scale were chosen because, during piloting, it was found that children required less training and practice to use the confidence scale correctly compared to descriptors which referred directly to levels of certainty (e.g., "very sure," "kind of sure," and "not so sure").

Finally, children received four practice trials in which they received both the picture-identification and certainty rating questions. For each trial, the experimenter stated the word and pointed to both pictures as in the previous practice trials. However, instead of receiving corrective feedback about their picture choice, the confidence scale appeared on the bottom of the screen while the two pictures remained present. To reduce visual clutter, the text for the word in the middle of the screen disappeared when the confidence scale appeared (See Figure 1.). For each trial, when the confidence scale appeared, the experimenter labeled the scale again by asked if the child "knew that right away," if he or she "had to think a little bit," or if he or she "had to think a lot" while pointing to each corresponding point on the scale. After children made their confidence choice, the experimenter gave corrective feedback about the correspondence between the children's choice and their behavior. If a child's behavior matched his or her certainty answer, the experimenter praised the child by saying "yeah, it looked like you (level of confidence) to me too." If the child's certainty answer did not match his or her behavior (e.g., saying they "knew it right away" when they displayed a lot of hesitation), the experimenter stated, "well, it looked like to me that you (level of confidence). Remember, when you feel that way, I want you to choose the (level of confidence) picture."

Test Trials. After completing the last set of practice trials, the experimenter told the children that they were now going to play the game on their own. Children received six test trials in total with three easy picture choice trials and three hard picture choice trials. The test trials were presented in a random order determined by the stimuli presentation software, and the position of the target picture (either on top right or top left part of the screen) was counterbalanced within trials. For each test trial, the experimenter followed the same procedures as before reading the word and pointing to each picture. After the child's picture choice, the experimenter also continued to label the confidence scale while pointing to each of the corresponding pictures. However, the experimenter and the presentation software no longer gave any corrective feedback to the child during the test trials.

Children's Social Understanding Scale (Parent Report). Parents filled out the Knowledge Subscale of the Children's Social Understanding Scale (CSUS; Tahiroglu et al., 2014). The CSUS is a validated, parent-report questionnaire designed to measure individual differences in children's theory of Mind development. The full scale consists of 5 subscales: Knowledge, Belief, Perception, Desire and Intention, and each subscale is correlated with the associated laboratory-based measures (i.e., the Scaling theory of Mind Tasks; Wellman & Liu, 2004). For each question, parents rated the truthfulness of a statement on a four-point scale which ranged from (1) "definitely untrue" to (4) "definitely true." Parents could also choose a fifth option ("don't know") if they felt like they could not accurately answer the question about their child. This option was scored as missing and was not included in subsequent analyses.

The knowledge subscale of the CSUS consisted of three questions asking about children's understanding of their own knowledge states (e.g., "My child can tell you how s/he found out about things"), three questions asking about children's understanding of others knowledge states (e.g., "My child realizes that experts are more knowledgeable than others in their specialty"), and one question which asked about both self and other (See Table 3 for the full text of all the questions).

Results

Self and Other Knowledge Tasks

Before evaluating whether parents are sensitive to self-other differences in children's theory of mind development, my first goal was to evaluate whether children's performance on the self and other knowledge tasks replicated my prior research (Gonzales et al., 2017). Previously, I found 3-year-olds only performed better than chance on the self-knowledge task and not the other-knowledge task. Older children were above chance on both tasks. In addition, I estimated there was approximately a sevenmonth difference between most children passing the self-knowledge task and most children passing the other-knowledge task.

The proportion of children in each age group passing the self and other knowledge tasks in the current study is presented in Table 1. As I found previously, 3-year-olds were only above chance performance (.25) on the self-knowledge task, and all other age-groups were above chance performance on both tasks. To test if the self-other difference in the knowledge tasks replicated my previous research, I conducted a multi-level logistic regression using M-Plus version 7.3.1 (Muthén & Muthén, 2010) which is analogous to a repeated measures ANOVA for dichotomous data (Cohen, Cohen, West, & Aiken, 2003). The person in each task (the self-task versus the other-task) was coded as a dichotomous variable (Self = 1) and was entered into the model as a Level-1 variable. Children's age and children's gender were entered as Level-2 variables. Children's age was entered as a continuous variable and centered at 36 months old and children's gender was entered as a dichotomous variable (female = 1).

The results of the multi-level logistic regression analysis are presented in Table 2. Overall, the full model showed significantly improved model fit over an intercept-only model, $\chi^2(3) = 193.55$, $p < .001$, McFadden's $R^2 = .29$. As predicted, person had significant effect on children's performance on the task, (odds ratio [OR] = 2.22, $p < .001$, 95% CI [1.38, 3.58]). On average, children performed better on the self-knowledge task ($M = .74$) than on the other-knowledge task ($M = .66$). Regarding the Level-2 variables in the model, the probability of children passing each of the tasks increased with age, (OR = 1.18, $p < .001$, 95% CI [1.13, 1.22]). The predicted probability of children passing the self-knowledge task and the other-knowledge task as function of age is illustrated in Figure 2. For the Self-Knowing task, children reached a 50% predicted probability of passing the task at 42 months old. For the other-knowing task, children reached a 50% predicted probability of passing the task at 47 months old.

In addition, there was also a marginally significant effect of gender on children's performance on the self- and other knowledge task, (OR = 1.90, p = .05, 95% CI [1.00, 3.66]. Girls had a higher probability of passing the tasks (*M* = .75) than boys (*M* = .64). To further probe this unexpected effect, I conducted a follow-up analysis which tested an interaction between the effect of gender the effect of children's age, which assessed whether the effect of gender overall was due to more girls passing the tasks at younger ages compared to boys. Results failed to support this prediction. The interaction-term between gender and age was non-significant (OR = 1.03, p =.214, 95% CI [.98, 1.09]), indicating that the small effect of gender was consistent across all ages in the study.

Children's Social Understanding Scale (Parent Report)

After establishing that the self-other difference in children's performance on the self- and other knowledge tasks replicated my prior research, my next goal was to evaluate whether parents were also sensitive to self-other differences in their children's theory of mind development. To evaluate this goal, parents completed the Knowledge subscale of the Children's Social Understanding Scale (CSUS; Tahiroglu et al., 2014) which contained seven questions about their child's understanding of their own and others' knowledge states. Within these seven questions, three evaluated children's understanding of their own knowledge, three evaluated children's understanding of others' knowledge, and one question evaluated children's understanding of both their own and other's knowledge states. The descriptive statistics for each question are presented in Table 3.

Before testing whether parents were sensitive to self-other differences in children's theory of mind, I first evaluated the dimensionality of the knowledge subscale of the CSUS. The CSUS was originally designed with the assumption that questions would load onto a single factor representing children's understanding of knowledge. However, the effect of person was not considered in the construction of the scale. Thus, further evaluation of this assumption is required. To evaluate whether the knowledge subscale of the CSUS is best represented by a single factor or a multi-factor model, I conducted a confirmatory factor analysis using M-Plus version 7.3 (Muthén & Muthén, 2010). Given the relatively large sample size and the amount of skewness and kurtosis within the scale items, each of models described below were estimated using restricted maximum likelihood (MLR). The correlations between individual scale items and children's age, gender, and performance on the self- and other-knowledge tasks are presented on Table 4.

To confirm that the current data could be adequately represented by a single factor, I conducted a confirmatory factor analysis using a single factor model. For this single-factor model, all seven items were allowed load freely onto a single latent factor with the variance of that factor fixed to be one. The standardized loadings of each question on the latent factor are presented in Figure 3. Each question loaded significantly onto the single factor ($p < .001$), and model fit indices all indicated a moderate level of fit, χ^2 (14) = 32.83, $p = .003$; RMSEA = .058, 95% CI (.032, .084); CFI = .096; SRMR = .040.

To test whether the data could be represented by separating children's self and other knowledge understanding, I conducted a confirmatory factor analysis using a two-factor model. I chose a two-factor model because, in my theoretical perspective, children's theory of mind development is dependent on their introspective ability. Children understand their own mental states first via introspection and then learn how to attribute the mental state to others via theorizing. Thus, children's understanding of others' mental states should be statistically correlated with their understanding of their own mental states. The correlation between questions about children's understanding of their own knowledge and questions about their understanding of others' knowledge states represents their introspective ability, whereas the differences between them represents their theorizing ability.

An oblique two-factor model approximates this relation by separating the commonality between scale items which represents children's self-understanding from the subset of items which also contain information about children's other-understanding. Thus, questions one, three, five and seven were allowed to load freely onto the first latent factor representing children's self-understanding, and questions two, four, six, and seven were allowed to load freely into a second latent factor. The variances of both factors were fixed to equal one, but the two factors were allowed to correlate with one another . The standardized loadings of the questions onto each of the factors are presented in Figure 4. All four of the self-knowledge questions loaded significantly onto the self-understanding latent factor ($p < .001$), and all items except for question seven loaded significantly onto the other-understanding latent factor ($p < .05$). All model fit indices indicated good fit, χ^2 (10) = 19.40, $p = .077$; RMSEA = .0440, 95% CI (<.001, .070); CFI = .985, SRMR =

.029, and the model fit difference test indicated that the bi-factor model fit the data better than single factor model, χ^2 (4) = 22.03, $p < .001$.

After establishing the multidimensionality of the knowledge subscale of the CSUS, I next evaluated the magnitude of the self-other difference present in the scale. To evaluate this effect, I first created sub-scores for self and other by averaging parents' responses to the self-questions, and averaging parents' responses to the other-questions. Because question seven from the scale only significantly loaded on the self-factor in the confirmatory factor analysis, it was only included in the self-score. Each of the sub-scores demonstrated a moderate level of internal reliability. The Cronbach's alpha for the self-score was .757, and the Cronbach's alpha for the other-score was .593. However, this is expected for scale scores that contain only a small number of items.

To evaluate the effect of person in the parent report data, I conducted a 4 (age: 3-year-old, 4-year-old, 5-year-old, 6-year-old) x 2 (person: self vs other) mixed design ANOVA. The results revealed a main effect of person F (1, 393) = 206.94, p < .001, partial eta squared = .345. Parents rated their children higher on average on the self-questions (M = 3.63) than on the other questions (M = 3.22). The results also revealed a main effect of age, F (3, 393) = 16.64, p < .001, partial eta squared = .113. Parents ratings of their children's understanding of knowledge increased with age. However, the results also revealed a significant interaction between person and age, F (3, 393) = 5.32, p = .001, partial eta squared = .039. Generally, the effect of person slightly diminished with age (see Figure 5).

My last goal regarding parent reports of their children's knowledge understanding was to evaluate how increases in the parent ratings were related to children's performance on the self- and other-knowledge tasks. To test these relations, I conducted a path model analysis using the oblique two-factor model described above and children's performance on the self and other-knowledge tasks while also controlling for the effect of children's age and gender. The path model is presented in Figure 6. The analysis revealed that children's performance on the self-knowledge task was the only variable that predicted improvements in the self-knowledge latent factor above and beyond other variables ($p = .017$). The only variables that uniquely predicted the other-knowledge latent factor was children's performance on the self-knowledge task ($p = .002$) and children's age ($p < .001$). Thus, parents seem to be sensitive to the initial shift in children's understanding of their own knowledge, and but only seem to rely on their children's age when evaluating their child's understanding of others' knowledge.

