



Infants' and toddlers' reasoning about others: Connections to prosocial development and language

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Infants' and toddlers' reasoning about others:
Connections to prosocial development and language

A dissertation presented
by
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to
The Department of Psychology

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Abstract

Often overlooked in the study of theory of mind (ToM) development, the understanding of motivational states, such as goals and desires, is both important in its own right and also a likely precursor to more advanced social and cognitive skills. This dissertation explored infants' and toddlers' reasoning about agents' motivational states, linking those representations to the domains of language and prosocial development.

Parts I and II of the dissertation asked about toddlers' abilities to use representations of others' motivational states to guide helping behaviors. Part I used a spontaneous helping paradigm with two goal objects, one previously liked and the other disliked. Three- but not 2-year-olds helped appropriately by giving an actor her desired object, reflecting prosocial concern for others' specific desires at age 3. Part II probed the understanding of goals and helping of 14- and 24-month-olds. After establishing that toddlers encode simple reaching actions as goal-directed, a series of 4 experiments using an object-giving paradigm investigated toddlers' abilities to use goal representations to guide helping. The results indicate that 24- but not 14-month-olds used representations of prior goals to inform their helping behaviors; 14-month-olds were capable of using only current goals to guide helping.

Part III of the dissertation asked whether there is continuity in the developmental relationship between language and ToM by investigating links between toddlers'

understanding of motivational states and their vocabulary size. Experiment 1 found no correlation between the vocabulary size of typically hearing toddlers and their performance on tasks measuring motivational state understanding. Experiment 2 compared the same motivational state understanding of typically hearing toddlers and deaf toddlers with smaller vocabularies, finding no differences in performance between groups. The results of these experiments indicate that the link between language and false belief that is present at age 4 does not extend to motivational state reasoning in the toddler years.

Together the findings of this dissertation highlight important limits and boundary conditions on young children's reasoning about motivational states. Further research is needed into the developmental trajectory and mechanisms of theory of mind reasoning.

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Introduction

Overview

As humans we constantly and automatically attribute mental states to others to explain their behavior. Without a theory of mind (ToM), we would be lost in interpreting jokes, movies, literature and our spouses. The study of ToM is important both theoretically, in terms of delineating what makes us uniquely human, and practically, in its implications for social and educational competency.

Within developmental psychology, research on ToM has been a dominant topic of inquiry for the past several decades (Premack & Woodruff, 1978; Wimmer & Perner, 1983). Researchers have sketched a picture of ToM development that began with gaze following, engagement in joint attention, and goal understanding in the first year of life, followed by an understanding of others' desires, knowledge states and true beliefs in the second and third (Poulin-Dubois, Brooker & Chow, 2009). For many years, the greatest challenge to ToM researchers was how to explain the dramatic shift around the fourth birthday in children's ability to reason about false beliefs (Wellman, Cross & Watson, 2001).

With the recent barrage of findings that even infants reason about agents' actions in terms of their mental states including false beliefs (for a review see Baillargeon et al., 2014), attention has shifted to the infant and toddler years in an attempt to characterize the earliest ToM competencies and reconcile findings of infants' precocious abilities with toddlers' shortcomings in explicit false belief reasoning. The questions that loom largest are those that apply to many areas of human cognition in general. What accounts for the differences between implicit and explicit reasoning? Where are there continuities and

discontinuities between abilities present in infancy and mature reasoning abilities? What is innate, what is dependent on experience, and how does experience impact development? This dissertation, though modest in its efforts to provide insight into these questions, is nonetheless inspired by these large questions as they relate to the domain of ToM development.

Methodological advances in the past several decades have allowed researchers to probe the extent of knowledge of younger and younger infants. Using looking time measures and other measures that require no overt response from the infant, scientists have detected a wealth of sensitivities to the intricacies of the physical and social world possessed by pre-linguistic infants. While it is tempting to claim that infants are all but omniscient and that what develops over the first few years of life are only executive functioning abilities and cultural-specific knowledge, it is worth paying attention to the limits of infants' and young children's knowledge and abilities. This dissertation probes these limits and focuses on young children's abilities to act on their representations of agents.

In this dissertation I investigate early ToM abilities as they relate to other domains of development—namely, language and prosocial development. Part I probes toddlers' abilities to consider an actor's object preferences when engaging in spontaneous helping. Part II extends this question to younger toddlers in an elicited helping paradigm following familiarization to simple goal-directed reaching events. Part III asks whether the relationship between language and ToM that is so strong in the preschool years is present in infancy. I begin by sketching the current understanding of ToM development and outlining outstanding open questions.

Theory of mind: theories, mechanisms and questions

ToM development in the preschool years. Despite debate over the mechanisms of ToM development, the basic phenomenon and developmental sequence of mental state reasoning had been relatively agreed-upon until recently. False belief reasoning appears around age four (Wellman et al., 2001), preceded by an understanding of true beliefs, awareness of the links between perception and knowledge, a grasp of others' desires (Wellman & Liu, 2004), and a notion of goals and intentions (Meltzoff, 1995; Woodward, 1998). The main dispute over ToM development focused on how these abilities develop, with two major camps arguing for emergence accounts on the one hand (Apperly & Butterfill, 2009; Carey & Spelke, 1994; Gopnik & Wellman, 1994; Wellman et al., 2001), wherein conceptual change occurs in children's theories of others' minds, and expression accounts on the other (Leslie, 1994; Leslie & Polizzi, 1998; Song, Onishi, Baillargeon & Fisher, 2008; Surian, Caldi & Sperber, 2007), which posit that changes in ToM ability stem from improvements in domain general cognitive skills that allow children's to express their existent understanding of others' minds.

In the domain of false belief reasoning, the fact that before children pass false belief tasks they perform *below chance* rather than *at chance* had been one of the most compelling and puzzling aspects of ToM development (Wellman et al., 2001). This sudden, rather than gradual change, has also been used as evidence of a discontinuity in the development of false belief reasoning, suggesting that children's theories of other's mental states may undergo significant conceptual change between ages 3 and 5. Indeed, researchers argue that the pattern of findings, wherein age is the most powerful variable

influencing performance across variation in task demands and types of tasks, supports emergence accounts rather than expression accounts (Wellman et al., 2001).

False belief reasoning in infancy. While these changes in young children's abilities to reason explicitly about others' minds constitute a real phenomenon, recent findings have called into question whether similar representations might be present, though not available to conscious awareness, from as early as the first year of life. The body of research on false belief reasoning in infancy is rapidly growing and diversifying to include new kinds of tasks and to present infants with new agents and events (for reviews see Baillargeon et al., 2014 and Poulin-Dubois et al., 2009). The seminal finding by Onishi and Baillargeon (2005) that 17-month-old infants interpreted an agent's reaching actions in light of her belief state has been replicated and extended to different kinds of events (Trauble, Marinovic & Pauen, 2010; Yott & Poulin-Dubois, 2012), to non-human agents (Meristo et al., 2012; Surian et al., 2007; Surian & Geraci, 2012), to beliefs about identity (Scott & Baillargeon, 2009) and beliefs about contents (He, Bolz & Baillargeon, 2011). This converging evidence of belief reasoning in infancy has become increasingly convincing and harder to dismiss with low-level explanations (Perner & Ruffman, 2005; Perner, 2010; Povinelli & Vonk, 2003).

Theories of ToM development. In light of the evidence of genuine change in children's ToM in the preschool years and the evidence that even infants reason about others' beliefs, the burning question is how both things can be true. Here I consider how each of the major schools of thoughts have attempted to accommodate the recent findings on infant false belief reasoning.

Hypothesis 1: expression. Under this hypothesis, the apparent growth in mental state reasoning in the preschool years does not reflect actual conceptual change, but rather growth in children's ability to express their understanding of other mental states. According to many accounts, the apparent change in ToM reasoning actually stems from maturation of executive functioning abilities (Baillargeon, Scott & He, 2010; Leslie, German & Polizzi, 2005).

If the expression hypothesis is true, it is relatively easy to explain the findings of sophisticated belief reasoning in infancy; the infant false belief findings simply demonstrate what expression accounts predicted all along—that false belief reasoning is present early in life, but masked by infants' immature executive functioning skills in highly-demanding explicit judgment tasks.

Baillargeon and colleagues (Baillargeon, Scott & He, 2009; Song et al., 2008) have proposed a fine-grained analysis of the texture of early psychological reasoning, positing that two systems are operational in infancy. The first, *Subsystem 1*, allows infants to reason about motivational and reality-congruent states like goals, intentions, preferences, desires, and knowledge. *Subsystem 2* encompasses reasoning about reality-incongruent states such as false beliefs and pretense. These researchers contend that *Subsystem 1* comes online within the first year of life, while *Subsystem 2* becomes operational sometime in the second year.

De Bruin and Newen (2012) have proposed a two-system account of a different flavor, involving an early acquired association module that allows infants to register others' actions towards objects, and an operating system that enables transformations of these representations. Critically, these two systems interact from early in infancy to allow

infants to compute a variety of representations of others' motivations, perceptions, actions and beliefs.

Expression accounts assume that ToM abilities in both infancy and the preschool years are undergirded by a common conceptual system. Therefore, the representations of mental states present in infants and preschoolers are of fundamentally the same kind, in terms of the format of representation, the mechanisms of development, and/or the ability to interact with other aspects of cognition (such as language and executive functioning).

Hypothesis 2: emergence. Accommodating the evidence on infant false belief reasoning has proved more challenging for the constructivist camp. A number of accounts have emerged positing two systems for reasoning about others' minds—one present in infancy and another which emerges in the toddler/preschool year (Apperly & Butterfill, 2009; Doherty, 2006; Sodian, 2011). According to these theories, the first system, which is present in infancy, is fast, automatic, and inflexible and produces outputs that are unavailable to conscious awareness. The second system emerges later in the toddler years and is slower, requires more computational power, is more flexible, and allows for explicit judgments. These two system accounts are not unfamiliar; they have been used to explain cognitive development in other domains such as number, as Apperly and Butterfill (2009) describe.

Sodian (2011), like Baillargeon and colleagues (Baillargeon et al., 2009; Song et al., 2008) adheres to the claim that there are two distinct systems underlying children's mental state reasoning—Conceptual System 1 (CS1), which computes representations about intentional action and reality-congruent states; and Conceptual System 2 (CS2), which critically is representational in nature, allowing for the attribution of reality-

incongruent states like false beliefs. Unlike Baillargeon, however, Sodian disputes the claim that CS2 is operational in infancy. The existence of two such distinct systems, with a division between representations of reality-congruent and reality-incongruent mental states, would predict, at least at some point in development, a dissociation between desire understanding and false belief reasoning.

Critically, unlike the two systems proposed by those in favoring an expression account of ToM development, the nature of the systems specified by emergence theories are fundamentally different. That is, emergence accounts allow for qualitative differences between the two systems in terms of format, mechanisms of development, and/or interaction with other aspects of cognition. Whether there are in fact two ToM systems, what sorts of representations each system governs, and the existence of qualitative differences between these systems are all empirical questions subject to investigation.

Interrelations between ToM abilities. Surprisingly little research has centered on the relationships between performance on tasks tapping different ToM abilities. What are the structures of the system(s) governing reasoning about others' minds, whether the representations in question involve intentions, desires or beliefs? In as much as different ToM abilities belong to the same system of psychological reasoning, performance on tasks tapping those abilities ought to be related. The evidence, however, is somewhat mixed.

Around the first birthday, the ability to engage in declarative pointing and the ability to attribute intentions based on failed actions appear to be related (Camaioni, Perucchini, Bellagamba & Colonesi, 2004). Looking time measures of goal understanding at 10 months and imitation tasks tapping intention understanding at 14

months have been found to be related longitudinally but not concurrently (Olineck & Poulin-Dubois, 2007). And there is very limited evidence of a relationship between a looking time measure of false belief reasoning and an understanding of intention based on failed actions at 18 months (Yott & Poulin-Dubois, 2012).

Between ages 2 and 4, Carlson, Mandell and Williams (2004) found that at age 2, desire and intention understanding were correlated even when controlling for age, sex and verbal ability. At age 3, the same correlations were found for tasks measuring understanding of the pretense-reality and appearance-reality distinctions. Assessing a range of ToM abilities encompassing understanding of pretense, deception and false beliefs, Hughes and Ensor (2007) found performance on these tasks to be somewhat related at age 2, and more strongly related at ages 3 and 4. Some studies have found correlated performance on tasks measuring understanding of false beliefs, representational change and the appearance-reality distinction around age 4 (Gopnik & Astington, 1988; Moore, Pure, & Furrow, 1990).

Based on the evidence just described, it appears that cohesion between ToM abilities increases with age. Still, the full picture of the relationships between constituent ToM abilities is yet to be established and requires further investigation, especially in the infant years.

Sequence of emergence. There is evidence for a regular sequence of development of ToM competencies, supporting the possibility that later-emerging abilities are dependent on and continuous with earlier abilities. Wellman and colleagues have demonstrated that ToM abilities emerge according to a stable progression. In a group of children aged 2;11 and 6;6 (Wellman & Liu, 2004), an understanding of

divergent desires emerged earliest, followed by an understanding of how knowledge is generated through perceptual access. Older children reasoned successfully about false beliefs in various contexts, while complex understanding of emotions appeared later still. The incremental emergence of ToM abilities is well-supported by this evidence, and suggests there is important change occurring in children's mental state concepts between ages 2 and 4 years. This developmental progression in mental state reasoning appears to be similar across cultures (Shahaeian, Peterson, Slaughter & Wellman, 2011; Wellman, Fang, Liu, Zhu & Liu, 2006; Wellman, Fang & Peterson, 2011) and in populations with different language abilities (Peterson & Wellman, 2009; Wellman, Fang & Peterson, 2011). A similar ordering of the ToM competencies available in the first two years of life, including implicit false belief reasoning, has yet to be established.

Longitudinal relationships in ToM development. Another question concerns whether early and later ToM abilities emerge independently of one another or are scaffolded upon one another. Longitudinal work suggests there is some dependency of later abilities upon earlier competencies. Studies by Wellman and colleagues have demonstrated that the social attention abilities of infants from 6 to 14 months are related to their preschool explicit ToM reasoning (Wellman, Phillips, Dunphy-Lelii & LaLonde, 2004), and this relationship remains stable even when controlling for IQ and verbal ability (Wellman, Lopez-Duran, LaBounty & Hamilton, 2008; Aschersleben, Hofer & Jovanovic, 2008). Specifically, infants' decrement of attention to habituation trials of a human agent's goal-directed reaching is correlated with their later false belief understanding. Another study expanded on these findings by predicting toddler false belief reasoning from infants' performance on an anticipatory looking false belief task

(Thoermer, Sodian, Vuori, Perst & Kristen, 2011). A third study found that infants' imitation of intention actions predicted their later understanding of intentions at age 4 (Olineck & Poulin-Dubois, 2007). Charman and colleagues (Charman, Baron-Cohen, Swettenham, Baird, Cox & Drew, 2000) conducted a comprehensive study attempting to link purported precursors of preschool ToM to later actual ToM abilities. Among their findings was a link between certain joint attention behaviors at 20 months and performance on a battery of ToM tasks at 44 months. Importantly, the ToM battery included measures of perspective taking, seeing-knowing and desire-based emotion understanding, all of which are outside the domain of false beliefs.

The fact that longitudinal ToM relationships holds across task types (from looking time to imitation to explicit reasoning) and across type of mental state concept is especially compelling evidence for the possibility of a unitary ToM system. Clearly more research is needed to fully catalog the longitudinal relationships between early and later ToM, but these initial findings are at least suggestive of a common underlying construct of mental state reasoning, with dependencies between earlier and later abilities.

Mechanisms of change in ToM. Regardless of the structure of the ToM system(s), a comprehensive theory of ToM development should describe the mechanisms of change in children's abilities to reason about and express mental state understanding. Most expression accounts of ToM development carve out a critical role for executive functioning abilities, whether in terms of selection between representations and actions, inhibition of default representations and actions, or both (e.g. Baillargeon et al., 2009; Leslie, German & Polizzi, 2005). Indeed, individual differences in executive functioning are related to individual differences in ToM reasoning (Carlson, Mandell & Williams,

2004; Carlson & Moses, 2001). Though a full exploration of executive functioning is beyond the scope of this dissertation, it is important to note that executive functioning is likely critical to both the development of ToM and to the ability to make explicit judgments about mental states.

It is quite possible that executive functioning operates in conjunction with language as a mechanism of change in ToM development. There is evidence that language plays a number of roles in supporting ToM reasoning, both generally and in terms of FB specifically. Considerable debate has focused on the relative contributions of various aspects of language to the development of false belief reasoning, with several strong candidate mechanisms likely playing unique roles. Harris, de Rosnay and Pons (2005) nicely sum up the possibilities: “mentalistic comments contain distinctive words (e.g., *think* and *know*), grammatical constructions (e.g., embedded propositions), and pragmatic features (e.g., the enunciation of individual perspectives).” (p. 71).

One theory that is a likely candidate for continuity of mechanism in ToM reasoning is that of language as enabler of conversational exchanges that grant the child access to others’ perspectives (Harris et al., 2005). Conversation, unlike semantics of mental states and complex syntax, is available even to preverbal infants. Joint attention, with its proto turn-taking and shared reference, may form the template for later linguistic conversation and provide the infant with early experiences of attending to others’ perceptions, attention, and intentions. As such, it is reasonable to posit that inasmuch as early vocabulary reflects experience with joint attention and proto-conversations, vocabulary may support the child’s understanding of intentional action and of gestural communication, as measured in the Part III of this dissertation.

Motivational state reasoning

Because the false belief test is the clearest marker of having acquired a representational ToM, most research has focused on this task. The milestone of passing explicit false belief tasks is preceded by other accomplishments in ToM development, such as understanding others' perceptions and how they lead to knowledge, inferring others' intentions, computing diverse desires, and reading others' emotions. The abilities present before FB reasoning are important in their own right as valuable social skills and also as potential building blocks of more complex abilities, both within and outside of the domain of ToM.

Defining motivational state concepts

Here it is helpful to clarify what is meant by *intention*, *goal*, *desire* and other such terms. Wellman and Woolley (1990) define *drive* and *simple desire* as two distinct states: "drives describe the organism's internal physiological state (e.g., he's hungry; she's thirsty); simple desires describe a specific object (or event or state of affairs) that is sought" (248). The authors further note that "both drives...and simple desires...are descriptive of motivational forces behind a potential action" (248). Both of these may differ from goals, which can be thought of as desires in action.

Searle (1980) critically distinguished between prior intentions and intention in action. Roughly, action is driven by some current intention and the intention in this action may be causally related to a prior intention. These two concepts, while inextricably linked, are nonetheless separate and separable things; one can have an intention and not act on it, and one can act intentionally without that action being connected to a prior intention. Prior intention and intention in action may map onto an internal state of goal or

desire and an external manifestation of such a state, respectively. Desire, like a prior intention, can exist purely internally, never being acted on, but when it is, we say that someone's behavior is goal-directed. Just as these two notions may be distinct philosophically, they may also be separate concepts for developing infants. Specifically, infants may understand intentions in action before they understand prior intentions, making assumptions about agents' behavior without positing anything about the internal states driving that behavior. Similarly, infants may understand goals in terms of behavioral tendencies before they understand the internal states, namely desires, that motivate them.

The development of motivational state understanding. *Joint attention* constitutes one of the infant's earliest and most powerful social competencies (for overviews see Moore & Dunham, 1995; Prezbindowski Adamson & Lederberg, 1998). Before 6 months of age, infant and caregiver engage in interactions that regulate attention and emotion through shared gaze and contingent vocal interactions. Around 9 months, the infant's attention is increasingly focused on objects in the environment and engages in supported joint attention, where the caregiver facilitates the infant's attention to objects. Supported joint attention gives way to coordinated joint attention, in which the infant is able to shift their attention between the object and their social partner, creating a triangle of attention. With coordinated joint attention skills firmly in place, the caregiver begins to introduce words and gestures that refer to objects and events in symbol-infused joint attention episodes. These episodes pave the way for word learning and further social development.

In the domain of *goals*, a vast body of research with infants suggests this understanding is in place in the first year of life, at least implicitly. Amanda Woodward pioneered the field of infant goal understanding, developing a powerful paradigm for assessing whether infants encode agents' actions as directed at a particular location or at a particular object. Using this paradigm in habituation studies, Woodward has shown that as young as 5 months, infants expect that intentional behavior, such as reaching, to be directed at objects as opposed to locations in space (e.g. Woodward, 1998). By 12 months infants recognize that some actions are subordinate in a larger plan of achieving a goal (Sommerville & Woodward, 2005). Importantly, infants appropriately expect that object goals will not generalize across individuals, even as they expect that labels for those objects will (Buresh & Woodward, 2007; Henderson & Woodward, 2012).

In recent years Luo and colleagues have expanded on Woodward's findings to include an understanding of others' *preferences*. Luo and Choi (2012) define *preference* as "a dispositional state that explains why an agent chooses a particular goal-object in the presence of another option." This definition purposely ascribes a mentalistic stance in preference understanding, but infants may understand preferences as a behavioral tendency rather than internal disposition motivating action. In a series of papers, Luo and colleagues demonstrated that infants assume an agent's actions are directed preferentially towards a particular object only when that action is undertaken with awareness of the presence of a second object (Luo & Baillargeon, 2007; 2010; Luo & Johnson, 2009). Furthermore, Luo and Beck (2010) demonstrated that 12-month-olds are able to consider how an agent's perceptions guide her goal-directed actions even when the agent's perceptions are different from the infant's.

In terms of *intention* understanding, imitation studies provide evidence that toddlers infer the underlying intent when reading agents' actions. By 18 months, toddlers are able to successfully complete an agent's intended act even when they have never seen that act completed successfully (Bellagamba & Tomasello, 1999; Meltzoff, 1995). Infants also read actors' intentions in interpreting their communicative acts (for a review see Akhtar & Tomasello, 2000), demonstrating the flexibility of infants' early intention understanding.

The most relevant study testing infants' ability to use cues to *desire* in fulfilling a request is that of Repacholi and Gopnik (1997), which uses affective cues to desires for food items. In this paradigm, which elicits infants' helping with an explicit request, 18- but not 14-month-olds handed the adult the food item she preferred rather than the one they themselves preferred in the critical conflicting-desires condition. An attempted replication of this finding by independent researchers did not produce the effect as robustly, suggesting that the ability to reason about another's desire, at least within the context of an object giving paradigm, may be just emerging around 18 months (Wright & Poulin-Dubois, 2012). By the third year children can reason about others' desires explicitly. Older 2-year-olds successfully predict a character's actions and emotions based on his prior desires and the actual outcomes, even when the character's desires conflict with their own (Wellman & Wooley, 1990).

