Beyond false belief understanding: Theory of Mind development in infancy

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Abstract

Beyond false belief understanding: Theory of Mind development in infancy

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Theory of Mind (ToM) development in infancy has generally been investigated using studies conducted on a single age group with a single task, usually measuring false belief. The goals of the current dissertation were to examine ToM understanding in infancy using multiple tasks, two paradigms, and a within-subjects design. An additional goal was to determine if ToM abilities in infancy follow a predictable pattern of development.

The aim of the first study was to investigate 14- and 18-month-olds' understanding of intentions, true beliefs, desires, and false beliefs using a violation of expectation paradigm. To do so, Study 1 used a within-subjects design, whereby infants observed both a congruent and an incongruent trial for each task. Results revealed that both groups of infants looked significantly longer at the incongruent trial on the intention and true belief tasks. In contrast, only 18-month-olds looked significantly longer at the incongruent trial of the desire task. Lastly, neither age group looked significantly longer at the incongruent trial of the false belief task. Furthermore, inter-task analyses revealed only a significant correlation between looking time at the false belief and intention tasks.

The second study examined if ToM abilities developed in a predictable sequence as observed in preschool children. To do this, 18-, 24-, and 30-month-olds completed four tasks measuring intention, emotion, desire, and false belief understanding, using interactive spontaneous-response tasks. Results revealed that infants' ToM understanding does develop in a predictable scale sequence. That is, infants were more likely to pass the intention task, followed by the emotion, desire, and false belief task. Moreover, infants' performance on the intention, emotion, and false belief tasks appeared to improve with age.

Together, the results from both studies suggest that ToM abilities begin to develop in infancy. However, results from the current dissertation also highlight some of the limitations in infants' ability to reason about other people's mental states. Nevertheless, using two distinct paradigms, the present findings demonstrate that intention, emotion, and true belief understanding develop before more complex ToM abilities, including desire and false belief

understanding. Furthermore, these results suggest that implicit ToM follows a similar developmental sequence as observed in more explicit ToM development.

Acknowledgements

First I would like to thank my supervisor, Dr. Diane Poulin-Dubois, for her expertise and guidance throughout this project. Her support and encouragement has fostered the development of my research skills, including my ability to create, conduct, and criticallly analyze research in the field. I am reminded everyday how fortunate I am to have been mentored by someone who is so dedicated and enthusiastic about research, as it has provided me with so many opportunities, for which I am forever grateful.

I would also like to acknowledge the encouragement, wisdom, and understanding of all past and present members of the Language and Cognitive Development laboratory, many of whom have become close friends. Alexandra Polonia, Katherine Gittins, Josée-Anne Bécotte, Sabrina Chiarella, Kristyn Wright, Jackie Legacy, and Cristina Crivello, I absolutely could not have accomplished this work without your support. With you all, I have learned life lessons that I will take with me wherever I go. A special thank you goes out to Janice LaGeorgia, Ionna Solomatina, Josée-Anne Bécotte, and Sarah Phillips for their help with data collection and coding.

I have been so incredibly fortunate to have an extraordinary family who has supported me every step of the way. I would like to thank my mom for inspiring and encouraging me, but most of all for her unconditional love and support. In addition, I would like to thank my brothers, James, Marc, and Brendan, for always letting me know how proud they are of me. To my friends, I could not possibly name you all, as I am so incredibly lucky to be surrounded by so many supportive, positive, and fun-loving people. I would like to thank each and every one of you for your interest in my research, but also for taking me out of the research world when necessary. Without all you, this work would not have been possible. Thank you.

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Contribution of Authors

This Dissertation consists of two manuscripts.

Study 1 (See Chapter 2)

Yott, J., & Poulin-Dubois, D. (in press). Are infants' Theory of Mind abilities well integrated? Implicit understanding of intentions, desires, and beliefs. *Journal of Cognition and Development.*

Study 2 (See Chapter 3)

Yott, J., & Poulin-Dubois, D. (2015). *Scaling of Theory of Mind Tasks in infancy.* Manuscript submitted to Cognitive Development.

Relative Contributions

I proposed the overall research topic for my dissertation, and given the gaps in the literature, Dr. Diane-Poulin-Dubois, my thesis supervisor, and I determined the focus of each study. I reviewed the literature on infant ToM development, and together we chose the experimental stimuli to be used, the design of the project, and the procedure to be used. We collaboratively made the methodological changes after pilot testing. Prior to testing for all studies, I helped the research coordinator prepare recruitment letters that would be sent out to potential participants. Recruitment calls were completed by lab volunteers, or myself when necessary. In preparation for testing, I created detailed scripts, procedures, and stimuli. With regard to data collection, I was the primary experimenter for 90% of participants in Study 1, and all participants in Study 2. Janice LaGeorgia, Ioanna Solamatina, Josée-Anne Bécotte, and Sarah Phillips, research assistants, helped with data collection as the second experimenter in both studies. For Study 1, Josée-Anne Bécotte and I each completed 50% of the coding for all 18-month-old infants. For the 14-month-old sample, Josée-Anne Bécotte, completed all coding, while Sarah Phillips completed the reliability coding. I coded all participants in Study 2, while undergraduate students Janice LaGeorgia, Ioanna Solomatina, and Josée-Anne Bécotte, completed coding for reliability. Following the completion of the studies, data entry was completed by various undergraduate students, after which I double-checked and finalized the data set. I completed all statistical analyses, interpretation of the data, and preparation of the manuscripts. For each manuscript, I wrote the first draft and Dr. Poulin-Dubois provided feedback and revisions throughout. After each study, I was also responsible for summarizing the studies' findings in our laboratory's newsletter, which is sent to thank families for their participation. Dr. Poulin-Dubois was available during all stages of the current dissertation, and provided guidance and feedback throughout the research process.

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Chapter 1

General Introduction

Understanding the behaviours of others is an essential skill to function appropriately in a social world. To make sense of people's behaviours, we must consider their mental states, including their emotions, intentions, desires, beliefs, and knowledge. For example, to understand the behaviour of Little Red Riding Hood, we understand that she *intends* and *desires* to bring her grandmother food, but *falsely believes* the wolf is her grandmother, because she does not *know* the wolf is dressed in her grandmother's clothes and *intends* to eat her for dinner. As adults, we gather and consider this information quite quickly, however, the development of these skills is protracted, starting in infancy and developing throughout childhood.

Understanding the mental states of others (e.g., intentions, desires, beliefs), or having a Theory of Mind (ToM), is an important milestone in both social and cognitive development, as it allows us to interpret, predict, and understand people's behaviours. In addition, ToM understanding in childhood predicts social skills, joint planning during pretend play, peer relations, and prosocial behaviours (Astington & Jenkins, 1995; Cassidy, Werner, Rourke, Zobernis, & Balaraman, 2003; Caputi, Lecce, Pagnin, & Banerjee, 2012; Devine & Hughes, 2013; Jenkins & Astington, 2000). From a cognitive perspective, ToM has been shown to be related to both language and executive functioning abilities during infancy, the preschool years, and middle childhood (Austin, Groppe, & Elsner, 2014; Marcovitch et al., 2015; Olineck & Poulin-Dubois, 2007; Yott & Poulin-Dubois, 2012).

Research on children's understanding of mental states emerged in the 1970s when researchers began to examine children's egocentrism, based on Piaget's claim that children are not aware that others may have perceptions, beliefs, knowledge that differ from their own (Flavell, 2000). This line of research was further popularized when Premack and Woodruff (1978) examined ToM understanding in chimpanzees. Three independent philosophers commented on this article, and together they suggested that examining an animal's understanding of false beliefs would be a critical test of ToM understanding, as it requires one to inhibit what one knows, from what someone else knows, and then predict someone else's behaviour according to his/her knowledge. Wimmer and Perner (1983) extended this research to children in a series of studies using the "unexpected transfer" procedure to examine false belief understanding specifically, and ToM more generally. Since the 1980s research on ToM development, and false belief understanding has increased dramatically, as researchers attempt to uncover when and how ToM abilities develop using both standard and novel procedures with children of all ages (Wellman, 2014).

The current dissertation aims to expand the current understanding of ToM abilities in infancy. To do so, it will first begin with a review of the literature on false belief understanding in preschoolers and infants based on both spontaneous-response and elicited-response measures. Following this review, the literature on other ToM abilities will be reviewed, including desire and intention understanding in infants and preschoolers. Lastly, the current debate on when children acquire a true ToM will be reviewed, as well as recent research addressing this question. Finally, the main goals of the dissertation will be outlined, while highlighting how each of the two manuscripts attempted to address these goals, followed by the two studies.

Spontaneous-response tasks versus elicited response tasks

Conclusions about infants and children's ToM understanding is very much dependent on the type of tasks that are used to measure these abilities. Elicited-response tasks, also sometimes referred to as explicit or direct tasks, are tasks that require the child to respond in some way. These tasks vary in terms of the demands they place on the child. High demand elicited-response tasks may require a child to answer a task verbally, while a low demand elicited response may require a child to respond non-verbally such as pointing to an object. In contrast, spontaneous-response tasks, also referred to as implicit and indirect tasks, are tasks that do not require the infant to respond, but rather measure infants' spontaneous responses during the task. For example, spontaneous-response tasks include tasks that measure looking times and pupil dilation. The current dissertation uses both spontaneous-(Study 1) and elicited-response (Study 2) tasks to measure ToM understanding. It is important to note however, that the elicited-response tasks used in the current dissertation are low demand tasks, as they do not require children to provide a verbal response. This is in contrast to elicited-response tasks used with preschoolers to measure ToM understanding.

Intention Understanding

Intention understanding has been well researched using both interactive and looking time designs. Most notably, Meltzoff (1997) demonstrated that by 18-months of age, infants understand an actor's intended actions even when they do not observe the entire intended action.

More specifically, infants watched an actor try but fail to complete an action three times. When given the stimuli, infants completed the actor's intended action 80% of the time. These results suggest that even though infants did not observe the entire action, they understood the actor's intention. These results have been replicated several times (Bellagamba, Camaioni, & Collonessi, 2006; Bellagamba & Tomasello, 1999; Carpenter, Akhtar, & Tomasello, 1998; Olineck & Poulin-Dubois, 2009; Yott & Poulin-Dubois, 2012). In addition, Carpenter and colleagues (1998) demonstrated that both 14- and 18-month-olds will imitate and differentiate between intentional and accidental actions, however 18-month-olds are better than 14-month-olds at understating intentional versus accidental intentions (Olineck & Poulin-Dubois, 2005) Taken together, results from multiple paradigms suggest that by 18 months of age, infants have some understanding of other's intentions.

Studies using spontaneous-response measures based on looking times have yielded similar findings. For example, using a habituation paradigm, Phillips and Wellman (2005) demonstrated that 12-month-olds understand others' intentions. That is, they had infants habituate to a video of an actor reaching over a barrier to grab a toy. Once infants were habituated, the barrier was removed and infants then watched the actor reach for the toy using two different paths; a direct and an indirect one. For the indirect reach, the actor reached for the toy in the same manner as he did during the habituation trials. That is, the actor reached in an over-arching path, grabbed the toy and remained still. For the direct reach, the actor reached directly, in a straight path, for the toy and froze. Results revealed that infants looked longer at the video when the actor reached indirectly for the toy, suggesting that they found this behaviour to be novel. Brandone and Wellman (2009) replicated and extended these results in 8-, 10- and 12-month-olds. However, they also demonstrated that only 10- and 12-month-old infants recognized failed intentional actions, while 8-month-olds did not. Results from studies using both interactive and looking time paradigms suggest that intention understanding develops in the first year of life, followed by an understanding of unfulfilled intentions.

Desire Understanding

ToM also includes the understanding of desires, that is, understanding what people want and then making predictions about their subsequent actions or emotions. The development of this form of mental state understanding has been well researched in toddlers and preschoolers. Research suggests that by the age of four, children understand people's beliefs and desires, even when they conflict with the child's own desires or beliefs (Astington, Harris, & Olson, 1988; Wellman & Liu, 2004; Wellman 2014). Wellman (1993) has suggested that younger children rely more heavily on desires than beliefs when reasoning about people's behaviours. Wellman and Wooley (1990) demonstrated that 2-year-old children understand that when people want something, they try to fulfill their desire. Additionally, children understand that people will display different emotions depending on whether or not their desire was fulfilled. With regard to language development, the extant literature shows that children begin to use desire terms such as "want" by 18 months of age (Bartsch & Wellman, 1995). Additionally, it has been demonstrated that only by 30 months of age, do children appear to understand that people may have desires that conflict with their own (Wellman & Bartsch, 1994). More recently, it has been demonstrated that the understanding of conflicting desires emerges in 3-year-old children, before the understanding of beliefs (Wellman & Liu, 2004). Taken together, results from interactive, verbal tasks support the notion that desire understanding emerges between 2 and 4 years of age, and is followed by belief understanding.

In a landmark study by Repacholi and Gopnik (1997), it was demonstrated that infants develop the ability to reason about subjective desires between the ages of 14 and 18 months. Infants observed an actor express a preference for one type of food and distaste for another. Results revealed that infants reliably offered the actor their preferred food, even when the food desired was at odds with the child's own preference. Although not an explicit measure, this task requires the infant to give the food that he or she thinks the actor prefers. Tasks examining preference and/or desire understanding using looking-time measures have demonstrated that these abilities emerge in the first year of life (Woodward, 1998). More specifically, 6- and 9-month-olds were habituated to an actor's hand reaching for one of two toys. Following the habituation trials, the toys' locations were reversed. In the test trials, infants observed an actor's hand either reach for the previously desired toy, in the new location, or the non-desired toy, in the desired toy's old location. Results revealed that infants looked longer when the actor reached for the non-desired toy in the desired toy's old location, suggesting that infants understood the actor's goal. There is less research on infants understanding of desires using implicit tasks, which incorporates understanding goals, preferences, and emotions. Although Repacholi and Gopnik (1997) demonstrate desire understanding in infancy using an interactive task, to our knowledge, there is no implicit version of this task, preventing the investigation of this ability in younger infants. It is also important to note however, that their findings have been difficult to replicate at the same age or in older children (Carlson, 2004; Wright & Poulin-Dubois, 2012).

False Belief Understanding

The most popular way of examining ToM understanding in children has been to use false belief tasks. Understanding false beliefs requires an individual to predict another person's behaviour based on a belief that they themselves know to be false (Wellman, 2014). One traditional false belief task, known as the Sally-Anne unexpected transfer false belief task, involves telling children a short story about two characters and their ball. In the story, Sally and Anne are together, and Sally puts her ball in a basket, and then leaves the scene. During Sally's absence, Anne takes the ball and places it in the box. When Sally returns, children are asked where she will search for her ball; in the basket or in the box? This test measures false belief understanding because children must predict Sally's behaviour based on where she *falsely believes* the ball to be hidden as opposed to where the ball is actually hidden. To do this, children must inhibit their own knowledge of the ball's location in order to predict Sally's behaviour. Other false belief tasks require children to reason about an actor's false belief about an object's identity or contents, as opposed to an object's location. In a meta-analysis conducted by Wellman, Cross, and Watson (2001) summarizing 591 false belief studies, it was reported that children under the age of four, reliably fail standard verbal false belief tasks. That is, in the case of the Sally-Anne task, 3-year-olds predict that Sally will search for the ball in its current location, the box. In contrast, 4- and 5-year-olds predict that Sally will search for the ball in the basket, as she does not know that Anne changed its location. Together, these results suggest that some important developmental shift occurs between the ages of 3 and 4 years of age, allowing for children to pass this test.

Although researchers agree that children pass the standard, explicit, verbal false belief task around four years of age, a study by Clements and Perner (1994) suggested that although 3-year-olds fail the traditional false belief task, they demonstrate implicit understanding of false beliefs. Using an Anticipation Looking (AL) paradigm, children observed an actor searching for her toy after its location was switched in her absence. Results revealed that 90% of children between 2 years, 11 months and 4 years, 5 months, looked at the location where the actor should look for her toy based on her false belief, as opposed to where the toy was actually located. However, among these same children, only 45% verbally responded that the actor would search for her toy according to her false belief, as opposed to its current location. In other words, 55% of children's verbal responses conflicted with their looking patterns. These results suggested that children under the age of four have an implicit understanding of false beliefs, but not an explicit understanding, which led to an explosion of research examining implicit false belief understanding in infancy and early childhood.