Certainty Monitoring Task

Before testing the relation between children's performance on the certainty monitoring task and the self and other knowledge tasks, I first examined whether the modifications to the task procedures had their intended effects. The stimuli for the picture-identification questions were modified so that there would be two levels of question-difficulty. Children were expected to be near ceiling performance on the easy picture-identification questions and no different than chance on the hard picture-identification questions. Children's average accuracy for the picture-identification question and average rating on the certainty rating question for each pair of stimuli are presented on Table 5. As intended, children were near ceiling performance on all the easy-choice stimuli and were no different than chance performance on the hard-choice stimuli (binomial tests: $p = .163$ through $p = .826$).

To test whether the difficulty of the picture-identification question affected children's certainty ratings, I conducted a 4 (age: 3-year-old, 4-year-old, 5-year-old, 6-year-old) x 2 (easy-choice vs hard-choice) mixed design ANOVA on children's certainty ratings. The results revealed a main effect of picture choice difficulty, F (1, 193) = 87.52, p < .001, partial eta squared = .312, and a significant interaction between picture-choice difficulty and age group, F (3, 193) = 8.516, p < .001, partial eta squared = .117. The main effect of age-group was not significant, F (3, 193) = 1.961, p = .121. Follow-up paired sample t-tests revealed that only the 3-year-old age group showed no effect of picture-choice difficulty, t (55) = .834, p = .408, whereas the 4-year-old age group, t (67) = 5.489, p < .001, 5-year-old age group, t (38) = 5.546, p < .001, and 6-year-old age group, t (33) = 7.202, p < .001 all showed significant effects of picture choice difficulty. The interaction is illustrated in Figure 7.

Relation between certainty monitoring and self- and other-knowledge.

After establishing that the modifications to the certainty monitoring task yielded similar results to prior studies, I next looked to evaluate whether individual differences in children's performance on the certainty monitoring task were related to their performance on the self- and other-knowledge tasks. According to my theoretical perspective, children's use of contrastive use of mental state language to correctly label their own mental states (i.e., "I know this, but I don't know that") is required for them to be able differentiate their ongoing stream of phenomenological experiences. According to Goldman's model of introspection, children's mental state concepts can emerge solely through the merit of the independent phenomenological dimensions of mental states themselves. According to the theory-theory model of introspection, children's ability to differentiate their certainty states should rely on learning a set of generalizable rules about the behaviors associated with uncertainty that can be applied to both the self and others (e.g., hesitation).

Thus, there are three possible predictions about the relation between the set of tasks. According to my theoretical perspective, only children who can pass the self-knowledge task should be able to correctly differentiate their certainty states, whereas according to Goldman's model, this ability should emerge prior to children passing the self-knowledge task. Lastly, according to the theory-theory model of introspection, correctly differentiating their certainty states should be primarily predicted by children's ability to pass the other-knowledge task.

In addition to further test my theoretical perspective that it is children's specific contrastive use of mental state language (i.e. "I know this, but I don't know that") and not just children's mental state language production in general that predicted children's certainty difference score, I also evaluated the association between the parent-ratings of children's self-knowledge understanding from the CSUS and children's certainty difference score. The self-knowledge CSUS questions typically ask whether children are verbalizing different aspects of knowledge (e.g., certainty, learning, sources of knowledge, etc.), thus they can also offer an estimate of children's more general mental state language production as well.

As in previous studies examining children's certainty monitoring (Coughlin et al., 2014; Lyons & Ghetti, 2013), individual differences in children's certainty monitoring ability was operationalized as a difference score. For the modified version of the task utilized in the current study, children's responses were coded as 2 if they responded with the “Know it right away” option, as a 1 if they responded with the “Think a little” option, or as a 0 if they responded with the “think a lot option.” Difference scores were calculated by subtracting children’s average certainty rating on the hard-picture choice questions from their average certainty ratings on the easy-picture choice questions. Thus, children’s difference scores could range from negative two to positive two. If children correctly indicated that they were more certain on easy-picture choice trials than on hard-picture choice trials, they received an increasingly positive certainty difference score. If children did not differentiate between easy- and hard-picture choice trials, they received a certainty difference score of zero, and if they incorrectly indicated they were more certain on hard-picture choice trials than on easy-picture choice trials, they received an increasingly negative certainty difference score.

The correlations between children’s age, gender, parent-report questions, certainty difference scores and their performance on the self and other knowledge tasks are presented in Table 6. A significant and positive correlation was found between children’s certainty difference score, children’s performance on the self- and other-knowledge task, and the parent-report of children’s self-knowledge. However, as in prior studies, children’s age was also related to these variables as well. Thus, to test whether the relation between children’s performance on the self- and other-knowledge tasks, their certainty difference score and the parent-report measure, persisted after controlling for the relation between age and gender, partial correlations were also calculated for those three variables as well. The significant correlations persisted in each case except for the parent report measure.

However, to further probe the relation between children's certainty monitoring and the parent-report measure, I also evaluated the relation with a single question in the parent report measure that asked specifically about their children's expressions of uncertainty (i.e., PK1: "my child uses words that express uncertainty"). The individual question was correlated with children's certainty monitoring, and this relation persisted even after controlling for age.

To evaluate whether the children's performance on the self-knowledge task uniquely predicted children's certainty difference score above and beyond the other variables, a 2 (self-knowledge: pass, fail) by 2 (other knowledge: pass, fail) ANCOVA was conducted on children's certainty difference scores with children's age, gender, and the parent report measure entered as covariates. Analyses revealed a significant effect of children's performance on the self-knowledge task, F (1, 194) = 8.69, p = .004, partial eta = .042, and a significant interaction between performance on the self-knowledge task and the other knowledge task, F (1, 194) = 4.83, p = .029, partial eta = .023. There was no main effect of children's performance on the other knowledge task with children's certainty difference scores, F (1, 194) = 0.02, p = .886. Additionally, after accounting for children's performance on the self and other knowledge tasks, the effect of children's age F (1, 194) = 3.09, p = .080, children's gender, F (1, 194) = 0.27, p = .603, and the parent-report measure, F (1, 194) = 0.63, p = .802, were also not significant predictors of children's certainty difference scores. A follow-up analyses which evaluated the single parent-report question about uncertainty revealed that it was also not a unique predictor of children's certainty monitoring F (1, 194) = 1.082, p = .300. Thus, children's performance on the self- and other-knowledge tasks accounted for children's certainty difference scores above and beyond the effect of the other variables.

The interaction between children's performance on the self and other knowledge tasks and children's certainty difference scores is illustrated in Figure 9. As predicted by my theoretical perspective, children who failed both the self and other knowledge tasks (*M* = .11, 95% CI [-.07, .29]) and children who only passed the other knowledge task (*M* = -.08, 95% CI [-.40, .23]) did not have a certainty difference scores that were significantly different from zero. Also, as predicted by my theoretical perspective, children who passed only the self-knowledge task on average had certainty difference scores that were significantly different from zero (*M* = .22, 95% CI [.01, .43]). However, children's certainty difference scores continued to increase for children who passed both the self- and other-knowledge tasks (*M* = .47, 95% CI [.37, .57]).

Finally, I also tested an alternative-explanation for changes in children's certainty monitoring scores. One possibility that the increases in uncertainty monitoring attributed to children's age, and children's performance on the self-knowledge and other-knowledge tasks could be due solely to changes in how the different groups of children used the certainty monitoring scale and not necessarily due to changes in their introspective ability. It is possible that increases in children's uncertainty monitoring could be due to the groups of children learning to better utilize the anchors of the rating scale (i.e., always saying "knew it right away" and "had to think a lot") which would result in increased uncertainty monitoring scores. Whereas this could be interpreted as increased uncertainty monitoring, it is also possible that it is just children learning to better maximize their performance on the picture matching game. Better evidence for genuine increases in children's uncertainty monitoring would consist of smaller, but more consistent certainty judgments (i.e., more consistently saying "knew it right away" on easy judgments and "think a little" on hard judgments).

Discussion

Recent research has driven renewed interest in the development of children's introspective ability during the preschool years (Ghetti et al., 2013; Gonzales et al., 2017; Ronfard et al., 2017) Whereas it was initially believed that children's introspective ability was severely limited until middle childhood (e.g., Flavell, Green, & Flavell, 1995), recent empirical research has challenged this view by demonstrating that preschool-aged children have privileged introspective access to their internal states, and that they utilize this ability to guide their strategic decision-making behavior. More generally, there has been considerable debate regarding the nature of children's introspective ability, whether it is the result of an epiphenomenal process stemming from the same processes utilized in children's reasoning about others' mental states (Carruthers, 2009; Gopnik, 1993), or the result of direct access to intrinsically recognizable and experienced mental states (Goldman, 2006). However, there has been little empirical or theoretical attention devoted to explaining how children can have a privileged introspective ability that develops alongside but separate from their understanding of others' mental states. Thus, the developmental mechanisms behind children's early emerging introspective ability are still not well understood.

In the current study, I provided a novel theoretical model for the development of children's introspective ability and argued that possible developmental mechanisms could be the type and quality of linguistic input children receive about their own mental states as well as children’s own linguistic ability to accurately label their own internal states in-line as they are being experienced. Parents’ use of mental state terms such as *see* and *know* when children are experiencing those states could scaffold children’s ability to introspect them in an online and direct fashion (Brown et al., 1996; Harris, 2006; Hughes & Devine, 2015; Taumoepeau & Ruffman, 2008). Stemming from these experiences, children should then learn the conceptual boundaries of different types of mental states (e.g., by helping them more readily distinguish between experiences of knowledge and ignorance or certainty and uncertainty). This understanding should then be reflected in children’s correct and “contrastive” usage of mental state terms (e.g., correctly saying "I know this, but I do not know that" when they should be experiencing those types of states).

In the current study, I tested two initial implications of this developmental model. First, if children’s introspective ability at least partially relies on the type of linguistic input they receive, parents should be sensitive to children’s understanding of their first-person mental states and how this differs from children’s understanding of others’ mental states. In order for parents to talk about their child’s mental state in a connected fashion with children’s actual experiences of internal states (Ensor & Hughes, 2008), it would seem necessary, or at least crucially helpful, for parents to recognize the self-other differences in their children’s conceptual understanding. Parents should be more inclined to comment or children should be more likely to elicit conversations about their own internal states if it is a topic of active conceptual development (Brown et al., 1996; Harris, 2006). In addition to testing this assumption, parent reports of their children’s self- and other-mental state understanding offered an additional opportunity to test for self-other differences children's theory of mind development using varied methodologies.