Developmental mechanisms of motivational state reasoning: a role for language?

Just as the bulk of research on ToM has focused largely on explicit false belief reasoning, so too have investigations of the role of language in ToM development, establishing that language in general plays a facilitative role in the acquisition of explicit

false belief reasoning. Whether the relationships between language and false belief at age 4 extend to other aspects of ToM and are present earlier in development is an important topic of inquiry and one of the questions posed in this dissertation. Our understanding of the cohesion of ToM components and the longitudinal continuity of the ToM system(s) can be informed by evidence on the developmental relationships between various ToM abilities and language. That is, if motivational state reasoning and false belief reasoning are part of a single ToM system and continuous through the first few years of life, we might expect that language, as a developmental mechanism for ToM, would have a qualitatively similar relationship to many aspects of ToM and across development.

One clearly specified explanation of how language facilitates ToM development comes from Jill de Villiers and colleagues (de Villiers & Pyers, 2002; de Villiers & de Villiers, 2009). Under de Villiers' theory, the syntax of complementation, in which one proposition is embedded within another, enables the representation of false beliefs. For instance, the sentence "she thinks it's raining" contains a complement clause (*it's raining*) that could be true or false, even as the whole sentence is true. This construction may be the best way of expressing false beliefs and may also be the key to the child's conceptual understanding of false beliefs. Evidence for a contingent relationship between understanding of the syntax of complementation and success on false belief tasks has been replicated with typically developing children (Low, 2010), language-delayed deaf children (Schick, de Villiers, de Villiers & Hoffmeister, 2007) and children with specific language impairment (Miller, 2004).

While it is not clear whether de Villiers' theory of the facilitative role of language on ToM applies to other aspects of ToM, explanations of the relationship between

language and ToM focusing on the role of semantics and conversation clearly do apply to other kinds of mental state concepts. Having labels for any of the range of ToM concepts—seeing, knowing, feeling, wanting, etc.—could plausibly help children identify, juxtapose, and hold in mind the corresponding cognitive, motivational and affective states (Barsch & Wellman, 1995; Ruffman, Slade & Crowe, 2002; Taumoepeau & Ruffman, 2006; Taumoepeau & Ruffman, 2008). And engagement in conversations (de Rosnay & Hughes, 2006; Harris et al., 2005), which begins in infancy as joint attention episodes and early communicative exchanges, could confer some understanding of others' attentional states and perspectives.

There are few investigations of how language might influence or be influenced by ToM concepts that emerge prior to false belief reasoning. There is evidence that deaf children with hearing parents are delayed relative to their hearing peers in the understanding of diverse desires (Peterson & Wellman, 2009) and in the understanding that seeing and hearing lead to knowing (Peterson & Wellman, 2009; Schmidt & Pyers, in press). In the domain of joint attention, it is early social skills that predict later language development (Brooks & Meltzoff, 2005; Carpenter, Tomasello, Nagell, Butterworth & Moore, 1998; Kristen, Sodian, Thoermer & Perst, 2011; Mundy & Gomes, 1996; Tomasello & Farrar, 1986). Indeed, it may be that the earliest ToM competencies, such as intention understanding, facilitate language acquisition (Tomasello, 2001). Whether early language drives ToM or vice versa, if there is a relationship between motivational state understanding and language early in life we should find evidence for it in the studies in Part III of this dissertation.

When and how does ToM ability connect with reasoning in other (social) domains?

Another driving question behind this dissertation is whether young children's social interactions are informed by their representations of their social partners' mental states. Do ToM abilities that are present in the early toddler years, such as goal and desire understanding, interact with other abilities such as positive social interaction?

It is no coincidence that ToM and high levels of prosociality have both been proposed as uniquely human capacities (Penn & Povinelli, 2007; Saxe, 2006; Tomasello & Herrmann, 2010; Tomasello & Rakoczy, 2003). It is well established that individual differences in ToM ability are related to (Cassidy, Werner, Rourke & Zubernis, 2003; Watson, Nixon, Wilson & Capage, 1999) and predictive of (Caputi, 2012; Izard et al., 2001; Lane, Wellman, Olson, LaBounty & Kerr, 2010) differences in prosocial behavior, though the developmental relationships between these abilities are complex (for a review see Hughes & Leekam, 2004). Most of the existing research on the relationships between ToM and prosocial behavior, however, has investigated the roles of emotion understanding and false belief reasoning in the preschool and early school years. Parts I and II contribute to this body of knowledge by expanding links between ToM and prosocial development to include representations of preferences and desires.

One limitation of previous research is that there has not been systematic investigation of the kinds of motivational state concepts children use to guide their own acts of helping. While understanding of the actor's goal is inherently necessary for appropriate helping, characterization of this goal understanding is often underspecified. For instance, in Hamlin's work infants appear to reason about helping in scenes involving sophisticated goals such as opening a box or playing a game with a ball (Hamlin & Wynn, 2011). While it would seem infants must have successfully computed the agents'

goals in order to attribute dispositions to them, there is no evidence that 3-month-old infants understand the kinds of goals in question on their own, let alone in the context of a social exchange. Given that by one year of age infants understand others' preferences for objects, can infants around this same age incorporate motivational state representations into their helping interactions?

Several studies have demonstrated that infants and toddlers make sophisticated inferences about people's mental states in prosocial interactions. In an elicited food-giving paradigm, 18-month-olds give an actor her preferred food item, even when it conflicts with the infants' preference, demonstrating an understanding that desires can differ across individuals and that giving should be guided by the recipient's preference (Repacholi & Gopnik, 1997). As discussed above, however, this finding has failed to replicate with infants as young as 18 months, leaving us uncertain as to infants' abilities to represent and help based on subjective desires (Wright & Poulin-Dubois, 2012). In two studies, Buttelmann and colleagues have shown that 18-month-olds help others based on their beliefs, whether true or false, about both the location of desired objects (Buttelmann, Carpenter & Tomasello, 2009) or the actor's disposition towards the contents of a container (Buttelmann, Over, Carpenter & Tomasello, 2014). If these findings replicate in independent laboratories, we can be confident that infants are using complex representations of others' mental states to guide their helping behaviors.

Part I of this dissertation probed 2- and 3-year-olds' abilities to help selectively based on an actor's desire, as conveyed through emotional expressions. This paradigm, in which the child can help by giving one of two possible goal objects, tests whether children's helping is guided by an interest in completing superficial goals or by genuine

prosocial concern for the specific desires of others. To date no study has asked whether infants and toddlers can use action-based representations of goals to guide their helping behaviors. Part II asked this question of 14- and 24-month-olds, inspired by the simple goal understanding paradigm developed by Woodward and colleagues (e.g. Woodward, 1998).

Overview of the current work

Part I asked whether toddlers were motivated to address an actor's specific goal during an instrumental helping task. In the test phase of this task, the actor considered two objects, regarding one with positive affect and the other with negative affect. Both objects then fell out of the actor's reach and she reached ambiguously towards both objects. At this point we measured children's rates of helping—both overall, by giving the actor any object, and by selectively giving her only her preferred object. When children help selectively it indicates they possess both a mature representation of the actor's desire as well as a motivation to address the actor's specific goal, suggesting that helping is motivated by genuine prosocial concern (as opposed to an interest in seeing superficial reaching goals completed).

In Part I we found that 3-year-olds did indeed engage in selective helping, giving the actor her preferred object much more frequently than the disliked object. Two-year-olds, on the other hand, while engaging in similar rates of helping in general, did not help selectively. Based on the results of the current study alone we cannot determine whether 2-year-olds failed to help selectively because of a lack of understanding of the actor's preferences or a lack of motivation to be maximally helpful by addressing the actor's specific goal. In light of this significant change in the selective helping behavior between

the ages of 2 and 3 years, we argue that children's ability to incorporate representations of specific goals into their helping behaviors emerges during this time.

Part II used a simpler paradigm with younger toddlers to ask a similar question: can young toddlers use goal-directed reaching events to guide later helping behaviors? Critically, the events toddlers watched prior to the test trials are identical to those which elicit goal attributions. We can therefore reasonably assume that toddlers attribute a goal to the actor based on her pattern of past actions. The question is then whether toddlers use these goal representations to support their helping behaviors.

A series of four experiments with object giving as the dependent measure found substantial development in the ability to incorporate goal representations into helping interactions between the ages of 14 and 24 months. Older toddlers successfully gave the preferred object when the actor asked for help while under the same conditions younger toddlers gave objects at random. Younger toddlers succeeded in giving the preferred object however, when the actor was currently reaching towards that object. Indeed, when the actor's preference changed between familiarization and test toddlers' object giving was guided exclusively by the actor's current goal.

We thus conclude that between 14 and 24 months toddlers gain the ability to integrate representations of goals and helping interactions. This finding mirrors that of Part II; I argue that a qualitatively similar development process is occurring in both instances.

Part III asks whether early psychological reasoning abilities are related to language as is the case in the preschool years. Specifically, we ask whether young toddlers' understanding of intentions and communicative pointing are related

concurrently to the child's vocabulary size. If the early mental state reasoning skills available in toddlerhood are modular, then we should expect no relationship between vocabulary size and motivational state reasoning. If, on the other hand, there is continuity in the relationship between language and ToM such that even motivational state reasoning abilities are linked to language, there should be a connection between performance on motivational state reasoning tasks and vocabulary size.

Experiment 1 posed this question in an individual differences study with 17- to 20-month-old toddlers. We measured their expressive and overall vocabulary sizes, and probed their understanding of intentions and ability to engage in and understand pointing. We found no correlations between vocabulary and motivational state understanding, although there were positive correlations between the intention understanding and pointing tasks, suggesting both sufficient power to detect relationships among the tasks and a common conceptual core to these abilities.

Experiment 2 asked whether early differences in vocabulary size, specifically between deaf toddlers with hearing parents and typically hearing toddlers, would confer a difference in motivational state understanding as well. Despite significant differences in vocabulary size of the deaf and hearing groups of children, the two groups performed markedly similarly in understanding intentions and producing and comprehending communicative pointing gestures. We thus find no support for a relationship between vocabulary size and motivational state reasoning, supporting a discontinuity in the mechanism of development of early motivational state reasoning and later explicit ToM reasoning.

Part I

What do you want? Three-year-olds, but not 2-year-olds help with specific desires

Kathryn Hobbs and Felix Warneken

Abstract

Young children engage in acts of helping from a very early age. However, the cognitive and motivational bases of early helping behaviors remain in question. The current study asked whether 2- and 3-year-olds would help selectively based on the recipient's specific goal in a spontaneous helping paradigm. Children first saw an actor display contrasting emotions towards each of two objects. The objects were then accidentally knocked onto the floor and the actor ambiguously reached towards both objects. Results showed that 3- but not 2-year-olds helped selectively by giving the recipient's preferred object. We discuss these findings in light of children's understanding of goals and desires as well as their prosocial motivations.

Introduction

Children are inclined to help spontaneously from toddlerhood, handing objects to others, sharing toys, removing obstacles, and pointing to inform others (Warneken & Tomasello, 2009; Paulus, 2014). For example, children help by picking up and returning an object that a person accidentally dropped on the floor, showing that they are often inclined to help spontaneously (Warneken & Tomasello, 2006). Yet there remains much debate over what motivational and cognitive processes underlie these helping behaviors. Several possible explanations for children's early helping behavior have been proposed: 1) Early helping may be rooted in self-interest, 2) early helping could be based on a drive towards mere goal completion, or 3) early helping is actually driven by genuine prosocial concern. We will first examine the evidence for each hypothesis in turn and then describe how the current study is designed to distinguishing between these different hypotheses about the psychological processes underlying children's early helping behaviors.

In support of the first possibility, Svetlova, Nichols and Brownell (2010) have argued that early helping behaviors may be grounded in equal measure in selfish interest in the people and objects in question and in actual concern for others' needs. That is, children might not be moved primarily by trying to facilitate another person's success at a task or alleviating their distress, but may be inclined to act on the objects for their own enjoyment without much consideration of another person's circumstances. This concern is attenuated by the finding that starting at 14 months of age, children begin to detect whether a person actually requires help and respond appropriately. Specifically, at least in very basic control conditions where no help is needed because the agent does not show a failure in completing a goal, infants engage in the target behavior at a significantly lower

rate (and often not at all) than when help is needed in the experimental condition where the agent fails to achieve a goal (Warneken & Tomasello 2006, 2007; Warneken, 2013; Dunfield, Kuhlmeier, O'Connell & Kelley, 2011). Further evidence against helping as motivated solely by selfish interests comes from a study using pupil dilation to measure toddlers' sympathetic arousal in response to one of three outcomes when a person reaches for an object: the child helps, a third person helps, or no one helps. Toddlers who witnessed the adult receive no help experienced a higher increase in pupil dilation compared to those who were allowed to help the adult or witnessed a third person help the adult (Hepach, Vaish & Tomasello, 2012). Thus even passively witnessing another's goal completed results in a similar sympathetic response as doing the helping oneself, suggesting children really do care about the completion of others' goals and are not solely interested in interacting with people and objects in exchanges that merely resemble helping.

An alternative hypothesis is that early instances of instrumental helping might not necessarily be based upon a prosocial motivation to satisfy another person's need, but are instead based in infants' interest in seeing goal-directed actions completed (Kenward & Gredeback, 2013). If children's helping is motivated by mere goal completion, completion of the superficial instrumental goal should suffice (e.g. handing an object over to complement the action of an outstretched arm). Indeed, when in Hobbs and Spelke (under review), 14-month-olds were faced with an actor who in first showed a preference for one of two objects through repeated reaching, and then asked the infant to give them a toy without indicating which object she desired, infants chose at random. However, when the actor was concurrently reaching for one of the objects, 14-month-olds

successfully gave the preferred object. This finding leaves open at least two possible interpretations: 1) children want to address the recipient's underlying goal but are not sure of the appropriate helping response or 2) children are satisfied by completing an unsuccessful reaching action with *any* object. A variation of the second alternative is that infants just wish to terminate the unsuccessful action. That is, they might not attend to the specific goal the person is trying to achieve, but try to find a means to stop the unsuccessful reaching attempt.

Lastly, it may be that young children's helping responses are driven by a genuine prosocial concern. This may include a concern for the other's emotional wellbeing or a more pragmatic concern about enabling others to fulfill their intended goals. In the domain of harm and distress, toddlers certainly show the capacity for genuine prosocial concern as indexed by their sympathetic responses and their tendency to comfort others (Eisenberg, Fabes & Spinrad, 2006). However, this raises the question whether this prosocial concern is also the motivator for children's instrumental helping behaviors.

One way to gain traction on what motivations underpin early helping is to assess whether children tailor their helping to a person's personal preference. Numerous studies using looking time methods have demonstrated that infants reason about people's actions in terms of preferences for objects during the first year after birth (e.g. Woodward 1998, 2009; Luo & Johnson, 2009). By 18 months infants use an actor's expressions of emotion to determine her food preferences and give the correct type of food when they are asked to select between two possible options (Repacholi & Gopnik, 1997). While this last finding shows that toddlers seem to be able to compute others' preferences, it did not occur within a context that measured children's spontaneous helping behavior. It thus

remains an open question whether instrumental helping behaviors are underpinned by an understanding of another person's selective preference.

While research has shown that children are selective in their helping when deciding *whom* to help (e.g. Dunfield & Kuhlmeier, 2010; Vaish, Carpenter & Tomasello, 2010), little is known about children's decision about *how* to help. That is, less research has focused on whether toddlers can reason about the best way to help an individual when several goals are in question. Buttelmann, Carpenter and Tomasello (2009) reported that 18-month-olds do not blindly help a person to open a box that previously held a desired toy when the person is ignorant about the fact that the toy had moved to another box. Instead, they seem to disregard the person's useless attempt to open the first box and retrieve the toy from the second box. This indicates that children act with the person's ultimate goal of wanting the toy, and not the more proximate action of opening a box. Similarly, Martin and Olson (2013) asked how 3-year-olds would assist when an actor's surface goal (asking for a cup that happens to be broken) conflicted with their ultimate goal (filling a cup with water). Three-year-olds were able to consider the actor's ultimate goal and the functionality of the objects in question by handing over the functional rather than the dysfunctional object when the ultimate goal was to pour water. This is a strong demonstration that by three years of age children are able to help selectively by deciding which of several possible objects best fulfills the recipient's need. However, rather than a subjective desire, the physical properties of the situation dictate how to help appropriately; it is not clear whether children take into account a person's subjective goal when deciding how to help. Our research aims to address this question.

In the current study we ask not only whether young children can infer the recipient's general need for help, but also whether they can further specify that need as it relates to one of two potential objects of desire. Using an out-of-reach object task with two potential goal objects, we conveyed the recipient's specific object preference from her emotions displayed towards each object; the recipient displayed positive facial affect and tone of voice towards one object and negative affect and tone of voice towards the other. In test trials, no further information about the recipient's specific desire was available, but the child could help instrumentally by giving an object to the recipient. Not only does the successfully helping child have to be motivated to help, but she must also infer the appropriate *way* to help based on the recipient's specific desire.

If children preferentially give the desired object, it would suggest that they are motivated not by the superficial reaching goal of the recipient but rather by her underlying desire. This result would rule out an interest in the objects (hypothesis 1) or mere goal completion (hypothesis 2) as motivators of helping and thus provide evidence that toddlers' helping behaviors aim to address the underlying specific desire of the recipient (hypothesis 3). Alternatively, if children fail to differentiate between goal-objects, they either may not be able to represent the person's desire or may not be inclined to act in accordance with that desire.

Methods

Participants

The final data set consisted of $n=18$ 2-year-olds and $n=24$ 3-year-olds who helped in at least one test trial. Among 2-year-olds, an additional 29 children were excluded due to fussiness (13) or failure to help in at least one test trial (16). Among 3-year-olds, an

additional 14 were excluded due to fussiness (5), failure to help in at least one test trial (8) or disinterest in the study (1). Participants were all English dominant.

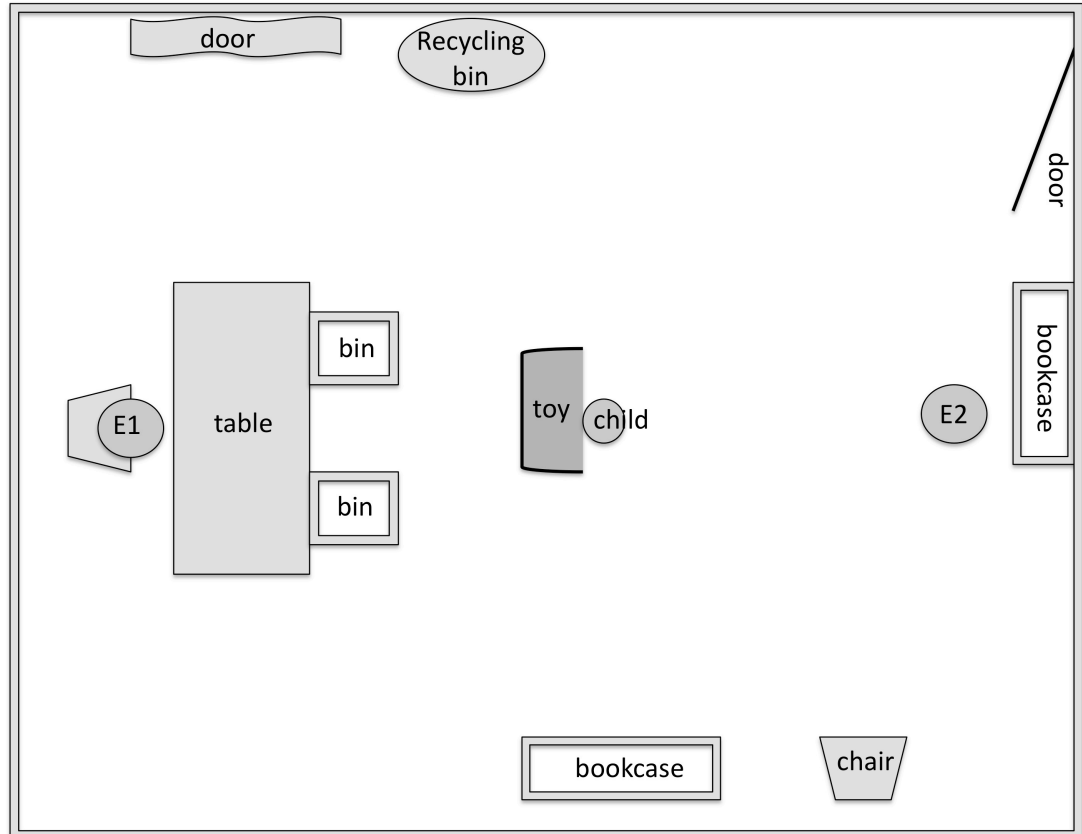


Figure 1: Diagram of the testing room measuring 3m x 6m.

Procedure

After playing for about 5-10 minutes in the waiting area, the child and E2 entered the testing room. The parents usually stayed outside and were in the room only when necessary for the child's comfort, in which case they sat passively in the corner. E2 showed the child the test objects while E1 was absent. The test objects were scattered on the floor, and E2 engaged the child in picking them up and putting them away in a box. As they went through the objects, E2 named each one in a neutral manner (e.g. "Here is a

brush."). This introduction was included to familiarize the children with the objects and indicate that they were allowed to touch them.

E1 then entered the testing room to demonstrate a closed jinglebox where children could send blocks down a chute into the box to create a musical sound. E1 encouraged the child to find other blocks around the room and put them into the jinglebox. This served several purposes: to familiarize children to the room, encourage them to move around and reach into the clear plastic bins, and to further build rapport with E1. E2 then put away the jinglebox and brought a ball ramp. Again E1 showed the child how the toy works, then taking leave to “do some cleaning” while the child could keep playing with the ramp.

During the *demonstration phase*, E1 sat at the table and the child played with the distracter. E2 first showed each object to the child, and then placed it on the table in front of E2, saying “here’s one.” E1 regarded each object with explicit preference language, facial emotion and tone of voice (e.g. “Oh yes, I really like that pen!” or “Oh no, I don’t like that pen”). E1 then placed the object in the appropriate location—her backpack for objects she liked, the clear bins below the table for objects she disliked. This phase consisted of two liked-object only trials and two disliked-object only trials.