Onishi and Baillargeon (2004) extended this investigation into the infancy period using the Violation of Expectation (VoE) paradigm, which is based on the assumption that infants will look longer at a scene that conflicts with their expectations. More specifically, Onishi and Baillargeon (2004) tested whether 15-month-old infants would look longer when watching an actor who did not behave according to her belief. To do this, they familiarized 15-month-old infants to an event that involved an actor hiding a toy in box A. Next, infants observed the agent witness (true-belief condition) or not witness (false-belief condition) a change in the toy's location from box A to box B. During the test trial, infants watched as the actor reached for the object in the full box (box B) or in the empty box (box A). Interestingly, infants in the true belief condition looked significantly longer when the actor searched in the empty box compared to the full box, indicating that they were surprised by the actor's behaviour. Conversely, infants in the false belief condition looked significantly longer when the actor searched in the full box compared to the empty box. According to the authors, these results suggest that infants expected the actor to behave according to where she believed the toy to be hidden, and not where the toy was actually hidden, indicating the presence of belief understanding. In the last 20 years, numerous studies have found evidence for belief understanding in children younger than four years of age, even in infants as young as 7 months of age, using a variety of looking time measures and contexts (Clements & Perner, 1994; He, Bolz, & Baillargeon, 2011; Kovács, Téglás, & Endress, 2010; Onishi & Baillargeon, 2005; Ruffman, Garnham, Import, & Connolly, 2001; Scott, Baillargeon, Song, & Leslie, 2010; Senju, Southgate, Snape, Leonard, & Csibra, 2011; Song, Onishi, Baillargeon, & Fisher, 2008; Southgate, Senju, & Csibra, 2007; Surian, Caldi, & Sperber, 2007; Surian & Geraci, 2012; Yott & Poulin-Dubois, 2012). In addition, a recent study replicated these findings using a within-subjects design comparing looking times for either a false or true belief task in 15-month-olds, providing further evidence for flexible belief understanding in infancy (Trauble et al., 2010). Taken together, these studies suggest that infants have a form of implicit belief understanding.

More recently, some researchers have begun to examine belief understanding in toddlers using novel interactive designs that do not rely solely on looking time measures. For example, using a spontaneous-response helping paradigm, Buttelmann, Carpenter, and Tomasello (2009) demonstrated that 72% of 18- and 83% of 30-month-olds took into account an actor's belief when helping them attain his/her goal. That is, infants helped the actor find her toy in one of two boxes, based on a true or false belief about its location. In addition, Scott, He, Baillargeon, and Cummins (2012) demonstrated that 2.5-year-olds correctly responded to two verbal spontaneous-response tasks examining false belief understanding as well as demonstrated preferential looking in a storybook false belief task. Taken together, these and other studies examining false belief in toddlers suggest that children under the age of four have an implicit false belief understanding that can be demonstrated using spontaneous-response tasks in verbal, looking, and helping paradigms (Buttelmann et al., 2009; Scott et al., 2010; Scott et al., 2012; Southgate et al., 2010).

ToM Development

More recently, researchers have begun to extend research beyond the investigation of a single ToM ability, by examining the sequence of development of multiple abilities. For example, to examine how and when children develop a range of ToM abilities, Wellman and Liu (2004) developed a ToM scale based on the assumption that children's insights about the mind develop in a predictable sequence. They proposed that understanding children's performance on a ToM scale provides more information about ToM development compared to using false belief tasks as a single marker of ToM understanding. To do this, they administered a set of five methodologically comparable ToM tasks to 3-, 4-, and 5-year-old children. These tasks measured different ToM constructs including desires, emotions, knowledge, and beliefs. Results revealed that children's understanding that people can have conflicting desires for the same object precedes their understanding that people can have differing beliefs about the same object. Next, children understand people's knowledge access, followed by the understanding of false beliefs. The last ability to develop in this ToM scale was the ability to understand that a person may display one emotion, but feel a different emotion. Thus, results from this study revealed that children's ToM understanding progressed in a fixed developmental sequence between 3 and 5 years of age. That is, children who passed the most difficult task were more likely to complete all the easier tasks, and conversely, children who failed the easiest task, likely failed the harder tasks. These results suggested that children's ToM abilities develop in a predictable sequence starting with the understanding of conflicting desires and ending with more difficult ToM abilities such as false belief understanding. These findings were subsequently replicated and extended to a sample of Chinese children, where the results revealed a similar overall pattern, with some minor differences in the sequence. These results suggested that there may be some kind of universal progression of ToM understanding, but with important socio-cultural differences (Wellman, Fang, Liu, Zhu, & Liu, 2006). More recently, this invariant sequence of ToM development has been replicated and extended with longitudinal designs and in atypical populations (Peterson, Wellman, & Slaughter, 2012; Wellman, Fang, & Peterson, 2011). However, no such scale has been examined in infancy using interactive or implicit methods, which means that much less is known about how and when ToM abilities emerge in relation to one another before the preschool period. Understanding ToM development in infancy is important as it also helps to clarify the debate about the nature of infants' ToM understanding, which allows for the investigation of how these earlier abilities relate to later ToM abilities as well as other cognitive abilities. From a clinical perspective, understanding the developmental sequence of ToM understanding may allow for the identification of children who present with atypical development, which may lead to later social developmental problems. To date, there has been no research to determine whether there exists a ToM scale based on low demand, elicited-responses measures developed for testing infants and toddlers. Moreover, to our knowledge, no studies have examined how multiple ToM abilities are related to one another during this period.

Researchers have also examined how ToM abilities are related to one another at different points in development. Research on inter-task correlations among ToM tasks in infants and preschoolers is limited. In the extant literature, ToM development tends to be researched as a unitary construct that is often measured using false belief understanding. Consequently, there are few studies that have examined how various ToM abilities are related to one another in infants, toddlers, or preschoolers. Those studies that have included more than a single measure of ToM have not done so to examine inter-task correlations per se, and therefore finding these results are sometimes challenging. Nevertheless, Hughes and Ensor (2005, 2007) examined inter-task relations among ToM tasks in preschool children, and found that a Deception task, Picture Book False Belief task, and Pretend Play task were only weakly correlated when age and verbal ability were controlled for. More specifically, at 2.5 and 3.5 years of age, results revealed a weak overall association between tasks, and only at 4.25 years of age did the relation between these tasks reveal a moderate correlation. In addition, Carlson, Mandell, and Williams (2004) found weak inter-task correlations among ToM tasks at 24 months of age, and by 3.5 years of age, inter-task correlations increased to reveal weak to moderate associations. Rice and Redcay (2013) demonstrated a lack of association between several ToM abilities in 4- and 6-year-olds, suggesting that only some ToM constructs may be related, even in childhood. In contrast, Gopnik and Astington (1988) reported strong correlations between performance on ToM tasks in preschoolers, but all three tasks measured children's grasp of conflicting representations within the same task. Similarly, Rakoczy, Bergfeld, Schwartz, and Fizke (2014) showed high inter-task relations between explicit perspective-taking tasks and the standard false belief task in 3- to 6-year-olds, demonstrating strong coherence in explicit ToM abilities.

There are even fewer studies examining concurrent inter-task correlations during the infancy and toddler period. Among them, Chiarella, Kristen, Poulin-Dubois, and Sodian (2013) reported no significant correlations among scores on ToM tasks in 30- to 38-month-old toddlers. More specifically, children completed tasks, including a visual perspective taking task, a desire understanding task, and an emotional perspective taking task, and results revealed no significant correlations between tasks. Lastly, in 18-month-olds, Yott and Poulin-Dubois (2012) demonstrated a trend association between an interactive intention task and an implicit false belief task. Based on the few studies examining concurrent inter-task correlations between ToM abilities, it appears that these abilities are weakly, if at all, related in the infancy period. If these early ToM tasks are found to be related, it would suggest that these abilities are relying on the same construct, despite whether this construct is fully developed or only emerging. This would provide some support for the proposal that ToM understanding in infancy is similar to ToM understanding in the preschool years.

Implicit vs. Explicit ToM Understanding

Taken together, research on ToM development suggests that although explicit ToM understanding develops between 3 and 5 years of age, infants and toddlers may have an implicit understanding of ToM understanding that emerges earlier. For example, the aforementioned studies conducted on belief understanding using implicit designs suggest that false belief understanding may be present in 15-month-olds (Onishi & Baillargeon, 2004). Additionally, research examining unfulfilled intentions demonstrates that an implicit understanding may be present at 10 months of age while a more explicit understanding only emerges at 18 months of age (Brandone & Wellman, 2009; Meltzoff, 1997). Lastly, studies examining desire understanding suggest that by 18 months of age, infants have an implicit understanding of subjective desires, but that a more explicit understanding only emerges around 3 years of age (Repacholi & Gopnik, 1997; Wellman & Liu, 2004). Based on these findings, it appears as though infants develop an implicit understanding of ToM prior to the development of an explicit understanding.

A question that consistently arises with regard to results obtained using research designs based on implicit responses, is whether or not they measure what they are supposed to measure. More specifically, when one compares infants' looking time at an "expected" or congruent event, to an "unexpected", or incongruent event, is one measuring the infants' representation of another person's mental state? Or alternatively, do these observed differences reflect an earlier concept of ToM that is not yet representational, but is a precursor for a later full-fledged ToM? Or lastly, do these differences in looking times simply reflect lower level processing, such as responding to learned behavioural rules or elements of novelty in the scene being observed? Based on the above literature, several theories of ToM development have been proposed to account for why children under the age of four fail the explicit and verbal false belief tasks, but pass implicit ones.

One such theory, proposed by Baillargeon, Scott, and He, (2010) is that infants in the second year of life have a representational ToM, however, task demands present in the standard, verbal, and explicit false belief task, cause children under the age of four to fail. More specifically, they have proposed that the standard, elicited false belief task masks infants' competence because they must represent the actor's false belief in the story, but also two additional executive functioning processes which ultimately cause them to fail (Baillargeon et al., 2010; Scott & Baillargeon, 2009; Scott et al., 2010). One executive functioning process involves inhibitory control, as children must inhibit their own knowledge of the toy's location to appropriately represent the actor's belief about the toy's location. The second executive functioning process involves response selection, as children must address the test question and select a response. According to the processing load account, children fail the false belief task because these executive functioning abilities develop after the infancy period. Baillargeon and colleagues propose that by the end of the first year of life, infants can understand and attribute motivational states and reality-congruent informational states, like goals and true beliefs

(Baillargeon et al., 2010; Leslie, Friedman, & German, 2004). In addition, they propose that it is only in the second year of life that infants develop the understanding of reality-incongruent informational states like false beliefs. Therefore, according to Baillargeon and colleagues, infants in the second year of life have a representational ToM understanding, in the same way that 4- and 5-year-olds do. Similarly, Leslie (1994) proposed that infants are born with two systems, one that allows them to understand goal-directed actions before 12 months of age, and the second, that allows them to form representational mental states around 18 months of age.

Apperly and Butterfill (2009) have also proposed a two-system account of ToM development, although they posit that infants are able to solve some ToM tasks due to the development of an efficient, yet limited and inflexible system. They argue that these limitations are only overcome when children acquire psychological concepts like belief and desire related to the development of language and executive functioning, which provides them with a new system for ToM reasoning that is flexible but less efficient. In contrast to Baillargeon and colleagues (2010), they do not believe that the reason that infants pass implicit ToM tasks is simply due to the removal of executive functioning and language demands. Instead, they believe that this system is in place to reason quickly about ToM, but that this system is inflexible and fragile. Apperly and Butterfill's (2009) theory fits well with the adult, chimpanzee, and infant literatures on belief understanding, and is consistent with results demonstrating fragile and inconsistent ToM reasoning in children (Surtees, Apperly, & Butterfill, 2012; Low & Watts, 2013; Low, Drummond, Walmsley, & Wang, 2014; Poulin-Dubois, Polonia, & Yott, 2013; Rakoczy, 2012).

Several 'leaner' alternative interpretations for these findings, all involving lower level processes, have also been proposed (Perner, 2010; Sirois & Jackson, 2007). For example, some researchers argue that looking times observed in tasks based on the VOE paradigm, may be explained by infants noticing that something is unusual in the scenes shown during the test trials (Haith, 1998; Perner & Ruffman, 2005; Ruffman & Perner, 2005). Another lean account posits, that infants' longer looking times observed in the implicit false beliefs tasks could be based on a learned behavioural rule. More specifically, infants may predict others' behaviours based on simple behavioural rules, such as "people will look for an object in the last place that they saw it" (Perner & Ruffman, 2005; Ruffman & Perner, 2005). For example, in the case of false belief, the child will expect an actor to search for his/her toy in the last place he/she saw it, because it is a learned behavioural rule, and not because the child understands that the actor has a false belief.

An alternative lower level account of early ToM understandings recently presented by Heyes (2014) proposes that infants' behaviour in these tasks is not due to domain-specific behaviour rules, but rather domain-general processes. More specifically, she argues that infants' longer looking times observed in the incongruent trials in the VOE designs are due to low-level novelty, and not an understanding of beliefs. That is, infants look longer due to perceptual novelty – infants reacting to changes in spatiotemporal relations among colors, shapes, and movements, or imaginal novelty – infants reacting to events that are remembered or imagined to have new spatiotemporal relations among colors, shapes, and movements. Heyes (2014) proposes that this low-level novelty account assumes that infants' behaviours in violation of expectation designs is due to domain-general processes including perception, attention, motivation, learning and memory, and not mental state understanding.

A second important question when using implicit and explicit measures of ToM understanding, is how, if it all are these two different types of measures related to one another? Does implicit ToM understanding tap into the same rich conceptual knowledge that explicit ToM is assumed to do? And lastly, if a child shows strong early implicit ToM understanding, does he or she also demonstrate early and strong explicit ToM understanding. Answering these questions is imperative to fully understand the nature of ToM development in infancy. In addition, understanding the relation between implicit and explicit ToM understanding will help clarify the debate on the development of ToM in infancy and childhood. Few studies have examined how implicit ToM understanding relates to explicit ToM understanding concurrently or longitudinally. Low (2010) demonstrated that 3- and 4-year-olds implicit false belief understanding (gaze) significantly predicted explicit false belief understanding (verbal). These results suggest that both implicit and explicit understanding of false beliefs draws on the same conceptual knowledge. However, it is important to note that explicit false belief understanding was also related to language and executive functioning abilities. Using a longitudinal design, Thoermer, Sodian, Vuori, Perst, and Kristen (2012) demonstrated that implicit false belief understanding at 18 months of age was related to explicit false belief understanding in a verbal task at 48 months of age. These results again suggest conceptual continuity in false belief reasoning from infancy to the preschool years. Much more research is needed to clarify the relation between implicit and explicit ToM understanding, however to date, it appears as though these types of understanding overlap and potentially draw from the same conceptual knowledge.

In sum, there is currently a hot debate in the literature about how and when children develop ToM understanding. The aim of the current dissertation was to expand on the current knowledge of implicit ToM understanding, while at the same time address how the current results fit with contemporary theories of ToM development. Together, the two studies that make up the current dissertation have several objectives designed to further our understanding of ToM development during the infancy period. Given that the current literature suggests that implicit understanding is related to later explicit understanding of ToM, we expect that implicit ToM understanding would follow a pattern similar to that observed for explicit ToM understanding. The first study, (Yott & Poulin-Dubois, in press) examined the development of implicit ToM understanding using a within-subjects design and the VOE research paradigm. To do so, 14- and 18-month-old infants completed implicit intention, true belief, desire and false belief tasks and the development of these abilities was examined across age groups. The second study, (Yott & Poulin-Dubois, under review) set out to develop a ToM scale in infancy such as the one developed by Wellman and Liu (2004) for preschoolers. Thus, 18-, 24-, and 30-month-old infants completed five interactive tasks measuring intention, emotion, desire, and false belief understanding. Additionally, in both Study 1 and 2, inter-task correlations were examined to understand if and how these ToM abilities are related. These studies were conducted in an effort to further our understanding of ToM in infancy by examining both implicit and more explicit understanding of multiple ToM abilities. In doing so, these results can be used to further inform developmental theories on how ToM emerges in children.