Second, if children's introspective ability relies on them learning to distinguish between and recognize the conceptual boundaries of different types of mental states, then children's own production and comprehension of mental state language should be related to uncertainty monitoring. Recent studies have established that young children are capable of introspecting their uncertainty during perceptual (Coughlin et al., 2014; Lyons & Ghetti, 2013) and memory judgments tasks (Hembacher & Ghetti, 2014). However, competing models of children's introspective ability (Carruthers, 2009; Goldman, 2006; Gopnik, 1993) place various levels of importance on children's own mental state language production and comprehension. I hypothesized that children eventually learn to use mental state vocabulary to segment their stream of ongoing internal experiences and establish the conceptual boundaries between different types of mental states. Thus, I tested one specific implication of this hypothesis. It should only be children who can accurately contrast between their knowledge and ignorance (e.g. "I know this, but I don't know that) that can readily recognize and actively monitor their experiences of certainty.

Hypothesis One: Parents' sensitivity to self-other differences

To test the first hypothesis, a large sample of children completed the self-knowing task (e.g., "I know this, but I don't know that") and other-knowing tasks (e.g., "s/he knows this, but doesn't know that") used in my previous research (Gonzales et al., 2017). Using the Knowledge Subscale of the Children's Social Understanding Scale (CSUS) (Tahiroglu et al., 2014), parents also rated a series of statements about their child's understanding of their own knowledge states (e.g. "My child uses words that expresses his or her uncertainty.") and other's knowledge states (e.g., "My child realizes that experts are more knowledgeable than others in their specialty"). I made two predictions about the relation between these measures. 1) I predicted that a two-factor model separating parent reports of children's self- and other-knowledge understanding would fit the parent report data better than a single factor model. This finding would indicate that parents recognize and are sensitive to the self-other differences in their children's understanding of knowledge observed in the lab-based measures. 2) I also predicted that children's performance on the self-knowing task would be related to parent's reports of children's self-understanding which would indicate that parents are specifically sensitive to children's awareness of their own knowledge states.

First, I replicated my previous finding of a self-advantage for children's performance on knowledge-access tasks (Gonzales et al., 2017) lending further support for robust self-other differences in children's theory of mind development. Critically for the specific goals of the study, parents also reported that children were better at understanding their own knowledge than understanding others' knowledge on average. Generally, parent reports of an introspective advantage in children's self- and other-knowledge understanding was stable across all age groups, and only decreased slightly as parent's ratings of children's self and other-knowledge approached ceiling with the oldest age-group in the study. Furthermore, using a confirmatory factor analysis, I found that a two-factor model of the parent report data which separated questions about children's self- and other-knowledge understanding fit the data better than a single factor model. By establishing multidimensionality in parent reports of children's self- and other-knowledge understanding, the current findings support the initial prediction from my theoretical model that parents are sensitive to self-other differences in understanding of knowledge, and thus have the capacity and inclination to help teach children about their own mental states.

However, there are possible alternative explanations of this finding that have to do with the nature of the types of questions asked about children's self-understanding and other-understanding. Many of the questions about children's self-understanding involved parents reporting about children's verbalizations (e.g., "My child uses words that expresses his or her uncertainty") whereas questions about children's other-understanding typically asked about more conceptual topics (e.g., "My child recognizes that experts are more knowledgeable in their field"). One possibility is that the self-other difference observed in the parent-report data may be at least partially due to parents being able to recognize their children's verbalizations more easily than their conceptual understanding.

However, counter to this alternative explanation, not all questions about children's other-understanding were purely conceptual in nature, which does weaken this interpretation of the findings. One of the lowest rated questions of children's other-understanding had to do with children's behavior in a game of "hide and seek," which should be a very overt and salient behavior that most parents are familiar with. Despite this difference in the nature of the question, it loaded equally well onto the latent factor representing children's other-understanding. Nevertheless, this issue should be explored further in future studies which should expand the types of questions used to include both behavioral questions as well as questions about children's speech for both their self- and other-understanding.

One way to the specific association between parent-reports of children's self- and other-understanding of knowledge is to examine the relation between the parent report data and children's performance on the self- and other-knowledge tasks. Using a path analysis to examine the relation between the self- and other-knowledge tasks and the latent factors representing children's self- and other-knowledge understanding from the parent report data, I found that children's observed performance on the self-knowing task predicted the latent factor from parent reports of children's self-understanding above and beyond children's age and children's performance on the other-knowledge task. Together, these findings provide two sources of evidence for self-other differences in children's theory of mind development. The patterns within the parent report data demonstrated that they are specifically sensitive to the introspective advantage in children's mental state understanding, and not just their verbalizations about knowledge and ignorance. As a result, parents should then have the capacity to specifically aid children's introspective development.

Finally, there was one additional and unexpected finding in the data. There was evidence for a small gender difference in children's performance on both the self- and other-knowledge tasks, which I also found in my previous research, but expected not to replicate. Girls performed better on average than boys on both versions of the knowledge tasks. Gender differences in measures of children's theory of mind development are not commonly found (Wellman et al., 2001), however when they are found, they usually favor superior performance for girls over boys (Hughes & Devine, 2015), which is consistent with the current set of findings. The exact mechanism for this gender difference is not well understood. However, for the current findings, it does not appear to simply reflect the earlier physical maturation of girls over boys. The small effect of gender persisted even after controlling for the effect of age and testing for potential interactions with other variables, which suggests that it is not simply the case the effect of gender was due to girls maturing faster and boys catching up at later ages. Thus, it seems likely that some sort of socialization process could explain the effect of gender in the self- and other-knowledge tasks. However, further investigation is warranted because the effect of gender was found only with the self- and other-knowledge tasks and not in any of the other tasks in the current study.

Hypothesis Two: Children's own mental state language and introspection

I also tested whether children's performance on the self- and other-knowledge task and parents reports of children's language production regarding their own knowledge states was related to children's introspective ability to engage in uncertainty monitoring. Recent studies have established that children's ability to engage in uncertainty monitoring emerges during the preschool years, and that this ability tends to increase with age. (Coughlin et al., 2014; Hembacher & Ghetti, 2014; Lyons & Ghetti, 2013). However, little is known about the specific developmental mechanisms driving these age-related changes. I hypothesized that children learn to use mental state vocabulary to segment their stream of ongoing internal experiences and establish the conceptual boundaries between different types of mental states. Thus, children who accurately contrast between knowledge and ignorance (e.g. "I know this, but I don't know that) should only then be able to recognize and monitor related (but more fine-grained) internal states of certainty.

In order to test this hypothesis, children completed a novel, short-form of a perceptual judgement task which I adapted from previous studies examining children's uncertainty monitoring (Coughlin et al., 2014; Lyons & Ghetti, 2013). Instead of relying on a comparison of children's certainty ratings on accurately and inaccurately identified trials as used to operationalize children's uncertainty monitoring in previous studies, children instead completed trials with differing levels of difficulty. Children rated their certainty after completing easy perceptual judgments with near ceiling performance and after completing hard perceptual judgments with near chance performance. Importantly, to rate their certainty, children were trained to use a three-point pictogram scale which involved more behavioral indicators of internal states (e.g., hesitation, body language and facial expressions). These changes in procedures allowed for a much shorter training and testing session (i.e., approximately five minutes versus 20 minutes needed for the original procedures). However, despite the procedural changes, I expected children to perform comparably on the novel form of the task. Specially, I two predictions about children's performance on this task. First, I expected to see similar age-related changes in children's ability to rate themselves as less certain on hard-perceptual judgments compared to their certainty ratings on easy-perceptual judgments Second, I expected these differences to only occur in children's who passed the self-knowing task regardless of age.

Regarding the age-related changes in children's performance, results were consistent with this initial prediction. The correspondence between children's certainty ratings with trial difficulty generally increased with age, such that 4- to 6-year-olds' (but not 3-year-olds') certainty ratings on easy perceptual judgments was significantly higher than their certainty ratings on hard perceptual judgments. Additionally, this difference increased with children's age.

Critically, children's performance on the self-knowledge was also associated with the average difference between their certainty ratings on easy- and hard-perceptual judgments. The analyses revealed that it was only children who passed the self-knowledge task (i.e., children who could contrast their knowledge and ignorance states by saying "I know this, but I don't know that") who reliably showed significant differences in their certainty ratings on easy- and hard-perceptual judgments. The significant main effect of children's performance on the self-knowledge task accounted for the variance in children's certainty rating differences above and beyond the effect of children's age and gender. Children who failed the self-knowledge task and could not contrast between their knowledge and ignorance states, on average, showed no significant difference in their certainty ratings between easy and hard-perceptual judgments.

However, this effect was also qualified by a significant interaction children's performance on the other-knowledge task. Whereas children who only passed the other-knowledge task did not show any differences in their certainty ratings on average, children who passed both the self- and other-knowledge tasks did have the largest certainty ratings differences between easy- and hard-perceptual judgments on average. One possible interpretation of this finding is that it at least partially supports the arguments from the theory-theory perspective that children's understanding of others' mental states is an important aspect of their introspective ability (Carruthers, 2009; Gopnik, 1993). However, this interpretation seems less likely when considering the full pattern of results. In the theory-theory perspective, there should be no significant differences between children who only pass the other-knowledge task versus children who pass both the self and other-knowledge tasks (i.e., because the difference in task performance should only be due to measurement error), however, children who only passed the other-knowledge task were no different than children who failed both tasks. Thus, the significant interaction observed with passing both the self- and other-knowledge tasks together does not fit the expected pattern of results for theory-theory.

The more plausible interpretation of this finding is that it represents the continued development of children's introspective ability beyond what is measured by passing the self-knowledge task. As found in my previous research and replicated in the current study, children should typically pass the self-knowledge task between five and seven months before passing the other-knowledge task. One implication of this pattern is that children who pass both the self- and other-knowledge task should have more experience introspecting their knowledge states than children who only pass the self-knowledge task. Research into metacognition more broadly has demonstrated that children's metacognitive ability continues to develop well into middle childhood and adolescence (Schneider, 2008). Thus, it would be expected to find continued improvement in children's introspective ability to engage in uncertainty monitoring as their metacognitive development continues forward. However, further research is needed to better disambiguate this finding.

In the last test of this hypothesis, I also examined whether children's performance on the self-knowledge task was associated with their uncertainty monitoring above the more general parent report measures of children's language production regarding knowledge. One important aspect of my theoretical perspective of the development of children's introspective ability is children's understanding of the conceptual boundaries between different types of mental states like knowledge and ignorance, and not necessarily just children's understanding or talk about mental states more generally. Whereas children's production of mental state language like "know" and "don't know" typically begins around two years of age (Bartsch & Wellman, 1995; Shatz, Wellman, & Silber, 1983), children do not typically pass knowledge-access tasks until around three or four-years-old (Gonzales et al., 2017; Wellman & Liu, 2004). Thus, children's uncertainty monitoring should be more associated specifically with their performance on the self-knowledge tasks rather than general measures of their language production regarding knowledge.