During the *practice phase*, E2 continued presenting objects to E1, with E1 responding the same way as before to liked and disliked objects. In the practice phase, however, E1 accidentally knocked the *single* object off the table and out of her reach. Following this accident the procedure for trials with liked and disliked objects diverged: with liked objects E1 gradually drew more attention to her need as follows. During trials with a liked object, the experimenter spent the first 10 seconds looking over the edge of

the table towards the floor trying to see the object that fell, and saying “oh, oops, hmm, oof.” During the next ten seconds she reached down towards the bins with one hand, making effortful noises and saying “oh, oops, hmm, oof” in a distressed manner. During the final 10 second block, the experimenter looked up at the child and said “[*child’s name*], it fell” repeatedly, alternating gaze between the child and the floor while continuing to reach towards the floor. In practice trials with a disliked object, the experimenter looked over the edge of the table towards the floor trying to see the object that fell, saying “oh, hmm, oh well” in a mildly positive manner. After this time the experimenter returned her attention to the box of objects on the table, ignoring the one that fell. This continued until she ended the trial after a total of 30 seconds. The practice phase consisted of two liked-object only trials and two disliked-object only trials.

No explicit feedback was given in the practice trials. If the child offered a liked object, E1 took it, named it in a neutral tone of voice, and placed it in her backpack. If the child threw away an object, E1 moved on to the next trial. If the child handed E1 a disliked object, E1 tossed it back into the bin below the table and started the next trial. If the child did not help within 30 seconds, E1 moved on to the next trial. After each trial E2 approached both clear bins and the recycling bin (throwing away any remaining toys or otherwise just looking) so that this same event occurred after every trial regardless of the child’s response.

The *test phase* resembled the practice trials, but two objects were considered together and E1 did not state her preferences explicitly; only facial affect and tone of voice were used to convey her attitudes. Liked objects were regarded with smiles and nods, accompanied by positive tone of voice, while disliked objects were regarded with

frowns and shakes of the head along with negative tone of voice. The content of E1's speech about each object was the same whether it was liked or disliked (e.g. "Oh a block, a block, a big blue block"). Object preference within a pair and location of objects was counterbalanced across children. One other difference to pretest trials was that E1 pulled pairs of objects from the cardboard box in front of her and E2 remained across the room "cleaning" and was not involved.

In test trials both objects were accidentally knocked out of E1's reach into the plastic bins. E1 followed the same incremental steps as in the practice trials to draw attention to her need and responded as in the pre-test trials to the child's various possible actions (giving objects, throwing away objects, no helping).

Children participated in one of four experimental orders, across which side and identity of preferred object were counterbalanced between children. The child received no reward or praise upon helping to ensure that they were not extrinsically motivated to help.



Figure 2: Demonstration trial objects: hat, glove, pen, spoon



Figure 3: Practice trials objects: baseball cap, ladle, scarf and water bottle



Figure 4: Test trial objects: block, ring, ball, bowl, cup, whale, duck, spatula, tiger, book, brush and glasses. Additional materials not pictured: cardboard box, small backpack.

Coding and preliminary analyses

Children's responses were coded from video by a primary coder and by a reliability coder who was blind to the target object identity and location. We measured overall frequency and latency of helping, as well as targeted helping in which the child preferentially gave the actor the object for which she had previously shown a liking. Agreement between the two coders was high (Cohen's Kappa = 0.96). Disagreements were resolved through a third blind coder.

There was no significant effect of experimental order or trial number in either age group. We thus summarized across these variables.

Results

In the practice trials, where a single liked or disliked object fell off the table, both 2- and 3-year-olds helped more frequently in positive trials than in negative trials. A 2 (trial type: liked vs. disliked) x 2 (age group: 2- vs. 3-year-olds) repeated measures ANOVA revealed a highly significant effect of trial type ($F(1,46) = 93.38, p < 0.001$), with no effect of age group ($F(1,46) = 0.730, p = 0.397$) and no interaction of age group and trial type ($F(1,46) = 1.346, p = 0.252$) (see Figure 1).

We first analyzed the overall rate of helping during test trials, irrespective of which of the two objects was given. Results showed that older children tended to help more than younger children. Specifically, 2-year-olds helped in an average of $M = 4.00$ ($SE = 0.45$) of the 6 trials, while 3-year-olds helped in $M = 5.08$ ($SE = 0.30$) trials on average, $t(40) = 2.08, p = 0.054$.

The main analysis of interest focuses on the selective giving behavior during test trials. For each child a difference score was computed by subtracting the number of times

the child gave the non-target object first from the number of times the child gave the target object first. For 3-year-olds, the average difference score was 2.58, representing a distribution significantly different from chance, $t(23) = 4.06, p < 0.001$. For 2-year-olds, however, the mean difference score was 0.44, which was not significantly different from chance, $t(17) = 0.79, p > 0.05$. The difference-scores of 2- and 3-year-olds were significantly different from one another, indicating that 3-year-olds selectively gave the target object more often than did 2-year-olds, $t(40) = 2.52, p = 0.016$ (see Figure 2). Furthermore, there were significant differences between 2- and 3-year-olds in both rate of giving the target object, $t(40) = 2.09, p < 0.05$, and rate of giving the non-target object, $t(40) = 2.267, p = 0.029$. With age, children's tendency to give the target object increased, and their tendency to give the non-target object decreased.

In addition to coding which object the child gave first, we also coded whether children attempted to give the second object as well (or gave both objects at the same time). Fourteen out of 18 2-year-olds and 11 out of 24 3-year-olds attempted to give both objects in at least one trial, a distribution which represents a marginal difference between age groups (Fisher's exact test, $p = 0.057$). Giving both objects, while helpful in one sense, might be considered a less mature strategy since it involves giving the experimenter an object she does not want.

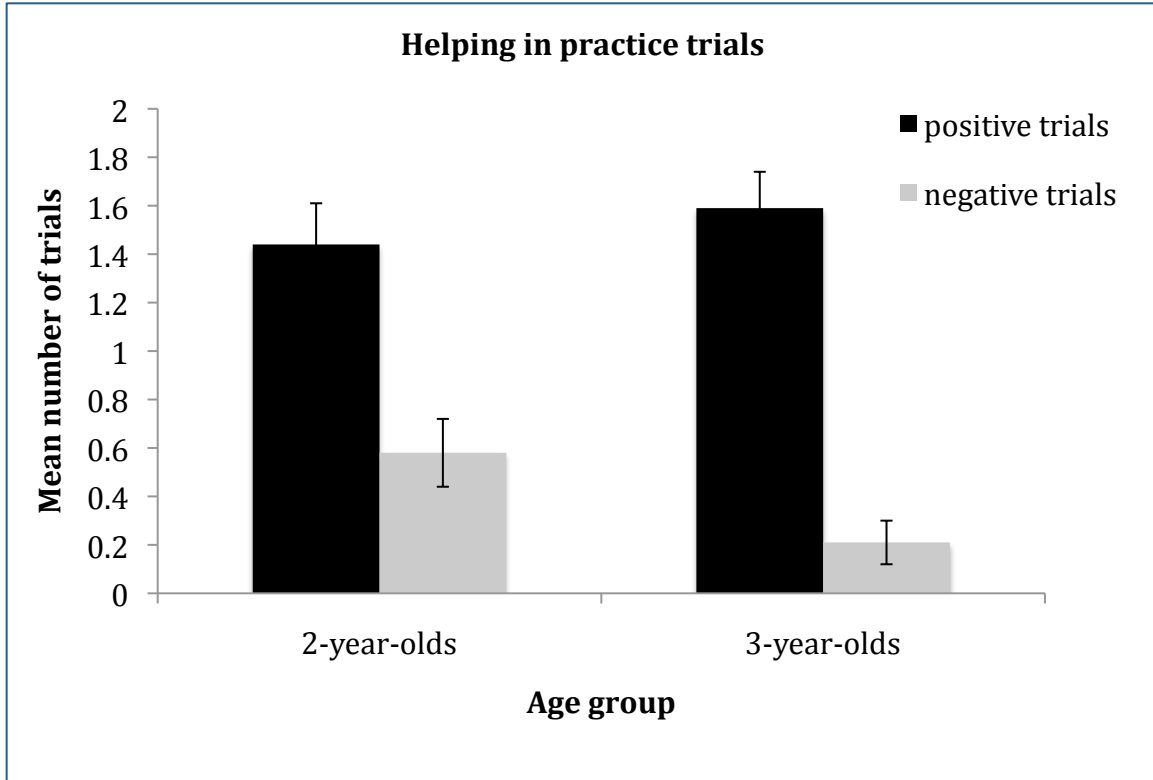


Figure 5: Mean number of trials with helping (out of 2) by age-group and type of practice trial. Bars depict +/- 1 standard error of the mean.

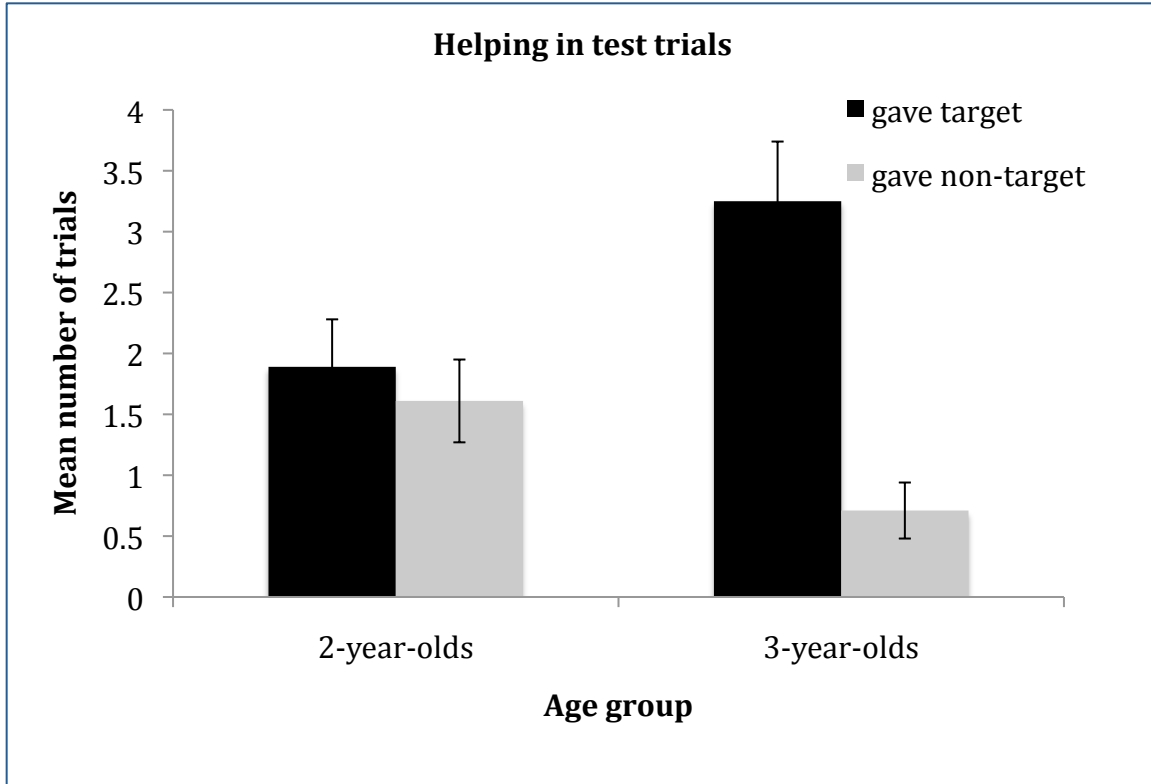


Figure 6: Mean number of trials with helping (out of 6) by age-group and type of response. Bars depict +/- 1 standard error of the mean.

We also analyzed children's latency to help, predicting that 3-year-olds would help more quickly than 2-year-olds. Indeed, 3-year-olds were significantly faster, taking on average of 12.9 seconds ($SE = 1.45$) to give an object as compared to 2-year-olds with $M = 18.1$ seconds ($SE = 2.01$), $t(40) = 2.11$, $p < .05$. A further question regarding latency to help is whether it was related to successful selective helping. We found that the more quickly the child helped the higher her helping difference score was ($r(40) = -0.39$, $p < .05$). That is, more selective helpers were also faster helpers. Latency might be thought of as an indicator of confidence or certainty, in which case children who were confident

of their answer helped appropriately more often, whereas children who hesitated also helped less appropriately.

Five children threw away objects into the trash bin during the test trials in addition to or instead of giving objects to the recipient, all of them 3-year-olds. Throwing away a disliked object constitutes a secondary act of helping, and when done in conjunction with giving the liked object could be considered maximally helpful.

Discussion

Several main findings emerged from this study. First, both 2- and 3-year-olds helped readily in the practice trials with liked objects and abstained from helping in the trials with disliked objects, with both age groups helping at similar rates. In the test trials with two objects, however, 3-year-olds engaged in more helping than did 2-year-olds. Critically, the 3-year-olds but not the 2-year-olds helped selectively, giving the experimenter the liked object more often than the disliked object.

How do these results speak to the different possible explanations of the motivation underlying children's early helping behaviors? We presented three major explanations of the factors driving early helping: 1) a (selfish) interest in the people and object involved; 2) a desire to see incomplete goals completed and 3) a genuine prosocial concern to satisfy the desires of others. We will now consider which factors may underlie the helping of 2- and 3-year-olds in the current study.

The 2-year-olds in the current study helped less frequently than the 3-year-olds, and when they did help the 2-year-olds did not act in accordance with the actor's object preferences. Instead, 2-year-olds gave objects at random, a pattern that is consistent with the second explanation for helping behaviors—a desire to see (superficial) goals

completed. On this story the 2-year-olds may have reasoned about the situation in terms of the superficial goal at hand (“the person is trying to reach an object”) instead of in terms of the underlying desire (“she wants *that* one”). The fact that so many 2-year-olds did not help at all further suggests that those children may have lacked both an interest in addressing the superficial goal of the actor and a personal interest in interacting with the objects and the actor. On the other hand, 2-year-olds did help appropriately during the practice trials where there was only a single object in play and the actor’s need was obvious at the point of response. The discrepancy between 2-year-olds’ appropriate helping in the practice trials and their indiscriminate helping at test suggests that 2-year-olds are discriminate in deciding *when* to help but may become easily overwhelmed when presented with multiple possibilities of *how* to help.

These results indicate that 2-year-olds are not willing or able to act prosocially with the recipient’s specific desires in mind. Specifically, it is possible that 2-year-olds lack a true understanding of emotions and/or object preferences. Alternatively, these young children may understand emotions and preferences but not have a fully developed concept of helping that places an emphasis on preferences. Lastly, it could be that they do not possess high levels of prosocial motivation, choosing to help without particular regard of the recipient’s personal needs.

Three-year-olds, on the other hand, helped frequently and selectively by giving the actor her preferred object. This finding is consistent with a genuine prosocial motivation account where 3-year-olds attend not only to the actor’s superficial reaching goal but also to the specific desire underlying the action goal. Given the difference in

responses between the 2- and 3-year-olds, we believe children's ability to incorporate specific goals into their helping responses matures between these ages.

While these interpretations rest upon the assumption that at least 3-year-olds succeeded in helping selectively based upon an understanding of goals and desires. However, a leaner account of 3-year-olds' success might be that they have learned the rule that objects that are smiled at or vocalized positively towards should go into the backpack, while objects that are frowned at and vocalized towards negatively should go into the recycling bin. Three-year-olds could have applied this rule to the test phase, resulted in what looked like successfully selective helping without utilizing any understanding of goals and desires. However, given the abundant research that even younger children have at least a basic notion of goals and desires (and go beyond mere association of objects and events), such an account seems improbable to characterize social cognition in this age-group more generally (Harris, 2006).

Another outstanding question concerns the relatively low rates of helping on the part of the 2-year-olds. Future research might manipulate the cues that help is needed to improve the overall rates of helping among younger toddlers. Second, what capacities do 2-year-olds lack that cause them to fail to help selectively? Future research should attempt to determine whether 2-year-olds are unsuccessful in our task because of a lack of understanding of emotions and preferences, an immature concept of helping or insufficient motivation.

Svetlova et al. (2010) distinguished between instrumental and empathic helping as a way of uncovering the motivation and meaning underlying prosocial acts by 18- and 30-month-olds. In their instrumental helping condition the child only needed to infer the

recipient's goal from her interrupted action, not emotion, in order to intervene helpfully by giving the appropriate object. In the empathy condition however, the child had to reason about the recipient's internal state in order to provide the appropriate object for the situation. Our own findings map onto this progression; 2-year-olds may have attempted to help by addressing the instrumental demands of the situation, while 3-year-olds engaged in empathic helping, representing and responding to the actor's internal state. This novel contribution to the understanding of prosocial development indicates that while even young infants are prosocially motivated, toddlers continue to mature in their ability to help in more nuanced situations and with more complex goals.

Part II

Goal Attributions and Instrumental Helping at 14 and 24 Months of Age

Kathryn Hobbs and Elizabeth Spelke

Abstract

Infants reason about goals and helping as early as 3 months of age, but toddlers fail to help others appropriately until well into the second year. Five experiments explored the reasons for this discrepancy. First, we verified that 14-month-old toddlers encode the goal of an actor's reaching action, in a situation that can also foster helping. Then, four further experiments presented toddlers with an agent who requested help in obtaining an out-of-reach object, after manifesting her goal in that situation. In all the experiments, toddlers responded to the actor's request for help by handing her an out-of-reach object, showing that they understood that a prosocial action was called for and were motivated to perform it. At 24 months, toddlers used the actor's prior goal-directed action to select the appropriate goal object, but 14-month-old toddlers did not. The younger toddlers failed to help appropriately even after viewing a full habituation sequence supporting goal attributions, as in the first experiment. They helped appropriately only when no attribution of enduring goals was necessary, because the actor could see the out-of-reach object and both looked at and reached for it while making her request. These findings suggest striking limits to 14-month-old toddlers' understanding of goals and helping.

Keywords: prosociality; instrumental helping; goal attribution; action understanding.

1: Introduction

Prosociality is an essential human characteristic manifest by young children (Warneken & Tomasello, 2007; Liszkowski, Carpenter & Tomasello, 2008), but the cognitive abilities that support children's earliest prosocial actions are not clear. For adults, helping is guided by an understanding of the other's intentional state, which may differ from that of the self, together with an understanding of how one's own goal-directed actions can be crafted so as to foster the actions of another person toward a different goal. Here we probe the development of this understanding in the second year, focusing on aspects of helping to which very young infants are sensitive.

At present, two bodies of evidence suggest conflicting accounts of children's developing understanding of helping and of mental states of desire. On one hand, numerous experiments provide evidence that children's understanding of subjective desires emerges between one and two years of age. In a seminal experiment (Repacholi & Gopnik, 1997), 18-month-old toddlers gave an actor, on request, the food for which the actor had expressed a preference by using language and emotional cues, even though her food preference was at odds with the child's own preference. In contrast, 14-month-old toddlers gave the actor the food item that they themselves preferred. In subsequent research, even the older toddlers' ability to ignore their own preference and give the object preferred by the experimenter was found to be fragile (Chiarella, Kristen, Poulin-Dubois & Sodian, 2013; Wright & Poulin-Dubois, 2012). Although somewhat younger children can use expressions of desire or aversion to gain information about objects (Klennert, Emde, Butterfield & Campos, 1986) their ability to reason about the desires of others may be hampered by the challenging task of linking expressions of emotion to

internal states or to goal-directed actions (Hepach & Westermann, 2013; Skerry & Spelke, 2014; Vaish & Woodward, 2010).

Further evidence that an understanding of desires emerges in the second year comes from studies of children's use of statistical sampling evidence to analyze the desires of other agents and to guide acts of giving to those agents (Ma & Xu, 2011). If an agent pulled 6 apparently boring objects from a jar containing only objects of that type, 22-month-old children gave her a new type of object if she requested an object after a more interesting object became available. If, however, the agent pulled 6 boring objects from a jar containing mostly interesting objects, children gave the agent the boring object in response to the same request, using the sampling information to infer that the agent's preference diverged from their own. At 16 months, in contrast, children did not reliably distinguish between these conditions. Like Repacholi and Gopnik's findings, these findings suggest that the ability to reason about an agent's distinctive preferences develops during the second year.

Research by Warneken and colleagues provides evidence that children begin to act altruistically in accordance with an agent's intentions earlier in the second year. At 14 months, toddlers recognize the intent of an actor straining towards an out-of-reach object and readily hand that object to the actor (Warneken & Tomasello, 2007). In this situation, the object that the actor is trying to reach is the only object within the agent's own field of attention; thus, the actor's goal can be read off the ongoing action and need not be inferred from prior actions. In contrast, 14-month-old children fail to help an actor reliably in situations where his goal must be inferred from a prior sequence of actions. For example, 14-month-old children who have viewed an actor stacking a succession of

books fail to help him by placing a book on top of a stack after it falls off, perhaps because a fallen book could elicit multiple actions, and only the actor's prior activity suggests which action is the appropriate one (Warneken & Tomasello, 2007).

In contrast to this literature, a second body of research suggests that a much earlier understanding of desires and preferences guides infants' interpretation of an actor's intentional actions. In a groundbreaking experiment (Woodward, 1998), 6-month-old infants were habituated to a human hand intentionally reaching for and grasping one of two different objects, and then the objects' locations were switched. In new goal test trials, the hand reached to the same location as in habituation but grasped a new object, whereas in new path trials the hand moved to the opposite location and grasped the original object. Infants dishabituated to the new goal trials, providing evidence that they encoded the reaching action as directed to the goal object. When given prior reaching experience, infants show this looking pattern as early as 3 months of age (Sommerville et al., 2005; Skerry, Carey & Spelke, 2013); 6-month-old infants show this pattern robustly (Woodward, 2009). Moreover, this pattern of looking preferences is elicited only when infants view the same actor during habituation and test: a pattern that suggests they appreciate that the preferred goal objects of different actors might differ (Buresh & Woodward, 2007).

Further research suggests that infants attribute not only goals but also choices and enduring preferences to the actors who engage in these actions. Luo and Baillargeon (2005) showed 5-month-old infants an agent approaching a specific object repeatedly when either a second object was present in a different location (two-object condition) or only the goal object was present (one-object condition). In subsequent test trials, both

objects were present in both conditions, and the actor alternately approached each of them. In the two-object condition, infants looked longer when the agent approached the new object in test trials, whereas infants in the one-object condition looked equally when the agent approached the two objects. Luo and Baillargeon concluded that infants viewed the agent as choosing the goal object when an alternative choice was available, in accord with Ma and Xu's findings with older (but not younger) toddlers. This choice led infants to infer that the agent preferred the goal object to the other object (Luo & Baillargeon, 2005).