Chapter 2

Are infants' Theory of Mind abilities well integrated? Implicit understanding of intentions, desires, and beliefs

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Are infants' Theory of Mind abilities well integrated? Implicit understanding of intentions, desires, and beliefs

Understanding others' mental states, and how they differ from one's own, is an important milestone in children's cognitive development, and has countless implications for social development (Wellman, 2014). That is, understanding someone's intentions, desires, and beliefs is an essential tool for humans to interact, understand, and predict other people's behaviour. This ability, termed Theory of Mind (ToM), has been heavily researched for over 30 years. The most common way of examining ToM understanding has been through the use of false belief tasks, as these tasks require an individual to predict another's behaviour based on a belief that they themselves know is false (Premack & Woodruff, 1978;Wellman, Cross, & Watson, 2001; Wimmer & Perner, 1983). It was traditionally believed that children do not understand false beliefs until four years of age when they pass verbal standard false belief tasks (e.g., location change false belief task; Wellman et al., 2001). The ability to attribute false beliefs requires being to differentiate what one knows from what another person knows, in order to predict his or her behaviour. For example, when observing a toy being moved during a person's absence, one must then inhibit this knowledge to understand that this person has a false belief about the toy's location. Consequently, one can predict and understand this person's behaviour according to this false belief. For example, this person may search for the toy where he or she falsely believe it to be hidden, instead of where it is actually hidden. When asked, children below the age of four make this error, and respond that the person will search for the toy in its actual location, as they are unable to inhibit and differentiate their own knowledge from another person's.

Understanding others' false beliefs is one ability in a complex network of mental state reasoning abilities that children develop in the first five years of life. To examine how and when children develop critical aspects of mental state reasoning, Wellman and Liu (2004) developed a ToM scale based on the assumption that children's insights about the mind develop in a predictable sequence. To do this, they administered a set of five methodologically comparable ToM tasks to 3-, 4-, and 5-year-old children. Results revealed that children first understand that they themselves can have a different desire than someone else for the same object, before they understand that they themselves can have a different belief than someone else about the same object. Next, children understand people's knowledge access, followed by false belief. The last ability to develop in this ToM scale was the ability to understand that a person may display one emotion, but feel a different emotion. Thus, results from this study revealed that children's ToM progresses in a fixed developmental sequence between 3 and 5 years of age. More recently, this invariant sequence of ToM development has been replicated and extended with longitudinal designs, in many different cultures, and in atypical populations (Peterson, Wellman, & Slaughter, 2012; Wellman, Fang, & Peterson, 2011).

During the past decade, researchers have begun to examine ToM abilities in infancy, using implicit non-verbal tasks. These tasks have also been coined indirect or spontaneous response tasks, as opposed to direct, explicit, or elicited response tasks (Onishi & Baillargeon, 2005; Yott & Poulin-Dubois, 2012). These studies use infants' spontaneous responses (e.g., looking time durations, anticipatory looking) to infer implicit ToM understanding. Using such tasks, a large number of studies have demonstrated a more precocious false belief understanding (or other ToM understanding) than is indicated by standard tasks. For example, in 2005, Onishi and Baillargeon published an influential paper in which they demonstrated that 15-month-olds have an understanding of both true and false beliefs using the violation of expectation (VOE) paradigm. More specifically, they demonstrated that infants look longer at a scene when the actor's behaviour is incongruent with their true or false belief about a toy's location. According to the authors, these results suggest that infants expected the actor to behave according to where he or she believed the toy to be hidden, and not where the toy was actually hidden, indicating the presence of belief understanding. Träuble, Marinović, and Pauen (2010) extended these findings by using a within-subjects design, comparing looking times in a false and true belief task in 15-month-olds, providing evidence for flexible belief understanding in infancy. In the last 20 years, numerous studies have reported belief understanding in children younger than four years of age, even in infants as young as seven months of age, using a variety of looking time measures and contexts (Buttelmann, Carpenter, & Tomasello, 2009; Clements & Perner, 1994; Kovács, Téglás, & Endress, 2010; Scott, Baillargeon, Song, & Leslie, 2010; Senju, Southgate, Snape, Leonard, & Csibra, 2011; Southgate, Senju, & Csibra, 2007; Surian, Caldi, & Sperber, 2007; Yott & Poulin-Dubois, 2012).

Similarly, research based on implicit response paradigms have been used to demonstrate other types of mental states in infancy such as intentions and goals (Olineck & Poulin-Dubois, 2007; Phillips & Wellman, 2005; Woodward, 1998). For example, Phillips and Wellman (2005) habituated 12-month-old infants to an actor reaching over a barrier to retrieve a toy. Next, the barrier was removed from the scene and the infants observed two types of test trials; a direct and an indirect reach for the toy. Results revealed that the 12-month-olds looked significantly longer when the actor reached indirectly for the toy, as opposed to directly, once the barrier was removed, indicating an understanding of goal directedness when a successful intentional action is observed. Understanding desires, or the preferences of others, has been well researched in toddlers and preschoolers using interactive and explicit tasks (Repacholi & Gopnik, 1997; Wellman & Liu, 2004; Wright et al., 2005). However, studies often vary in terms of their task demands, as well as how they measure desire/preference understanding. In a landmark study of desire understanding in infancy, Repacholi and Gopnik (1997) showed that infants begin to take into account the subjective desires of others between 14 and 18 months of age. Infants observed an actor express a preference for one type of food and distaste for another. Results revealed that infants reliably offered the actor their preferred food, even when the food desired was at odds with their own preference. Although not an explicit measure, this task requires the infant to give the food that he or she thinks the actor prefers. Tasks examining preference and/or desire understanding using looking-time measures have demonstrated that these abilities emerge in the first year of life (Henderson & Woodward, 2012). However, to our knowledge, there are no implicit versions of the Repacholi and Gopnik (1997) task, demonstrating implicit knowledge of desires. Therefore, one goal of the current study was to develop an implicit desire understanding task, based on the task designed by Repacholi and Gopnik (1997).

An important issue with regard to data obtained with non-verbal, implicit tasks is whether these tasks measure what they are assumed to measure; that is, the representation of others' mental states. For example, do the longer looking times associated with incongruent trials on the belief task reflect full-fledged belief understanding, or a more primitive concept that is a precursor of belief understanding? Recent research has begun to address this question with longitudinal designs and has confirmed that performance on implicit ToM tasks is related to later, explicit ToM knowledge more generally (Low, 2010; Olineck & Poulin-Dubois, 2007; Thoermer, Sodian, Vuori, Perst, & Kristen, 2012). These findings suggest some continuity between early ToM abilities and the more explicit ToM understanding that develop later. Such continuity is compatible with the views that implicit tasks are measuring some kind of early ToM understanding. However, more research is needed, including examining concurrent relations between ToM tasks to determine if a similar pattern of integration is present for implicit and explicit forms of these tasks.

Nevertheless, there is a hot debate in the literature regarding whether or not infants have a true ToM understanding (Sodian, 2011; Ruffman, 2014). Researchers have proposed a range of explanations for why infants demonstrate ToM understanding in infancy, and have proposed developmental theories to support their claims. One possible explanation for why children under four years of age fail the standard false belief task, and yet infants pass implicit versions of such task, is that an understanding of false belief emerges earlier in development, but methodological aspects of the traditional false belief task mask competence. More specifically, it has been proposed that children fail this type of task because of task demands that require a range of cognitive skills, such as language competence and executive functioning, that are not yet fully developed (Baillargeon, Scott, & He, 2010; Carlson, Moses, & Claxton, 2004). As such, these accounts propose that by the end of the first year of life, infants can understand and attribute motivational states and reality-congruent informational states, like goals and true beliefs (Baillargeon et al., 2010; Leslie, Friedman, & German, 2004). In addition, they propose that it is only in the second year of life that infants develop the understanding of reality-incongruent informational states like false beliefs. Moreover, they explain that the reason infants pass these implicit tasks, and not those with explicit demands in the second year of life, is that all language and executive functioning requirements have been removed. However, recent research has demonstrated that some executive functioning abilities are related to performance on implicit belief tasks, suggesting that implicit tasks may not completely eliminate executive functioning requirements, but rather decrease these demands (Yott & Poulin-Dubois, 2012).

Apperly and Butterfill (2009) have also proposed a two-system account of ToM development, although they posit that infants are able to solve some ToM tasks due to the development of an efficient, yet limited and inflexible system. They argue that these limitations are only overcome when children acquire psychological concepts like belief and desire related to the development of language and executive functioning, which provides them with a new system for ToM reasoning that is flexible but inefficient. In contrast to Baillargeon and colleagues (2010), they do not believe that the reason that infants pass implicit ToM tasks is simply due to the removal of executive functioning and language demands. Instead, they propose that a system is in place to reason quickly about ToM, but that this system is inflexible and fragile. Apperly and Butterfill's (2009) theory fits well with the adult, chimpanzee, and infant literatures on belief understanding, and is consistent with results demonstrating fragile and inconsistent ToM reasoning in children (for a review see Surtees, Butterfill, & Apperly, 2012; Low & Watts, 2013; Low, Drummond, Walmsley, & Wang, 2014; Poulin-Dubois, Polonia, & Yott, 2013). In contrast, others have also proposed that ToM understanding in infancy as demonstrated by implicit tasks, may not reflect any mental state attribution, but could, in principle, reflect novelty effects or low-level processing (Heyes, 2014; Perner, 2014; Ruffman & Perner, 2005; Ruffman, 2014). That is, it has been proposed that infants might simply respond to something unusual in the display, or react according to violation of behavioural rules.

In sum, our current understanding of ToM development in infancy is incomplete, and research has focused primarily on belief understanding. Keeping these limitations in mind, it is of foremost importance to understand what ToM abilities are present in infancy, how they relate to one another, and when they develop. One way to contribute to the debate on the nature of implicit ToM reasoning in infancy is to examine the development of a wide range of ToM abilities across more than one age group. Additionally, examining inter-task correlations among ToM tasks in infancy and how they compare to those found in older children might help to clarify this debate. Research on inter-task correlations among ToM tasks in children is limited and much of the extant literature has focused on the preschool period. Results from these studies vary considerably, reporting anywhere from weak to strong inter-task correlations. For example, some studies have demonstrated weak to moderate inter-task relations among ToM tasks in 3- to 4-year-olds (Carlson, Mandell, & Williams, 2004; Hughes & Ensor, 2007), whereas other studies including children in the same age range have reported strong correlations (Gopnik & Astington, 1988; Rakoczy, Bergfeld, Schwartz, & Fizke, 2015).

In infancy, even fewer studies have examined inter-task correlations. Chiarella and colleagues (2013) reported no significant correlations among scores on ToM tasks in 30- to 38-month-old toddlers. More specifically, children completed two or three ToM tasks, including a visual perspective taking task, a desire understanding task, and an emotional perspective taking task, and results revealed no significant correlations in either a Canadian or German sample. In contrast, some studies have revealed some weak inter-task relations in 24-month-old children (Carlson et al., 2004; Hughes & Ensor, 2005). Lastly, in 18-month-olds, Yott and Poulin-Dubois (2012) demonstrated a trend-level association between an interactive intention task and an implicit false belief task. Taken together, these few results suggest that ToM abilities in young children are weakly, if at all, related, and may only integrate later in development, but only a few tasks have been compared. Together, these studies suggest that ToM abilities in children may only integrate later in development.

To date, there have been no studies examining the inter-task correlations of multiple ToM abilities in infancy using a within-subjects design. Additionally, there is a paucity of research examining developmental trends of multiple ToM abilities in infancy. Based on these important gaps in the literature, the goals of the present study were threefold: (1) to investigate the development of ToM abilities between the ages of 14 and 18 months, (2) to examine how concurrent ToM abilities relate to one another, as assessed with the VOE paradigm, and (3) to document desire understanding using a novel, implicit desire task.

Method

Participants

A group of forty-three 14-month-old infants (24 males) and fifty-three 18-month-old infants (32 males) participated in the study. The mean age for the 18-month-old sample was 1;6 (*range* = 1;4 to 1;8) and the mean age for the 14-month-olds was 1;2 (*range* = 1;1 to 1;3). The sample was ethnically diverse, and included families who identified themselves as being of Caucasian descent (*n* = 57), Asian descent (*n* = 8), African descent (*n* = 6), Arab decent (*n* = 8), South American descent (*n* = 5), Caribbean descent (*n* = 4), or did not report their ethnicity (*n* = 8). On the basis of parental reports, infants had no visual or auditory impairments, and had a minimum 35-week gestational period. All infants were recruited from birth records provided by a governmental health services agency and were exposed to primarily English or French.

An additional six (12%) 14-month-old infants participated but were excluded from the sample due to fussiness (*n* = 4), parental interference (*n* =1), and missing their second appointment (*n* = 1). Similarly, an additional nineteen (26%) 18-month-olds infants participated but were excluded from the study due to fussiness (*n* = 8), parental interference (*n* = 2), technical difficulties (*n* = 2), a reported developmental delay (*n* = 1), and missing one of the two testing sessions (*n* = 6).

Materials

A stage-like apparatus (107 cm x 61 cm x 211 cm) was used to administer all four tasks. The experimenter was visible through a window (86 cm x 91cm), located approximately 80 cm from the bottom of the front panel. Visible through the window was a flat surface, which was used as stage where the toys were placed for any given the task. Just below the surface top was a small circular opening where a digital camera was placed in order to record infants' looking behaviour. Infants observed the experimenter from a high chair (*n* = 61) placed approximately 110 cm from the display, or from their parent's lap (*n* = 35). All parents were asked to remain silent during the testing procedures. A white curtain that was operated by the experimenter covered the window of the display. Infants' looking patterns were coded live by a second experimenter using the Habit 2000© program (University of Texas) on a Mac G4 computer.

Receptive Vocabulary. To measure receptive vocabulary, parents completed the MacArthur-Bates Short Form Vocabulary checklist: Level 1, which includes 89 words. Parents were asked to indicate the words that their child understood.

Intention task. For the intention task, a black barrier (30 cm x 25 cm) was used and placed on the right side of the stage. At the beginning of the task, a small yellow duck (12 cm x 12 cm) was placed on the far side of the barrier, facing the infant.

Belief tasks. A red cup (7.5 cm diameter, 10.5 cm height) or a yellow duck (11cm x 11 cm) was placed on the surface top directly between a yellow and a green box (14 cm x 14 cm x 14 cm). The distance between the boxes was 18 cm. Each box had an opening on the side facing the cup or duck (14 cm x 14 cm) that was covered with a fabric fringe. A rectangular opening underneath each box allowed for the attraction between a magnet located inside the cup and duck (2.5 cm x 5 cm length x 0.6 cm) and a magnet under the stage, operated by the experimenter (7.6 cm diameter). The magnet was used to unobtrusively transfer the cup or duck from one box to the other underneath the stage.

Desire task. Two food pairings were used during the desire task. The first pairing was lettuce and Honey Nut Cheerios, and the second pairing was broccoli and Pepperidge Farm gold fish crackers. All food items were placed in clear plastic containers.

Design and Procedure

Infants and their parents were invited to the laboratory for two testing sessions that each lasted approximately 45 minutes, scheduled one to two weeks apart. Upon arrival, they were brought to a reception room, where infants were familiarized with the experimenters and the environment, and parents completed a consent form, a demographic questionnaire, and the receptive vocabulary checklist. The receptive vocabulary checklist was administered to control for infants' verbal ability. Tasks were recorded in order to code infants' responses off-line. All families were offered $20 in financial compensation per session for their participation in this study.