Results of the analyses were consistent with this prediction. Children's performance on the self-knowledge task predicted their uncertainty monitoring above and beyond the parent report measures of children's language production regarding knowledge. Whereas parent report measure was significantly correlated with children's uncertainty monitoring, the effect did not persist after controlling for the effect of children's age. To further probe the relation of the parent report measure and children's uncertainty monitoring, I also examined the relation with individual questions in the parent report measure. One question within the parent report measure asked specifically about children's use certainty language (e.g., "My child uses words that express his/her uncertainty"). This individual question was significantly correlated with children's uncertainty monitoring, and the relation persisted even after controlling for the effect of age. However, children's performance on the self-knowledge task continued to be a better predictor children's uncertainty monitoring. When examining the relation of both variables to children's uncertainty monitoring, only the self-knowledge task continued to predict children's uncertainty monitoring whereas the language production question did not.

In sum, the combination of these findings supports my theoretical perspective that children's accurate and contrastive use of mental state language to label their knowledge states is an important and necessary component for their ability to engage in more fine-grained judgments of uncertainty. This pattern of results also persisted after accounting for the effects of children's understanding of others' knowledge as predicted by theory-theory perspectives as well as the associations with more general measures of children's language production regarding knowledge and uncertainty.

Broader Implications.

Together, the pattern of results from both hypotheses has several important broader implications for the field. First, these findings offer an important preliminary step in examining the developmental mechanisms of young children's early introspective ability. Second, along with additional recent findings from other related areas, the current findings also offer potential insights for the extant body of literature on parental and other socio-cultural influences on children's theory of mind development. Finally, the current findings also offer important implications for intervention efforts in educational settings and other social domains aimed at improving children's early metacognitive development.

Many theories of children's theory of mind development have often been framed within or have at least started at the philosophical tradition of the "problem of other minds", i.e., that the main task children face in the development of their social understanding is figuring out what *others* are thinking or feeling. As a result, the mechanisms of development for children's understanding of *themselves*, i.e., their introspective ability, has either been underspecified (Goldman, 2006), or assumed to be the same as mechanisms utilized the in the development of children's understanding of others' mental states (Gopnik, 1993).

In combination with the current findings, recent research has started to challenge many of these older assumptions. By replicating previous findings of self-other differences in children's understanding of knowledge across two separate methodologies, it appears that this self-other difference is genuine and should be rather robust across different domains as well. In addition, the current pattern of results across both methodologies supports the notion that children's introspective ability is also developing during the preschool years. Whereas the current study only offers a starting point of exploring possible developmental mechanisms of children's introspective ability, together, the pattern of results does indicate that children's introspective ability is an important and independent aspect of children's theory of mind development.

The current findings also have implications for the extant literature on how parents influence their children's theory of mind development. The impact of different types of parental practices on children's theory of mind development have been well documented (Pavarini et al., 2013). Specifically, the content and quality of parent-child conversations has shown to be a specific predictor of children's theory of mind development both concurrently and longitudinally (Devine & Hughes, 2016). An important aspect of this literature for the current study is the specific relation with the connectedness of parent-child conversations (Meins et al., 2003). How well parent-child conversations flow from one idea to another or how well parent-child conversations match the current situation has shown to be a better predictor of children's social understanding more so than just the simple quantity of mental state talk that children are exposed to (Meins et al., 2012). This has led several researchers to speculate about the importance of children receiving appropriate linguistic input for their internal states as they are experiencing them (Hughes & Devine, 2015; Taumoepeau & Ruffman, 2006, 2008).

One potential reason why socialization practices could be such strong predictors of children's theory of mind development is because they could be acting directly on children's metacognitive development. Socio-cultural perspectives of theory mind development (Carpendale & Lewis, 2004), and developmental systems theories more broadly (Overton, 2013), have long argued that and one's sense of self is deeply intertwined with types of social experiences or the type of culture one is exposed to. In this view, children's self-understanding is co-constructed by both their recognition of their own internal experiences as well as how their environment or their culture teaches them to then interpret these experiences.

Thus, children who are in an environment that readily teaches them to recognize and monitor different types of mental states are potentially at an advantage to learn about others' mental states as well. Several theories of children's theory of mind development have argued that children utilize their understanding of their own mental states to help reason about others' mental states as well, either through a process of simulation or pretense (Harris, 2000), or through a process of self-experimentation and theorizing (Wellman, 2014). In either perspective, a better understanding of oneself sets children's up to learn better about other's mental states as well. Thus, parent-child conversations about children's own mental states could then in turn help boost their understanding of others' mental states as well.

Lastly, the current findings can have implications for intervention efforts in educational settings as well as broader interventions aimed at improving young children's social-cognitive development. Children's metacognitive ability has long been held as an important skill that is necessary for optimal self-guided learning and strategic decision making (Flavell, 1979; Koriat & Goldsmith, 1996). This is evident whether it is children's ability to monitor their uncertainty about their memories, knowledge, or perceptual judgments. In education settings, it is adaptive to know when to spend more time studying with topics that are difficult to learn or when to seek help from a teacher (Coughlin et al., 2014). In social scenarios, it is important to know for certain that one is giving truthful information to peers and other social partners (Koriat, Goldsmith, Schneider, & Nakash-Dura, 2001) or to know when to request clarifications after receiving ambiguous messages from peers or adults (Pratt & Bates, 1982). More broadly, effective certainty monitoring is a necessary component behind young children's general information seeking behaviors (i.e., incessant "why?" questions) and in fostering their general curiosity about the world (Chouinard, 2007). By improving our understanding how uncertainty monitoring develops and how it can be promoted in early childhood, this could elucidate designs of age-appropriate curricula that can indicate how to help children from a variety of different backgrounds learn best.

Limitations and Future Directions

The current findings support the notion that parents recognize self-other differences in children's understanding of knowledge; however, the exact mechanism of how they affect their children's metacognitive development needs to be further explored. In my theoretical perspective, parent's ability to appropriately comment on children's knowledge states as they are experiencing them is a critical component of how children learn the conceptual boundaries of knowledge and ignorance. Thus, accurate linguistic input about children's knowledge should influence their ability to actively recognize and monitor their feelings of certainty and uncertainty.

Prior studies have demonstrated that naturalistic measures of the connectedness of parent-child conversations is a robust predictor of children's social understanding more generally (Devine & Hughes, 2016), however no prior studies have assessed whether these types of measures are also specifically related to children's metacognitive development. Measurements of how well parent's mental state talk in day to day conversations lines up with children's actual experiences of mental states should be predictive of children's ability to engage in uncertainty monitoring, like they are with broader measurements of children's theory of mind.

However, the naturalistic measures also need to be complimented by more experimental manipulations as well. Children are also likely to directly elicit conversation from their parents' (Sabbagh & Callanan, 1998) and from their peers (Brown et al., 1996) about mental states, thus children's own propensity towards their internal states could influence the type of linguistic input they receive from their parents. In addition, parental mental state talk is also influenced by a host of other variables that are plausibly related to children's metacognitive development (i.e., parental socioeconomic status, attachment style, etc.). Thus, it would be difficult to establish the direct causal effect of parental linguistic input on children's metacognitive development from naturalistic measures alone. Thus, a training study which manipulates directly manipulates the type and quality of linguistic input children receive about their mental states is also needed.

Finally, furthered varied methodologies measuring self-other differences in children's mental state understanding should also be explored. One potential avenue is naturalistic measures of children's own mental state language production. If children are first required to learn about their own mental states before they are able to learn about another person's mental states, then a similar pattern should be found in children's mental state talk. Specially, children should begin talking about their own mental states before they are able to talk about other's mental states. The findings from the extant literature (Bartsch & Wellman, 1995; Shatz et al., 1983) on children's mental state language production demonstrates a relatively small delay (i.e., approximately a 3-month difference) between children's first utterance referencing their own mental states and children's first utterance referencing another person's mental state. However, there are several potential problems with these findings. First, the findings are only based on a few studies which directly tested for self-other differences, and the number of children in each study was small. Thus, it is difficult to know whether the findings reported in these few studies are robust and would have a good chance of replicating or if they are normative to the general population. In addition, these studies tended to focus only on a few epistemic terms (i.e., "think," "know," "believe," etc.). Future studies should focus on a wider range of mental state terms (i.e., perceptions and desires) in a larger sample of children to provide a better test of self-other differences in children's theory of mind development.

References

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition*, *21*(1), 37–46. https://doi.org/10.1016/0010-0277(85)90022-8

Barsalou, L. W. (1999). Perceptual symbol systems. *The Behavioral and Brain Sciences*, *22*(4), 577-609–60. https://doi.org/10.1017/S0140525X99252144

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

Biederman, I. (1985). Human image understanding: Recent research and theory. *Computer Vision, Graphics, and Image Processing*, *31*(3), 400–401. https://doi.org/10.1016/0734-189X(85)90050-7

Brown, J. R., Donelan-McCall, N., & Dunn, J. (1996). Why talk about mental states? The significance of children's conversations with friends, siblings, and mothers. *Child Development*, *67*(3), 836–849. https://doi.org/10.2307/1131864

Brownell, C. A., Svetlova, M., Anderson, R., Nichols, S. R., & Drummond, J. (2013). Socialization of Early Prosocial Behavior: Parents' Talk About Emotions is Associated With Sharing and Helping in Toddlers. *Infancy*, *18*(1), 91–119. https://doi.org/10.1111/j.1532-7078.2012.00125.x

Carpendale, J. I. M., & Lewis, C. (2004). Constructing an understanding of mind : The development of children ' s social understanding within social interaction, (2004), 79–151.

Carruthers, P. (2009). How we know our own minds: the relationship between mindreading and metacognition. *The Behavioral and Brain Sciences*, *32*(2), 121-38-82. https://doi.org/10.1017/S0140525X09000545

Chouinard, M. M. (2007). Children's Questions: A Mechanism for Cognitive Development. *Monographs of the Society for Research in Child Development*, *72*(1), 1–129. https://doi.org/10.1111/j.1540-5834.2007.00417.x

Cohen, J., Cohen, P., West, S., & Aiken, L. (2003). *Applied Multiple Regression / Correlation Analysis for the Behavioral Sciences*. Routledge.