These findings and others (Luo & Baillargeon, 2007, Luo & Johnson, 2009) suggest that one-year-old infants possess an understanding of intentional action that is linked both to representations of perceptual awareness and to preferences, and that is elicited when infants view agents who choose between two objects. Nevertheless, a wealth of experiments provides evidence that infants can attribute goals to an actor who reaches for a single object in the absence of other objects (see Gergely & Csibra, 2003, for review). This evidence has prompted alternative interpretations of Luo's findings that do not attribute to infants any representations of an agent's enduring preferences (Hernik & Southgate, 2009).

Further research on young infants suggests that they understand helping interactions between agents that they observe, long before they engage in active helping. In research by Hamlin and colleagues, infants viewed events in which an actor first attempted to climb a hill, open a box or play with a ball, and then two other agents acted in a manner that either allowed the first actor to complete his goal or prevented the actor from doing so. After these events, infants were given a choice between the latter two

agents. At 6 months, infants reached more for the agent who previously was helpful (Hamlin, Wynn & Bloom, 2007). At 3 months, infants looked more at the previously helpful agent, relative to the hinderer (Hamlin, Wynn & Bloom, 2010). Both findings suggest that young infants prefer an agent who helps an actor to achieve his goal, indicating critically their ability to distinguish between helpful and harmful actions. These abilities do not require an understanding of an actor's enduring goals or preferences, however, because the actor's goal is apparent at the time of the helper's and hinderer's actions.

In further experiments, however, 10-month-old infants showed striking sensitive to the interplay of perceptions, actions, and desires in their social evaluations of helpers (Hamlin, Ullman, Tenenbaum, Goodman & Baker, 2013): They preferred an agent who acted in accordance with the recipient's previous, rather than their ongoing, goal-directed action. Moreover, infants showed this preference only when the recipient's actions involved a choice between two available objects, as in Luo's studies, and only when the agent had witnessed the recipient's choice. These findings suggest that infants under one year of age incorporate information about both helpers' and recipients' perceptual states when reasoning about helping situations, testifying to a rich and accessible understanding of the intentions, perceptions, and preferences of other agents.

The findings of Hamlin et al. (2013) are bolstered by the findings of a recent study probing 12-month-old infants' expectations about the actions of a potential helper (Martin, Onishi & Vouloumanos, 2012, Exp. 4). Infants saw an actor selectively reaching for one of two objects repeatedly in familiarization trials while a second actor (the helper) was present and watched these actions. In test trials, the objects were

accessible to the helper but not to the actor, and the helper presented the actor with each object on alternating trials. Infants looked longer when the helper gave the non-preferred object under these conditions, but not under control conditions in which the helper did not witness the actor's original actions. All these studies provide evidence that when 12-month-old infants are observers rather than participants in helping interactions, they infer an actor's preferences and goals from her previous actions, and they expect helpers to act in accord with the actor's preferences so as to further her goals.

Thus far, most of the reviewed evidence favoring a later development of an understanding of desires, preferences, and helping comes from studies using active helping tasks, whereas the evidence favoring an early emergence of this understanding uses passive observation tasks. Four further findings from experiments using passive observation tasks nevertheless suggest limits to infants' understanding of preferences and goals, even on tasks requiring no overt, instrumental actions. First, 14-month-old toddlers use an agent's visual attention but not her emotions to predict her actions in a Woodward task (Vaish & Woodward, 2010). Second, sensitivity to congruency between actions on objects and emotional reactions to objects emerges between 10 and 14 months in a pupil dilation paradigm (Hepach & Westermann, 2013). Third, 9-month-old infants tested in a Woodward paradigm use information from an agent's prior goal-directed actions on an object to interpret her new actions on the same object when they view the agent in the same room but not when they, and the agent, move to a different room (Sommerville & Crain, 2009), suggesting that attributions of enduring preferences are fragile at best (see also Garvin & Woodward, 2014). Finally, expectations that an agent will react with positive emotion when her actions successfully attain her goals, and with

negative emotion when they fail to do so, emerges between 8 and 10 months in a violation of expectation paradigm and is not complete at 10 months of age (Skerry & Spelke, 2014). All these findings suggest that young infants fail to make the desire or preference attributions that adults make when they observe agents' goal-directed actions.

In summary, research on children's helping, children's responses to acts of helping by others, and children's inferences about the goals and preferences of other actors paints a complex picture of the early development of understanding of goals, preferences, and helping. Why do children evaluate acts of helping appropriately as young as three months of age (Hamlin et al., 2010) yet engage only in very limited helping actions at 14 months (Warneken & Tomasello, 2007)? Moreover, why do children appear sensitive to the preferences of goal-directed actors as early as 3 months in some studies (Luo, 2011; Hamlin et al., 2010), and yet fail to take account of these preferences in their own prosocial acts of helping until much later (Repacholi & Gopnik, 1997; Warneken & Tomasello, 2007)?

The current study attempted to address these questions through experiments whose methods bridge these two literatures. We asked whether toddlers can reason about an agent's goals and preferences for the purposes of prosocial interaction when there is more than one object available for instrumental helping, and when the children must use prior evidence from an agent's goal-directed actions to infer the agent's current perceptions and preferences. In contrast to many studies using active helping paradigms, we tested for these abilities using very simple events, designed to match events used in the simplest studies of infants' attributions of goals and preferences to agents (Woodward, 1998; Luo & Johnson, 2009). We first demonstrated, in Experiment 1, that 14-month-old

toddlers encode reaching actions in terms of goal objects in a social context that might also elicit helping. Then, across four additional experiments, we provided toddlers with this evidence of an agent's object preference and then presented them with a situation in which the preferred and the dispreferred object both lay beyond the agent's reach and sight, and the agent requested the child's help in obtaining the desired object. By manipulating both the location and the visibility of the desired object, we ask whether toddlers use information from an agent's prior goal-directed reaching to guide their acts of helping.

More specifically, the four helping experiments first presented toddlers with an actor who reached consistently for one of two visible objects, following the method of Woodward (1998) and the events and method of Experiment 1. Participants then received test trials in which the two objects were presented either outside the agent's view (Experiments 2-4) or within view but out of reach (Experiment 5), and the agent asked the child for help in finding and retrieving the object that she desired. We measured the rate at which children gave the preferred object, relative to the other object. Experiments 2 and 3 used a familiarization paradigm with 14- and 24-month-old toddlers, respectively, as in Warneken and Tomasello's (2007) studies. In contrast to those studies, however, we presented test trials in which the agent was manifestly ignorant of the preferred object's location and so could not cue toddlers to that location with directed looking or reaching. At 24 months, children gave the agent the preferred object, but at 14 months, they did not. Accordingly, Experiment 4 presented the younger children with the same reaching events using the habituation paradigm, as in Woodward's (1998) studies and in Experiment 1, so as to give toddlers stronger evidence of the agent's preference. After

this experience, the 14-month-old toddlers again gave the preferred and dispreferred objects equally often, providing no evidence that goal or preference attributions guided their acts of helping. Finally, Experiment 5 altered the procedure to give toddlers continued evidence of the agent's preference at the point of response, following Hamlin, Hallinan and Woodward (2008) and Warneken and Tomasello (2007). Now toddlers succeeded, showing that they were motivated to give the preferred object and could do so when given direct, current cues to its identity. Together, the experiments suggest strong limits to young toddlers' understanding of helping, of others' desires and preferences, or both.

2: Experiment 1

Experiment 1 was undertaken to investigate whether the simple action sequences that elicit goal attributions and preferences in young infants (Woodward, 1998; Luo & Johnson, 2009) also elicit goal attributions in toddlers, presented with events that might also elicit helping. Experiment 1 presented toddlers with the actor and the reaching events to be used in Experiments 2-5. Following the method of Woodward (1998), it assessed toddlers' sensitivity to the actor's goal. Toddlers were habituated to an actor reaching for and grasping one of two objects for at least 6 trials. After meeting a criterion of habituation or viewing 12 successive trials, the objects switched locations and children saw two test events in alternation: new goal trials, in which the actor reached for the new object in the same direction as her previous reaches, and new side trials, in which the actor reached for the same object as in habituation but on the opposite side. Looking times to these two test events were measured and compared. If infants encoded the

reaches as directed to the goal object, then they should have looked longer on the new goal trials.

2.1: *Method:*

Displays. The experiment was conducted with the participant facing an experimenter, who sat behind a table in a small booth. The walls of the booth were covered with black fabric to minimize distraction. On the table sat a tray with a platform measuring 81 cm wide by 18 cm tall by 22 cm deep. Objects were placed 46 cm apart on top of this platform during habituation and test trials. The objects—a small soft orange basketball and a brown plush teddy bear—measured approximately 13 cm in size. A black foam board screen could be raised and lowered between the child and the experimenter, occluding the booth between trials.

Participants. Participants were 18 children (10 girls) aged 13 months, 22 days to 15 months, 10 days (mean age 14;9). Participants were recruited from a database of families in the greater Boston area who have agreed to participate in research; they came from a variety of language and ethnic backgrounds. An additional 4 participants began the experiment but were excluded due to fussiness (3), or failure to attend to at least two pairs of test trials (1).

Design and procedure. As in experiments by Woodward (Woodward, 1998; Buresh & Woodward, 2007), toddlers participated in 6-12 habituation trials in which the actor reached for and grasped the ball or bear, and then paused until the child ceased to attend to the event. Trials were ended by a 2-s look away, following the first 1-s look at the display after the actor grasped the object (minimum: 2 s, maximum: 60 s). The

habituation sequence was ended upon a decline of 50% in the total duration of looking at the event outcomes on three successive trials, relative to the first three trials.

Following habituation to the reaching action, children viewed one additional habituation trial as a baseline measure of their post-habituation attention, and then a single object switch trial, which was participant-controlled as in the habituation events. During the switch trial the actor was present and looked at the middle of the tray, then at the child, saying “oh! Where did it go? Did it move? Where is it?” The actor then looked down to break eye contact with the child and paused until the trial ended. Toddlers were then presented with three pairs of test trials: one new goal trial and one new side trial in alternation, with order of trial type counterbalanced between participants.

2.2: Results:

There were no effects of sex, side of target object, target object identity or order of test trials. A t-test comparing the proportion of looking at new goal trials out of total looking time to chance (.5) was significant ($t(17) = 2.290, p = 0.035$). Like the 6-month-old infants (Woodward, 1998) and the 3-month-old infants (Sommerville et al., 2005) in previous research, the toddlers encoded the goal of the actor's reach and dishabituated to a change in goal object, relative to a change in reaching direction.

2.3: Discussion:

The toddlers in Experiment 1 looked significantly longer at the new goal test events than the new side test events, demonstrating that the events of Experiment 1 do elicit, at 14 months, the kind of goal attributions found by Woodward (1998) and others. In Experiments 2-4, therefore, we presented toddlers with the same events, followed by a switch trial that was the same as in Experiment 1 except in one respect: the objects were

presented out of the agent's sight and reach. Finally, the toddler was brought within reach of the two objects, and the agent requested the toddler's help in obtaining her desired object. Across a series of test trials, we measured whether toddlers would use the goal information from the agent's prior reaching to determine which object to give her.

3: Experiment 2

Fourteen-month-old toddlers saw a human actor look at each of two objects and then reach for and grasp one of them. Then the objects were moved out of the actor's sight and reach. In test trials, the actor searched the stage where the objects had been with a puzzled expression, asking "where did it go?" and then made a request to the child, both verbally and with an outstretched hand—"can you help me?"—as the two objects moved within reaching distance of the child while remaining out of the actor's reach and view. We asked whether toddlers would hand the actor the object for which she had previously chosen to reach.

Children were presented with one test round with a single object followed by two test rounds with two objects (the "choice test"). The no-choice test round served to familiarize the participant with the experimental procedure and the experimenter, and to provide positive feedback for giving of objects. Choice test rounds were procedurally similar, but two objects were present throughout both the familiarization and test phases, requiring toddlers to make a choice about which object to give to the experimenter. On these test trials, the first object given was coded. Toddlers were presented with two rounds of these choice tests, each with two test trials for a total of four choice test trials.

3.1: Materials

The experiment was conducted with the same physical setup as Experiment 1. The tray and platform had wheels so that the tray could move toward the participant, from a position beyond to a position within reach. Objects were placed 46 cm apart on top of this platform during familiarization trials and on the side closer to the participant for the test trials. The objects used included those from Experiment 1 and additionally a blue plastic bowl, a blue plastic cup, a metal spoon, a yellow rubber ducky, and an orange toy dump truck.

3.2: Participants

Eighteen toddlers (10 girls) between the ages of 13;18 and 15;12 (mean age 14;16) participated in the experiment. Participants came from a variety of ethnic backgrounds, but English was their primary language. An additional 9 participants began the study but were excluded due to fussiness (2), unwillingness to respond (6), or parental interference (1).

3.3: Design:

The experiment was conducted in three phases: warm-up, no-choice test phase and choice test. In the warm-up and no-choice phases, single objects were presented to children in a fixed order. In the test phase, target objects, target-object/side pairings, and side of first target object were counterbalanced between subjects. Side of target object at test was counterbalanced within subjects between rounds, with a child receiving one test round with the target object on the left and the next with the (new) target object on the right. All children saw the bear and ball in the first test round. Eight children (2 girls) saw the cup and the spoon in the second test round, and 10 children saw the duck and truck (8 girls).

3.4: *Procedure*

Two experimenters conducted the study. The first author was always the actor (E1), and one of several research assistants played the role of the other experimenter (E2). The entire procedure took between 10 and 20 minutes.

3.4.1: Warm-up phase

After playing in the waiting room with the two experimenters, the child and parent were escorted into the testing room and seated in a chair in front of the booth. E2 then familiarized the child to the rolling tray and its movement, showed the child the test objects, and elicited giving in the following manner. E2 produced a single object from beneath the table and looked at it briefly, saying e.g. “oh neat, a bowl.” She then offered it to the child, saying “do you want to see it?” If the child did not readily take the object from E2, E2 passed the object to the parent and invited the parent to show it to the child. E2 remained engaged, talking to the child while he or she explored the object. Once the child began to lose interest in the object, E2 asked for the object back, extending a hand palm up towards the child and saying “can I have it back?” If the child did not give the object back immediately, she was given a few more seconds to play with it and then E2 again requested the object. If the child refused to give back the object, E2 asked the parent to hand her the object. This procedure was repeated for the other test objects.

3.4.2: No-choice test phase

Once the toddler had played with all of the test objects, the screen was lowered in front of the booth and E1 took E2’s place behind the table. Using a single object, the bowl, three familiarization trials occurred, in which the screen was raised to reveal the actor, who greeted the child, then looked at and reached for the bowl. As she reached for

and then grasped the bowl she said “oh, hmm” in a neutral tone of voice with neutral facial expression, pausing in this position for 10 seconds. Between familiarization and test, the bowl was then placed at the end of the tray close to the child and out of sight of the actor. In test trials, the actor looked at the empty platform and said “oh, where did it go?” The tray then moved toward the child, moving the bowl into the child’s reaching space, and the actor extended her hand toward the child, palm up, saying “can you help me?” If the child handed the actor the bowl she clapped and thanked the child. If the child did not give the bowl to the actor the trial simply ended with the actor saying cheerfully, “let’s do that one more time” (before another no-choice test trial) or “let’s try something new now” (before the next test phase).

3.4.3: Choice Test phase

Toddlers first saw three familiarization trials, in which the actor looked at each of the two objects, reached for one of them, and her hand rested on that object while she looked at it for 10 seconds before the screen was lowered to end the trial. Except for the timing, these events were the same as the habituation events in Experiment 1. Following these familiarization trials, the objects’ locations were switched and the objects moved to the child’s side of the platform out of the experimenter’s sight and closer to the child. Toddlers then saw a single switch scene to familiarize them to the new locations of the objects. For approximately half of the participants the actor was not present and did not speak during the switch scene, which lasted 10 seconds. For the remaining participants, the actor was present and spoke to the child at the start of the scene, as in Experiment 1,

and then looked down for 10 seconds to give the child time to notice the new locations of the objects.¹

Two test trials followed, as in the no-choice phase. If the toddler gave any object she was applauded and thanked. If the toddler was holding either or both objects at the end of the trial, the actor asked the parent to put the object(s) back onto the tray. Once both objects were back on the tray the screen was lowered and the objects reset in their starting positions for the next trial.

Following these two test trials the second test round was conducted following the same procedure.



Figure 7: Illustrations depicting the familiarization/habituation trials (1a) and test trials (1b) for the choice test phase of Experiments 2-4.

3.5: Results

Toddlers gave an object on average in 72.2% of the no-choice trials and 72.2% of the choice trials. Across the four test trials, on average, they gave the target and foil objects on 1.28 and 1.61 trials, respectively, a non-significant difference that is opposite

¹ The children in these two switch scene conditions did not differ in their rates of giving or in their selective giving of the target object, so all analyses collapsed across these conditions.

in direction to that predicted by effective helping (mean difference score: -0.333 , $t(17) = -1.065$, $p = 0.302$, two-tailed). An independent-samples t -test comparing giving of the target versus non-target object for male and female participants revealed no significant effect of sex on performance.

A further analysis focused on toddlers' performance on the first choice trial on which any object was given, prior to receiving any (uniformly positive) feedback from the experimenter. Six participants gave the target object on this trial whereas 12 participants gave the foil object: a non-significant preference for giving the incorrect object ($p = 0.238$, two-tailed binomial test).

3.6: *Discussion*

In Experiment 2, 14-month-old toddlers saw goal-directed reaching evidence of an actor's object preference and then were asked to help the actor by giving her an object. On single object trials, the children exhibited high rates of giving, replicating and extending the findings of Warneken and Tomasello (2007) and suggesting that children understood the request for help and were motivated to comply with it. On choice trials, the toddlers continued to show high rates of giving, but they failed to give the target object significantly more often than the foil object. Thus, the 14-month-old toddlers seemed to understand the verbal request for help and its accompanying gesture as a request for an object, and they were both motivated and able to provide one. Nevertheless, they failed to use preference information to guide their choice of which object to give.

Why did toddlers fail to give the actor the object that she sought in this experiment? The findings of Experiment 1 suggest that children perceived the actor's goal during the reaching events. Perhaps, however, her actions were unnatural in some way during the giving test. Because she interacted minimally with the child during the reaching events, for example, children may have been puzzled by her request for help. Contrary to this possibility, the toddlers' acts of giving objects suggest that they may have interpreted her request for help appropriately. The young toddlers may have failed to infer the object that she desired, however, as they have done in other studies using active helping paradigms in which direct information concerning the current desire is absent (Repacholi & Gopnik, 1997; Ma & Xu, 2011; Warneken & Tomasello, 2007). Experiment 3 tested this possibility by repeating the method of Experiment 2 with older toddlers, at 24 months of age.

4: Experiment 3

4.1: Method

Participants were 18 toddlers (10 girls) between the ages of 1;11;10 and 2;0;29 (mean age 2;0;2). Participants came from a variety of ethnic backgrounds, with English as their primary language. Seven additional participants were excluded due to fussiness (3) or unwillingness to give any objects during the test trials (4). The displays, design, procedure, and measures were the same as Experiment 2. 8 children (4 girls) saw the cup and the spoon in the second test round, and 10 children (6 girls) saw the duck and the truck.

4.2: Results

Children gave an object on average in 97.2% of the no-choice trials and 95.8% of the choice trials. Rates of giving in the no-choice trials and the choice test trials were significantly greater for the 24-month-old toddlers in Experiment 3 than for their 14-month-old counterparts in Experiment 2 (no-choice trials: $t(34) = -2.39$, $p = 0.023$; choice trials: $t(34) = 3.002$, $p = 0.005$, two-tailed).

Across the four choice trials, children gave the target object more often than the foil (respectively, on 2.78 and 1.56 trials), a significant difference (mean difference score: 1.222; $t(17) = 2.15$, $p = 0.028$, two-tailed). An independent-samples t-test comparing giving of the target versus non-target object for male and female participants revealed no significant effect of sex on performance.

On the first choice test trial on which children gave an object, 10 children gave the target object, 7 children gave the foil object, and one child gave both objects simultaneously: a non-significant difference ($p = 0.315$, one-tailed binomial test).

A 2 (Age: 14 vs. 24 months) by 2 (Object: target vs. foil) repeated-measures ANOVA compared rates of giving the target and foil objects across the four choice trials of Experiments 2 and 3. There was an interaction between Age and Object given, with the older children in Experiment 3 giving the target object over the non-target object significantly more often than did the younger children in Experiment 2 ($F(1,34) = 6.79$, $p = 0.014$). In an analysis of performance on the first choice trial on which children gave an object, however, the interaction between Age and Object type did not attain significance (Fisher's exact test: $p = 0.12$).

4.3: *Discussion*

The 24-month-old toddlers in Experiment 3 succeeding at helping the experimenter in accordance with her object preference, giving her the target object significantly more often than the foil object. Children's success in this paradigm at 24 months suggests that the younger toddlers in Experiment 2 did not fail because the helping situations were opaque or unnatural. A comparison of Experiment 2 to Experiment 3 instead suggests that between 14 and 24 months of age, children's helping begins to be guided by information concerning the actor's goals and preferences.

Though children at both ages evidenced relatively high rates of giving overall, the 2-year-old children gave at significantly higher rates than did the 14-month-old children. This finding accords with the evidence that prosocial behavior increases during the second year of age (Warneken & Tomasello, 2006; Warneken & Tomasello, 2007).

One aspect of the present findings suggests that children's use of preference information is still fragile at the end of the second year: Children did not reliably use preference information to guide their very first choice of which object to give the actor. Because the feedback that children received was independent of the object that they gave, children's success on subsequent trials provides evidence that they indeed inferred the actor's goal from her past actions, and that they used this inference to guide their own acts of helping. Nevertheless, this process was not firm or robust enough to elicit appropriate helping on the first trial.