All infants participated in one belief task, one desire task, and the intention task during their first visit, and the second belief and desire task during their second visit. The order of the tasks was counterbalanced so that each task was presented first, second, or third. It is important to note that if an infant completed the belief task first during the first visit, then he/she did the second belief task first at the second visit. Counterbalancing created 12 different orders. No order effects were observed.

Intention task. The intention task was adapted from Phillips and Wellman (2005). This task consisted of seven trials. The first three trials were familiarization trials, during which a black barrier separated the experimenter from a yellow duck. Each familiarization trial began with an attention-attracting noise and the curtain rising. During the ensuing 2-second demonstration phase, the experimenter reached over the barrier, grabbed the duck, and held it in front of her while gazing at it. Trials were coded live and began once the experimenter paused while holding the duck. The trial ended if the infant looked away from the display for more than two consecutive seconds after looking at the display for a minimum of two cumulative seconds, or if he/she looked away for ten consecutive seconds. A trial lasted a maximum of 30 seconds. The test trials were identical except that the barrier was removed from the stage. Of the four test trials, two trials were congruent, where the experimenter reached directly for the duck and then held it in front of her. In contrast, during the incongruent trial, the experimenter reached for the duck indirectly by following the same path as though the barrier was present. This reach was considered incongruent because the experimenter no longer needed to follow this path. The trials alternated between congruent and incongruent.

Belief tasks. Infants participated in two belief tasks, a Full Box belief task and an Empty Box belief task, each completed on a separate day. The belief tasks were adapted from Onishi and Baillargeon (2005) to examine infants' understanding of true and false beliefs. These tasks are non-verbal and based on the VOE paradigm. During each of the belief tasks, all infants completed three familiarization trials, followed by a false belief induction trial and a false belief test trial, and then a true belief induction trial followed by a true belief test trial. An attention-attracting sound played at the beginning and end of each trial when then curtain was raised and then lowered.

During the 8-second familiarization trial, the experimenter raised the curtain, picked up the cup and placed it inside one of the two boxes. Once the cup was hidden, the experimenter paused with her hand inside the box. The trial ended if the infant looked away from the display for more than two consecutive seconds after looking at the display for a minimum of two cumulative seconds. In addition, if infants looked away for ten consecutive seconds before having looked at the screen for the minimum two seconds, the trial ended. A trial lasted a maximum of 30 seconds. During the second and third familiarization trials, the experimenter reached into the box where the cup was hidden and then paused with her hand inside the box until the trial ended.

During the false belief induction trial, the cup moved from one box to the other through a magnet operated by the experimenter. Next, the infants observed a false belief test trial during which the experimenter reached into the full box (the box with the cup). This search behaviour was considered incongruent, because the experimenter's behaviour (searching in the full box) was incongruent with her belief (no knowledge of the cup's new location). Next, infants observed a true belief induction trial, where the experimenter moved the cup back to its original location. In contrast to the false belief induction trial, the experimenter remained in sight and followed the cup's movement from one box to the other. Lastly, infants observed the true belief test trial during which the experimenter again reached into the full box (the box with the cup). This time, the trial was considered to be congruent, because the experimenter's action (searching in the full box) was consistent with her belief (knowledge of the cup location). This belief task is called the Full box task, as infants observed the experimenter search in the full box during each test trial. However, in the case of the false belief test trial, the trial was incongruent, whereas during the true belief test trial, it was congruent.

During the Empty Box belief task, infants observed the same experimenter and trials, except that the yellow duck replaced the toy cup, and the experimenter searched in the empty box instead of the full box during the true and false belief test trials. Like the Full Box belief task, infants observed both an incongruent and a congruent trial, but this time, the congruent trial occurred during the false belief test trial, because the experimenter searched in congruence with her belief (the toy's original location). In contrast, the incongruent trial corresponded to the true belief test trial, because the experimenter searched in the empty box, after having observed the cup change locations.

By the end of the second visit, all infants had observed an incongruent and a congruent trial following both the true and false belief induction trials. By using a within-subjects design, infants' individual looking times during the incongruent and congruent trials could be compared for both the true belief and false belief scenarios. The order in which the infants completed the belief tasks was counterbalanced. Additionally, the design allowed for a congruent belief trial to be presented first, and an incongruent trial to be presented second in one belief task, and vice versa in the second belief task.

Desire task. This task was adapted from Repacholi and Gopnik's (1997) interactive desire task. Infants participated in the congruent desire task during one visit and the incongruent desire task during the second visit. The congruent task was comprised of three familiarization trials, followed by one test trial. The familiarization trials began with an attention-attracting sound and the curtain rising. Placed in front of E2 were two plastic containers, one filled with crackers and the other with broccoli. Placed in front of the primary experimenter (E1) were three pieces of broccoli and three crackers. The trial began with E1 picking up a cracker, showing it to the infant, and then eating it. After she placed the cracker in her mouth, she said with a look of content, "Mmm Crackers, Mmm". She then picked up a piece of broccoli, placed it in her mouth and said, "Eww broccoli, Eww" with a look of disgust. She ate all food items in the same manner while E2 watched with a neutral facial expression. These familiarization trials lasted approximately 20 seconds.

The test trial began when E1 turned to E2, looked up at the full containers in front of her, and said, "Can I have some?" with her hands open in front of her, palms up. E2 then looked at both containers of food, reached for the crackers, and placed some in her hand. E1 turned toward the infant and then looked down at the food with a neutral facial expression and paused. Both experimenters remained still for 10 seconds. The incongruent desire task followed the same procedure, except that the crackers and broccoli were replaced with Cheerios and lettuce. In addition, during the familiarization trials, E1 demonstrated a preference for the Cheerios, however, during the test trial, E2 gave her lettuce. In this way, the incongruent desire task differed from the congruent desire task, because E1 received the food for which she did not demonstrate a preference.

Coding and Reliability

Infants' looking times at the scene during each task was coded offline using INTERACT 8.0 (Mangold, 2010). To be included in the analyses, infants were required to observe at least 70% of the test demonstration phase(s) for all tasks. Based on this criterion, seven infants were excluded from the intention task (five 14-month-olds; three 18-month-olds), 11 infants (eight 14-month-olds; three 18-month-olds) from the true belief task, four infants from the false belief task (four 14-month-olds; no 18-month-olds) and one 18-month-old infant from the desire task. Additionally, an infant who did not watch the still phase of any test trial (score of 0) was excluded from the final analyses. As such, six infants were excluded from the true belief task, one from the intention task, and one from the desire task.

To establish inter-rater reliability, an independent observer coded a minimum of 25% of the data. Using Pearson product-moment correlations to compare overall looking time at the scene, the mean inter-observer reliability was calculated. Scores above r = .9 were considered to reflect high agreement. For all tasks, the entire trial was coded for looking time on and off the scene, however looking time on screen was the variable of interest. In all cases, reliability was above r = .90, (ps < .001).

Results

Preliminary analyses revealed that the looking time measures for the Intention, Desire, True, and False Belief tasks were not normally distributed, and therefore an additive (+1) log10 transformation was applied. Following these adjustments, the data were normally distributed, thereby meeting the normality assumption for parametric statistical tests. As the results from analyses on both raw and transformed scores revealed the same findings, only those from the original raw scores are reported. To examine group performance on each task individually, only the scores from the infants who completed a given task were used, and therefore the sample size varied depending on the task being examined (n = 63 to n = 81; see Table 1). Additionally, because infants were administered up to three VOE tasks during a testing session, infants' looking time during each demonstration phase was examined to control for potential fatigue

Table 1. *Sample size per task and age group*.

Task	14 month-olds	18 month-olds
Intention	n = 32	n = 35
True Belief	n = 27	n = 36
Desire	n = 35	n = 46
False Belief	n = 29	n = 43

effects. For all tasks, the average percentage of time infants watched the demonstration phase was above 97%, with a minimum percentage looking time above 70%. These results suggest high attention during the VOE tasks in the final sample. To ensure that infants were equally attentive during each of the true and false belief induction trials, infants' looking times were compared using a mixed-design ANOVA. Results revealed no main effect of trial nor interaction suggesting that infants looked equally long during both the True Belief induction trials (incongruent induction trial: $M = 8.67$s, $SD = 6.40$; congruent induction trial: $M = 8.40$s, $SD = 5.44$), as well as the False Belief induction trials (incongruent induction trial: $M = 6.44$, $SD = 4.61$; congruent induction trial: $M = 7.67$ s, $SD = 5.80$).

To examine infants' understanding of intentions, desires, true and false beliefs, and desires, a mixed-design ANOVA with age group (14-month-olds, 18-month-olds) as the between-subjects factor and test trial (incongruent, congruent) as the within-subjects factor was used for each task. To examine infants' performance on the Intention task, looking time at the first and second pair of congruent and incongruent test trials was averaged and then compared. Results revealed a main effect of trial (F (1,66) = 5.92, $p = .02$, $\eta_p^2 = .08$; incongruent trial: $M = 6.30$s, $SD = 4.08$; congruent trial: $M = 5.11$s, $SD = 2.50$; see Figure 1). No significant age effect or interaction effects were observed.

Results from the True Belief task revealed a main effect for trial, $F(1,61) = 3.88$, $p = .05$, $\eta_p^2 = .067$; incongruent trial: $M = 7.45$, $SD = 5.94$; congruent trial: $M = 5.63$, $SD = 4.02$.; see Figure 2) Additionally, there was a main effect of age, F(1,61) = 5.67, $p = .02$, $\eta_p^2 = .09$, such that 18-month-old infants looked longer at the scene compared to 14-month-olds. There was no significant interaction between age group and trial.

Results from the Desire task revealed no main effect of trial, however, an interaction effect was observed, $F(1,79) = 6.57$, $p = .01$, $\eta_p^2 = .08$. As shown in Figure 3, planned follow-up pairwise comparisons revealed that 18-month-old infants looked significantly longer at the incongruent trial ($M = 8.99$s, $SD = 1.36$) compared to the congruent trial ($M = 8.41$s, $SD = 1.91$, $p = .04$, $\eta_p^2 = .05$). In contrast, younger infants looked equally long at the incongruent ($M = 8.57$, $SD = 1.37$) and congruent ($M = 9.07$, $SD = 1.90$, $p = .12$, $\eta_p^2 = .03$; see Figure 3) test trials.

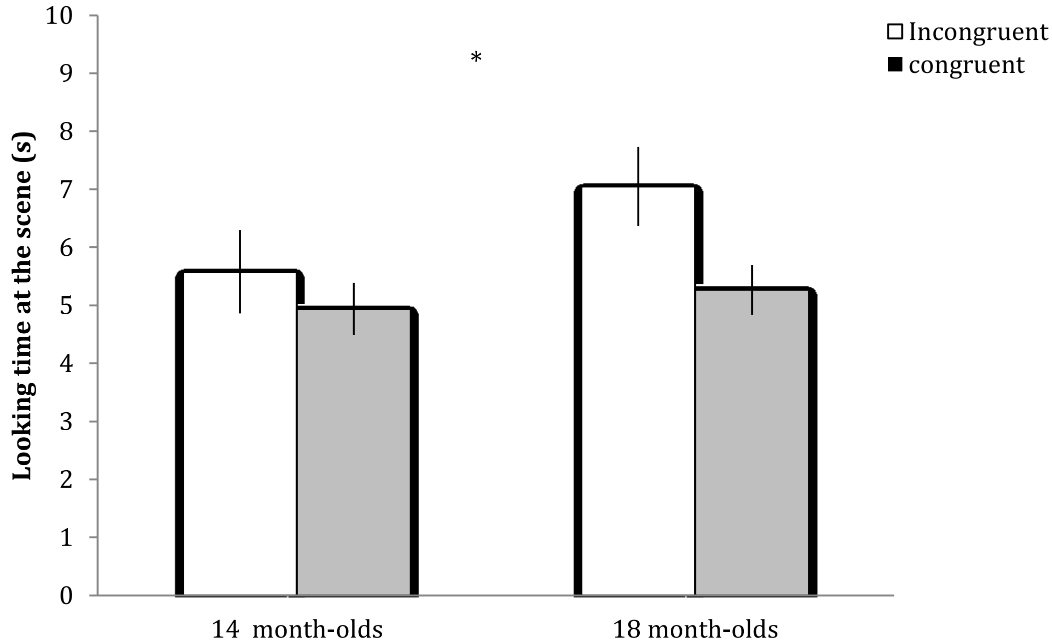

Figure 1. Mean looking time at the incongruent and congruent trials in the intention task by age.

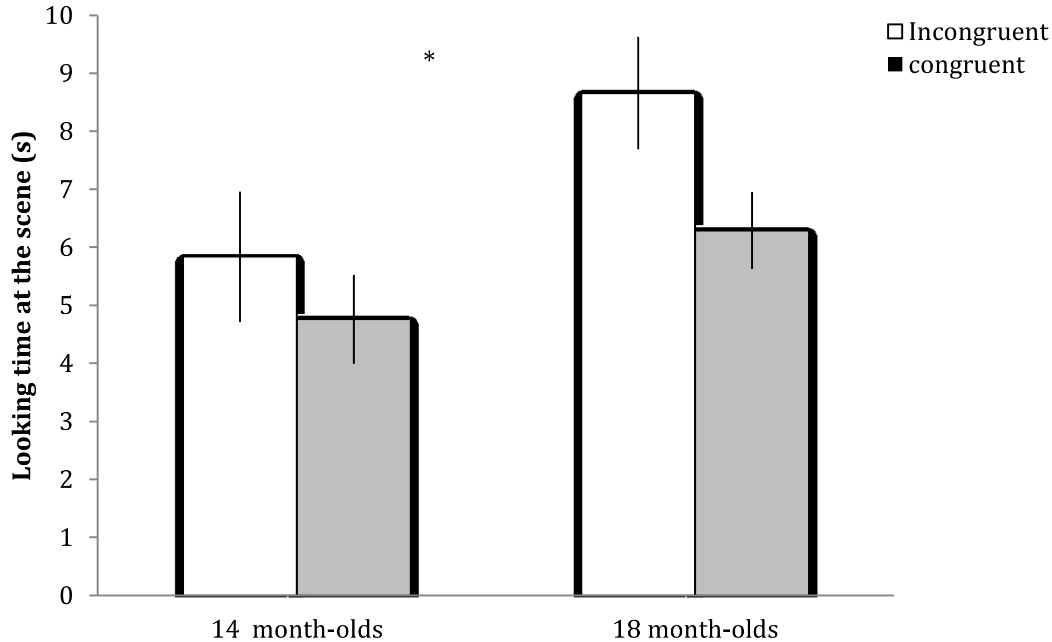

Figure 2. Mean looking time at the incongruent and congruent trials in the true belief task by age

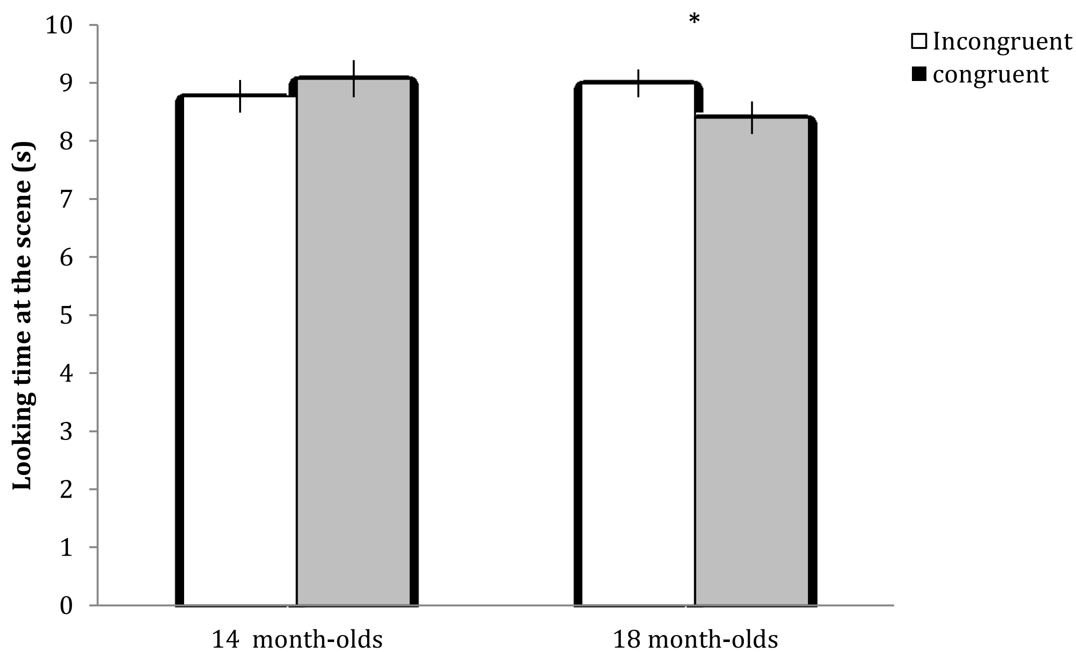

Figure 3. Mean looking time at the incongruent and congruent trials in the desire task by age

Results from the False Belief task revealed an effect of trial at the trend level, $F(1,70) = 2.88$, $p = .09$, $\eta_p^2 = .04$; incongruent trial; $M = 7.72$s, $SD = 6.41$; congruent trial: $M = 6.19$s, $SD = 5.83$; see Figure 4). No age group or interaction effects were observed.