Corriveau, K., Kipling, R., Ronfard, S., Biarnes, M., Jeye, B. M., & Harris, P. L. (2015). The Living Laboratory® Model: A Mutual Professional Development Model for Museum-Based Research Partnerships. In D. M. Sobel & J. Jipson (Eds.), *Cognitive Development in Museum Settings*. New York, NY, US: Routledge. https://doi.org/10.4324/9781315667553

Coughlin, C., Hembacher, E., Lyons, K. E., & Ghetti, S. (2014). Introspection on uncertainty and judicious help-seeking during the preschool years. *Developmental*

Science, *18*(6), 957–971. https://doi.org/10.1111/desc.12271

Cultice, J., Somerville, S., & Wellman, H. M. (1983). Preschoolers' memory monitoring: Feeling-of-knowing judgments. *Child Development*, *54*(6), 1480–1486. Retrieved from http://www.jstor.org/stable/1129810

Devine, R. T., & Hughes, C. (2016). Family correlates of false belief understanding in early childhood: A meta-analysis. *Child Development*, *0*(0), 1–17. https://doi.org/10.1111/cdev.12682

Doan, S. N., & Wang, Q. (2010). Maternal discussions of mental states and behaviors: relations to emotion situation knowledge in European American and immigrant Chinese children. *Child Development*, *81*(5), 1490–503. https://doi.org/10.1111/j.1467-8624.2010.01487.x

Egger, M., Smith, G. D., Schneider, M., Minder, C., Davey Smith, G., Schneider, M., … Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ (Clinical Research Ed.)*, *315*(7109), 629–34. https://doi.org/10.1136/bmj.316.7129.469

Ensor, R., & Hughes, C. (2008). Content or Connectedness ? Mother – Child Talk and Early Social Understanding. *Children*, *79*(1), 201–216.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, *34*(10), 906–911. https://doi.org/10.1037/0003-066x.34.10.906

Flavell, J. H., Everett, B. a., Croft, K., & Flavell, E. R. (1981). Young children's knowledge about visual perception: Further evidence for the Level 1–Level 2 distinction. *Developmental Psychology*, *17*(1), 99–103. https://doi.org/10.1037//0012-1649.17.1.99

Flavell, J. H., Green, F. L., & Flavell, E. R. (1995). Young children's knowledge about thinking. *Monographs of the Society for Research in Child Development*, *60*(1), 1–96. https://doi.org/10.2307/1166124

Gallese, V., & Goldman, A. (1998). Mirror neurons and the simulation theory of mind-reading. *Trends in Cognitive Sciences*, *2*(12), 493–501. https://doi.org/10.1016/S1364-6613(98)01262-5

Ghetti, S., Hembacher, E., & Coughlin, C. a. (2013). Feeling Uncertain and Acting on It During the Preschool Years: A Metacognitive Approach. *Child Development Perspectives*, *7*(3), 160–165. https://doi.org/10.1111/cdep.12035

Gleitman, L. (1990). The Structural Sources of Verb Meanings. *Language Acquisition*, *1*(1), 3–55. https://doi.org/10.1207/s15327817la0101_2

Goldman, A. I. (1992). In Defense of the Simulation Theory. *Mind & Language*, *7*(1–2), 104–119. https://doi.org/10.1111/j.1468-0017.1992.tb00200.x

Goldman, A. I. (2006). *Simulating Minds*. New York, NY, US: Oxford University Press.

Goldman, A. I., & Sebanz, N. (2005). Simulation, mirroring, and a different argument from error. *Trends in Cognitive Sciences*, *9*(7), 320–320. https://doi.org/10.1016/j.tics.2005.05.008

Gonzales, C. R., Fabricius, W. V., & Kupfer, A. S. (2017). Introspection Plays an Early Role in Children's Explicit Theory of Mind Development. *Child Development*, *0*(0), 1–8. https://doi.org/10.1111/cdev.12876

Gopnik, A. (1993). How we know our minds: The illusion of first-person knowledge of intentionality. *Behavioral and Brain Sciences*, *16*(1), 1. https://doi.org/10.1017/S0140525X00028636

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*(1), 26. https://doi.org/10.2307/1130386

Gopnik, A., & Slaughter, V. (1991). Young children's understanding of changes in their mental states. *Child Development*, *62*, 98–110. https://doi.org/10.2307/1130707

Gopnik, A., & Wellman, H. H. M. H. H. M. (1992). Why the child's theory of mind really is a theory. *Mind & Language*, *7*(1–2), 145–171. https://doi.org/10.1111/j.1468-0017.1992.tb00202.x

Gopnik, A., & Wellman, H. M. (2012). Reconstructing constructivism: Causal models, Bayesian learning mechanisms, and the theory theory. *Psychological Bulletin*, *138*(6), 1085–1108. https://doi.org/10.1037/a0028044

Harris, P. L. (1991). *The work of the imagination*. (A. Whiten, Ed.), *Natural theories of mind: Evolution, development and simulation of everyday mindreading*. Oxford, NY: Blackwell Publishing. https://doi.org/10.1017/S1360641701392584

Harris, P. L. (1992). From simulation to folk psychology: The case for development. *Mind & Language*, *7*(1–2), 120–144. https://doi.org/10.1111/j.1468-0017.1992.tb00201.x

Harris, P. L. (2000). *The work of the imagination*. Oxford: Blackwell Publishing.

Harris, P. L. (2006). It's Probably Good to Talk. *Merrill-Palmer Quarterly*, *52*(1), 158–169. https://doi.org/10.1353/mpq.2006.0004

Hembacher, E., & Ghetti, S. (2014). Don't look at my answer: subjective uncertainty underlies preschoolers' exclusion of their least accurate memories. *Psychological*

Science, *25*(9), 1768–76. https://doi.org/10.1177/0956797614542273

Hofmann, S. G., Doan, S. N., Sprung, M., Wilson, A., Ebesutani, C., Andrews, L. A., … Harris, P. L. (2016). Training children's theory-of-mind: A meta-analysis of controlled studies. *Cognition*, *150*, 200–212. https://doi.org/10.1016/j.cognition.2016.01.006

Hughes, C., & Devine, R. T. (2015). A Social Perspective on Theory of Mind. *Handbook of Child Psychology and Developmental Science*, 1–46. https://doi.org/10.1002/9781118963418.childpsy314

Hutchins, T. L., Prelock, P. A., & Bonazinga, L. (2012). Psychometric evaluation of the Theory of Mind Inventory (ToMI): A study of typically developing children and children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *42*(3), 327–341. https://doi.org/10.1007/s10803-011-1244-7

Koenig, M. A., & Jaswal, V. K. (2011). Characterizing children's expectations about expertise and incompetence: Halo or pitchfork effects? *Child Development*, *82*(5), 1634–1647. https://doi.org/10.1111/j.1467-8624.2011.01618.x

Koriat, A., & Goldsmith, M. (1996). Monitoring and control processes in the strategic regulation of memory accuracy. *Psychological Review*, *103*(3), 490–517. https://doi.org/10.1037/0033-295X.103.3.490

Koriat, A., Goldsmith, M., Schneider, W., & Nakash-Dura, M. (2001). The Credibility of Children's Testimony: Can Children Control the Accuracy of Their Memory Reports? *Journal of Experimental Child Psychology*, *79*(4), 405–437. https://doi.org/10.1006/jecp.2000.2612

Liben, L. S., & Belknap, B. (1981). Intellectual realism: Implications for investigations of perceptual perspective taking in young children. *Child Development*, *52*(3), 921. https://doi.org/10.2307/1129095

Liu, D., Wellman, H. M., Tardif, T., & Sabbagh, M. a. (2008). Theory of mind development in Chinese children: a meta-analysis of false-belief understanding across cultures and languages. *Developmental Psychology*, *44*(2), 523–31. https://doi.org/10.1037/0012-1649.44.2.523

Lohmann, H., & Tomasello, M. (2003). The role of language in the development of false belief understanding: a training study. *Child Development*, *74*(4), 1130–1144. https://doi.org/10.1111/1467-8624.00597

Lyons, K. E., & Ghetti, S. (2010). Metacognitive Development in Early Childhood: New Questions about Old Assumptions. In *Trends and Prospects in Metacognition Research* (pp. 259–278). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4419-6546-2_12

Lyons, K. E., & Ghetti, S. (2011). The Development of Uncertainty Monitoring in Early Childhood. *Child Development*, *82*(6), 1778–1787. https://doi.org/10.1111/j.1467-8624.2011.01649.x

Lyons, K. E., & Ghetti, S. (2013). I don't want to pick! Introspection on uncertainty supports early strategic behavior. *Child Development*, *84*(2), 726–736. https://doi.org/10.1111/cdev.12004

Marvin, R. S., Greenberg, M. T., & Mossler, D. G. (1976). The early development of conceptual perspective taking: Distinguishing among multiple perspectives. *Child Development*, *47*(2), 511. https://doi.org/10.2307/1128810

Masangkay, Z. S., McCluskey, K. A., McIntyre, C. W., Sims-Knight, J., Vaughn, B. E., & Flavell, J. H. (1974). The Early Development of Inferences about the Visual Percepts of Others. *Child Development*, *45*(2), 357. https://doi.org/10.2307/1127956

Maxwell, S. E., Lau, M. Y., & Howard, G. S. (2015). Is psychology suffering from a replication crisis? What does "failure to replicate" really mean? *American Psychologist*, *70*(6), 487–498. https://doi.org/10.1037/a0039400

Meins, E., Centifanti, L. C. M., Fernyhough, C., & Fishburn, S. (2013). Maternal mind-mindedness and children's behavioral difficulties: Mitigating the impact of low socioeconomic status. *Journal of Abnormal Child Psychology*, *41*(4), 543–553. https://doi.org/10.1007/s10802-012-9699-3

Meins, E., Fernyhough, C., de Rosnay, M., Arnott, B., Leekam, S. R., & Turner, M. (2012). Mind-Mindedness as a Multidimensional Construct: Appropriate and Nonattuned Mind-Related Comments Independently Predict Infant-Mother Attachment in a Socially Diverse Sample. *Infancy*. https://doi.org/10.1111/j.1532-7078.2011.00087.x

Meins, E., Fernyhough, C., Wainwright, R., Clark-Carter, D., Das Gupta, M., Fradley, E., & Tuckey, M. (2003). Pathways to understanding mind: construct validity and predictive validity of maternal mind-mindedness. *Child Development*, *74*(4), 1194–1211. https://doi.org/10.1111/1467-8624.00601

Milligan, K., Astington, J. W., & Dack, L. A. (2007). Language and theory of mind: meta-analysis of the relation between language ability and false-belief understanding. *Child Development*, *78*(2), 622–46. https://doi.org/10.1111/j.1467-8624.2007.01018.x

Moore, C., Bryant, D., & Furrow, D. (1989). Mental terms and the development of certainty. *Child Development*, *60*(1), 167. https://doi.org/10.2307/1131082

Muthén, L. K., & Muthén, B. O. (2010). *Mplus user's guide. Sixth edition*. Los Angeles, CA: Muthén & Muthén.

Nelson, K. (2005). Language Pathways into the Community of Minds. *Why Language Matters for Theory of Mind*. https://doi.org/10.1093/acprof:oso/9780195159912.003.0002

Nisbett, R. R. E., & Wilson, T. T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, *84*(3), 231–259. https://doi.org/10.1037/0033-295X.84.3.231

Olson, D. R. (1988). On the origins of belief and other intentional states in children. In J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), *Developing theories of mind* (pp. 414–426).