Together, Experiments 2 and 3 provide evidence for a developmental change, between 14 and 24 months, in children's use of preference information to guide their helping. This evidence accords with the findings of past studies using active helping

paradigms (Warneken & Tomasello, 2007; Repacholi & Gopnik, 1997; Ma & Xu, 2011). Nevertheless, questions remain concerning both the course of this developmental change and its underlying meaning. It is possible that the younger children in Experiment 2 failed to give the target object more often than the foil object because they failed to encode or remember the actor's preference. Because Experiments 2 and 3 presented only three familiarization trials each with two sets of two objects, the younger children's memory may have been overtaxed by these events. In contrast, both the infants in past experiments and the toddlers in Experiment 1 were presented with the same object-directed actions on 6-12 trials in a habituation paradigm. Experiment 4 tested this explanation by presenting 14-month-old toddlers with the same helping test after full habituation to the reaching actions.

5: Experiment 4

Experiment 4 assessed the helping behavior of 14-month-old toddlers after presenting the same sequence of reaching events presented to toddlers in Experiment 1: events that elicited goal attributions that endured for the duration of the subsequent switch trial and the six test trials that followed. Participants were presented with the habituation events from Experiment 1, followed by events in which the objects changed locations and the experimenter spoke as in that experiment. Instead of the six looking time test trials from Experiment 1, however, the toddlers then were given four test trials using the giving method from Experiments 2 and 3, with the same pair of objects and with re-exposure to the original habituation event after the first pair of trials.

5.1: *Method*

The method was the same as Experiment 2, except as follows. The test objects consisted of the blue plastic bowl, plush brown teddy bear and soft basketball used in that experiment.

Participants were 18 toddlers (11 girls) between the ages of 13;24 and 15;13 (mean age 14;19). Children came from a variety of ethnic backgrounds, with English as the primary language. An additional 12 participants began the experiment but were excluded due to fussiness (2), unwillingness to respond (9) or parental interference (1).

After warm-up and no-choice tests identical to those of Experiment 2, children participated in a choice test consisting of 6-12 participant-controlled habituation trials in which the actor reached for and grasped the ball or bear and then rested on the object until the child ceased to attend to the event, as in Experiment 1. Following habituation to this action, children viewed a single object switch trial and then received two choice test trials. After 2 test trials, children were given one participant-controlled re-familiarization trial in which the actor reached for the target object in its original location. Then children saw a single trial in which the actor was not present and the objects, though not switching sides after this re-familiarization, had moved forward on the tray closer to the child. During the choice test, the target objects, target-object/side pairings, and side of target object in first test trial were counterbalanced as in Experiment 2. Thus, the same pair of objects was used for all four test trials, and the side of the target object at test was switched for each child between rounds, with a child receiving one test round with the target object on the left and the next with the target object on the right.

5.2: Results

Toddlers gave an object on average in 84.4% of the no-choice trials and 81.9% of the choice trials. These rates of giving did not differ significantly from those of Experiment 2 (no-choice: $t(32) = -0.897, p = 0.379$; choice: $t(34) = -1.084, p = 0.286$, two-tailed).

Toddlers' rates of giving of the target object and the foil were statistically indistinguishable (respectively, 1.83 and 1.28 trials on average, mean difference score: 0.556, $t(17) = 1.033, p = 0.316$, two-tailed). Ten children gave the target object on the first choice test trial on which they gave an object, whereas 8 children gave the foil object on that trial ($p = 0.407$, one-tailed binomial test). An independent-samples t-test comparing giving of the target versus non-target object for male and female participants revealed no significant effect of sex on performance.

A 2 (Experiment: 2 vs. 4) by 2 (Object: target vs. foil) repeated-measures ANOVA on performance over the four choice test trials compared the performance of the toddlers in Experiments 2 and 4. There was no significant interaction between Experiment and Object given, with children in both experiments giving the target and foil objects at similar rates ($F(1,34) = 2.04, p = 0.162$). On the first trial for which toddlers gave an object, the children in the two experiments were equally likely to give each object (Fisher's exact test: $p = 0.315$).

5.3: Discussion

The 14-month-old toddlers in Experiment 4 failed to give the actor the target object more often than the foil object. This failure occurred despite increased exposure to

the actor's goal-directed actions in Experiment 4. Because the present paradigm followed the procedure of Experiment 1 closely, and presented events that were encoded as goal-directed by the 14-month-old toddlers in that experiment, it is unlikely that the toddlers in Experiment 4 failed to help the actor because they failed to attend to or remember her actions. Instead, the events of Experiment 4 likely induced the same goal attributions as in Experiment 1, and yet failed to guide toddlers' acts of giving objects during the choice test trials. Together with Experiment 1, Experiment 4 therefore provides the most direct evidence for a discrepancy between 14-month-old toddlers' understanding of goals and their ability to use goal information to guide their helping.

Why did the 14-month-old children in Experiments 2 and 4 fail to help the actor appropriately by handing her the target object? First, toddlers' tendency to give the actor the object she desired may have been counteracted by a preference for giving the foil object, because children wanted to see something new happen, and the actor had never manipulated the foil object. Second, toddlers may have been motivated to help appropriately yet believed that the actor was mistaken to want the target object and would be equally or more pleased by the other object. On either of these two accounts, young toddlers fail to help as older toddlers do because of their differing motivations, to show the actor something new. Third, toddlers may have wished to give the actor the object that she desired, but they may have been unable to determine, from her past behavior, which object that was. Despite the findings from studies of infants (Luo & Baillargeon, 2007; Luo & Johnson, 2009), toddlers may attribute goals, but not enduring object preferences, to actors who repeatedly reach for the same object. Fourth, toddlers may lack some aspect of understanding of helping. On either of the last two accounts, young

toddlers fail to help as older toddlers do because of limits to their social cognitive abilities: in particular, limits to their understanding of preferences, of helping, or both.

To distinguish the two motivational from the two cognitive explanations for young children's helping failures in Experiments 2 and 4, Experiment 5 reduced the representational demands of the paradigm presented in the previous experiments while maintaining the same motivational structure. In the congruent condition of Experiment 5, 14-month-old toddlers saw the same goal-directed reaching evidence of the actor's preference in familiarization trials as in Experiment 2. In contrast to all the previous experiments, however, the children also received reaching evidence of the actor's preference during the choice test. At the point of response, therefore, toddlers did not need to rely exclusively on a preference attribution based on the actor's prior actions together with her current request: They only needed to attend to the actor's current reaching gesture. If 14-month-old toddlers failed to give the target object in Experiments 2 and 4 because they preferred to see the actor handle a new object, or because they thought the actor might be happier with the new object, then the same pattern of performance should be observed in this condition of Experiment 5: Toddlers ought to give the test target object no more often than the test foil.

In addition to the motivational and cognitive accounts of toddlers' failure to give the correct object in Experiments 2 and 4, a further account can be offered. In the looking time experiments showing precocious performance in infants, children view events without the need to act upon them in the moment. Under these circumstances, they may retrieve information concerning an actor's past perceptions and actions and use that information to interpret the actor's current observed actions. In active helping

experiments, in contrast, toddlers must use incoming information to guide their immediate actions. In all the studies in which 14-month-old toddlers help successfully, their helping actions are supported by the ongoing behavior of the actor whom they help. In Warneken and Tomasello's (2006, 2007) experiments, in particular, 14-month-old toddlers hand the actor the very object to which he is currently looking and reaching. It is possible that toddlers, like infants, can use past information to bear on their interpretation of an actor's present actions. In order to act themselves so as to help the actor, however, they may require concurrent behavioral support by the actor.

The second purpose of Experiment 5 was to test this possibility, by assessing toddlers' use of prior goal-directed actions to interpret an actor's current actions, in a more supportive helping context. The full experiment consisted of two conditions: the congruent condition described above and an incongruent condition. In both conditions, an actor asked for the toddler's help in retrieving one of two out-of-reach objects while looking at and reaching for the desired object. In the congruent condition described above, this helping test was preceded by familiarization events in which the two objects stood within the actor's reach, and the actor reached for and attained the same object. In the incongruent condition, this helping test was preceded by familiarization events in which the actor reached for and attained the other object. We reasoned as follows. If 14-month-old toddlers require present support from an agent's current actions to guide their actions, but they are nevertheless sensitive to information from the agent's past goal-directed actions, and if they use those past actions to guide their interpretations of the agent's present actions, then the children should respond to the agent's request for help by giving her the requested object more consistently in the congruent condition than in the

incongruent condition. In contrast, if toddlers' acts of helping an agent are not influenced by the agent's prior goals, then the children in both conditions should be equally likely to give the actor the object to which she currently looks and reaches.

6: Experiment 5

In Experiment 5, we presented 14-month-old toddlers with the same familiarization trials as in Experiments 2 and 3, followed by test trials in which the two objects were out of reach but remained visible to the actor, who attempted to attain an object by reaching in its direction. Experiment 5 consisted of two conditions: a congruent reaching condition, in which the actor reached for the same object during familiarization and test, and an incongruent reaching condition, in which the actor reached for one object during familiarization and the other object during test. By comparing rates of giving the test target object across these two conditions, we asked whether toddlers who are presented with supportive concurrent information about an actor's goals and desires also are influenced by an actor's prior goal-directed actions in interpreting the actor's request for help or selecting the helpful action. Furthermore, by comparing toddlers' helping responses in the congruent condition of Experiment 5 to the helping of children in Experiments 2 and 4, we address motivational accounts of toddlers' failures to choose helpful actions in those experiments, by asking whether toddlers are motivated to help by giving the actor's desired object when the actor's current goal is present and obvious.

The methods for Experiment 5 were a hybrid of those used in Experiments 2 and 4, with familiarization trials as in Experiment 2 and test trials presenting only one pair of objects, as in Experiment 4. Experiment 5 importantly differed from all the previous

studies in that during both all the helping trials, the two objects were visible to the actor, although they were now out of her reach. Thus, the actor looked and reached toward an out-of-reach target object while requesting help from the child.

6.1: *Method*

Experiment 5 was conducted using the same setup as Experiment 2, except that the rolling tray with platform was replaced with a similar rolling tray with a lower platform (2.5 cm high), over which the experimenter could both see and reach toward the target object in test trials, but over which she could not complete her reach from her seated position. As in Experiment 4, the bowl, ball and bear served as objects.

Participants were 36 toddlers (10 girls) aged 13;15 to 15;15 (mean age 14;14) split across the two conditions. Children came from a variety of ethnic backgrounds, with English as the primary language. An additional 19 participants began the experiment but were excluded due to fussiness (3), failure to give an object on any test trial (13), parental interference (1) or experimenter error (2).

As in Experiment 4, children participated in one no-choice test round and one choice test round. As in Experiment 2, they saw 3 familiarization trials prior to each test round. The test trials in Experiment 5 differed importantly from those in Experiments 2 and 4 both in the visibility of the goal object(s) and in the behavior of the experimenter on test trials.

On the two no-choice test trials, the bowl was centered at the end of the tray close to the child. When the screen was raised, the tray moved toward the child into his or her reaching space. Simultaneously, the actor extended her hand towards the bowl making a

grasping motion but failing to reach the bowl and saying “oh, I can’t reach.” She continued reaching for the bowl and made eye contact with the child saying “can you help me?” The no-choice test trials ended exactly as did those in Experiments 2-4.

For the choice test round, toddlers were familiarized with three trials in which the actor reached for the familiarization target object, as in Experiment 2, and then they saw a single trial (10 seconds) in which the objects were moved to the end of the tray close to the child, while the actor was not visible. In the congruent condition, the objects always switched positions prior to the first test round and then moved back to their original positions for the second test round. Thus, if a child saw the goal object on the left during habituation that object would appear on the right during the first two trials, then again on the left side for the re-familiarization trial, and on the left for test trials 3 and 4. In the incongruent condition, the timing of this switch (before test round one or two) was counterbalanced between subjects.²

There followed two choice test trials, in which the actor reached for but failed to attain the test target object as the tray moved away from her and toward the child. She continued to reach for the test target object, making a grasping motion with her hand and alternating gaze between the child and the object, saying “oh, I can’t reach. Can you help me?” After 2 test trials, children were given one more familiarization trial in which the actor reached for the familiarization target object. Then children saw a single trial in which the actor was not present and the objects had again moved forward on the tray closer to the child. Two more choice test trials followed.

² The children in these two object switching conditions did not differ in their rates of giving or in their selective giving of the target object, so all analyses collapsed across these conditions.



Figure 8a



Figure 8b

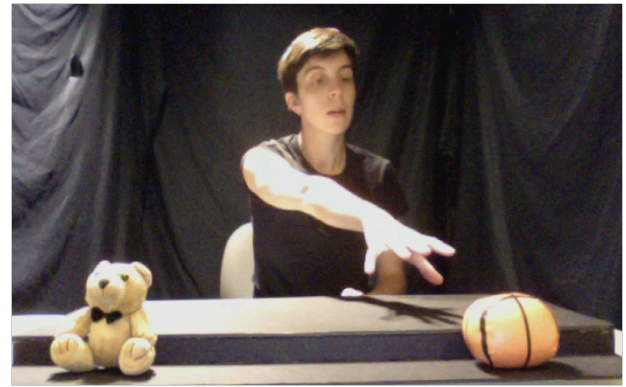


Figure 8c

Figure 8: Illustrations depicting the familiarization trials (8a) and test trials for the choice test phase of Experiment 5, congruent (8b) and incongruent (8c) reaching conditions.

6.2: Results

Congruent vs. incongruent conditions. On the no-choice trials, toddlers gave the object on 75% of trials in the congruent condition and 55.6% of trials in the incongruent condition. This difference was not significant ($t(34) = 1.38, p = 0.176$) and no such difference would be expected, as the no-choice test was identical in the two conditions. On the choice trials, in contrast, toddlers gave an object on 76.4% of trials in

the congruent condition, and 70.8% of trials in the incongruent condition. These rates of giving also did not differ from one another, $t(34) = 0.56, p = 0.576$.

A 2x2 ANOVA performed on the choice trials only, with Condition (congruent vs. incongruent) as between-subjects factor and Object given (test target vs. test non-target) as the repeated measure, revealed a main effect of Object given ($F(1,34) = 10.02, p = 0.003$), but no main effect of Condition ($F(1,34) = 0.47, p = 0.498$) and no interaction of Condition and Object given ($F(1,34) = 0.66, p = 0.424$). Toddlers exhibited higher giving of the test target versus test non-target object across both conditions, and they showed this selective giving equally in the congruent and incongruent conditions.

Across conditions, 24 children gave the test target object on their first active trial (congruent: 13; incongruent: 11) and 12 children gave the test non-target object (congruent: 5; incongruent: 7) ($p=0.065$, two-tailed binomial test). An independent-samples t-test comparing giving of the target versus non-target object for male and female participants revealed no significant effect of sex on performance either within or across conditions.

Experiment 5 congruent condition vs. Experiments 2 and 4. Toddlers' rates of giving an object during no-choice and choice test trials in the congruent condition of Experiment 5 did not differ from those in Experiment 2 (no-choice: $t(34) = 1.061, p = 0.297$; choice: $t(34) = 0.146, p = 0.885$) or Experiment 4 (no-choice: $t(34) = 1.89, p = 0.068$; choice: $t(34) = 1.372, p = 0.179$, two-tailed). Thus, toddlers showed equal motivation to give an object across these experiments.

Nevertheless, a 2 (Experiment: 2 vs. 5—congruent) by 2 (object: target vs. foil) repeated-measures ANOVA on the choice test performance revealed a significant

interaction of Experiment and Object given, with the children in the congruent condition of Experiment 5 giving the target object relative to the non-target object at higher rates than those in Experiment 2 ($F(1,34) = 9.842, p = 0.004$). On the first trial for which a child gave an object, the children in the congruent condition of Experiment 5 also were significantly more likely than those in Experiment 2 to give the target object (Fisher's exact test: $p = 0.047$). Both these analyses provide evidence that toddlers' choice of objects was influenced by the current, ongoing behavior of the actor who requested the objects.

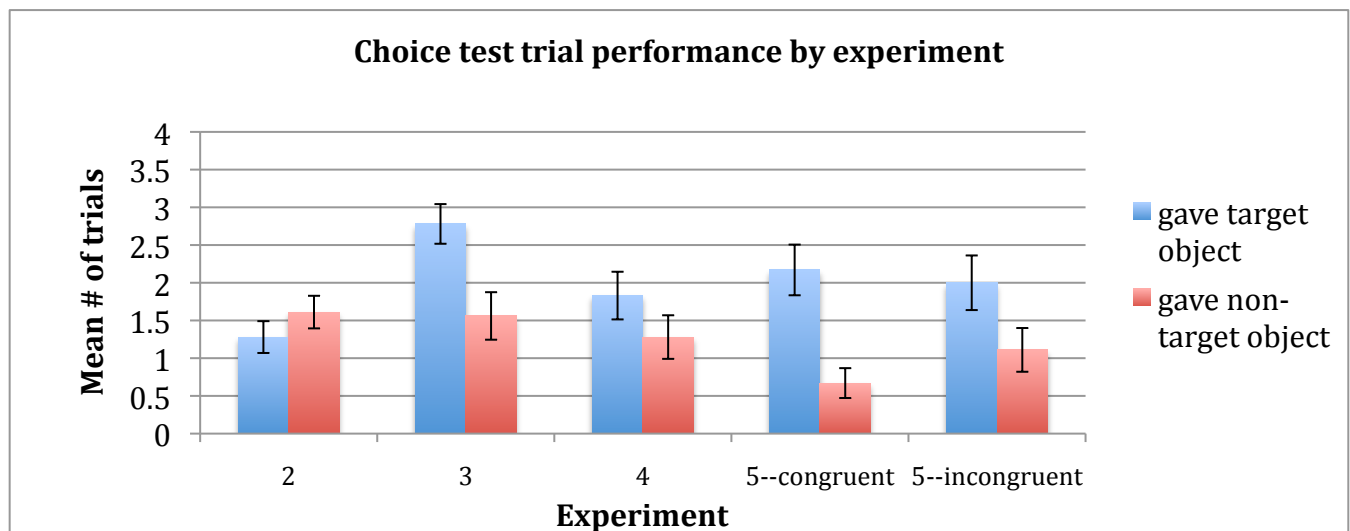


Figure 9: Performance in the choice test phase across experiments 2-5

6.3: Discussion:

The toddlers in the congruent condition of Experiment 5, unlike their same-aged counterparts in Experiments 2 and 4, tended to give the actor the object that was the goal of her reach. What produced this difference? The congruent condition of Experiment 5 differed from Experiments 2 and 4 primarily in the nature of the choice test trials. In the congruent condition of Experiment 5, the actor continued to reach, albeit unsuccessfully,

towards the target object during choice test trials, allowing children to infer the actor's goal from her current, ongoing action. The actor also could see both objects, and she looked in alternation at the desired object and at the child. In Experiments 2 and 4, in contrast, toddlers had to use the actor's previous actions to infer her goal, as she neither looked nor reached towards either object during choice test trials (because she could not see the objects).

Toddlers' successful helping in Experiment 5 suggests that their less appropriate helping in Experiments 2 and 4 did not occur because their desire for novelty, either for themselves or for the actor, led them to disregard the actor's preference for the familiar object. Instead, both the negative findings of Experiments 2 and 4 and the positive findings from the two conditions of Experiment 5 suggest that toddlers' failures to give the target object in Experiments 2 and 4 stems from limits on their ability to use the prior goal-directed action of the agent to guide their helping behaviors.

The analyses comparing performance in the congruent and incongruent conditions of Experiment 5 begin to shed light on the nature of those limits. In this experiment, we tested whether toddlers can use information gained from an agent's prior goal-directed actions to infer his enduring preferences, and then use those preferences in a situation with greater behavioral support for helping than the situation studied in Experiments 2-4. In Experiment 5, the actor asked for help while both looking at and reaching for an object. If prior goal information influences toddlers' attributions of enduring desires, then this request should have been more compelling for children tested in the congruent condition, in which the current behavior of the actor was congruent with the prior goal and preference information, than in the incongruent condition, in which it was not.

Contrary to that prediction, toddlers in the congruent and incongruent conditions of Experiment 5 gave the test target object at similar rates, despite the markedly different history of object-directed reaching shown by the actor. In the incongruent condition, every successful, deliberate act of reaching produced by the actor in familiarization and seen by the toddler was directed to the object that served as the foil at the time of the test. Nevertheless, toddlers were as successful at avoiding this foil, and giving the actor the object of her current reach, in the incongruent condition as in the congruent condition. This finding suggests that 14-month-old toddlers' acts of helping are guided only by information about an actor's current, ongoing actions and perceptions, not by information from her history of goal-directed action. This finding is consistent with evidence that even 8-month-old infants infer agents' desires from their ongoing actions (Luo, Markson, Fawcett, Mou, & vanMarle, 2010).

7: General Discussion

Although 14-month-old toddlers encode reaching events in terms of object goals (Experiment 1) and can use information from an actor's ongoing goal-directed action to help appropriately by giving the actor the object that she seeks (Experiment 5), we found a developmental change, from 14 to 24 months, in toddlers' ability to infer, from an actor's prior goal-directed action, what action to take in response to a request for help. This pattern of development of both desire understanding and prosocial interaction between the first and second birthdays is consistent with existing findings from studies of helping in the second year. Toddlers fail to use emotional expressions to guide helping at 14 months but succeed by 18 months (Repacholi & Gopnik, 1997). Moreover, 20-month-

old children use sampling evidence to infer a preference and choose a toy for an adult accordingly, but 16-month-old toddlers show a much weaker ability to do this (Ma & Xu, 2011). Finally, toddlers help at 14 months in situations like that of Experiment 5, in which an actor reaches toward a single out-of-reach object, but not until 18 months in situations in which more potential objects and actions are available (Warneken & Tomasello, 2006; 2007).

In contrast, evidence from some (but not all) looking-time studies has been interpreted to show that infants infer stable preferences from the present patterns of intentional action well before their first birthdays: They use information about an agent's perceptual access to various objects to guide their reasoning about goal-directed actions (Luo & Baillargeon, 2007; Luo & Johnson, 2009), and they engage in appropriate social evaluations of helpers and hinderers, exhibiting both social preferences for helpers and expectations that others will prefer helpers as well (Hamlin et al., 2007). Infants even show understanding of how a helpful agent ought to act in light of a recipient's object preferences (Hamlin et al., 2012; Martin et al., 2012).

The present experiments cast doubt on one potential explanation of the discrepancy between infants' successful reasoning about helping and preferences in looking time studies and toddlers' early failures in active helping tasks. Most previous studies using active helping methods presented toddlers with relatively complex events in a rich and potentially distracting environment, in which the adult actor addressed the child directly and a variety of objects were available as targets of action and attention. In contrast, most previous studies using looking time methods present infants with simple events involving limited numbers of objects and minimally responsive actors. In those

studies, infants might appear to reason more maturely about agents' goals, preferences, and helpful actions in looking time experiments, because the events displayed are extremely simple and easy to parse; they often involve action alone, without complex emotions, language or social interactions. Naturalistic helping studies, on the other hand, tend to be more complex and thus harder for toddlers to process and attend to successfully.