Results from the belief tasks revealed that infants looked significantly longer at the incongruent trial compared to the congruent trial in the True Belief task, but not in the False Belief task. Recall that during each testing session, infants completed an incongruent false belief trial and a congruent true belief trial, or a congruent false belief trial and an incongruent true belief trial. Therefore, looking times at the incongruent and congruent trial within the same session can be compared as a measure of belief understanding. A mixed-design ANOVA was used to compare looking time, with day (first session, second session) and trial (incongruent, congruent) as within-subjects factors, and age (14-month-olds, 18-month-olds) as the between subjects factor. Results revealed only a main effect of trial $F(1,57) = 8.61$, $p = .01$, $\eta_p^2 = .13$. No main effect of age or testing day was found, nor were any significant interactions observed.

Lastly, to examine inter-task relations, partial correlations between looking times on incongruent trials, controlling for age and receptive vocabulary, revealed a statistically significant correlation only between the False Belief and Intention scores (see Table 2). Additionally, as expected, language abilities were not correlated with performance on the VOE tasks, except for a marginally significant association with looking time at the incongruent scene in the True Belief task. No other significant correlations were observed when incongruent looking times or congruent looking times were compared across tasks.

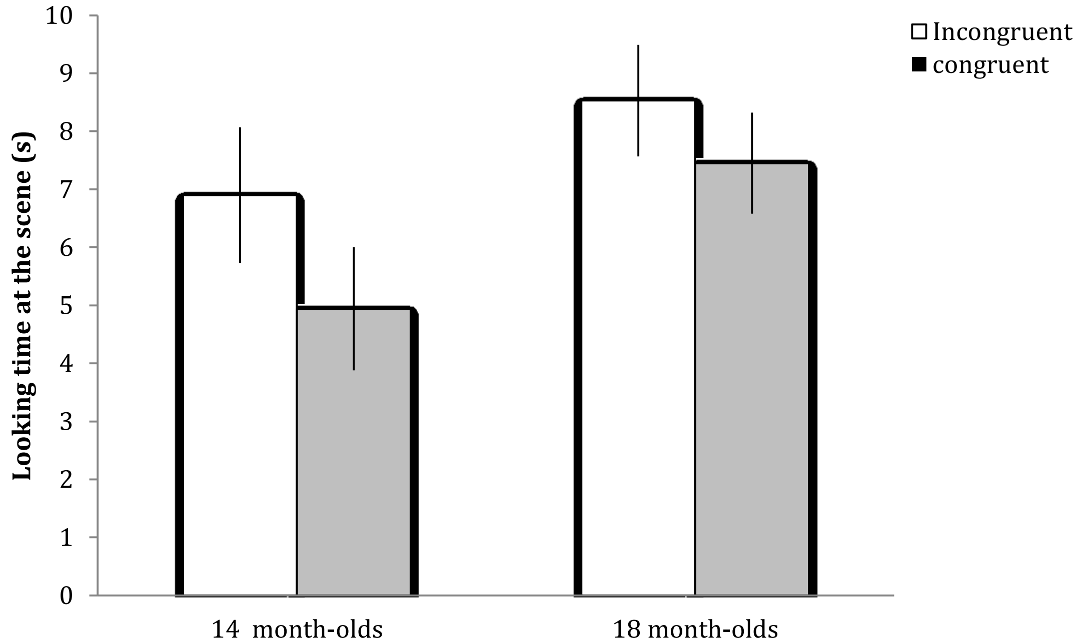

Figure 4. Mean looking time at the incongruent and congruent trials in the false belief task by age.

Table 2. *Partial correlations between looking time at the incongruent scenes in Intention, True Belief, Desire, and False Belief tasks, controlling for age and receptive vocabulary.*

Task	1	2	3	4
1. Intention	-			
2. True Belief	.06 n = 46	-		
3. Desire	.11 n = 55	-.07 n = 60	-	
4. False Belief	.41* n = 49	-.01 n = 59	-.01 n =64	-

Note. * p < .01.

Discussion

The findings from the present study provide many contributions to the literature on ToM development in infancy. Firstly, it addresses an important gap in the literature by examining the development of multiple ToM abilities at two time points during the second year of life. Secondly, the inclusion of a wide range of ToM tasks combined with a within-subject design provides information about how theory of mind abilities are related to one another.

As expected, during the second year, no developmental changes in intention understanding, were observed, as shown by longer looking times on average at the incongruent test trials compared to the congruent ones in both age groups. These results are consistent with previous research showing that infants have developed an understanding of intentions by the end of the first year of life (Olineck & Poulin-Dubois, 2007; Phillips & Wellman, 2005; Woodward, 1998). With regard to the True Belief task, our results revealed that both 14- and 18-month-olds looked longer at the incongruent test trial compared to the congruent one. Again, these results are consistent with previous findings indicating true belief understanding in 15-month-old infants, with both within- and between-subject designs (Onishi & Baillargeon, 2005; Träuble et al., 2010).

Results from the Desire task suggest that 18-month-old infants were sensitive to another person's desires, and that they remembered the emotional expression associated with each type of food during the familiarization trials. However, 14-month-olds did not show this pattern. This is the first VOE adaptation of the Repacholi and Gopnik's (1997) interactive task to measure desire understanding in infancy. This is an important addition to the literature because younger infants typically fail to respond to an object or food request. Thus, a VOE adaptation of the subjective desire task allows for the testing of desire understanding in younger samples with minimal task demands. These results suggest that infants' ability to reason about another person's desires develops during the second year, because even after removing the demands of the original desire task (food request, inhibition of own food preference), 14-month-olds do not appear to understand desires.

Finally, results from the False Belief task revealed that infants only tended to look longer at the incongruent scene compared to the congruent one, which is inconsistent with studies conducted with both between- and within-subject designs demonstrating false belief understanding at 7- (Kovács et al., 2010), 13- (Surian et al., 2007), 15- (Onishi & Baillargeon, 2005; Träuble et al., 2010), 18- (Yott & Poulin-Dubois, 2012), and 24-months of age (Southgate et al., 2007). In contrast, these results do support the idea that false belief understanding may be fragile and/or that it emerges later during the second year of life, as reported in other recent studies (Poulin-Dubois et al., 2013; Sodian, 2011; Thoermer et al., 2012). For example, the present results replicate previous research by Thoermer and colleagues (2012), who demonstrated that only 55% of their 18-month-old sample looked significantly longer at the correct versus incorrect location with the anticipatory looking procedure Taken together, these findings only partially support developmental theories that propose that true belief understanding develops in the first year of life, followed by false belief understanding by the middle of the second year of life (Baillargeon et al., 2010). These results do, however, fully support the proposed developmental sequence of true belief developing before false belief, a hypothesis that has yet to be demonstrated empirically using a longitudinal design.

There are several possible explanations for lack of replication of previous false belief findings based on the VOE or anticipatory looking paradigms. First, in the current design true and false belief tasks were combined with the incongruent and congruent trials administered on separate days. Administering the tasks in this way provides a very conservative test of infant's belief understanding because infants' looking times are a sensitive measure that can be affected by extraneous variables. Additional analyses revealed that if looking time during the incongruent and congruent trials within the same day were compared, infants looked significantly longer at the incongruent trials on both days. These results suggest infants were more surprised by the incongruent test trials in both the false belief and true belief scenarios. However, these results should be interpreted with caution, as the looking times are being compared across two different types of belief tasks.

The current study provides unique information about inter-task relations between ToM tasks based on the VOE paradigm. A significant correlation was observed between false belief incongruent looking time and intention incongruent looking time. This finding is particularly interesting, as it replicates previous research demonstrating a relation between performance on the same False Belief task and intention measured with the Behavioural Re-enactment task (Yott & Poulin-Dubois, 2012). It seems possible that in order to interpret an actor's false belief, infants also need an understanding of her intention to find the object, regardless of the object's location. This requirement may be less important in true belief understanding, where both the actor and the child observe the same events. It is important to highlight, however, that no other significant correlations were observed. The fact that infants' looking times at the scenes were largely unrelated across tasks is consistent with previous research on ToM development in toddlers or young children using interactive tasks (Carlson et al., 2004; Chiarella et al., 2013; Hughes & Ensor, 2005). Taken together, these results suggest that ToM concepts may develop independently in infancy and may only integrate during the preschool years. Moreover, it is possible that the lack of inter-task correlations is due to the fact that looking time measures are sensitive to extraneous variables and therefore may have low test-retest reliability. However, even in the preschool years, research on inter-task associations reveal mixed results ranging from no association to strong associations depending on the abilities being measured (Carlson et al., 2004; Hughes & Ensor, 2005; Rakoczy et al., 2015).

We believe that the present findings have implications for recent proposals about the nature of the precocious ToM abilities reported in infancy over the past decade. Supporters of a rich interpretation of implicit ToM understanding in infancy have proposed that infants possess a representational ToM but that this understanding is masked by the demands of standard tasks, including advanced language and executive functioning abilities (Baillargeon et al., 2010). Such competence is revealed when tasks based on spontaneous responses are used to test theory of mind abilities, such as those based on the violation of expectation paradigm. At first glance, results from the current study fit with such a rich proposal in the sense that, like the mature form of ToM observed years later, intention, true belief, and desire concepts develop before false belief understanding (Wellman & Liu, 2004). However, our results are inconsistent with previous findings demonstrating false belief understanding using implicit designs at 18 months of age or earlier (Onishi & Baillargeon, 2005; Scott et al., 2010; Träuble et al., 2010).

In contrast, supporters of lean or minimalist interpretations of implicit ToM in infancy have argued that a conceptual shift occurs in development and that performance on implicit ToM tasks can simply be accounted for by low-level perceptual processing or detection of statistical regularities (Heyes, 2014; Ruffman, 2014). Although the current study was not designed to directly address such proposals, if infants' responses in the tasks were explained by these low-level accounts, specifically in the belief tasks, one would expect such variables to influence performance consistently across tasks. Given that we observed variability in performance across tasks and little or no coherence among task performance at either age, it seems unlikely that infants were simply reacting to low-level changes between the familiarization and the test scenes or to violation of statistical irregularities. In addition, the observed developmental progression from intention and true belief understanding to desire and false belief understanding is difficult to explain using these minimalist interpretations. Furthermore, we believe that the pattern of results observed for the Desire task alone, which shows developmental changes during the second year cannot be easily explained in terms of perceptual novelty or processing of statistical irregularities.

Results from the current study are consistent with the idea that infants' belief understanding is initially rigid and inflexible (Apperly & Butterfill, 2009). According to this view, infants can solve some ToM tasks, but cannot solve more difficult ToM ones. The current findings support this theory by demonstrating infants' understanding of intentions and true beliefs, but only a nascent understanding of desires and false beliefs. Apperly and Butterfill (2009) proposed that children begin to reason about desires and beliefs gradually as they develop language, executive functioning, and an understanding of psychology concepts. The development of these related abilities allow for the emergence of a more flexible theory of mind system, which allows for the attribution of desires and false beliefs. Results from the current study do in part support this notion, as language abilities were not related to task performance. The current study suggests that implicit ToM abilities develop in much the same way as later, more explicit, abilities emerge, starting with intention understanding, followed by more complex ToM abilities such as desire and false belief understanding. Moreover, while implicit ToM understanding may not reflect the same explicit understanding observed in preschool children, the current study combined with longitudinal studies suggest that these earlier ToM abilities are pre-conceptual abilities that provide the foundations for later explicit ToM understanding.

One of the limitations to the current study is that approximately half of the original sample of infants did not complete all four tasks. One reason for the high attrition rate was that infants had to complete tasks across two testing sessions. Measuring looking times across days opens up this measure to extraneous variables, such as mood, fatigue, or interest level. Therefore, if infants did not complete the belief task on one of the two days, they were excluded from the analyses. Future research should examine different ways of measuring multiple ToM abilities, using implicit designs in a single session (e.g., anticipatory looking paradigm), to reduce attrition rates, but to also replicate and extend our findings. Another limitation to the current study is that individual patterns of ToM development could not be examined. That is, we were unable to examine if infants were likely to pass tasks in a particular sequence. This was due to several factors, including the fact that looking times were used to examine ToM ability, that only two age groups were examined, and that the number of infants who completed all four tasks was low. Nevertheless, in an effort to address this question, infants were given a pass or fail score on each task: on all tasks, the percentage of infants passing each task was not significantly above chance. In addition, we observed no significant difference in task performance or difficulty level. Taken together, these results suggest that changing the variables from continuous to dichotomous likely removed the individual variability observed in the looking times on incongruent and congruent trials. Moreover, the lenient pass/fail score was likely not sensitive enough to observe individual or group differences, if any. Future studies should examine individual differences in ToM development using interactive implicit tasks that are scored as success or failure. Additionally, it would be very interesting to examine how ToM abilities assessed with looking times measures relate concurrently to ToM abilities assessed with interactive measures. We are currently investigating this issue with a range of implicit measures and hope to contribute to this literature on ToM development in infancy (Yott & Poulin-Dubois, 2015).

In conclusion, the present study confirms and extends previous research on infants' ToM abilities, expands our knowledge of inter-task relations among ToM tasks, and makes an important contribution to the literature with regard to ToM development in infancy. Moreover, this is the first study to use a within-subjects design to examine ToM development in infancy with a wide range of tasks, including for the first time, a VOE adaptation of the desire task based on Repacholi and Gopnik's (1997). Taken together, the results from the present study add to the mounting evidence supporting the notion that there is limited coherence with respect to infants' ToM understanding. This, in turn, suggests that mental state reasoning involves significant developmental changes and that the data on infants' ToM "may not reflect the working of an innate, well-formed theory of mind" (Perner, 2014). However, how these skills develop from infancy to childhood and what important cognitive changes take place during this period remains open to debate.

Chapter 3

Scaling of Theory of Mind Tasks in infancy

Yott, J., & Poulin-Dubois. (Submitted). *Cognitive Development*.

Scaling of Theory of Mind Tasks in infancy

Theory of mind (ToM) is defined as the ability to make attributions about other people's mental states, such as beliefs, emotions, intentions, and desires (Poulin-Dubois, Brooker, & Chow, 2009; Sodian, 2011; Wellman, 2014). ToM is essential for social and cognitive development because without a ToM one would not be capable of interpreting, predicting, or understanding the behavior of others (Meltzoff, 1995). In addition, ToM development has been related to social development, including peer relations and prosocial behaviour in children (Hughes & Leekam, 2004; Devine & Hughes, 2013; Caputi, Lecce, Pagnin, & Banerjee, 2012).