Osório, A., Meins, E., Martins, C., Martins, E. C., & Soares, I. (2012). Child and mother mental-state talk in shared pretense as predictors of children's social symbolic play abilities at age 3. *Infant Behavior and Development*. https://doi.org/10.1016/j.infbeh.2012.07.012

Overton, W. F. (2013). *Relationism and Relational Developmental Systems: A Paradigm for Developmental Science in the Post-Cartesian Era*. *Advances in Child Development and Behavior* (Vol. 44). https://doi.org/10.1016/B978-0-12-397947-6.00002-7

Pavarini, G., de Hollanda Souza, D., & Hawk, C. K. (2013). Parental Practices and Theory of Mind Development. *Journal of Child and Family Studies*, *22*(6), 844–853. https://doi.org/10.1007/s10826-012-9643-8

Perception Research Systems. (2007). Paradigm Stimulus Presentation. Retrieved from http://www.paradigmexperiments.com

Perner, J., Kloo, D., & Stöttinger, E. (2007). Introspection & remembering. *Synthese*, *159*(2), 253–270. https://doi.org/10.1007/s11229-007-9207-4

Peterson, C. C., Wellman, H. M., & Liu, D. (2005). Steps in Theory of Mind Development for Children with Deafness or Autism. *Child Development*, *76*(2), 502–517. https://doi.org/10.1111/j.1467-8624.2005.00859.x

Pratt, C., & Bryant, P. (1990). Young children understanding that looking leads to knowing (so long as they are looking into a single barrel). *Child Development*, *61*, 973–982. https://doi.org/10.1111/j.1467-8624.1990.tb02835.x

Pratt, M. W., & Bates, K. R. (1982). Young editors: Preschoolers' evaluation and production of ambiguous messages. *Developmental Psychology*, *18*(1), 30–42. https://doi.org/10.1037/0012-1649.18.1.30

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behabioral and Brain Sciences*, *1*(4), 515–526. https://doi.org/10.1016/j.celrep.2011.1011.1001.7.

Ronfard, S., Bartz, D. T., Cheng, L., Chen, X., & Harris, P. L. (2017). *Children's Developing Ideas About Knowledge and Its Acquisition*. *Advances in Child Development and Behavior* (1st ed.). Elsevier Inc. https://doi.org/10.1016/bs.acdb.2017.10.005

Ruffman, T., & Olson, D. (1989). Children's ascriptions of knowledge to others. *Developmental Psychology*, *25*(4), 601–606. https://doi.org/10.1037//0012-1649.25.4.601

Sabbagh, M. A., & Callanan, M. A. (1998). Metarepresentation in action: 3-, 4-, and 5-year-olds' developing theories of mind in parent-child conversations. *Developmental Psychology*, *34*(3), 491–502. https://doi.org/10.1037/0012-1649.34.3.491

Saxe, R. (2005). Against simulation: the argument from error. *Trends in Cognitive Sciences*, *9*(4), 174–9. https://doi.org/10.1016/j.tics.2005.01.012

Schneider, W. (1998). Performance prediction in young children: Effects of skill, metacognition and wishful thinking. *Developmental Science*, (1985), 291–297. https://doi.org/10.1111/1467-7687.00044

Schneider, W. (2008). The Development of Metacognitive Knowledge in Children and Adolescents : Major Trends and Implications for Education. *International Mind, Brain, and Education Society*, *2*(3), 114–122.

Scholl, B., & Leslie, A. (1999). Modularity, development and "theory of mind." *Mind and Language*, *14*(1), 131–153.

Schwitzgebel, E. (2014). Introspection. In E. N. Zalta (Ed.), *Encyclopedia of the Mind*. 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc. https://doi.org/10.4135/9781452257044.n163

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*(3), 301–321. Retrieved from http://www.sciencedirect.com/science/article/pii/0010027783900082

Shin, H., Bjorklund, D. F., & Beck, E. F. (2007). The adaptive nature of children's overestimation in a strategic memory task. *Cognitive Development*, *22*(2), 197–212. https://doi.org/10.1016/j.cogdev.2006.10.001

Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning & Memory*, *6*(2), 174–215. https://doi.org/10.1037/0278-7393.6.2.174

Tahiroglu, D., Moses, L. J., Carlson, S. M., Mahy, C. E. V., Olofson, E. L., & Sabbagh, M. A. (2014). The Children's Social Understanding Scale: Construction and validation of a parent-report measure for assessing individual differences in children's theories of mind. *Developmental Psychology*, *50*(11), 2485–2497. https://doi.org/10.1037/a0037914

Tardif, T., Wellman, H. M., Fung, K. Y. F., Liu, D., & Fang, F. (2005). Preschoolers' understanding of knowing-that and knowing-how in the United States and Hong Kong. *Developmental Psychology*, *41*(3), 562–573. https://doi.org/10.1037/0012-1649.41.3.562

Taumoepeau, M., & Ruffman, T. (2006). Mother and infant talk about mental states relates to desire language and emotion understanding. *Child Development*, *77*(2), 465–481. https://doi.org/10.1111/j.1467-8624.2006.00882.x

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*(2), 284–302. https://doi.org/10.1111/j.1467-8624.2007.01126.x

Wellman, H. M. (1977). Tip of the tongue and feeling of knowing experiences: A developmental study of memory monitoring. *Child Development*, *48*(1), 13–21. Retrieved from http://www.jstor.org/stable/1128875

Wellman, H. M. (2014). *Making Minds*. Oxford, NY: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199334919.001.0001

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development*, *72*(3), 655–684. https://doi.org/10.1111/1467-8624.00304

Wellman, H. M., & Liu, D. (2004a). Scaling of theory-of-mind tasks. *Child Development*, *75*(2), 523–41. https://doi.org/10.1111/j.1467-8624.2004.00691.x

Wellman, H. M., & Liu, D. (2004b). Scaling of Theory-of-Mind Tasks. *Child Development*, *75*(2), 523–541. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-8624.2004.00691.x/abstract

Wellman, H. M., & Liu, D. (2004c). Scaling of theory of mind tasks. *Child Development*, *75*(2), 523–541. https://doi.org/10.1111/j.1467-8624.2004.00691.x

Wimmer, H., & Hartl, M. (1991). Against the Cartesian view on mind: Young children's difficulty with own false beliefs. *British Journal of Developmental Psychology*, *9*(1), 125–138. https://doi.org/10.1111/j.2044-835X.1991.tb00866.x

Wimmer, H., Hogrefe, G.-J. G., & Perner, J. (1988). Children's understanding of informational access as source of knowledge. *Child Development*, *59*(2), 386–396. https://doi.org/10.2307/1130318

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. Retrieved from http://www.sciencedirect.com/science/article/pii/0010027783900045

Woolley, J. D., & Wellman, H. M. (1993). Origin and truth: Young children's understanding of imaginary mental representations. *Child Development*, *64*(1), 1. https://doi.org/10.2307/1131434

Yussen, S. R., & Levy, V. M. (1975). Developmental changes in predicting one's own span of short-term memory. *Journal of Experimental Child Psychology*, *19*(3), 502–508. https://doi.org/10.1016/0022-0965(75)90079-X

Table 1.

The proportion of children passing the self- and other-knowledge tasks by age group

Age Group	Self-Knowledge Task	Other-Knowledge Task
3-year-olds (N = 112)	.37**	.31
4-year-olds (N = 106)	.81***	.66***
5-year-olds (N = 86)	.88***	.80***
6-year-olds (N = 91)	.97***	.96***

Note: Asterisks represent binomial tests against performance being greater than chance performance (.25) ** $p < .01$ *** $p < .001$

Table 2:

The summary of the multi-level logistic regression analysis for the self- and other-knowledge tasks.

Variable	Beta	S.E. of Beta	Odds Ratio
Person	.798***	.244	2.22
Age (in months)	.165***	.020	1.18
Gender (Female=1)	.641*	.335	1.90
Intercept	-1.843***	.390	

Note: Odds ratios < 1.0 indicate a decrease in odds and odds ratios > 1.0 indicate an increase in the odds.
*$p < .05$, ***$p < .001$

Table 3.

The descriptive statistics for items in the knowledge subscale of the Children's Social Understanding Scale.

Question	Question type	Mean	SD	Skewness	Kurtosis
Q1. Uses words that express uncertainty (e.g., "We might go to the park"; "Maybe my shoes are outside").	Self	3.51	.81	-1.73	2.40
Q2. Realizes that experts are more knowledgeable than others in their specialty (e.g., understands that doctors know more than others about treating illness).	Other	3.34	.78	-1.08	0.76
Q3. Can tell you how s/he found out about things (e.g., "Sally told me about it"; "I saw it happen at the park"; "I heard it on the radio").	Self	3.67	.63	-2.17	4.98
Q4. Is good at playing "hide and seek" (e.g., is hard to find, does not make give-away noises).	Other	3.11	.97	-0.86	-0.30
Q5. Talks about teaching and learning (e.g., says "My dad taught me how to play that game"; "I learned that song at daycare").	Self	3.67	.62	-2.03	4.05
Q6. Is good at explaining things to younger children	Other	3.17	.80	-0.84	0.38
Q7. Talks about what people know or don't know (e.g., "I know who it is"; "He doesn't know where his ball is").	Both	3.63	.63	-1.78	3.25

Table 4. The correlations between the knowledge subscale CSUS items, children's age, gender, and performance on the self-knowledge and other-knowledge tasks.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. PK1	-									
2. PK2	.324***	-								
3. PK3	.332***	.359***	-							
4. PK4	.144**	.265***	.249***	-						
5. PK5	.384***	.337***	.569***	.335***	-					
6. PK6	.212***	.383***	.340***	.348***	.432***	-				
7. PK7	.411***	.415***	.543***	.259***	.528***	.388***	-			
8. Age	.134**	.249***	.158**	.283***	.249***	.330***	.199***	-		
9. Gender	n.s.	n.s.	n.s.	n.s.	-.127*	n.s.	n.s.	n.s.	-	
10. SK	.203***	.308***	.211***	.191***	.276***	.297***	.234***	.517***	-.150**	-
11. OK	.226***	.209***	.155**	.213***	.291***	.272***	.201***	.529***	n.s.	.543***

Note: PK1 through PK 7 represent the parent report questions as numbered in Table 3. SK equals the self-knowledge task, and OK equals the other knowledge task. Children's gender was coded as Female = 1.

Table 5. The percent correct picture-choice and average certainty rating by trial.

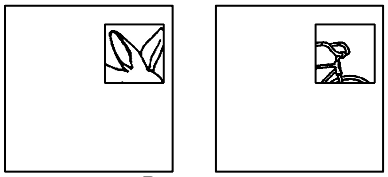
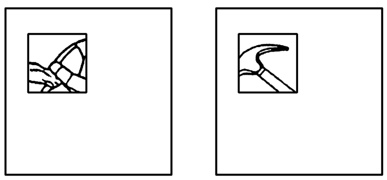
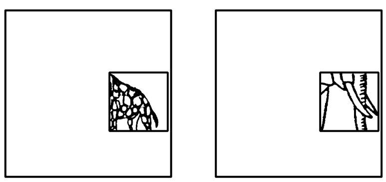
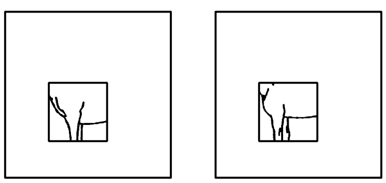
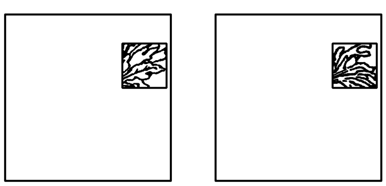
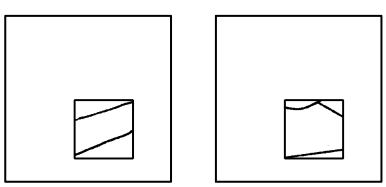
Trial	Trial Type	% Correct Picture Choice	Average Certainty Rating (0 to 2)
 Bunny	Easy	97%	1.58
 Turtle	Easy	97%	1.59
 Elephant	Easy	99%	1.60
 Horse	Hard	54%	1.30
 Carrot	Hard	45%	1.32
 Bed	Hard	51%	1.18

Table 6. The correlations (and partial correlations) between variables

Variables.	1	2	3	4	5	6
1. Age	-					
2. Gender (female = 1)	n.s.	-				
3. Self-Knowledge	.529***	.258***	-			
4. Other-knowledge	.450***	.144*	.568*** (.451***)[b]	-		
5. CSUS-Self Score	.265***	.167*	.411 (.282***)[b]	.345 (.257***)[b]	-	
6. PK1[a]	.184**	n.s.	.256 (.140*)[b]	.305 (.258***)[b]	.764*** (.733***)[b]	-
7. Certainty Difference Score	.329***	n.s.	.352*** (.236***)[b]	.279*** (.177*)[b]	.161* (n.s.)[b]	.166* (.136*)[b]

Note. n.s. = nonsignificant, * $p < .05$, *** $p < .001$

[a] The parent-report question as reported on Table 3.