Such an explanation cannot account for the present findings. The active helping studies presented to toddlers in Experiments 2-4 used actions that are identical to those presented to infants in previous preferential looking experiments (Woodward, 1998), and to toddlers in Experiment 1. Both infants and toddlers attribute goals to the actor in these events. Moreover, the object choice presented to toddlers in the helping task of Experiments 2-4 is the same as that presented in Experiment 5. Toddlers successfully gave the correct object in that experiment. Despite these features, 14-month-old toddlers failed to use information about the goal of an actor's prior actions to infer her preferences and thereby guide their own helping behavior. They failed to use this information either in Experiments 2 and 4, in which only prior goal information specified the desired object, or in Experiment 5, in which prior goal information could have been used together with the actor's current behavior, serving to enhance toddlers' choice of actions in one condition and to attenuate that choice in the other condition. Fourteen-month-old toddlers' failure to use information from the actor's prior actions in any of these experiments therefore provides evidence that early failures in active helping tasks cannot be explained by the complexity of the events or tasks. Toddlers fail to use information

from past actions to guide their helping, even when the actions are appropriately encoded (Experiment 1) and the behavioral task is readily achieved (Experiment 5).

Could toddlers' failures stem from limits to their understanding of enduring preferences or desires? Experiments by Hamlin et al. (2007; 2010; 2013) and Luo and colleagues (Luo & Baillargeon, 2005; 2007; Luo & Beck, 2010; Luo & Johnson, 2009; Luo, 2011) have been interpreted as showing that infants attribute enduring desires to agents. The evidence for desire understanding is indirect, however, and alternative interpretations of the findings of these experiments have been offered (Hernik & Southgate, 2012). Studies using active measures of desire understanding have found continued development in this domain during the second year (Chiarella et al., 2013; Wright & Poulin-Dubois, 2012). In the present studies, toddlers appear clearly to discern the desire of an agent who is actively attending to, and attempting to reach, an object (Experiment 5). It is possible, however, that toddlers do not attribute enduring preferences to agents: preferences that they expect will be maintained as the environment changes. Indeed, recent studies suggest that infants and toddlers do not attribute goals to individuals that endure across time or after changes in their position within the physical environment (Garvin & Woodward, 2014; Sommerville & Crane, 2009). Further research is needed to delineate when children do and do not attribute enduring goals to agents.

A second possible limit concerns toddlers' understanding of helping. The mature concept of helping depends on an understanding of second-order goals: One person intentionally helps another only if the actions of the helper are directed to the goal of fostering the goal of the actor that she helps. Infants begin to represent second-order

goals of a single agent toward the end of the first year, when they first interpret actions (such as opening a box) as aiming to foster further actions (such as taking the object that the box contains). It is possible that children begin to understand second-order goals that span two agents later than those that span a single agent. The evidence for young infants' prosocial evaluations of helpful agents is consistent with that possibility, because those studies do not reveal whether young infants attribute second-order goals to agents whose actions benefit others (Hamlin, 2013).

A different explanation for the difference in performance between children in Experiments 2 and 3, on one hand, and 5, on the other, appeals to differences in young children's understanding of communication. Younger toddlers, faced with a request for help as in Experiment 2, may respond according to only the current, ambiguous situation where the objects are out of the actor's view and reach, and not in terms of the information that they have gained concerning their communicative partner's preferences and goals. The older children in Experiment 3, in contrast, resolve the request for help by interpreting the situation in light of the actor's past goals. This explanation fails to account for the findings of Warneken and Tomasello (2007), however, which reveal the same developmental change in toddlers' helping in a situation in which the person to be helped does not communicate with the toddler in any way. Thus, we believe it is more likely that the developmental change stems from changes in toddlers' understanding of desires and helping, rather than from changes in their understanding of communication.

Lastly, it is possible that toddlers have all of the necessary understanding of goals, desires and helping, but that they lack the cognitive resources to use this understanding so as to generate helpful actions. A recent eye-tracking study found that infants took longer

to make goal-based action predictions than location-based predictions, suggesting that even passive reasoning about goals is cognitively demanding for infants (Krogh-Jespersen & Woodward, 2014). Furthermore, the difficulty of generating one's own acts of helping may stem from the demands that tasks requiring controlled actions place on processes of inhibitory control and executive function. This hypothesis gains plausibility from research in a different domain, concerning the development of representations of objects. Very young infants represent objects as existing and moving continuously whether in or out of view (Baillargeon, 1987; Baillargeon, Spelke & Wasserman, 1985), but older children fail to engage in systematic patterns of manual search to retrieve such objects (Piaget, 1954). Indeed, even 2-year-old children sometimes fail to use knowledge of a hidden object's position and motion to search for such an object appropriately (see Keen, 2003 for review). When presented with an event in which a ball rolls behind an occluder towards a solid wall, infants expect the ball to roll continuously to the wall if unobstructed, but expect the ball to stop rolling if it contacts a barrier that has been placed in its path. That is, even very young infants expect objects to adhere to the physical principles of solidity and continuity. 2.5-year-old children, however, fail at an action-based version of this task which requires them to search for the ball once the event is concluded: Children sometimes reach for the ball on the wrong side of the barrier, behaving as if they expected the ball to violate the continuity and solidity constraints.

Research by Keen (2003) reveals that this discrepancy stems from the action task's demand for both prediction and action planning. When given a looking-time version of the search task they fail, 2.5-year-old children succeed at the task: They look longer when the door is opened to reveal the same rolling ball stopped on the far side of

the barrier rather than in front of it, providing evidence that they represented the correct position of the ball. This same explanation could apply to the discrepancy between our present findings of toddlers' helping behaviors and the looking-time studies of infants' understanding of goals and helping. Indeed, the same cognitive capacities of working memory (Munakata, McClelland, Johnson & Siegler, 1997) and inhibitory control (Diamond, 1990), might mediate the developmental changes in the domains of object and social cognition. The present findings therefore invite research probing the nature and sources of this developmental change in the domain of helping. Especially compelling would be evidence that individual differences in helping abilities are related to individual differences in inhibitory control or executive functioning more generally.

In summary, the present findings provide evidence for a significant developmental change in children's helping, over the second year, allowing 24- but not 14-month-old toddlers to help appropriately a person who requests an object that she has previously been seen to choose. Moreover, they provide evidence that the change involves at least some cognitive factors and is not purely motivational, both because children at the two ages showed equally high levels of giving, and because younger children gave the appropriate object under conditions that did not require reasoning about enduring preferences.

Nevertheless, the specific concepts and cognitive processes that account for this change remain to be clarified. In this endeavor we urge caution in over-attributing knowledge, perhaps especially knowledge of social relationships, to very young infants. The results of the present study suggest limits to children's understanding of goals, preferences, or helping. Further research, both on infants and on toddlers, should seek to

identify both the nature and limits to the social cognitive abilities that emerge in the first year. Studies of such limits, and of the cognitive changes by which children overcome them, may shed light not only on the developmental mechanisms at work in this domain but also on mature conceptions of actions, mental states, and prosocial behavior. We hope that the present methods will prove useful for this effort.

Part III

Relations between motivational state reasoning and vocabulary size in toddlerhood

Kathryn Hobbs, Westley Resendes, Jennie Pyers and Susan Carey

Abstract

An abundance of evidence points to a strong facilitative role of language on the development of explicit false belief reasoning in the preschool years. Much less is known, however, about the relationship between language and other aspects of theory of mind, especially the understanding of motivational states that emerges in the first and second years of life. In two experiments, the current study asks whether language and motivational state reasoning are related in the second year. In experiment 1, 86 typically hearing 18-month-olds were tested on intention understanding, comprehension and production of communicative pointing, working memory, and receptive and expressive vocabulary. Experiment 2 used the same measures to compare the abilities of typically hearing and language-delayed deaf children of hearing parents. The findings of both experiments 1 and 2 suggest motivational state reasoning emerges independently of early vocabulary. The findings are discussed with regard to current debates on the structure of the systems governing theory of mind reasoning.

Introduction

Theory of mind (ToM) reasoning encompasses representations about a variety of epistemic states including knowledge and beliefs, on the one hand, and non-epistemic mental states of perception, attention, intention, desire and emotion, on the other. Though false belief reasoning is often treated as the hallmark of ToM, the capacities that emerge prior to *epistemic state* understanding, such as intention understanding and joint attention abilities—what we will refer to as the understanding of *motivational states*—are important ToM skills in their own right and are also the foundation for later false belief reasoning (Aschersleben, Hofer & Jovanovic, 2008; Olineck & Poulin-Dubois, 2007; Thoermer, Sodian, Vuorii, Perst & Kristen, 2011; Wellman & Brandone, 2009; Wellman, Phillips, Dunphy-Lelii & LaLonde, 2004; Wellman, Lopez-Duran, LaBounty & Hamilton, 2008; Yamaguchi, Kuhlmeier, Wynn & vanMarle, 2009). Recent research has expanded our understanding of ToM by investigating the ToM abilities present prior to explicit false belief reasoning, and an abundance of findings point to the presence of false belief reasoning certainly in the second year of life, and even in the first (see Baillargeon, Scott, He, Sloane, Setoh, Jin, Wu & Bian, 2014 for a review). An outstanding puzzle within developmental psychology, therefore, is whether the ToM representations available to infants are fundamentally the same (Baillargeon, Scott & He, 2010; Onishi & Baillargeon, 2005; Song, Onishi, Baillargeon & Fisher, 2008; Surian, Caldi & Sperber, 2007; Träuble, Marinović & Pauen, 2010) or different (Apperly & Butterfill, 2009; Carey & Spelke, 1994; Gopnik & Wellman, 1994; Wellman, Cross & Watson, 2001) from those which emerge in the preschool years. Relatedly, recent research has begun to ask whether the variety of ToM representations available in infancy—encompassing false belief

reasoning, intention understanding, joint attention and communication skills—belong to a common system for reasoning about others' minds.

Between birth and 4 years of age, there is enormous change in children's performance on tasks that tap into this range of ToM concepts (see Wellman et al., 2001 for a review). Alongside changes in performance with age are differences in performance based on the kinds of task used—whether *spontaneous-response*, *indirect-elicited-response/prompted-action* or *elicited-response*, as Baillargeon and colleagues have classified them (Baillargeon, Scott & He, 2010; Baillargeon et al., 2014). These performance differences by both age and task type have generated vast debate over how to think about children's ToM development.

Theories of ToM development

Two major schools of thought contrast expression and construction accounts of the changes in ToM that occur during the first four years. Those who argue for an expression account propose that there is continuity between infants' and preschoolers' abilities to attribute false beliefs to others (Baillargeon et al., 2010; Onishi & Baillargeon, 2005; Song et al., 2008; Surian et al., 2007; Träuble et al., 2010), and what develops between infancy and age 4 is the child's ability to express their understanding of others' minds. On this account the reason 3-year-olds continue to fail explicit tests of false belief lies merely in methodological differences between the kinds of tasks used at each age, such that the tasks given to preschoolers pose performance demands that exceed their information processing or executive functioning capacities (Baillargeon et al., 2010; Leslie, German and Polizzi, 2005).

Advocates for the construction account of ToM development, on the other hand, argue that new conceptual resources are constructed over the preschool years.

Constructivists believe that the kind of ToM abilities present in infancy are fundamentally different from those that emerge around age 4, with conceptual change required for the acquisition of the adult explicit ToM system.

That language is strongly related to ToM is a piece of evidence used to advance the construction argument. Under this hypothesis, various aspects of language may act as facilitators of the conceptual change that occurs between birth and age 4 in ToM reasoning (for a review see Astington & Baird, 2005). de Villiers and colleagues have claimed that the syntax of complementation, which allows for efficient linguistic encoding of false beliefs, may provide the representational structure for children's representation of false beliefs (de Villiers & Pyers, 2002). Others have pointed to the role of semantic knowledge of mental state terms as a critical factor in reasoning about mental states (Barsch & Wellman, 1995; Ruffman, Slade & Crowe, 2002; Taumoepeau & Ruffman, 2006; Taumoepeau & Ruffman, 2008). And still others have emphasized the role of conversation and pragmatic language skills in allowing children to appreciate others' unique perspectives (Harris, de Rosnay & Pons, 2005). The evidence for a relationship between language and ToM is most abundant in the domain of false belief reasoning. Such studies have been conducted with both typically hearing children as well as deaf populations, for whom language acquisition is often specifically delayed.

Language and ToM in hearing children

The meta-analysis by Milligan, Astington & Dack (2007) found that language ability accounted for a significant portion of the variance in children's false belief

reasoning, even when controlling for age. The analysis examined different aspects of language ability—general language, semantics, receptive vocabulary, syntax and complement comprehension—and found that each is significantly related to false belief understanding. Furthermore, the results of this meta-analysis shed some light on the causal relationship between language and ToM; though early false belief scores predicted later language ability, early language ability was a significantly stronger predictor of later false belief reasoning.

The findings of longitudinal studies also endorse a facilitative role of language on false belief development by demonstrating that milestones in language acquisition systematically precede related milestones in ToM development. de Villiers & Pyers (2002) found that children consistently pass false belief tests after they pass tasks of complement comprehension, sentential complements being the linguistic structure that *best* allows for the verbal expression of false beliefs. They also demonstrated that understanding complements at time 1 predicts false belief reasoning at a later time point, but the reverse is not true; this longitudinal evidence is consistent with the idea that advances in language drive growth in ToM abilities, not the other way around. Astington & Jenkins (1999) similarly found that early language abilities predicted later ToM skills but not vice versa, and found syntactic skill to be a stronger predictor of later ToM than semantic development.

Training studies present the strongest case for a causal role of language in the emergence of ToM reasoning, indicating that advances in language skills may drive growth in false belief reasoning. Lohmann and Tomasello (2003) found that children's false belief reasoning improved in two language training conditions but not in their no

language training condition, lending support to syntax, semantics and discourse as causal agents in the development of false belief reasoning. Another training study found that children in a false belief training condition improved on false belief tasks but not on language measures, while children in a sentential complements training condition showed gains in both complement comprehension and false belief reasoning; children in a relative clause training condition showed improvement only on relative clauses (Hale & Tager-Flusberg, 2003). This finding also supports the hypothesis that language, specifically sentential complement understanding, plays a causal role in the development of false belief reasoning.

Outside of false belief reasoning there is less evidence of a causal role for language in ToM development, though some correlational and longitudinal evidence does exist. For one thing, parents' use of mental state language is positively predictive of children's later scores on a range of ToM abilities including desire, emotion and false belief understanding (Meins et al., 2003; Ruffman, Slade & Crowe, 2002; Taumoepeau & Ruffman 2006; 2008). Furthermore, the child's own production of mental state language reliably precedes (Barsch & Wellman, 1995) and predicts successful reasoning about mental states (Taumoepeau & Ruffman, 2006; Taumoepeau & Ruffman, 2008).

Language and ToM development in deaf populations

Studies with deaf populations have also provided evidence for the role of language in the development of ToM. In particular, deaf children with hearing parents (DoH) usually experience a delay in language acquisition stemming from a lack of accessible input, whether signed or spoken. While DoH children are delayed in language, they are otherwise cognitively and socially typical, having normal IQ, executive

functioning skills and social interactions. Many studies have found that DoH children who are delayed in language acquisition are also delayed in false belief reasoning (Peterson & Siegal, 1995; Peterson & Siegal, 2000; Peterson & Wellman, 2009; Pyers & de Villiers, 2013; Russell et al., 1998; Schick, de Villiers, de Villiers & Hoffmeister, 2007; Woolfe, Want & Siegal, 2002). In the only study investigating the false belief reasoning of deaf toddlers, Meristo and colleagues (Meristo et al., 2012) found a difference in 17- and 26-month-old deaf and hearing children's anticipatory looking based on a character's false belief. And deaf adults who gain access to natural language only later in life do not attain success in reasoning about false beliefs until they have acquired sufficiently complex language (Pyers & Senghas, 2009).

While there is abundant evidence that DoH children are delayed in false belief reasoning, less is known about whether other aspects of ToM are spared or impaired in this population. In particular, few studies have investigated whether DoH children struggle with the ToM abilities that emerge in the infant and toddler years, such as intention understanding and joint attention. One study has investigated deaf children's ability to reason about actions in terms of their underlying goals (Want & Gattis, 2005). In a gestural imitation task, both deaf and hearing children took shortcuts that suggested they encoded particular actions in terms of the end goal as opposed to the means; furthermore deaf and hearing children performed very similarly on this imitation task. This study, however, examined the intention understanding of older deaf children (ages 4-7 years), whereas the understanding of intentions is believed to emerge in TH infants within the first year after birth. No study has yet investigated the goal understanding of deaf toddlers under the age of 4.

A study by Peterson and Wellman (2009) investigated the role of language on a range of ToM abilities, testing deaf children on tasks tapping understanding of desires, the seeing-knowing connection, belief reasoning, and social pretence skills. While the study poses limitations in terms of the highly verbal nature of the tasks and the use of an interpreter during administration of the tasks, it nonetheless provides some compelling hints at deaf children's ToM reasoning prior to false belief understanding. First, replicating the findings of Peterson, Wellman & Liu (2005), the study finds deaf children to be delayed relative to hearing children on all tasks within Wellman & Liu's (2004) ToM scale. Most of the tasks in the scale measure epistemic state understanding, however, with only one task tapping motivational state understanding (diverse desires). Importantly, the study also finds a very similar progression of abilities to that of hearing children, with children advancing up the scale of ToM tasks with age. Another study of deaf children's understanding of the link between perception and knowledge found that deaf children are delayed relative to hearing children in their understanding that seeing and hearing lead to knowledge (Schmidt & Pyers, in press). Thus there is suggestive evidence that deaf children's ToM reasoning even prior to false belief understanding may be delayed relative to that of hearing children, though no study has yet probed deaf toddlers' understanding of motivational states.

Motivation for the current study

Mapping the role of language in ToM development beyond false belief reasoning could potentially inform the debate over whether continuity exists between early and later ToM abilities. The growing bodies of research showing a consistent sequence of emergence of ToM skills and a specific predictive relationship between early and later

capacities constitute two kinds of evidence of continuity of the ToM system(s). Another kind of evidence to contribute to the continuity argument is that of supporting mechanisms for ToM development and reasoning. That is, if there is continuity between early and later ToM, the same types of representations that underlie ToM abilities in the preschool years should also undergird those abilities present in the infant and toddler years. Is language, as one of the mechanisms that clearly supports explicit false belief reasoning, also supporting motivational state reasoning?

Furthermore, discovering how language and ToM might be related in infancy and toddlerhood could ultimately inform early intervention practices with deaf, language-delayed and Autistic children. The current study begins to map young deaf toddlers' ToM abilities to better understand how to improve early intervention practices.

This study contrasts two hypotheses: 1) Language and ToM are related even in the second year of life; 2) infant ToM development is independent of language acquisition.

Hypothesis 1: language and ToM are related in late infancy

Hypothesis 1 would be supported if either language or ToM is dependent on the other, or if both are dependent on a common third factor (e.g. executive functioning). Though the development of ToM in the preschool years has been shown to be more dependent on language than the reverse, during the infant and toddler years the opposite may well be the case. That is, language development may depend in part on a child's ability to read others intentions and reason about social partners' internal states (Tomasello, 2001). Alternatively, it may be that early ToM abilities depend on the

toddler's burgeoning vocabulary or more generally their experience with language and conversation.

Another reason to predict that early ToM and language might be related centers on the importance of joint attention episodes. Joint attention abilities are strongly predictive of language development (Brooks & Meltzoff, 2005; Carpenter, Tomasello, Nagell, Butterworth & Moore, 1998; Kristen, Sodian, Thoermer & Perst, 2011; Mundy & Gomes, 1996; Tomasello & Farrar, 1986) and may also facilitate ToM development (Moore & Corkum, 1994). Joint attention episodes also provide important experiences for infants to learn about others' perceptions, attention and intentions. Importantly, there are qualitative and quantitative differences in joint attention engagement between hearing-hearing dyads and deaf-hearing dyads (Gale & Schick, 2009; Meadow-Orlans & Spencer, 1996; Prezbindowski, Adamson, & Lederberg, 1998). Thus, inasmuch as DoH children have less experience with joint attention abilities owing to reduced frequency of joint engagement with their hearing parents, their abilities to read other's intentions may be diminished relative to their hearing peers.

Hypothesis 2: language and ToM are not yet related at 18 months

Conversely, we might find no connection between language and motivational state understanding. If these early ToM abilities are rooted in a ToM module that develops independently of linguistic experience (Apperly & Butterfill, 2009; Leslie, 1994), we should find no relationship between individual differences in vocabulary and understanding of motivational states, and no differences between deaf and hearing toddlers. Indeed, there is plenty of evidence of motivational state reasoning present very early in infancy, even before productive language has come online (Baillargeon et al.,

2014; Poulin-Dubois, Brooker & Chow, 2009). If motivational state reasoning is indeed present in infancy and operates independently of language, the question becomes when and how language and ToM become related in the later toddler and preschool years.

The current study. We now turn to two experiments that use different methods to ask the same question—is motivational state understanding related to language?

Experiment 1 investigates the link between motivational state understanding and language in a large sample of typically hearing toddlers between the ages of 17 and 28 months. Language ability is tested with the Short Forms of the MacArthur Communicative Development Inventories, which are fully normed parent-report checklists of expressive and receptive vocabulary. To assess motivational state understanding we use two conditions of an imitation task (Meltzoff, 1995) and a pointing task with four conditions (Camaioni, Perucchini, Bellagamba & Colonesi, 2004).

Experiment 2 takes a different approach to investigating motivational state reasoning and its possible relationship with language. Modeled on research with older deaf children (e.g. Schick et al., 2007), experiment 2 asks whether deaf toddlers who are at risk for language delays show any differences in their motivational state understanding from typically hearing toddlers. Experiment 2 again uses multiple measures of understanding of motivational states and parent report measures of expressive and receptive vocabulary size. Importantly, the deaf children included in experiment 2 have significantly smaller receptive and expressive vocabularies than their hearing peers, allowing us to ask whether impaired language ability confers delays in motivational state understanding in the toddler years.