Research on the development of children's ability to reason about mental states goes back to metacognitive development research in the 1970s, and before that, to early research on perspective taking, inspired by Piaget's claim that children are cognitively egocentric (Flavell, 2000). The study of ToM development became popular in the 1980s, when Wimmer and Perner (1983) first reported evidence for false belief understanding around four years of age. The ability to understand false belief – the fact that although an individual knows the truth about a situation, others may hold mistaken beliefs about that same situation – is one of several cognitive achievements involved in developing a ToM, along with the ability to understand that others' intentions, emotions, and desires may be at odds with our own (Wellman, 2014). Despite these other important and related areas of ToM development, false belief understanding has remained the litmus test for the understanding of mental states as representational.

A large number of studies have now examined when children develop an explicit understanding of false belief, and a meta-analysis conducted by Wellman, Cross, and Watson (2001) demonstrated that children develop this ability between four and five years of age. Although researchers agree that children pass the traditional, explicit false belief task around four years of age, there is a hot debate in the literature about when toddlers (and even infants) develop a more implicit understanding of false beliefs. This debate originated with Clements and Perner's (1994) demonstration that although 3-year-old children fail the traditional explicit false belief task, they show eye gaze patterns demonstrating an implicit understanding of false beliefs. This was followed by studies investigating the development of ToM understanding in infancy using implicit measures, such as the Violation of Expectation (VoE) paradigm. The first studies conducted with infants showed that goal and desire understanding can be documented between

6- and 18-months of age (Poulin-Dubois, 1999; Poulin-Dubois, Brooker, & Chow, 2009; Sodian, 2014; Wellman, 2014; Woodward, 1998).

In extending this paradigm to test false belief, Onishi and Baillargeon (2004) demonstrated that 15-month-old infants looked significantly longer at a scene when an actor's actions were inconsistent with their false belief, demonstrating an earlier implicit understanding of false beliefs. These results have been replicated and extended to children as young as 7 months of age using this same design, as well as anticipatory looking (Clements & Perner, 1994; He, Bolz, & Baillargeon, 2011; Kovács, Téglás, & Endress, 2010; Onishi & Baillargeon, 2005; Ruffman, Garnham, Import, & Connolly, 2001; Scott, Baillargeon, Song, & Leslie, 2010; Senju, Southgate, Snape, Leonard, & Csibra, 2011; Song, Onishi, Baillargeon, & Fisher, 2008; Southgate, Senju, & Csibra, 2007; Surian, Caldi, & Sperber, 2007; Surian & Geraci, 2012; Yott & Poulin-Dubois, 2012). It has been proposed by some that children pass these implicit false belief tasks because they have lower tasks demands. That is, the implicit tasks require limited or no language abilities and fewer executive functioning abilities (Baillargeon, Scott, & He, 2010; Bloom & German, 2000; Carlson, Moses, & Claxton, 2004; Carlson, Moses, & Hix, 1998; Carlson & Moses, 2001).

The interpretation of false belief understanding based on VoE tasks has been challenged recently (Apperly & Butterfill, 2009; Heyes, 2014; Perner, 2010; Ruffman & Perner, 2005). One argument, proposed by Ruffman and Perner (2005), is that infants' looking times in these implicit tasks are due to behavioural rules. More specifically, that an infant will look longer when an actor does not search for an object in the last place he/she saw it because it violates a behavioural rule, as opposed to violating a false belief. Additionally, it has been proposed that infants' looking times may be explained by three way associations formed between the object, the actor, and the location, and not by anything to do with computing false beliefs. Heyes (2014) proposes that infants in these implicit paradigms are responding to perceptual novelty in the scene, and not to an actor's true or false belief about an object's location. Lastly, Apperly and Butterfill (2009) have proposed that infants' responses on these implicit tasks are due to infants registering the location of an object, which is based on a limited and inflexible reasoning system, as opposed to a full understanding of others' mental states.

To address these alternative explanations, researchers have developed false belief tasks that have lower processing demands but do not rely solely on looking time patterns. With these novel tasks, false belief understanding has been demonstrated in children under the age of three (Buttelmann, Carpenter, & Tomasello, 2009; Scott et al., 2010; Scott, He, Baillargeon, & Cummins, 2012; Southgate et al., 2010). For example, using a helping paradigm, Buttelmann and colleagues (2009) demonstrated that 72% of 18- and 83% of 30-month-olds took into account an actor's belief when helping them attain his/her goal. That is, infants helped the actor find their toy based on a true or false belief about its location. Taken together, these tasks demonstrate that the development of false belief understanding possibly begins in infancy, and that performance on false belief tasks may depend on the paradigm being used, signifying a limit to our understanding of the development of this ability.

Although false belief understanding has been heavily researched, much less is known about how ToM develops more broadly, and how the development of other mental states contribute to, or precede, the development of false belief understanding. Given that performance on false belief tasks varies as a function of the paradigm being used, it stands to reason that it is important to understand the development of ToM more broadly, as well as understand how false belief development is related to the development of other ToM abilities. Other ToM tasks that have been examined in early childhood are intentions, emotions, and desires. With regard to intention understanding, Meltzoff (1995) demonstrated that 18-month-olds understand an actor's intended actions. That is, infants watched an actor with novel stimuli try but fail to complete an action three times. When given the stimuli, infants completed the actor's intended action 80% of the time. These results have been replicated in multiple settings (Bellagamba, Camaioni, & Collonessi, 2006; Bellagamba & Tomasello, 1999; Carpenter, Akhtar, & Tomasello, 1998; Olineck & Poulin-Dubois, 2009; Yott & Poulin-Dubois, 2012). Taken together, results from multiple paradigms suggest that by 18 months of age, infants have a concrete understanding of other's intentions.

Several studies have demonstrated the development of emotion understanding, particularly in the second year of life. Chiarella and Poulin-Dubois (2013) showed that by 18 months of age, infants display more hypothesis testing (checking behaviors) when an actor displayed an unjustified emotion (e.g., sad when obtaining a desired object), compared to a justified one. Additionally, Hepach and Westermann (2013) revealed that 14-, but not 10-month-olds are sensitive to the congruence of a person's emotions and their actions. That is, infants demonstrated more sympathetic arousal (as indicated by pupil dilation) when a person's emotions did not match their actions. Using interactive tasks, Svetlova, Nochols, and Brownell (2010) demonstrated that infants show an increase in their emotional understanding and subsequent helping behaviour between 18 and 30 months of age. In sum, these studies suggest that at the beginning of the second year of life, infants begin to understand how emotions relate to actions and experiences.

Understanding desires has been well researched in toddlers and preschoolers using interactive and explicit tasks (Repacholi & Gopnik, 1997; Wellman & Liu, 2004; Wright et al., 2005). Repacholi and Gopnik (1997) for example, showed that infants take into account others' subjective desires between 14 and 18 months of age. Infants observed an actor express a preference for one type of food and distaste for another, and following the demonstration, the actor made a generic request for food. Results revealed that at 18 months of age, infants reliably offered the actor their preferred food, even when the food desired was at odds with the child's own preference. These results suggest that by 18 months of age, infants demonstrate desire understanding in an interactive task when another person's desires conflict with their own. However, it is important to note that these findings have been difficult to replicate at the same age or in older children (Carlson, 2004; Wright & Poulin-Dubois, 2012).

In an attempt to provide a comprehensive account of the development of ToM abilities in preschoolers, Wellman and Liu (2004) conducted a study with 3-, 4-, and 5-year-olds examining various abilities, including desire, false beliefs, and real versus apparent emotion understanding. Wellman and Liu (2004) showed that these abilities develop in a predictable pattern, and they subsequently devised a scale of ToM development. More specifically, they demonstrated that 80% of the children who completed all five ToM tasks passed the tasks in the same sequence, beginning with discrepant desire understanding, and finishing with real versus apparent emotion understanding. Additionally, they demonstrated that children did better on the scale with age. This ToM scale has been replicated in an Asian culture, with atypical and younger populations, and using longitudinal designs (Hiller, Weber, & Young, 2014; Peterson, Wellman, & Slaughter, 2012; Wellman, Fang, Liu, Zhu, & Liu, 2006; Wellman, Fang, & Peterson, 2011). Moreover, this study has contributed to our understanding of ToM by measuring the development of multiple ToM tasks with multiple age groups, and by demonstrating the pattern of ToM of development in preschoolers.

Developing a similar ToM scale in infancy is important for several reasons. Firstly, recent studies using VoE tasks suggest that the development of ToM occurs much earlier than what was originally believed, and that task demands mask the true competence of infants' abilities (Onishi & Baillargeon, 2004; Scott et al., 2010). As a result, documenting how and when ToM develops in infancy will help to clarify how performance on implicit and more explicit tasks is related. In addition, establishing that these abilities develop in a reliable, predictable, and valid progression would add to our current understanding of ToM development, over and above false belief understanding. Secondly, it is important to demonstrate ToM understanding in infancy using multiple tasks and paradigms. Thirdly, replicating previous research and extending the scale to younger children would clarify the progression of these abilities during the infancy period. Lastly, understanding how ToM abilities typically develop allows for better identification of atypical ToM development, and consequently atypical social-cognitive development.

Therefore, the main goal of the present study was to determine if there is a scale of ToM abilities in infancy, similar to the one documented in preschool children with standard verbal tasks. A secondary goal was to replicate previous research by using multiple tasks and a within-subjects design with 18-, 24- and 30-month-olds. Based on previous research, it was hypothesized that infants would first demonstrate the development of intention understanding, followed by emotion, desire, and false belief understanding.

Method

Participants

A total of 147 infants were included in the present study: sixty-five 18-month-olds (M = 18.29, SD = .65, *range* = 17.10-20.30), forty-two 24-month-olds (M = 24.17, SD = .64, *range* = 23.30-25.90), and forty 30-month-olds (M = 30.52, SD = .51, *range* = 29.30-31.80). An additional seven 18-month-olds, five 24-month-olds, and two 30-month-olds were excluded due to fussiness (n = 13) and parental interference (n = 1). Due to the high attrition observed in the 18-month-old sample, a larger sample was recruited to ensure that a sufficient number of infants completed all tasks, which was important for the planned analysis. On the basis of parental report, infants had no visual or auditory impairments, and had a minimum 35-week gestational period. All infants were recruited from birth records provided by a governmental health services agency and were primarily exposed to English or French.

Materials

During all tasks, the child was seated either in a high chair, or on the parent's lap, across the table from the experimenter.

The Intention task. The materials used for this task closely resembled those used by Meltzoff (1995), Bellagamba and colleagues (2006), as well as Olineck and Poulin-Dubois (2009). The materials consisted of five novel object pairs. Each pair of objects could be used to complete an intended target action. The first object pair was a blue dumbbell that could be separated at the middle into two pieces. The second object pair was a box with a recessed button and a plastic wand (the box was supported by a base that tilted 30 degrees off the table so that the button faced the infant). The third object pair was a loop and a protruding prong (the loop could be hung horizontally on the prong, which protruded towards the child and had a bulbous end). The fourth object pair consisted of a cup and a string of colourful beads. The fifth object pair consisted of a wooden dowel and a transparent plastic square with a hole cut out of the middle (the dowel was mounted on a square wooden base).

The Emotional Helping task. Two toys were used for this task: a small brown teddy bear and a pair of yellow rubber ducks.

The Desire task. During this task, the participants were presented with two sets of plastic containers holding food. This first set consisted of Cheerios cereal and lettuce, and the second set consisted of Pepperidge Farm Goldfish Crackers and broccoli.

The False Belief task. For this task, a plastic toy caterpillar was used, as well as two wooden boxes (30 x 30 x 30 cm; one painted orange, one green) with lids that could be locked with wooden pins (as described in Buttelmann and colleagues 2009). The lids of the boxes had handles on top so that the participants could open the boxes themselves or help the experimenter open the box. The pins (5 cm long) were inserted in a circular (2 cm diameter) hole in the front of each box.

Procedure

Infants and their parents were invited to the laboratory for a session that lasted approximately 60 minutes. Upon arrival, they were first brought to a reception room where infants were familiarized with the experimenters and the environment. During this initial waiting period, parents completed a consent form and a demographic questionnaire. Tasks were recorded in a separate room using two cameras, and recordings were used to code infants' responses off-line. Infants were seated in either a high chair (n = 91) or in their parent's lap (n = 57). All families were offered $20 in financial compensation for their participation. In total, the study was comprised of four tasks: the Intention task, the Emotional Helping task, the Desire task, and the False Belief task. Tasks were presented in a fixed order. The False Belief task was administered first, followed by the Intention task, the first trial of the Emotional Helping task, The Desire task, and then the second trial of the Emotional Helping task. This order was used for several reasons. Firstly, the False Belief task was always administered first to prevent against carry-over effects from the Emotional Helping task. Specifically, during the Emotional Helping task, there was the potential for infants to view the second experimenter negatively, and the authors wanted to ensure that this would not affect infants' behaviour toward the second experimenter during the False Belief task. Additionally, since the False Belief task was hypothesized to be the most difficult, it was administered first to control for any fatigue effects. A native speaker of either French or English conducted testing depending on the child's dominant language.

The Intention task. The procedure used for this task was based on those used in Meltzoff (1995), Bellagamba and colleagues' (2006), and Olineck and Poulin-Dubois' (2009) studies. More specifically, infants were only tested on the "Demonstration of Intention" condition of the re-enactment task (Meltzoff, 1995). The task consisted of five test trials, each with one novel object pair. Two distinct presentation orders were used across infants. For this task, the Experimenter 1 (E1) presented the object pair to the child and said, "Hi (Child's name). Watch, I have something to show you". E1 then modeled the intention to perform an action three times. Importantly, the experimenter did not provide verbal or facial expressions during the demonstrations. For the dumbbell object, the experimenter held a wooden cube in each hand and appeared as though she was trying to pull it apart into two halves. The experimenter failed to do so, however, because one of her hands slipped off the end as she tried to pull. The hand that slipped off the end alternated between left and right for the three demonstrations. For the box with the button, the experimenter placed the box on the table so that the button was facing the infant. She then tried to push the button with the wand but missed all three times. For each attempt, she lifted the wand and slowly moved it toward the button but missed it by hitting slightly above, below, and to the right of the button. For the demonstration with the horizontal prong and loop object pair, the experimenter placed the prong device facing her, on her left hand side. This was done so that the infant could get a clear view of the demonstration. The experimenter picked up the loop and attempted to hang it on the prong, but “accidently” missed all three times. For the cup and beads trial, the experimenter placed the cup in front of her on the table and the beads just next to it. She then picked up the beads and attempted to place them inside the cup, but missed all three times. For the demonstration with the plastic square and wooden dowel, the experimenter first placed the objects on the table in front of her. She then picked up the plastic square, and using both hands, attempted to place the square onto the dowel, but missed all three times. After the demonstrations for each novel object pair, the experimenter offered the objects to the child and said, “Now it’s your turn.” This task was administered to measure children’s understanding of others’ intentions. Therefore, children’s successful completion of the experimenter’s intended action was coded for a total of 5 trials.

The Emotional Helping task. This task was adapted from Svetlova and colleagues’ (2010) altruistic condition and consisted of two trials. In one trial, E1 showed the child a stuffed toy bear. During this presentation, E1 explained that this was her favourite toy and that the bear made her very happy. As she said this, the experimenter smiled and gave the bear a hug. Then E1 offered the bear to the child. If the child did not want to take the bear, it was placed within reaching distance of the child. Next, Experimenter 2 (E2) entered the testing room and whispered into E1’s ear then left the testing room. E1 then began to express sadness through a series of prompts separated by five to seven seconds. Increasingly direct prompts to provide emotional help by giving the bear to the experimenter were given to the child. The trial ended once the child gave E1 the bear, or once E1 reached the final and most direct prompt.

In the second trial, E1 showed the child two rubber ducks. As she presented the ducks she made pretend “quacking” noises and expressed to the child that these were her favourite ducks. As she said this, she smiled and gave the ducks a big hug. Next, E1 gave the child one of her two ducks to play with. Then E2 entered the room and proceeded to take E1’s duck from her hand, and left the room. E1 then began to express sadness and a need for emotional help through the same series of prompts. As with the first trial, the second trial ended once the child gave E1 the duck, or when E1 reached the final and most direct prompt. The original study administered three emotional helping trials which did not differ in difficulty level, however in the interest of time, the current study only administered two (Svetlova et al., 2010). This task was administered to measure children's understanding of emotions and their willingness to respond to these emotions.