[b] The partial correlation controlling for age and gender.

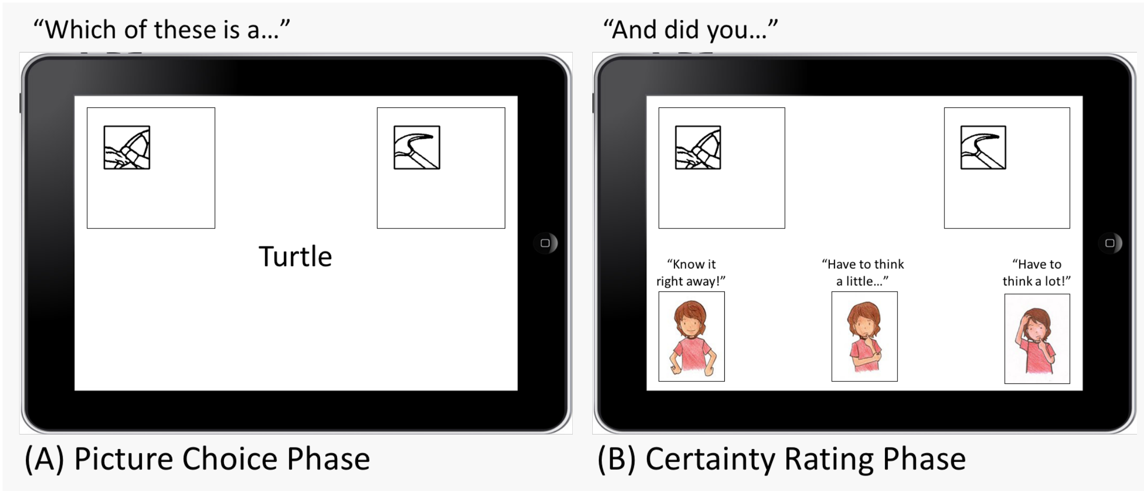


Figure 1. A diagram of the (A) Picture Choice Phase and the (B) Certainty Rating Phase of the certainty monitoring task.

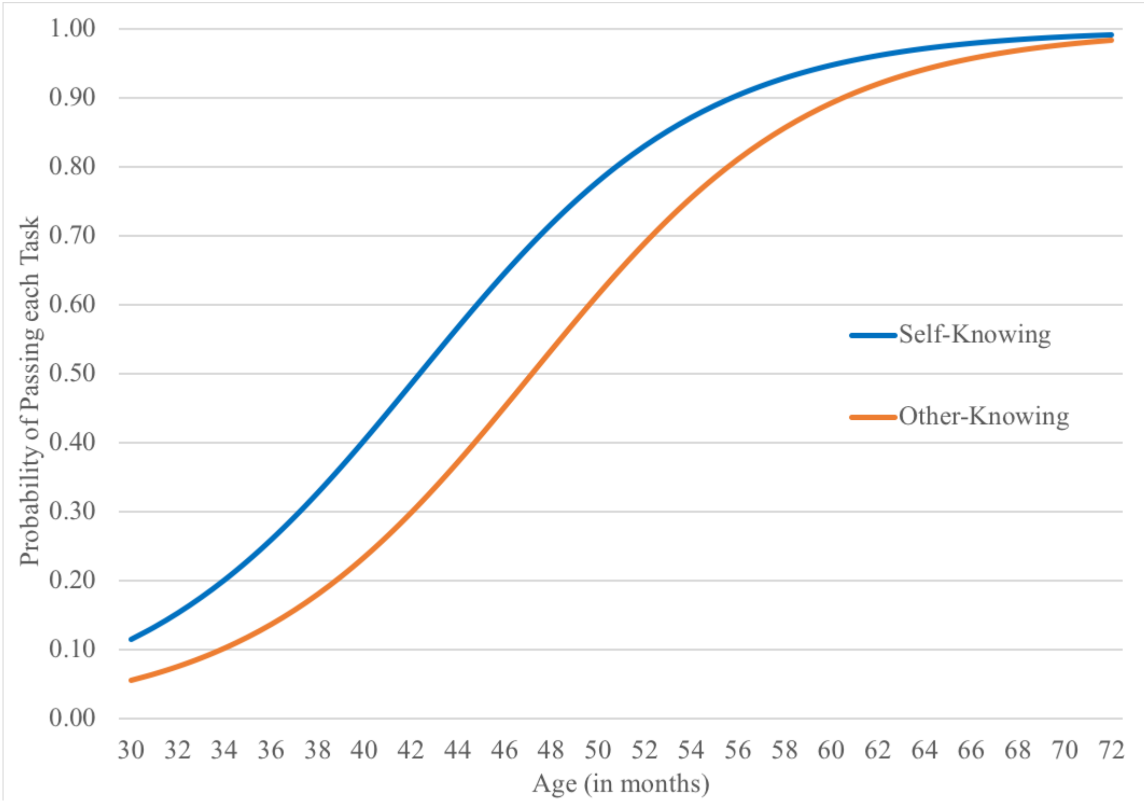


Figure 2. The predicted probability of passing the self- and other knowledge tasks by age (in months).

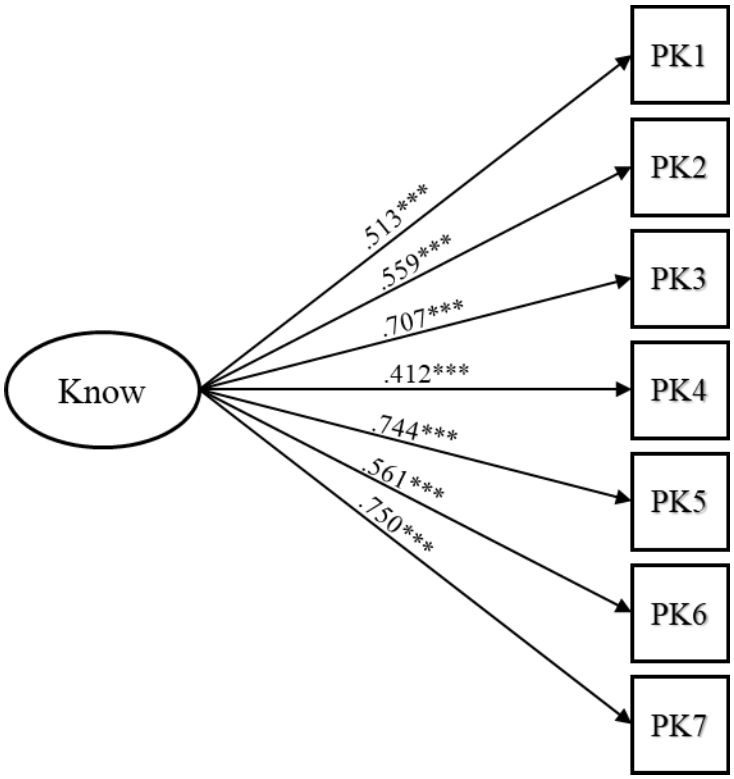


Figure 3. The path model for a confirmatory factor analysis consisting of a single latent factor ("Know") representing a general theory of mind ability as measured by the seven parent-report questions (PK1 through PK7 as numbered in Table 3) in the knowledge subscale of the CSUS. All paths are significant at $p < .001$.

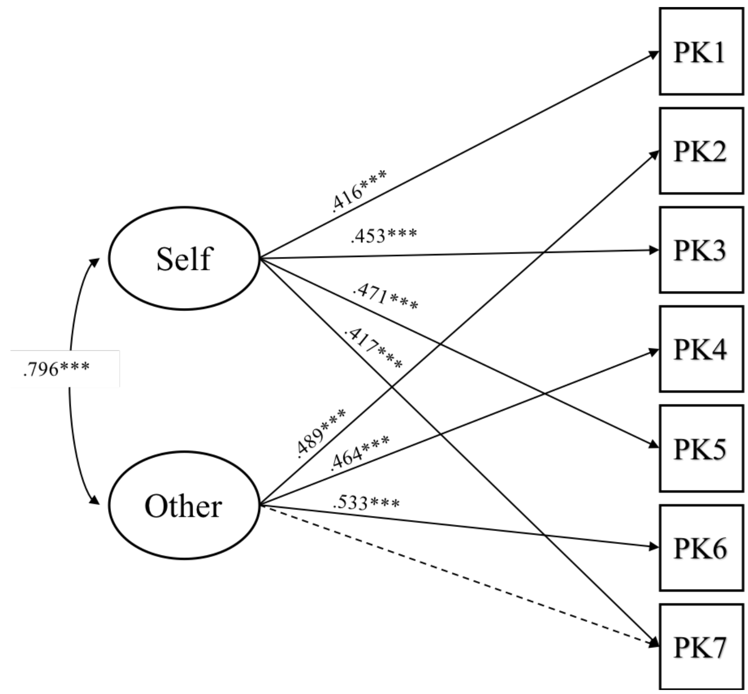


Figure 4. The path model for a confirmatory factor analysis consisting of two latent factors for self and other.. The first latent factor ("Self") extracts the commonality from four parent report questions that asked about self-knowledge (PK1, PK3, PK5, and PK 7 as noted in Table 3). All paths from the Self factor are significant at $p < .001$. The second latent factor ("Other") extracts the commonality between the four parent-report questions (PK2, PK4, PK6, and PK7) which contain information about children's understanding of others' knowledge states. All paths from the Other factor except for PK7 were significant at $p < .001$. The correlation between the Self factor and the Other factor was significant at $p < .001$.