We chose vocabulary as our measure of language ability for several reasons. First, vocabulary is the most highly developed aspect of language in the toddler years, unlike syntax and pragmatics, which are relatively nascent in the second year, making it a powerful measure for assessing individual differences. Second, there are normed, valid, reliable and rapid assessments of vocabulary available for our age range of interest—the Infant and Toddler CDI Short Forms (Fenson, Pethick, Cox, Dale & Reznick, 2000). Though still in its development, the American Sign Language (ASL) CDI (Anderson & Reilly, 2002) was selected as the best available instrument for assessing vocabulary development in ASL. Lastly, vocabulary in the first two years of life is a strong predictor of both later language (Bates & Goodman, 1997; Feldman et al., 2005; Marchman et al., 2004; Metsala, 1999) and cognitive abilities (Bornstein & Haynes, 1998; Marchman & Fernald, 2008).

We chose the motivational state understanding measures because they reflect fundamental skills in their own right, are related in the toddler years (Camaioni et al., 2004), and are predictive of later ToM abilities (Charman et al., 2000; Olineck & Poulin-Dubois, 2007). All these findings suggest that the imitation and pointing tasks tap into common representations of motivational states, reflecting a consistent, integrated construct of understanding of motivations.

Lastly, we chose the working memory task in order to have a measure of cognitive development outside the domains of ToM and language. This is especially important in comparing the deaf and hearing toddlers; if we do find group differences in motivational state understanding we need to know if these differences are pervasive or

specific to motivational state reasoning. We chose this particular memory task because norms exist for the age range of interest (Diamond, Prevor, Callender & Druin, 1997).

If language and motivational state reasoning are already strongly related in the first two years of life we should expect to find correlations between our vocabulary and motivational state understanding tasks in experiment 1 and differences in motivational state understanding between the deaf and hearing toddlers in experiment 2.

Experiment 1

Method

Participants. Eighty-six typically hearing toddlers between the ages of 17;00 and 19;26 participated in Experiment 1 ($M_{\text{age}}=18;11$; 52 males and 34 females). They were tested in a laboratory setting and were compensated with a small toy and a \$5 travel reimbursement. Included in the sample were 68 monolingual English-speaking toddlers and 15 toddlers exposed to one or more non-English languages. The toddlers in our sample came from a range of SES backgrounds, but the majority came from upper-middle class families with one stay-at-home parent. Toddlers were recruited through a database of families in the greater Boston area willing to participate in developmental research.

Materials & Procedure. The procedure for the working memory task (Diamond et al., 1997), imitation tasks (Meltzoff, 1995) and pointing tasks (Camaioni et al. 2004) are all described in greater depth in the cited papers and only briefly here.

Vocabulary Assessment. The MacArthur Communicative Development Inventory—Short Form (Fenson et al., 2000) in English was used to assess expressive vocabulary and total vocabulary. Parents completed both the Level I (Infant, <18 months)

and Level II (Toddler, >18 months) forms. If the child was learning any languages other than English, the parent also filled out the CDI—Short Form with translation equivalents. All vocabulary checklists were completed within 2 weeks of the testing session. Our Total Vocabulary measure combines all known receptive and expressive words from both forms. Our Expressive Vocabulary measure combines all the words the child produced from both the infant and toddler forms (with duplicate words counted just once). Expressive percentile scores were derived from the Toddler Form only, as this was the measure used in norming the instrument by age and sex.

Working memory (Diamond et al., 1997).

Materials: Three identical rubber duck finger puppets (4cm tall x 4cms wide x 2.5cms deep), 3 identical plush bear finger puppets (8cms tall x 8cms wide x 3.5cms deep), 3 white ping pong balls (4cms in diameter), a colorful plastic ball ramp (68cms tall x 25cms wide), 3 different colored cylindrical containers (6cms in diameter, 6.5cms tall; size; red, yellow and gray), a black foam-core tray (40.5cms long x 15cm wide) with cutouts for the containers (6cms in diameter) and a black foam-core occluder (26.5cms tall x 50.5cms wide, with 9cm deep base) were used in the working memory task.

Procedure: This task consisted of a hide-and-seek game in which the child attempted to retrieve hidden toys from differently shaped and colored containers. Each child participated in a practice round and two test rounds, administered by two experimenters. Each round began with E1 lining up the three containers in the tray, then showing the child the three identical toys, placing one in front of each container. E1 then opened one container, showed the child that it was empty (with E2 saying “look in here” and pointing) and placed a single toy in the container. This procedure was repeated until

all three toys were hidden in the containers. E1 then pushed the tray towards the child, and E2 said “ok, it’s your turn.” The child was allowed to choose one container to open. If the child chose more than one container the trial was repeated. E2 helped the child open the container and responded excitedly upon finding a toy inside.

In the practice round, the empty container was returned to the tray, and the experimenter shuffled the three containers in the child’s sight. The above steps were repeated until the child retrieved all three toys from the containers. If the child opened an empty container E2 shook her head with a mildly sad expression and said “no, not in there. Let’s try again.”

Two test rounds followed the practice round with new toys in the same three containers. The main difference between practice and test was that in the test rounds, empty containers were shuffled behind an occluder so that the child could not track the movement of the containers. Once the containers were hidden behind the occluder after each trial, a 5-second delay was imposed before beginning the next trial. The shuffling of containers followed fixed orders depending on which container the child chose first. This ordering ensured that if the child took the strategy of always selecting a container from the same location on each trial she would open an empty container at least once within the first three trials.

Scoring: The number of times the child chose an empty container in each round was scored, as well as the child’s repeated reaches to the same location and same colored container. We reverse scored the average number of errors across the two test rounds, with a higher score representing fewer errors and hence better performance.

Imitation task (Meltzoff, 1995).

Materials: The five items used in Meltzoff (1995) were re-created as closely as possible, and the same items were used in both the inference and control conditions. The prong and loop item consisted of a straight metal hook affixed to a rectangular foam core stand covered with felt (19.5cm wide x 16cm tall, with 26cm wide x 19cm deep base) and a loop of white cotton string (27cm long). The square and post consisted of a colorful (10cm) square of foam core with a 3.5cm hole in the middle, and a colorful square of foam core with a plastic cylinder (2.75cm wide x 2cm tall) in the middle. The cylinder and beads item consisted of an orange plastic cup (5cm at base, 7.5cms at top x 9cm tall) glued to an orange foam-core base (11cm x 11.5cm) and a string of green plastic beads (40.5cm long). The dumbbell was made of two brown wooden blocks (3.75cm cubes) glued to pieces of white open tubes of flexible plastic that could fit together easily (11cm long x 2.5cms wide). We modified the box and stick tool to be suitable for use with the deaf participants of Experiment 2. The box component was the same as Meltzoff's, and covered in black electrical tape. Instead of a recessed button we created a hole (2.25cm x 3.5cm x 4.5cm deep) all the way through the box through which the accompanying wooden stick (2.5cm x 2cm x 18.25cm) could be passed. Instead of making a buzzing noise, the wooden stick, when passed through a hole in the box, activated four small red lights on the side of the box. This change from a recessed button to a hole resulted in the box item being especially demanding of fine motor skills.

Procedure: The imitation task is designed to assess children's ability to infer an actor's goal based on her goal-directed action attempts. In the inference condition, modeled after Meltzoff's "demonstration (intention)" condition, the experimenter tries but fails 3 times to complete the target action. The items are then passed to the child for a

20-second response window. In the control condition, modeled on Meltzoff's "demonstration (target)" condition, the actor successfully completes the target action three times. As in the inference condition, the items are then passed to the child for a 20-second response window. The control condition is matched in motor and social demands but lacks the requirement that the child make a goal inference. Unlike in Meltzoff's study, each toddler participated in both the inference condition and the control condition.

Scoring: In both the inference and control conditions, the child received 1 point for each item for which they produced the correct target action, for a total of five possible points per condition. The target actions for each item were as follows: hang the loop from the prong; place the square over the post; place the beads into the cylinder; completely pull apart the dumbbell pieces; put the wooden stick through the hole in the light box.

Pointing task (Camaioni et al., 2004).

Materials: Similar materials were used in the two trials of each of the four pointing task conditions. The imperative production trials used a wind-up pterodactyl/butterfly or a wind-up ladybug. The imperative comprehension trials used a two-piece plastic kayak-and-rider (kayak: 12cm x 6cm x 3cm; rider: 55cm tall x 3.5cm wide x 2cm deep) toy or a two-piece wooden globe (9.5cm diameter). The declarative production trials used a laptop (28.5cm x 18cm screen) with colorful animated dancing stars or a color-changing light, both operated by remote control. The declarative comprehension trials used a color calendar page (30.5cm x 30.5cm) of 3 rabbits or a crayon drawing of a rainbow (21.5cm tall x 28cm wide) affixed to the wall on either side of the child midway between the child and the experimenter.

Procedure: The pointing task was a 2 (production vs. comprehension) x 2 (imperative vs. declarative) design resulting in four conditions. Each condition was tested with two test trials, each with a different set of stimuli for a total of 8 possible points. In their study Camaioni et al. (2004) administered 8 trials per condition; we might expect diminished performance in our study based on this reduction in the number of trials.

For the imperative production trials, the experimenter activated a wind-up toy to engage the child's interest in the toy. After playing with the toy together for a few seconds, the experimenter then picked up the toy and held it in front of her chest on her open palm. A 15-second response window followed in which the experimenter looked at the child and smiled silently.

For the declarative production trials, the experimenter surreptitiously activated the laptop slideshow of dancing stars or the flashing light by remote control while looking straight ahead at the child. A 15-second response window, in which the experimenter smiled silently and looking at the child, began once the child noticed the laptop/light.

In the imperative comprehension trials, the experimenter played briefly with the two-part toy, taking it apart and putting it back together. She then gave one piece to the child, holding the other piece. After a few seconds she looked down at the piece of the toy she was holding saying "hmm" and then said the child's name and pointed at the piece of the toy the child had. During the ensuing 15-second response window she looked at the child, continuing to point to the piece of the toy the child had. If during the response window the child pointed insistently to the piece of the toy the experimenter was holding, she also gave this piece to the child and began another 15-second response window, pointing as above.

In the declarative comprehension trials the experimenter looked at the child and said the child's name, and then looked and pointed at the picture on the wall. After glancing briefly at the picture, she continued to point at the picture but looked at the child, beginning the 15-second response window. During the declarative comprehension trials, we asked parents to close their eyes so they would not be tempted to follow the experimenter's point and inadvertently guide their children to look at the picture.

Scoring: Children were given 1 point for each trial in which they responded appropriately, for a total of 8 possible points. A 2-part coding scheme was used following Camaioni et al., 2004. For imperative production trials, children needed to do all of the following to receive one point for that trial: point to the toy, produce another target action in conjunction with the point (request gesture, leaning towards the object, reaching, vocalizing towards the object, producing a proto-word, whining or pointing continuously) and make eye contact with the experimenter with 2 seconds before or after pointing. The criteria were similar for the declarative production trials, but the target actions included smiling or vocalizing towards the stimulus, producing a word or proto-word directed at the stimulus and imitating the stimulus.

For imperative comprehension trials children received a point if they both localized the stimulus after the experimenter's point and produced an additional target behavior (handing the object to the experimenter, refusing to hand the object to the experimenter, physically or vocally affirming or denying the experimenter's request, or leaving the object on the table for the experimenter while looking at her). In declarative comprehension trials children received a point if they localized the stimulus and produced

an appropriate accompanying target action (smiling or vocalizing towards the stimulus or producing a word or proto-word directed at the stimulus).

Design

Performance on the two motivational state reasoning tasks has been shown to be related, yet the tasks have different demands and superficial structures. Within the pointing task the comprehension items could provide a valid measure even for children who are inhibited and unlikely to engage in active pointing in the production conditions. The imitation—control condition also serves as a control to the imitation—inference condition in that the two conditions have similar memory and response demands yet only the latter requires the child to make an inference about the experimenter’s intention, allowing us to isolate the child’s intention understanding.

Children were tested in a single session of approximately 25 minutes in a small testing room in our laboratory. Because of the attentional demands of such a relatively lengthy session, we might expect performance to suffer on tasks administered later in the battery. Parents filled out the demographic survey and consent forms prior to the test session and completed vocabulary checklists after the test session. We followed a fixed order of task administration for all children: imitation—inference, pointing, imitation—control, working memory. Children sat on their parent’s laps or in their own chair with their parent seated behind them, across a table from the experimenter. Parents were instructed not to interact with their children during the testing session.

Within each task the order of administration of items/conditions was fixed as follows. Imitation—inference and control: prong and loop, square and post, cylinder and beads, dumbbell, box and stick tool. Pointing: imperative production 1 (bird/bird),

declarative production 1 (laptop), imperative comprehension 1 (kayak-and-rider), declarative comprehension 1 (rainbow), imperative production 2 (ladybug), declarative production 2 (light), imperative comprehension 2 (globe), imperative production 2 (rabbits).

Results

We first describe participants' performance on our tasks, and then we compare performance in our sample to that of previous studies. We then examine the relationships within the motivational state understanding measures and within the language measures, and conclude by reporting the relationship between language and motivational state understanding measures.

Task performance: In order to ask whether there are significant correlations between a child's vocabulary size and her understanding of motivational states, we must have sufficient variance on all our measures to detect relationships among the individual differences. We therefore examined the range and distribution of participants' performance on our measures. Table 1 (below) gives the mean score, range and variance (standard deviation) on each task. There are neither floor nor ceiling effects on any of our measures and participants' performance is distributed well across the range of possible scores, suggesting that it will be possible to detect correlations between measures should they exist.

Task	Mean	Min	Max	SD
Imitation—Inference (proportion correct)	0.38	0	1	0.26
Imitation—Control (proportion correct)	0.66	0	1	0.27
Pointing (proportion correct)	0.38	0	1	0.26
Working memory (# errors, reverse scored)	6.71	0	11	2.63
Expressive vocab (# words)	36.09	2	118	27.55
Total vocab (# words)	68.93	11	134	25.01

Figure 10: descriptive statistics for Experiment 1 measures

Comparing our tasks to those in the literature:

While there are notable differences in the design of our study and previous versions in the literature, it is nonetheless useful to compare the performance of participants in our study to that of samples from other studies. Similar performance on our measures to that of previous studies indicates our tasks are appropriately tapping the capacity intended to be measured and also serves as a replication of previous research.

Vocabulary: In the current study the average expressive percentile score by age and sex was 34.4 (range: 0-95, SD = 26.9), well below the norms from Fenson et al. (2000).

Working memory: Compared with Diamond et al.'s (1997) performance by typically developing 18- to 21-month-olds (Mean # errors: 1.25) our participants made slightly more errors across the two trials (Mean: 2.1, range: 0-5.5).

Imitation (inference and control conditions): The study on which our imitation tasks is based, Meltzoff (1995), compared inference and control conditions between subjects, whereas ours was a within-subject design. Performance in our control condition (mean proportion of target acts produced = 0.66) was comparable to that of Meltzoff's (mean = 0.76). Performance in our inference condition (mean proportion of target acts

produced = 0.38), however, was markedly lower than that in the comparable condition of Meltzoff (1995) (mean = 0.8).

Bellagamba and Tomasello (1999) also administered a condition similar to our inference condition between subjects, and while the mean proportion of target acts produced in their study ($M = 0.72$ at 18 months) was slightly lower than that in Meltzoff (1998) ($M = 0.80$), it is still higher than that observed in our sample ($M = 0.38$). At a mean age of 14 months the sample in Camaioni et al. (2004) is younger than ours and those of Bellagamba & Tomasello (1999) and Meltzoff (1995), and the mean number of target acts produced is 0.64.

Neither Meltzoff (1995) nor Bellagamba & Tomasello (1999) found a significant difference between performance in their demo (target) and demo (intention) conditions, which were administered between subjects. Our study is the first to administer these conditions within subjects and we do find a significant difference in performance between the demo (target) (our control) and demo (intention) (our inference) conditions ($t(79) = 9.021, p < 0.001$) even as performance on these measures is significantly correlated ($r(79) = 0.378, p = 0.001$). Children likely performed better in the control condition as it was their second time seeing and acting on the objects.

In sum, we found somewhat lower performance in the inference condition than in previous studies. This difference could be due to population differences or to the increased motor demands of the box item due to our adaptive modification. In general, we do replicate the phenomenon that children will complete incomplete actions by inferring people's intentions and thus this is a valid task for examining possible relationships with ToM tasks and vocabulary scores.

Pointing task: In this task we find a similar pattern of results to that in Camaioni et al. (2004), albeit with somewhat lower rates of pointing and responses to pointing. The table below (Table 2) compares task performance in our own pointing task and that of Camaioni et al. (2004).

Camaioni et al. (2004) report a significant difference in performance by modality (production vs. comprehension), with infants giving more target responses in the comprehension conditions than in the production conditions. We similarly found this effect, with the mean comprehension score ($M = 1.765$, $SD = 1.07$) being significantly higher than the mean production score ($M = 1.07$, $SD = 1.19$) ($t(67) = 4.215$, $p < 0.001$) despite these two scores being significantly correlated ($r(68) = 0.285$, $p = 0.019$).

In comprehension trials, toddlers responded to points appropriately in about half of trials in both studies. Success in pointing production trials was less frequent than in pointing comprehension trials across both studies, at around one third of trials. Across the four conditions of the pointing task we find more variance, as illustrated by higher standard deviation scores, than in Camaioni et al. (2004), increasing the possibility of finding correlations between performance on the pointing task and other tasks in our study.

Our pointing task used just 1 trial per item instead of 4, as in Camaioni et al. (2004). It seems likely that this methodological difference would result in lower performance in our study, given that in our study a child has just one opportunity per stimulus item to respond appropriately, compared with 4 opportunities per stimulus item in the Camaioni et al. (2004) study. It is possible that children increased their appropriate

responding over trials in the Camaioni et al. (2004) study, resulting in a higher overall level of performance than in our procedure.

Camaioni et al. (2004) also looked at the relationship between production of declarative pointing and understanding of intentionality (based on performance in the inference condition of the imitation task from Meltzoff (1995)). In Camaioni et al. (2004), infants who scored above the median on the imitation inference condition scored significantly higher on the declarative production pointing condition (with age entered as a covariate). In the current study there is a trend towards this pattern of results, with high performers on the inference condition of the imitation task scoring somewhat higher on the declarative production condition (mean declarative production score=0.39 vs. 0.31 for low imitation performers), but this difference does not attain significance. In our sample we did, however, find a relationship between overall performance on the pointing task and performance in the inference condition of the imitation task ($r(78) = 0.233$, $p = 0.037$), providing evidence for a common set of underlying motivational state reasoning abilities.

Our rates of successful pointing and responding are slightly lower than those of Camaioni et al., a finding we attribute to our shortened procedure with fewer trials. Nonetheless, we replicate Camaioni et al.'s (2004) findings of a discrepancy between pointing production and comprehension. We also replicated their finding of a relationship between pointing and the inference condition of the imitation task.

	Camaioni (session 2)		Current study	
	Mean	SD	Mean	SD
Age (months)	14.73	1.13	18.4	0.8
Imperative Comprehension (proportion of possible pointing acts)	0.57	0.33	0.51	0.38
Declarative Comprehension	0.59	0.23	0.44	0.41
Imperative Production	0.46	0.29	0.26	0.37
Declarative Production	0.27	0.23	0.33	0.42

Figure 11: performance on the pointing measure comparing the current study with that of Camaioni et al. (2004).

Across our motivational state reasoning tasks we find lower performance by the participants in our sample than in previous studies, but nonetheless find the same basic patterns of performance as reported in the literature. It is likely that our participants' performance suffered due to the number of tasks and the amount of sustained attention demanded of them during this relatively long testing session.

Relationships between tasks: To investigate whether the motivational state reasoning measures are tapping a common underlying construct of understanding others' intentions, we looked at correlations in task performance between measures.

Imitation Inference and Control Conditions: Performance on the inference and control conditions of the imitation task were significantly correlated ($r(78) = 0.378$, $p = 0.001$). This is not surprising given that the two tasks had equivalent behavioral demands in terms of social engagement, inhibition, motor coordination, etc. Furthermore, performance in the control condition, which was administered second, was likely improved by the child's previous exposure to the objects in the inference condition.

Production and comprehension of pointing. Performance on the comprehension and production subsets of the pointing task were positively correlated ($r(68) = 0.285, p = 0.019$). The correlation between production and comprehension conditions is especially convincing given the different behavioral demands of the production and comprehension conditions. In the comprehension condition children had to respond appropriately to the experimenter's point by e.g. handing her an object or acknowledging a picture in the room. In the production condition, by contrast, children had to make appropriately timed eye contact, and produce both a pointing gesture and another target gesture. This finding is consistent with the possibility that these abilities stem from a common underlying ability, perhaps non-verbal communicative skill or joint attention ability.

Among motivational state reasoning tasks. The inference condition of the imitation task was correlated with performance on the pointing measure ($r(78) = 0.233, p = 0.037$). Yet the control condition of the imitation task was not correlated with the pointing task ($r(79) = 0.169, p = 0.131$). This dissociation between control and experimental conditions of the imitation task as they relate to the pointing task demonstrates the specificity of the relationship between pointing and imitation— inference tasks. While the control and experimental conditions of the imitation task clearly share many task demands around approaching novel toys, social interaction, attention, etc, they are clearly different in their demand for attention to intentional action, and it is this component of the task that is uniquely related to the child's pointing abilities. This pattern of results suggests that the pointing and imitation—experimental tasks are tapping a common motivational state understanding.

Given the positive correlations between the imitation—~~inference~~ and imitation—control tasks and the imitation—~~inference~~ & pointing tasks, we are confident our tasks possess the variance necessary to detect relationships with the language measures if such relationships exist. These positive relationships between the pointing and imitation (E) measures also provide evidence that these tasks are tapping into a common underlying motivational state reasoning capacity.

Task relationships with age. No measure was significantly correlated with age. While improvement with age on any of our measures is expected, it is likely that the relatively narrow age range studied did not allow for age effects to emerge.

Task relationships with working memory. Total errors and on the working memory task correlated with the imitation—~~inference~~ task ($r(73) = -0.219, p = 0.60$) and did not correlate with performance on any other measure.

Relations between language and motivational state reasoning measures. Given the adequate variance in performance on the motivational state understanding tasks and the vocabulary measures, as well as the significant correlations between imitation—~~inference~~ and pointing tasks, we are equipped to ask whether similar correlations exist between the motivational state understanding measures and the vocabulary measures. Neither the expressive nor receptive measure of vocabulary was related to any ToM task (all $ps > 0.326$). A full correlation matrix is presented below (Table 3).