T**he Desire task.** The Desire task was adapted from Repacholi and Gopnik (1997) and included two conditions: a Match and a Mismatch condition. In both conditions, E1 placed two plastic containers on a tray, equidistant from one another and from the child. For the match condition, which was always presented first, children were presented with crackers and broccoli. The location of the food was counterbalanced so that half of the time the crackers were on the child's left, and the other half of the time, on the child's right. First, E1 invited the child to try the food. The child was allowed adequate time to taste one or both foods. During this time, the experimenter observed which food the child tasted first, and therefore was assumed to prefer. Then, E1 placed the containers in front of, but just outside of the child's reach, and tasted the food from each container. In the Match condition, the experimenter expressed pleasure when tasting the food the child preferred (usually crackers), and disgust when tasting the food that the child liked least (usually broccoli). That is, the experimenter said "Mmmm Crackers, mmm", and then "Eww Broccoli, eww", while displaying appropriate facial expressions. Next, the experimenter placed the containers in front of the child and said, "Can I have some?" as she placed her hand, palm up, in between the two containers. The experimenter always waited for the child to have nothing in their hands before making her request. The same procedure was used in the Mismatch condition, except that the experimenter demonstrated pleasure when tasting the food the child appeared not to prefer, and disgust when tasting the food that the child preferred. Children's choice of food to give to the experimenter was observed. If children gave the experimenter the food she (experimenter) preferred in the mismatch condition, it was assumed that they had an understanding of conflicting desires.

The False Belief task. The False Belief task was adapted from Buttelmann and colleagues' (2009) original study. The main adaptation was that the task was completed at a table as opposed to on the floor. This change was made so that children would not have to change locations throughout the testing session. The two wooden boxes were placed on the table in front of the child, equidistant from one another and from the child. The task began with E1 saying to the child, “Wow, look at these boxes” as she opened and tilted each box so that the child could see that they were in fact empty. E1 then announced that she was going to find a toy for her and the child, and left the room. Then, in E1’s absence, E2 demonstrated to the child how to lock and unlock the boxes using the wooden pins. Next, E2 then gave the child the opportunity to lock and unlock the boxes. To move on from this part of the task, the child had to lock and unlock each box twice. At this point, E1 re-entered the room with a plastic caterpillar. She sat across from the child and E2 and showed them the toy. E1 then offered to play with the child by rolling the caterpillar across the table and around the boxes. This play period lasted approximately one to two minutes, or until the child lost interest in the caterpillar. Next, E1 suggested that they put the caterpillar inside one of the boxes. She then put the toy into the box and closed it. Experimenter 1 then exclaimed, “Oops! I forgot my keys outside. I’m going to go get them, I’ll be right back” and then left the room. In E1’s absence, E2 then said to the child, “Shhhh, let’s play a trick on (Experimenter 1’s name)” as she proceeded to take the toy from box 1 and place it into box 2. Next she said, “Now let’s lock the box” as she placed the pin in each box. E1 then returned to the testing room and stood in front of the two boxes on the table and said “So”. She then tried to open the box where she had originally placed her toy. When she unsuccessfully opened the box, she turned toward the child and said, “Hmmm?” with a confused facial expression. At this point, she looked down slightly, with her gaze in between the two boxes. If the child did not proceed to touch or unlock a box, E2 prompted the child to help E1. When a child unlocked or tried to unlock a box, E1 thanked the child for his or her effort. E2 remained in the room throughout the entire task, while E1 entered and left the room. This task was administered to measure children’s understanding of false beliefs. Therefore, if the child tried to open the box that now contained the toy (the full box), then it was assumed that he or she understood that E1 did not know that her toy had been secretly moved to box 2. That is, the child understood that E1 had a false belief about the toy’s location.

Coding and Reliability

Participant behaviours during each task were coded off-line using video recordings of the sessions. To measure inter-rater reliability, a second coder who was blind to the hypotheses coded the videos; an intra-correlation or Cohen’s Kappa agreement value superior to 90% was found between the two coders on all tasks.

For the Intention task, if the child successfully completed the experimenter's intended action they were given a score of one, for a maximum score of five. Children were then given a proportion correct score, calculated by dividing the number of successful trials by the number of trials completed. A proportion of correct responses that was 60% or higher was required to pass this task. This criterion was chosen as we wanted to ensure that in order to pass this task, children had to get more than 50% of the trials correct.

In the Emotional Helping task, the dependent variable was a score between 0 and 8, which was determined in each case according to the last prompt given by the experimenter before the participant gave the toy (e.g., a score of 8 if the participant responded after the first cue of sadness, through 0 if she or he did not give the toy to the experimenter before the end of the trial). Thus, the scores reflected both the time elapsed between the start of the trial and the participant's response, as well as the degree of explicitness of the prompt immediately preceding the response. Children's scores on each of the Emotional Helping trials were averaged to provide a total score on this task. If children had a score of 3 or higher, they were judged to have passed his task. Children who received a score below three were given a fail on this task. This criterion was chosen because following this prompt, children are asked to help the experimenter or share the toy.

In the Desire task, the dependent variable was the type of food that the child gave to the experimenter after she extended her hand in the Mismatch condition. A pass/fail score was determined for this task as well; the participant had to give the experimenter the type of food that she expressed a preference for during the Mismatch condition. Children who shared their preferred food instead, were given a fail on this task. Children who did not respond were excluded from the analyses. Consequently, 11 children were excluded from the analyses; five 18-month-olds, three, 24-month-olds, and three 30-month-olds.

For the False Belief task, the dependent variable was the child's choice of box in response to the prompt to help Experimenter 1. A pass/fail score was given to each participant. In order to pass the task, the child had to touch, or try to open the box where the toy was located. Children who tried to open the box where the toy was originally placed were given a fail on this task. Children who did not respond were excluded from the analysis. Consequently, four 18-month-olds were excluded from the analyses.

Results

Before the data were analyzed, the normality of the two continuous variables, the Intention task and the Emotional Helping Task, was verified. Results revealed that both variables were normally distributed, did not contain any outliers, and had acceptable skewness and kurtosis values. Performance on each task was first examined separately, so that the maximum number of participants could be included. The mean proportion of correct trials on the Intention task was $M = 78.48$ ($SD = 23.09$, *range* = 0-100). A one-way ANOVA was conducted to compare children's performance across age groups (18 months, 24 months, 30 months) and revealed a significant effect of group, $F(139, 2) = 33.44$, $p = .001$, $\eta^2 = .32$. Follow-up comparisons revealed that 30-month-old children ($M = 94.87$, $SD = 11.89$,) performed better than both 24 month-old children ($M = 84.63$, $SD = 15.42$, $p = .02$) and 18-month-old children ($M = 64.43$, $SD = 24.14$, *range* = 0-100, $p = .01$). In addition, 24-month-olds performed better than 18-month-olds on this task ($M_{diff} = 20.20$, $p = .01$).

To examine performance on the Emotional Helping task, children's score on each of the two trials were averaged. Results revealed that the summed performance on this task equalled $M = 8.14$ ($SD = 4.53$, *range* = 0-16). A one-way ANOVA was conducted to compare children's performance across age groups (18 months, 24 months, 30 months) and revealed a significant effect of group, $F(136, 2) = 2.40$, $p = .09$, $\eta^2 = .04$. Planned follow-up comparisons revealed that 30-month-olds ($M = 4.76$, SD =2.04,) performed significantly better than the 18-month-olds (M =3.75, $SD = 2.40$, $p = .03$). The 24-month-old sample ($M = 4.12$, $SD = 2.05$) did not differ significantly from either age group.

To compare children's performance across all four tasks, pass/fail scores were given to each child on each task. For the Intention task, children with a proportion correct score of 60% or higher were given a pass, while infants below 60% were given a fail. For the Emotional Helping task, children with a score above 3 were given a pass, while children below a score of 3 were given a fail. For the Desire task, infants who shared the food that the experimenter preferred, passed the task, and those who did not failed. Lastly, for the False Belief task, infants who opened, or tried to open, the box where the toy had been moved to (Full box) during the experimenter's absence, passed the task (See Table 3 for frequency of pass/fail by age group). Based on the proportion of children passing, the tasks were ordered by difficulty level. That is, the task with the highest rate of passers was classified as the easiest, followed by the task with the second highest rate of passers. When ordered in this way, the Intention task was easiest with 88% passers, followed by the Emotional Helping task with 75.2% passers, followed by the Desire and False Belief tasks, at 44.4% and 44.2% respectively. When children's pass/fail scores were compared across age groups, results revealed that 24- and 30-month-olds passed the Intention task significantly more than the 18-month-olds, $\chi^2(2) = 15.06$, $p = .001$, and that 30-month-olds performed better than both 18- and 24-month-olds on the Emotional Helping tasks, $\chi^2(2) = 15.06$, $p = .01$. Pearson Chi-square tests examining performance on the Desire task

Table 3. *Percentage of children who pass each task by age group.*

Age	Intention (N)	Emotion (N)	Desire (N)	False Belief (N)
18 Months	76.2% (63)	65.6% (61)	43.5% (46)	36.6% (41)
24 Months	97.5% (40)	74.4% (39)	34.5% (29)	37.5% (40)
30 Months	97.4% (39)	91.9% (37)	54.5% (33)	59% (39)
Total	88% (142)	75.2% (137)	44.4% (108)	44.2% (120)

Note. N represents total sample size for each task.

revealed no effect of age group. With regard to the False Belief task, children's performance increased with age at trend level, $\chi^2(2) = 1.27$, $p = .08$. Follow-up comparisons revealed that 30-month-olds performed significantly better on the False Belief task compared to 18-month-olds, $X^2(1) = 4.02$, $p = .05$.

In order to assess whether or not children's scores conformed to a scale, the first step was to examine if the tasks differed in terms of difficulty level. That is, when the tasks are ordered according to the percentage of children passing, is the Intention task easier than the Emotional Helping task, and is the Emotional Helping task easier than the Desire task, and so forth. Therefore, McNemar comparisons were used to examine whether the tasks differed in terms of their difficulty levels. Results revealed that the Intention task was significantly easier than the Emotional Helping task (McNemar = 8.53, $p = .01$). Likewise, the Emotional Helping task was significantly easier than the Desire (McNemar = 26.74, $p = .001$) and False Belief tasks (McNemar = .08, $p = .001$). The Desire task and the False Belief task, however, were not significantly different from one another.

To examine the overall pattern of development across the four tasks, Rasch analyses were used. The Rasch item-response theory measurement model can be used to determine if individuals follow a proposed developmental sequence. That is, the analysis determines if children are more likely to pass the easier tasks first (e.g., Intention task) followed by the more difficult tasks (e.g., False Belief task). In other words, does a child who passes the most difficult task, also pass the easier tasks and conversely, if a child fails an easier task, does the same child also fail the more difficult tasks? To do this, dichotomous items (e.g., pass/fail) were ordered in terms of difficulty level. Next, each child's performance was examined in relation to the proposed pattern of development. The Rasch analysis is probabilistic; it examines whether an individual who passes a difficult task is likely to pass the easier tasks. The Rasch analysis estimates both item difficulty for each task, as well as individual ability levels (performance on the four tasks). If a task's difficulty level exceeds an individual's ability level then the individual will probably fail the task at a probability level below .5. In contrast, if an individual's ability level exceeds the task difficulty level, then the individual will probably pass the task at a probability level above .5.

To conduct the Rasch analysis, only infants who completed all four tasks were included. To determine if children's performance on the ToM tasks followed the proposed pattern of development, the Rasch analysis was used to examine if children first passed the Intention task, followed by the Emotional Helping task, followed by the Desire task, and finally the False Belief task. Based on this criterion, 90 children were included in the analysis. This included thirty 18-month-olds, twenty-seven 24-month-olds, and thirty-three 30-month-olds.

Performance on the four tasks was analyzed with a Rasch model using the WINSTEPS/BIGSTEPS computer program (Linacre, 2003; Linacre & Wright, 1994). Results from these analyses are presented in Table 4. This table includes summaries of item measurement scores, person measurement scores, and fit statistics. The highest item measurement score indicates the most difficult task, and the lowest item measurement score indicates the easiest task. The difference in item measurement score ranges from 0.12 to 1.5 (in score units) between successive items. The Rasch analysis evaluates whether a person with a given ability level will likely respond successfully to less difficult items and unsuccessfully to more difficult items. In addition, the analysis provides fit statistics. Infit statistics are sensitive to unexpected responses close to the item or person's measurement level. In contrast, outfit statistics are sensitive to unexpected responses far from the item or person's measurement level (Linacre & Wright, 1994; Wellman & Liu, 2004; Wright & Masters, 1982). Standardized infit and outfit statistics for individual items (or tasks) have an expected value of 0. Standardized fit statistics for individual items greater than 2.0 indicate a misfit (Wright & Masters, 1982). Table 4 demonstrates that all four tasks have standardized infit and outfit statistics that are below 2.0. In addition, the average personal ability statistics are also below 2.0, indicating that the participants fit the scale well (Wellman & Liu, 2004).

Table 5 demonstrates the number of individuals in the present study who fit the proposed pattern of development by age group. The first column represents the number of children who failed all four tasks. The second column represents the number of children who passed the Intention task, but failed the other tasks, and so on and so forth. Based on the proposed pattern, 59% of the sample passed these tasks in this specific sequence. Due to the similarity in performance on the Desire and False Belief tasks, we examined how many children failed the desire task, but passed the False Belief task; thereby making these children not fit the proposed pattern of ToM development. There were an additional 23 children (26%) who fit this alternative pattern. Lastly, results demonstrated that the number of children fitting the proposed pattern increased significantly with age, $\chi^2(2) = 6.69$, $p = .04$.

Table 4. *Item and Person Measure Summary and Fit Statistics for the four-Item Rasch Model*

	Measure	Error	Standardized infit	Standardized outfit
Item difficulty summary and fit statistics				
False Belief	1.62	0.26	0.8	0.2
Desire	1.48	0.26	- 0.6	- 0.6
Emotional Helping	-1.02	0.34	- 0.2	- 0.2
Intention	-2.08	0.46	0.3	0.3
M	0.00	0.33	0.1	- 0.1
SD	1.60	0.08	0.5	0.4
Person ability summary and fit statistics				
M	1.16	1.43	0.0	0.1
SD	1.50	0.25	0.9	0.8

Note. Expected values for standardized infit and standardized outfit is a mean of 0 and standard deviation of 1.0; fit statistics > 2.0 indicate misfit.

Table 5. *Scalogram patterns for four-item scale.*

Task	1	2	3	4	5	Other	N
Intention	-	+	+	+	+		
Desire	-	-	+	+	+		
Emotion	-	-	-	+	+		
False Belief	-	-	-	-	+		
18 month-olds	3%	6.5%	6.5%	17%	6.5%	60%	30
24 month-olds	3.5%	3.5%	30%	19%	11%	33%	27
30 month-olds	0%	3%	15%	27%	24%	30%	33
Total	2%	4%	17%	21%	15%	41%	90

Note. A minus sign means a child failed the task in question; a plus sign means the child passed. Children who did not fit the proposed pattern were classified as other. Numbers reflect the proportion of infants who fit the proposed pattern.

Discussion

The present study makes two important contributions to the literature on ToM development during the infancy period. Firstly, as Wellman and Liu (2004) demonstrated in preschoolers, we report a ToM scale for infants and toddlers, which shows that there is a predictable sequence in which specific ToM cognitive abilities emerge in infancy. Given the numerous studies that have already demonstrated intention, emotion, desire, and belief understanding in infancy using implicit tasks and often with a single age group, it was imperative to use a within-subject design that would permit a direct comparison of performance across ages and ToM concepts. In addition, in developing a ToM scale, we were able to replicate and extend previous research.