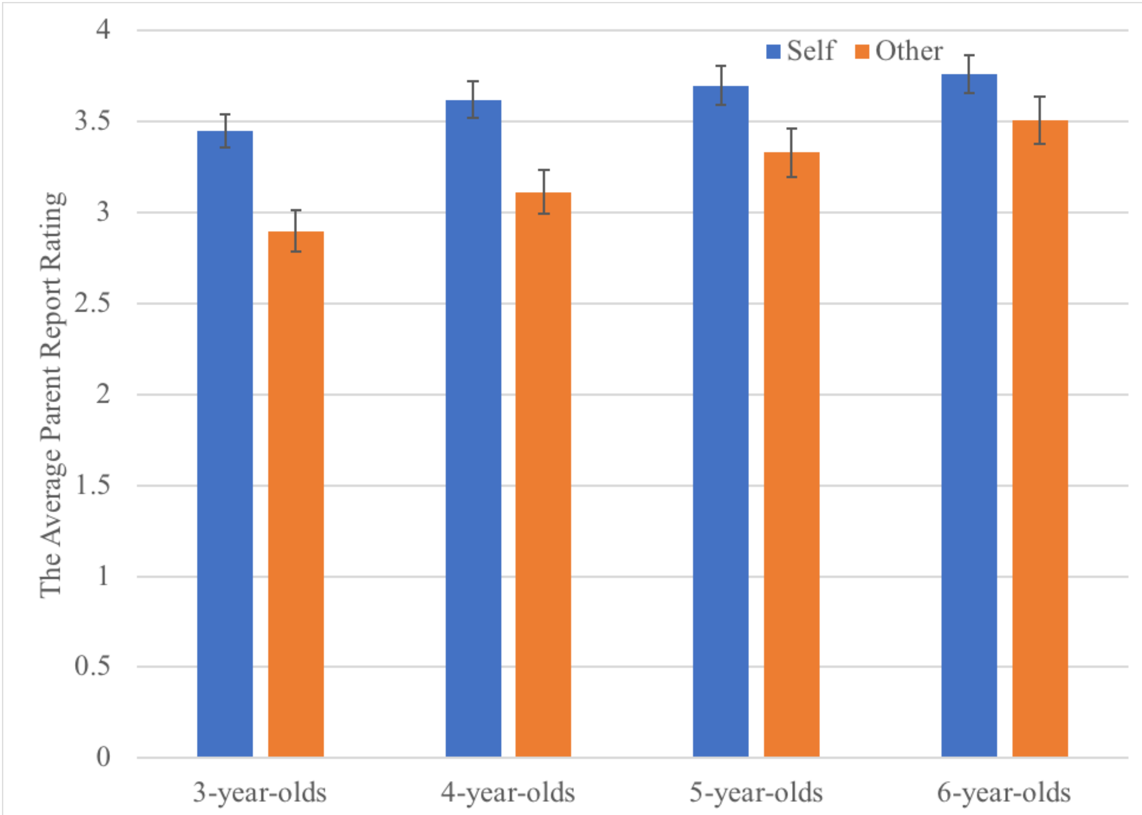


Figure 5. The relation between parent's average ratings on the self- and other-questions of the knowledge subscale of the CSUS and children's age.

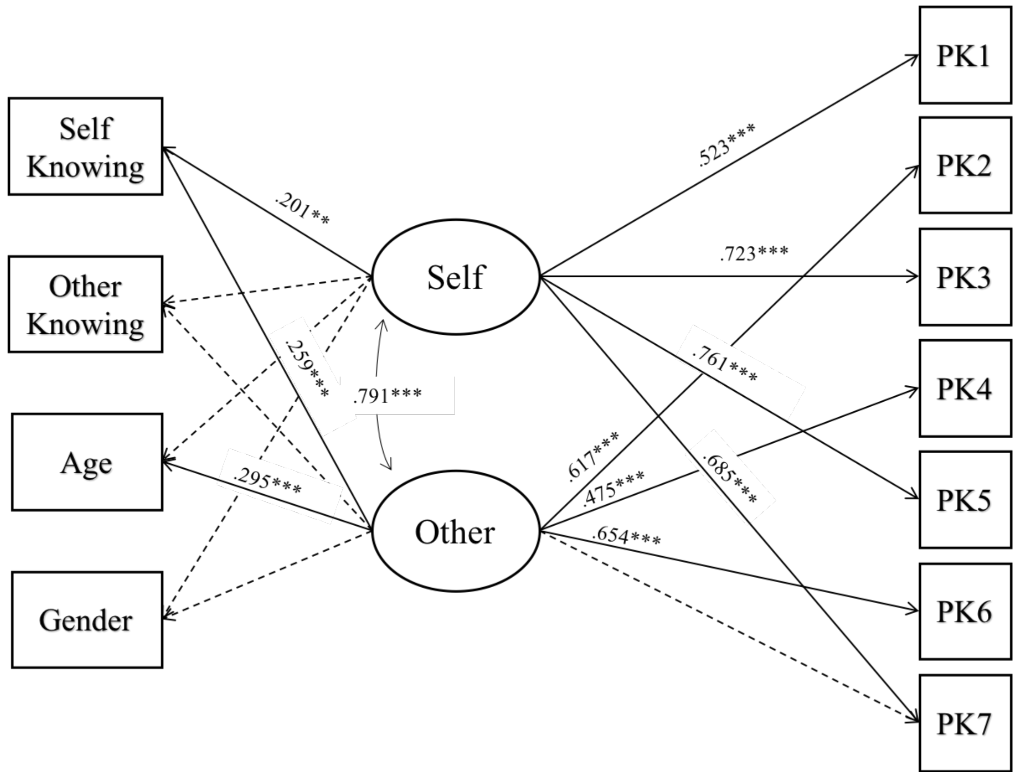


Figure 6. The path model for a structural equation analysis of the relation between the Self and Other latent factors measured from the oblique two-factor model of the parent report data from the knowledge subscale of the CSUS and children's age, gender, and performance on the self- and other-knowledge tasks. The path from the self-factor of the parent report data to children's performance on the self-knowledge task was significant at $p < .01$, and the path from the other-factor of the parent report data to children's performance on the self-knowledge task and children's age was significant at $p < .001$.

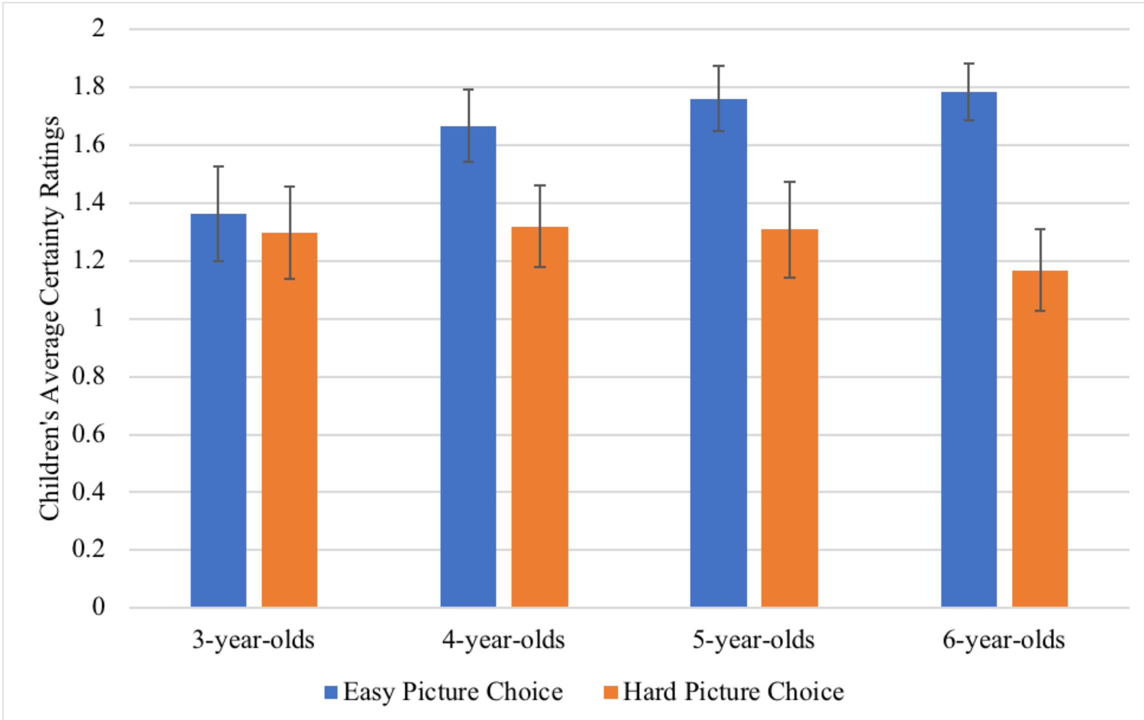


Figure 7. The relation between children's average certainty ratings on easy and hard picture choices by age group.

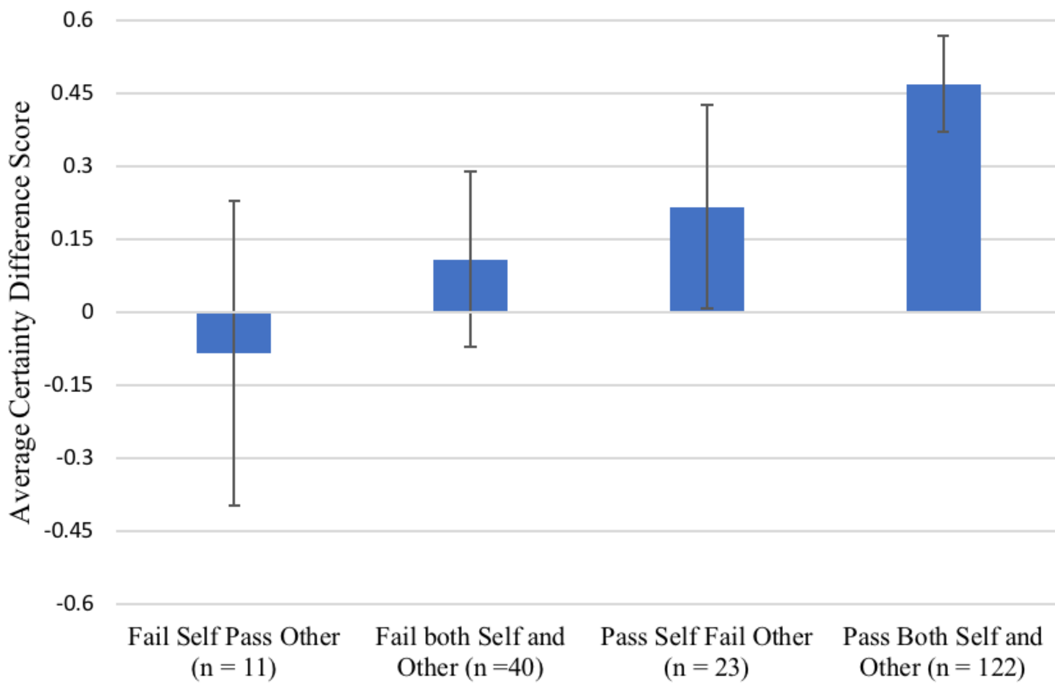


Figure 8. The estimated mean certainty rating difference scores by performance on the self- and other-knowledge tasks controlling for age and gender