None of the imitation and pointing measures was correlated with any vocabulary measure. Thus, we find no evidence that vocabulary and motivational state reasoning abilities are related in our sample of 17- to 20-month-old typically developing children. This non-correlation between language and motivational state understanding was our

main analysis of interest and the finding runs counter to the strong relationship between language and ToM found so often with older children.

	1	2	3	4	5	6
1. Age	---					
2. Expressive vocab	0.202+	---				
3. Total vocab	0.154	0.844**	---			
4. Imitation (E)	0.019	0.28	0.005	---		
5. Imitation (C)	0.039	0.077	0.019	0.378**	---	
6. Pointing	-0.059	-0.001	-0.040	0.229*	0.161	---
7. WM total errors	0.071	0.177	0.147	0.219+	-0.122	-0.048

Figure 12: Matrix of Pearson correlation coefficient (r) values for the tasks in Experiment 1 (**: $p < 0.01$; *: $p < 0.05$; +: $p < 0.10$).

Experiment 2 investigates the possible connection between vocabulary and motivational state understanding using a different methodology—comparing the abilities of typically hearing toddlers and DoH toddlers with language delays. If motivational state reasoning and vocabulary size are independent of one another in the toddler years, motivational state reasoning should be comparable for deaf and hearing toddlers.

Experiment 2

Method

Participants.

Seventeen deaf toddlers with hearing parents between the ages of 18;15 and 27;00 (mean age = 22;10; 6 females) participated in Experiment 2. Participants were included on the basis of the following criteria: (a) bilateral hearing loss, (b) no other known developmental disabilities, (c) and hearing parents. An additional 7 toddlers were tested

but excluded from analyses for the following reasons: child had a developmental disability (2) or child scored above the 50th percentile in expressive vocabulary on the toddler form of the English CDI Short Form (5).

The deaf toddlers were recruited from parent-infant programs and early intervention programs in Massachusetts and were tested in a variety of locations: laboratory settings, therapy rooms at early intervention programs, a private room at a public library, and families' homes. The set-up of the testing stimuli was made to be as uniform as possible in all locations. Participants were compensated with a small toy and, if they traveled beyond their home or early intervention settings, a \$5 travel reimbursement.

Most deaf participants wore assistive hearing devices, including 4 participants with hearing aids and 9 participants with cochlear implants (information not available for 4 participants). 6 participants had low hearing loss (mild to moderate) and 8 participants had severe to profound hearing loss (information not available for 3 participants). For all but 4 participants, English was their primary language. For these 4 participants, ASL was their dominant language; some of the other participants knew varying degrees of sign language (7) while others knew none (6).

The participants represented a variety of socioeconomic statuses, parental education and racial and ethnic populations. Figure 14 below compares demographic information for the deaf and hearing groups.

Seventeen hearing toddlers were selected as matched controls. Hearing toddlers were matched to deaf children on the basis of sex, age (within 8 days) and SES (where possible). Only hearing children scoring at or above the 50th percentile for expressive

vocabulary on the CDI Short Form (Toddler Form) were considered as matches³.

Materials and procedure.

The procedure for Experiment 2 followed that of Experiment 1 exactly except as follows. The study was conducted in the dominant language(s) of the participant—English (N = 8), American Sign Language (N = 1), or both ASL and English used concurrently (N = 8). Parents filled out vocabulary forms for any languages the child was learning—English, other spoken languages and ASL. To measure ASL vocabulary the ASL CDI (Anderson & Reilly, 2002) was administered.

Results

Basic task performance

In order to verify that the performance of hearing participants in Experiment 2 is consistent with that of hearing participants in Experiment 1, we present descriptive information on task performance in the table below. We also present this information on the deaf participants in Experiment 2. The participants in Experiment 2 are several months older than those in Experiment 1, so it is not surprising that scores in Experiment 2 are often somewhat higher than those in Experiment 1. Though deaf children's expressive and receptive vocabulary scores are lower than that of their hearing matches, the performance of deaf and hearing toddlers on working memory and social cognition tasks is strikingly similar; we analyze differences between deaf and hearing participants in Experiment 2 later in the results section.

³ In the case of three deaf participants the best current hearing matches have expressive vocabulary scores at the 40th (N = 1) or 45th (N = 2) percentile. We plan to continue testing potential hearing participants until suitable matches are found.

Measure	Statistic	Experiment 1 (hearing)	Experiment 2—hearing	Experiment 2—deaf
Age	Mean	18.37	22.4	22.33
	Range	17.0-19.87	18.7-27.1	18.5-27.0
	SD	0.77	2.80	2.79
Imitation— Inference (proportion correct)	Mean	0.38	0.53	0.47
	Range	0-1	0-0.8	0-1
	SD	0.26	0.26	0.32
Imitation— Control (proportion correct)	Mean	0.66	0.81	0.79
	Range	0-1	0.4-1	0.4-1
	SD	0.27	0.22	0.17
Pointing (proportion correct)	Mean	0.38	0.36	0.39
	Range	0-1	0-0.63	0-1
	SD	0.26	0.23	0.39
Working memory (reverse scored)	Mean	6.71	7.65	7.43
	Range	0-11	5-11	1-11
	SD	2.63	1.97	3.13
Expressive vocab (# words)	Mean	36.09	106.31	34.15
	Range	1-118	44-147	0-94
	SD	27.55	37.42	30.61
Total vocab (# words)	Mean	68.93	124.77	68.54
	Range	11-134	67-147	19-147
	SD	25.01	23.67	41.83

Figure 13: task performance by participant group in Experiments 1 and 2.

Comparing groups: background measures. The deaf and hearing groups did not differ from one another on background measures including age, family income (Median Test $p = 1$), parental educational attainment (Mann-Whitney U-test, $ps > 0.39$)

or number of children attending daycare (Fisher’s exact test $p = 0.27$, two-tailed). The two groups also did not differ on their scores on the working memory task ($t(26) = -0.222, p = 0.826$).

		Hearing	Deaf
Family income (median)		101-120K	101-120K
Parent 1 ed (median)		BA	BA
Parent 2 ed (median)		MA	BA
Number attending daycare		8 (1 no response)	4 (2 no response)
Race/ ethnicity	African or African-American	0	1
	Asian or Asian-American	3	1
	European or White-American	11	10
	Hispanic or Latino-American	0	1
	Native-American	0	2
	Multi-racial	3	1
	no response	0	1

Figure 14: demographic information by hearing-status group

Comparing groups: vocabulary. Because of the nature of the two vocabulary assessments used, the ASL CDI being a long form and the English CDI a short form, it was not feasible to combine across these two measures in the case of bilingual deaf children to form a conceptual vocabulary composite score. We thus decided to compare the vocabulary scores of only English dominant deaf toddlers ($N = 13$) and their hearing matches. Independent sample t-tests revealed significant differences between the deaf and hearing groups in both expressive ($t(24) = 5.38, p < 0.001$) and total vocabulary scores ($t(24) = 4.22, p < 0.001$). Mann-Whitney U tests confirmed these results ($ps \leq 0.001$).

In deciding to include the 4 non-English-dominant deaf participants in the current analyses, we considered their performance on the motivational state reasoning tasks relative to that of the other deaf participants. An informal analysis suggested the English-dominant and non-English-dominant participants performed similarly on the pointing and imitation tasks. Furthermore, excluding the non-English-dominant participants did not

alter the pattern of results when comparing motivational state reasoning between deaf and hearing groups.

Comparing groups: motivational state understanding. Having ensured that the deaf and hearing groups of children differ only in their language abilities and not SES or working memory measures, we can now ask whether this difference in vocabulary scores confers a similar disadvantage to deaf children in their motivational state understanding. We find no difference in performance between the deaf and hearing groups of children on the imitation—*inference* ($t(31) = 0.67, p = 0.51$), imitation—*control* ($t(31) = 0.37, p = 0.72$), or pointing tasks ($t(32) = -0.34, p = 0.74$). The same findings were obtained through Mann-Whitney U tests (all $ps > 0.53$).

Summary. In experiment 2 we compare matched samples of deaf and hearing toddlers on motivational state reasoning measures. The two groups did not differ on background measures such as age, parent education, family income or working memory abilities. Critically, however, the sample of deaf toddlers had significantly lower vocabulary scores than the hearing toddlers. Given this difference in vocabulary size, we asked whether hearing children were similarly advantaged in their motivational state reasoning measures. We did not find any differences, however, in deaf and hearing toddlers' performance on the imitation or pointing tasks. In sum, though the two groups differed markedly in their vocabulary sizes, no differences were found in their motivational state understanding.

Discussion

Experiment 2 compared two matched samples—deaf toddlers with hearing parents and typically hearing toddlers—on the vocabulary and motivational state

reasoning measures. While the deaf toddlers had significantly smaller vocabulary sizes than their hearing matches, the two groups performed remarkably similarly on the working memory and motivational state reasoning measures. Experiment 1 investigated the relationship between vocabulary size and motivational state understanding in 85 typically hearing toddlers between 17 and 20 months of age. Though a strong relationship was found between the imitation—inference and pointing tasks, suggesting that these two tasks are tapping a common system of motivational state reasoning, no correlations were found between language and motivational state understanding. The results of both experiments suggest that motivational state reasoning abilities, such as understanding others' intentions and engaging in joint attention through pointing, emerge independently of the child's language acquisition.

These results are somewhat unexpected for several reasons. For one, as reviewed in the introduction, there is mounting evidence of continuity between early and later ToM abilities. This evidence comes in the form of longitudinal predictive relationships, where variation in early ToM abilities predicts differences in later false belief reasoning, as well as evidence that ToM abilities emerge in a consistent order, with later abilities presumably building upon earlier ones. If there is continuity between early and later ToM abilities we would expect there to also be continuity in the relationship between language and motivational state reasoning inasmuch as language serves as a mechanism of development for mental state reasoning.

The current findings must also be reconciled with the findings that early joint attention abilities predict later language outcomes (Carpenter et al., 1998; Charman et al 2000; Morales et al 2000; Mundy & Gomes, 1996; Watt, Wetherby & Shumway, 2006).

In the current study we do not find a concurrent relationship between our pointing task, a measure of joint attention, and vocabulary size. While our findings may appear to contradict the results of such longitudinal studies, the explanation may lie precisely in the developmental relationship between joint attention and language. That is, joint attention episodes provide the context for language learning, and thus over time may facilitate word learning on the part of the child. But this relationship may not appear concurrently or may not appear within the age range of the current study. Indeed, several studies that found a predictive relationship between early joint attention and later language found a weak concurrent relationship or no relationship between these abilities (Charman et al., 2000; Morales et al., 2000; Watt et al., 2006).

Furthermore, our findings of a lack of relationship between language and motivational state reasoning appear to be at odds with those of Meristo et al., the only other study of deaf toddlers' ToM abilities to date. In their study 10 DoH and 10 typically hearing toddlers participated in both false belief and true belief conditions of an anticipatory looking false belief task. The researchers found that while both groups correctly anticipated the correct location the protagonist cat would search for the mouse in the true belief condition, when the cat had a false belief about the location of the mouse only the typically hearing toddlers looked in anticipation to the location the cat should look based on his false belief; all 10 of the DoH children looked in anticipation to the location where the mouse was actually hiding.

While this finding appears to illustrate a striking difference in the false belief reasoning of young DoH and hearing toddlers, there are methodological concerns. To be confident that deaf toddlers as young as age 2 are already delayed in their reasoning

about false beliefs, one must obtain converging results from a variety of methods and paradigms. A visual attention task, while powerful in its ability to detect implicit understanding and elegant in the control and simplicity of its design, may in fact put deaf children at a disadvantage; there is some evidence that a visual attention functions differently in deaf and hearing infants (C. Shafto, personal communication, 10/19/2011). As such, we should be cautious in attributing delays to deaf toddlers based on findings using visual attention measures as the sole index of understanding. Furthermore, even if Meristo et al.'s findings do reflect a genuine difference in DoH and hearing toddlers' false belief reasoning skills, we cannot assume that the groups are different in all ToM abilities globally. The results of the current study certainly demonstrate that DoH toddlers' abilities to represent others' intentions and to share attention through communicative pointing are intact. Future research should investigate differences between deaf and hearing toddlers on the full spectrum of ToM abilities.

In theoretical terms, the findings of the current study support a discontinuity between early and later ToM abilities, at least in their relationship to language as a mechanism for conceptual change in this domain. The present findings are consistent with the possibility that understanding of intentionality in the infant and toddler years is modular; the motivational state reasoning abilities probed in the current study appear to emerge independently of experience with language, at the very least. Whether the same is true of other aspects of early ToM, especially implicit false belief reasoning, remains to be seen.

One question raised by the findings of the current study is how older deaf children become delayed in their reasoning about epistemic states (Schmidt & Pyers, 2014;

Peterson & Wellman, 2009; Schick et al., 2007) given that deaf toddlers' understanding of intentionality is not delayed at age 2. It is likely that intention understanding and a mastery of communicative pointing are both critical for the development of language and more advanced ToM abilities. But these abilities, which are intact in deaf toddlers, are not enough to keep deaf children from becoming delayed in language or ToM. Rich, accessible linguistic input, embedded in joint attention episodes support language acquisition, making available to the child the semantic terms and linguistic structures needed for more advanced ToM reasoning. One contributor to later delays in language and ToM for deaf children may lie in differences in the quantity and quality of joint attention episodes between hearing-deaf parent-child pairs and hearing-hearing pairs (for a review see Pyers & de Villiers, 2013).

Hearing parents of deaf children likely find it challenging to manage the triangle of attention between themselves, their child and an object when their child has a different hearing status from themselves (Gale & Schick, 2009). Whether the parent is using spoken language, signed language or a combination, communication with a deaf child requires significant attention in the visual domain. Hearing parents may therefore struggle to make themselves, the objects of attention and language all “visible” to the child in a single interaction. Whether the child's ability to engage in joint attention is intact cannot be assessed in isolation in such studies involving dyadic interaction, and so the strength of young deaf toddlers' joint attention skills has been less clear.

Our results, drawn from controlled study of toddlers' communicative pointing abilities, suggest that young deaf toddlers' joint attention skills are not lacking in the least. Parents and practitioners can capitalize on these foundational abilities to promote

the proper development of more complex social cognitive abilities. Specifically, training hearing parents on the skills necessary for frequent and prolonged symbol-infused joint attention with their deaf children might prevent deaf children from becoming delayed in language or ToM abilities.

There are several limitations to the current study that should be addressed with future research. For one, we must consider whether the sample of DoH toddlers in experiment 2 is representative of the larger population of DoH children. Previous studies have found that DoH children with language delays are delayed in ToM relative to typically hearing children even up until age 11. Yet the deaf children in those studies might be drawn from a different sub-population of deaf children than are the DoH children in our study. Studies with older deaf children often involved children who attend schools for the Deaf, and these children might be more likely to have struggled within mainstream education settings. The samples of DoH children in previous studies therefore might not be representative of all DoH children. The DoH toddlers in our study were recruited from early intervention and parent infant programs that might be more likely to draw parents with higher than average income and education levels. That is, the deaf toddlers in our sample might be less likely to be language delayed than the average DoH toddler, attenuating their risk for later delays in ToM reasoning.

Given these concerns about sampling methods and the generalizability of the current findings, future research would benefit from longitudinal studies of deaf children from birth through the early school-aged years. Following a cohort of children longitudinally would allow us to address concerns about sampling bias and possible

demographic differences between the deaf toddlers in the current study and school-aged deaf children in previous research.

Longitudinal research can also answer questions about continuity in ToM development and connections to language acquisition during the infant, toddler and preschool years. When and how does language become an important facilitator of ToM development? As with the link between early joint attention and later language, the various relationships of language and ToM may appear only longitudinally. Future studies should take care to probe the developmental relationships between language and all aspects of ToM, not just false belief reasoning.

Conclusion

Summary of Findings

Parts I and II of this dissertation asked whether toddlers' use representations of the motivational states of others to guide their own helping behaviors. Part I, using a spontaneous helping task with two goal objects, found that 3- but not 2-year-olds helped selectively by the giving the experimenter her desired object. Part II found that 24- but not 14-month-olds similarly helped selectively based on prior goal-directed reaching evidence of the actor's goal. Importantly, in both studies children in the younger age group helped at high rates, though their helping was not always appropriate. This pattern of results is consistent with the possibility that early representations of goals and desires are not available to other systems, such as those that drive social interaction.

Part III of the dissertation addressed the following question: is there a relationship between motivational state reasoning and vocabulary size in the toddler years? In Experiment 1, we found no correlations between understanding of intentions or pointing in joint attention episodes and expressive or receptive vocabulary size. This result was corroborated by the findings of Experiment 2, in which we found no difference in the motivational state reasoning abilities of typically hearing and language-delayed deaf children. Together these findings point to a lack of relationship between early vocabulary and motivational state reasoning.

Theoretical and Practical Implications

The findings of all three studies point to important limitations and boundary conditions on toddlers' representations of mental states. Based on the current evidence, young toddlers are not yet able to link representations of others' goals and desires with

their systems for reasoning about social partners and exchanges. Furthermore, toddlers' motivational state concepts, unlike preschoolers' epistemic state concepts, are not dependent on language as a developmental mechanism. These findings are consistent with the possibility of a discontinuity between early and later mental state concepts and/or motivational state and epistemic state reasoning.

If expression accounts of ToM development are correct, future studies are needed to explain the development in prosocial development and the language-ToM relationship in the toddler years. Expression accounts would predict that under optimal conditions, those which do not place executive demands on toddlers, we should find adult-like understanding of the role of subjective preferences in helping exchanges.

If emergence accounts are correct, further work must be done to clearly describe ToM systems in terms of constituent capacities, the role of task demands (i.e. executive and linguistic) in performance on various kinds of tasks, and mechanisms for development. If there are dissociations between multiple ToM systems, do the systems separate along the lines of motivational states versus epistemic states, false belief and all other ToM capacities, or some other division? Longitudinal work, as described below, should make a systematic investigation into language as a mechanism of change in ToM reasoning, paying attention to discontinuities and changes in the role of language in ToM across ontogeny.

The present findings, especially those of Part III, have major practical implications for education and early intervention. The findings of Part III suggest that appropriate interventions for young deaf toddlers should focus on boosting hearing parents' abilities to engage in joint attention episodes with their deaf children. According

to Part III, deaf toddlers are not delayed in their abilities to read others' intentions or use and comprehend communicative pointing.

Still, language acquisition, and in turn explicit false belief reasoning, cannot proceed without high quality, accessible linguistic input. Specifically, it is recommended that deaf children be exposed to fluent sign language, even if they are also exposed to spoken language and use assistive devices (Humphries et al, 2012).

The findings of Part I showing development between the ages of 2 and 3 years have implications for early education and care as well. The finding of a developmental change in toddler's abilities to consider others' desires in prosocial interactions supports the importance of preschool curricula that explicitly teach emotion understanding and social skills (e.g. Bierman et al, 2008; Domitrovich, Cortes & Greenberg, 2007). These curricula have the potential to improve children's understanding of emotions and social competencies, skills that are clearly still developing in the preschool years.

Future Directions

Future research should aim to use a common paradigm to test toddlers' abilities to help based on action-based representations of goals, on the one hand, and emotion-based representations of desires on the other. The experimental paradigms employed in Parts I and II were vastly different. Part I used a spontaneous helping task while Part II involved elicited helping; Part I presented the child with many more different object-affect pairings to encode than did Part II; Part II used repeated demonstrations of the actor's goal while Part I presented this information only once; and the physical environment in Part I was much more rich, and therefore perhaps more distracting, than that of Part II. These methodological differences may have contributed to the different ages of emergence of

the ability to use motivational state representations to guide helping.

Still, it is possible that the ability to represent actions and goals emerges earlier than mature reasoning about desires based on emotions; indeed here is some evidence that these abilities dissociate in infants (Vaish & Woodward, 2010). Direct comparison of toddlers' abilities to use action and emotion to attribute preferences and help accordingly could be made in a common instrumental helping paradigm. Such an experiment might follow the design of the studies in Part II, which presents the agent's preference in a context that is minimally computationally demanding.

One challenge of such an experiment is how to decouple attention and affect. That is, if an actor emotes positively towards one object and ignores the other, differential attention has been paid to each of the objects. As visual attention is construed as a goal-directed action by infants (Johnson, Ok & Luo, 2007), this confounding of attention and affect poses a limitation.

One solution to this problem might be to have the experimenter attend to both objects, controlling for attention, emoting positively to one and negatively (or neutrally) toward the other. This procedure would successfully decouple attention and affect, but would present another obstacle—how to present the equivalent of positive and negative emotion in action terms. Perhaps the experimenter grasps one object and moves it towards her and pushes the other away; here there is the same amount of action on the objects with differences in the quality or valence of that action. While this procedure would appear to provide a solution, it assumes that toddlers can distinguish between positive and negatively valences actions, a point that has not yet been established.

In following up on the findings from Part III, comprehensive longitudinal

research is clearly in order. Systematic study should investigate the relationships between various aspects of language and the full range of ToM competencies. In infancy, goal understanding, joint attention abilities, desire reasoning and implicit false belief understanding should be assessed, along with general receptive and expressive vocabulary, gestural communication and parents' used of mental state language to their children. In the toddler years, the same capacities should be measured, with the addition of tasks that probe knowledge attribution, the seeing-knowing connection, explicit desire understanding, and false belief tasks with low inhibitory and linguistic demands.

Toddlers' language should also be assessed more thoroughly, using a standardized vocabulary assessment, inventory of mental state terms, test of syntactic development and measures of discourse and pragmatic skill. Assessment around age 4 should include the cumulative battery of tasks, even if they must be adapted for older children. For instance, it is not clear whether implicit tasks of false belief understanding are valid for preschool aged children and if so, how older children perform on such tasks. A question of great interest concerns the relationship between implicit and explicit false belief reasoning in both older children and adults. It is imperative that such future studies be longitudinal rather than cross-sectional in design, as previous research has often found relationships between language and ToM only longitudinally, not concurrently.

Final conclusions

The findings of this dissertation suggest that there is continued development in children's reasoning about others in the second and third years. Specifically, there is growth in toddlers' prosocial competencies, with increasing integration of mental states into social interactions. In addition, the relationship between language and mental state

reasoning, which is firmly in place by age 4, does not appear to be present prior to age 2, suggesting that this relationship becomes established between these ages. What remains to be specified is exactly what is developing in the toddler years to account for these changes in mental state reasoning.

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