Results from the current study demonstrate that Intention task performance, which measures infant's understanding of an actor's intention when completing an incomplete action, increases significantly with age. That is, 24-month-old infants performed better than 18-month-olds, and 30-month-olds performed better than both the 24- and 18-month-olds. These results are consistent with previous research demonstrating that at 18 months of age, children complete approximately 3-4 out of the five trials on Meltzoff's (1995) Behavioural Re-enactment task (Bellagamba & Tomasello, 1999; Yott & Poulin-Dubois, 2012). Additionally, administering this task with 24- and 30-month-olds extends our knowledge of intention understanding by demonstrating that performance on this task reaches ceiling at 24 months of age. These results are also consistent with previous research demonstrating that infants in the second year of life can process other forms of intention understanding such as intentional vs. accidental actions, and unwilling vs. unable (Behne, Carpenter, & Tomasello, 2005; Bellagamba, Camaioni, & Colonesi, 2006; Carpenter, Akhtar, & Tomasello, 1998; Olineck & Poulin-Dubois, 2005). Intention understanding is an important and precocious milestone in the development of ToM. Moreover, grasping *unfulfilled* intentions is a conservative test because it requires understanding that someone has an intention that is inconsistent with what has been observed. However, this form of intention understanding is less difficult than understanding that someone may have an intention that is different than one's own.

With regard to emotion understanding, results from the current study demonstrated that infants' performance on the Emotional Helping task also increased significantly from 18-30 months of age. These results are consistent with the findings from the original study that showed that in the empathy condition, where the infants were required to give up an item that belonged to the examiner, 18-month-olds obtained a score between 2-3, and 30-month-olds obtained a score between 5-6 (Svetlova et al., 2010). Together, these findings demonstrate that between 18 and 30 months of age, infants develop both their understanding of others' emotions, and appropriate subsequent helping behaviour. Additionally, results demonstrate that at 18 months of age, children required more explicit communicative cues, such as direct requests for assistance, before they are willing to provide help. These results are consistent with those from the Intention task, which suggests that intention and action understanding are present by 18 months of age. In contrast, 30-month-olds require less communicative support and scaffolding from an adult to help, thereby demonstrating a greater ability to infer another's needs based on emotion understanding, and not an individual's intentional actions, such as reaching for a toy. It was for this reason that the criterion used for pass/fail was an average score of 3 on each emotion helping trial, as this prompt expressed the experimenter's need without directly labeling or requesting the object in need. Helping in response to others' emotions requires an additional step in social-cognitive development (Svetlova et al., 2010). Svetlova and colleagues (2010) have proposed that developmentally, at 18 and 24 months of age, infants can help in action/goal related situations, but that by 30 months of age, toddlers are able to help in emotion-related situations, which require a more complex understanding of another's intentions, emotions, and internal states.

In contrast to the Intention and Emotional Helping task, the current study did not replicate the results from Repacholi and Gopnik's (1997) Desire understanding task. Among 18-month-olds, 43.5% shared the appropriate food in the mismatch condition. That is, less than half of the sample shared the food the examiner preferred (usually lettuce) when this food differed from their preferred food (usually Cheerios). These results are inconsistent with the original study, where 69% of 18-month-olds responded appropriately to the examiner's request in the mismatch condition. At 24 months, infants in the current study shared the appropriate food with the examiner only 34.5% of the time, indicating that they were significantly more likely to share the food they themselves preferred. Only at 30 months of age, did children tend share the examiner's preferred food, as 67% of children shared the correct food in the current study. Although not included in the development of the scale, the match condition of the original study was also administered. Results from this condition revealed that 69% of children shared the correct food, which is significantly above chance. This result is consistent with Repacholi and Gopnik's original study, which reported that 76% of the 18-month-old infants passed the match condition. Thus, the poor performance on the mismatch condition cannot be explained by a failure to understand the task. Instead, it seems that by 24 to 30 months of age, children view this task as a game. Particularly in the 30-month-old age group, some children laughed at the experimenter when she displayed disgust, or engaged in a teasing-like game, where they pretended to share with the experimenter, but ultimately did not. Despite the lack of replication with the original study, these results are consistent with previous research indicating that the emotion of disgust is only fully understood later in childhood, around nine years of age (Widen & Russell, 2013). Additionally, these results are consistent with Pons, Harris, and Rosnay (2004), who demonstrated that between the ages of 5 and 7, children understand emotions related to desires, suggesting that the understanding of desires may develop more gradually during childhood. Based on these results and others, it would appear that during the second year of life, when children's social skills and play skills improve, this task is no longer a clear measure of desire understanding (Carlson et al., 2004; Wright & Poulin-Dubois, 2012). This may also explain why children demonstrate low performance on the mismatch condition as well as the match condition. Future studies may wish to use this same task but have the experimenter express sadness as opposed to desire. This adaptation may increase performance and demonstrate children's understanding of desire, outside of their understanding of disgust.

Children's performance on the False Belief task revealed that 36% of 18-month-olds, 37% of 24-month-olds, and 59% of 30-month-olds passed this task. Although more children tended to respond correctly in the oldest age group, overall, children did not choose to open the correct box significantly above chance. These results suggest that at 18 and 24 months of age, children did not help the experimenter based on their assessment of her false belief. These results are inconsistent with the original study conducted by Buttelmann and colleagues (2009), which reported that 83% (10/12) of 30-month-olds opened the correct lid and that 72% (18/25) of 18-month-olds opened the correct box. One possibility for why the current results do not replicate previous findings is that the current within-subject design required changes to the procedure so that all tasks took place at a table as opposed to on the floor. In the original study, children observed the experimenter from one meter away, which means that when the time came to help the experimenter, children were required to walk over to the boxes. This small methodological change might have led to the observed differences because it gave children less time to process which box the experimenter wanted to open. Thus, the additional delay to respond may have prevented children from responding impulsively to the experimenter's actions. Nevertheless, these changes in procedure do not detract from the task, but simply make it a more conservative test. Results from the current experiment demonstrate that between 18 and 30 months of age, children's understanding of others' false beliefs and their related helping behaviours are still emerging. Moreover, results from the current study suggest that false belief understanding at these ages is sensitive to task demands (Poulin-Dubois, Polonia, & Yott, 2012).

The main goal of the current study was to develop a scale of ToM abilities in very young children. In doing so, our main goal was to further our current understanding of ToM development in toddlers using implicit tasks that do not rely on looking time measures. Given the number of studies that have examined ToM abilities, particularly false belief understanding using looking time measures, it was important to demonstrate these abilities using a different paradigm. In doing so, it contributes to our understanding of early ToM development and supports the notion of an implicit ToM understanding in infancy. Results from the current study demonstrated a pattern of ToM development from 18 to 30 months of age. More specifically, infants first passed the Intention task, followed by the Emotional Helping task, and then the Desire and False Belief task. While the intention task was found to be significantly easier than the Emotional Helping task, and the Emotional Helping task significantly easier than the Desire task, the Desire and False Belief tasks did not differ from one another. In addition, performance on the Intention, Emotional Helping, Desire, and False Belief tasks, all increased with age.

Based on these results, the tasks were ordered in terms of difficulty, starting with Intention, followed by Emotion, Desire, and False Belief. The current study is the first to demonstrate a four-item scale of ToM development during the infancy and toddler years. Using the Rasch scale analysis, the four-item scale was found to appropriately fit the data for children 18 to 30 months of age. Based on this scale, 59% of the children followed the proposed pattern of development. Given that the Desire and False Belief tasks did not differ from one another in terms of difficulty, the alternative pattern of failing the Desire task, but passing the False Belief was examined. Results revealed that an additional 26% of children fit this alternative pattern. In Wellman and Liu's (2004) study reporting a ToM scale in 3-, 4-, and 5-year-olds, overall, 80% of the children fit the proposed pattern of ToM development. Although this is a higher number of children than in the present study (59%), it is well known that performance on laboratory-based tasks in the infancy period has much more variability. It is also worth pointing out that Wellman and Liu's youngest age group (36-month-olds) included the highest percentage of children (36%) who did not fit the proposed pattern. This percentage is consistent with those in the current study for the 24- and 30-month-old age groups, who had 30% and 33%, respectively, of the sample who did not fit the proposed pattern. In contrast, in our youngest age group, more than half of 18-month-olds did not fit the proposed pattern. Together results demonstrate that the number of children following the proposed pattern increases significantly with age. These results suggest that in the infant and toddler years there is more variability with respect to task performance and potentially ToM development. That is, perhaps there is a larger age range in the emergence of these abilities compared to older children. The Wellman and Liu (2004) scale was recently extended to a sample of 24-month-olds and this study demonstrated some understanding of conflicting desires and beliefs. However it appeared that many children did not pass many tasks (Hiller, Weber, & Young, 2014). Although it is informative to understand how toddlers perform on this well-established scale, it is equally important to scale ToM abilities by using tasks that have been developed for infants and toddlers.

The present results support the idea of early ToM understanding in infants and toddlers, however they also highlight limits in children's understanding at these very young ages. Future studies should aim to examine when these abilities are fully mastered and how they relate to Wellman and Liu's (2004) preschool ToM scale. Given the number of studies demonstrating implicit ToM understanding in infancy using looking time paradigms, it would also be useful to examine how performance on the present interactive implicit tasks are related to ToM tasks based on looking time measures. Examining this link would support the notion that infants have an early and implicit understanding of ToM evidenced by tasks completed in different paradigms at various ages.

The current study has two important limitations. The first is the high attrition rate observed in the 18-month-old sample. Although a majority of 18-month-olds completed at least one task, only a small number of infants completed all four tasks included in the scale. This high exclusion rate suggests that the task demands may have been too high for this age group resulting in fatigue and fussiness, and could potentially explain the higher number of 18-month-olds who did not fit the proposed pattern of ToM development. The second limitation of the current study is the fact that the Desire and False Belief tasks did not differ significantly from each other in terms of difficulty. This can be problematic for a scale analysis, since children appear to be passing these tasks at the same level in our sample. It would be interesting to test a fourth, older age group and determine which ability, desire or false belief understanding, emerges next. Nevertheless, the proposed scale, with desire emerging before false belief understanding, is consistent with the data and theory on the development of these abilities. It is also important to note that the Desire and False Belief tasks required infants to reason somewhat differently about the mind. That is, in the Intention and Emotional Helping tasks, infants had to reason about something they observed but that they themselves did not know. More specifically, they observed the experimenter try but fail to complete an intended goal, and were required to reason about what she intended to do, with no prior knowledge of this action. Similarly, in the Emotional Helping task, children had to reason about the examiner's emotions and needs, regardless of their own. In contrast, the Desire and False Belief tasks required infants to reason about the experimenter's desires and beliefs, when they conflicted with their own desires and beliefs. These more difficult tasks required children to inhibit what they desire or what they know in order to respond to the experimenter. For this reason, it makes sense theoretically, that children would present with more difficulty on the Desire and False Belief tasks compared to the Intention and Emotion tasks, as these tasks require a representational ToM. The fact that performance on the Desire and False Belief tasks did not differ significantly from one another was not expected, however these results are consistent with previous work. Pons, Harris, and de Rosnay (2004) demonstrated in a study examining the development of emotions and ToM abilities that conflicting desire and false belief understanding developed around the same time, between 5 and 7 years of age, as opposed to desire developing before belief as observed in Wellman and Liu's (2004) ToM scale. Although the current study used different tasks to measure these abilities in younger children, the results are consistent with Pons and colleagues (2004), suggesting that conflicting desire and false belief understanding may be equally difficult for children, and may develop more closely in unison than originally believed.

In sum, the current study took the first step in acquiring a comprehensive understanding of ToM during the infancy period, by providing a proposed pattern of ToM development, using multiple tasks and multiple age groups. Although the current study does not directly address how children develop a ToM, it adds to our understanding of ToM development and provides support against some of the lean interpretations proposed to explain infants' false belief understanding in infancy using implicit tasks, by demonstrating early ToM understanding (Heyes, 2014, Perner & Ruffman, 2005). However, whether infants fail standard false belief tasks due to task demands, such as language or executive functioning requirements, or whether infants have yet to develop a more sophisticated and flexible system to reason about beliefs remains to be seen. Future research in ToM development should aim to examine the relation between early ToM understanding using implicit measures and later ToM using both explicit and implicit measures to understand how these two levels of measurement and understanding are related (Low, 2010; Thoermer et al., 2012). Moreover, it would be equally important to understand how performance on different types of ToM tasks are related concurrently, to better how ToM understanding develops both implicitly and explicitly (Yott & Poulin-Dubois, in preparation).

Chapter 4

General Discussion

The development of a theory of mind (ToM) is an important social-cognitive milestone that has implications for later cognitive and social functioning. More specifically, ToM has been shown to be related to cognitive abilities including executive functioning and language, as well as later social functioning, including peers relations and social skills (Devine & Hughes, 2013; Jenkins & Astington, 2000; Wellman, 2014). There has been an abundance of research examining when children develop a ToM, and much of this research has demonstrated that children can reason explicitly using a representational ToM around approximately 4-5 years of age, when they pass the explicit standard false belief task. Additional research during the preschool years demonstrates that children first understand that people can have conflicting desires, before they understand that people can have conflicting beliefs. In fact, a sequence of ToM development has been demonstrated, beginning with the understanding of conflicting desires around 3 years of age, and ending around 5 years of age, when children understand that a person can display one emotion, but feel another (Wellman & Liu, 2004). These ToM abilities, which are all important for social functioning, appear to develop in a predictable sequence in most children. More recently, using age-appropriate measures such as looking time or helping behaviors, ToM understanding has been demonstrated in toddlers with spontaneous-response tasks (Buttelmann et al., 2009; Scott et al., 2010; Scott et al., 2012; Southgate et al., 2010). Understanding the developmental sequence of ToM development is important for several reasons. Firstly, it allows for the identification of atypical development, as deficits in certain ToM abilities have been found in children and adults with autism. Secondly, understanding how and when these abilities, as well as how they are related, adds to our understanding of ToM as a construct, and how it relates to the development of other abilities. To date, there has been no research to determine whether there exists a ToM scale based on implicit measures developed for testing infants and toddlers. Moreover, to the author's knowledge, no studies have examined how implicit ToM abilities develop in infancy, and how these abilities are related to one another if at all.

Goals and Overview of Findings

The goals of the two studies included in the current dissertation focused on expanding our understanding of ToM development in infancy. The first goal was to examine the development of implicit ToM understanding in young infants using looking time measures. Do infants demonstrate a fixed developmental progression in ToM understanding using multiple tasks based on the VOE paradigm? A second goal was to examine if performance on ToM tasks was related to one another. A third goal was to examine implicit ToM understanding using these measures in the context of a within-subjects design. To address these goals, a sample of 14- and 18-month-olds participated in Study 1 (Yott & Poulin-Dubois, in press), where they completed four ToM tasks, including intention, desire, as well as true and false belief. For each task, infants observed an actor act both congruently and incongruently with regard to her intention, desire, and beliefs. Then, infants' looking times when watching each of these scenes were compared. Results revealed that both groups of infants looked significantly longer at the incongruent trial on the intention and true belief tasks. In contrast, only 18-month-olds looked significantly longer at the incongruent trial of the desire task. Lastly, neither age group looked significantly longer at the incongruent trial of the false belief task. These findings demonstrate a developmental change in ToM development between 14 and 18 months of age, addressing the second goal of the current dissertation. In addition, results from Study 1 revealed that only performance on the intention and false belief tasks were related, a finding that is consistent with previous research on inter-task relations in ToM abilities (Yott & Poulin-Dubois, 2012). Lastly, the current dissertation examined ToM understanding using looking time measures based on the VOE paradigm and a within-subjects design, thereby adding to the current literature on implicit ToM understanding in infancy. Interestingly, using a within-subjects design, only results from the intention, desire, and true belief tasks were consistent with previous research with a between-subject design. In contrast, results from the false belief task were not consistent with previous research.

The fourth goal was to determine if ToM abilities develop in a predictable sequence, in other words, if ToM development follows a scale in infancy. Study 2 (Yott & Poulin-Dubois, under review) was designed to examine multiple ToM abilities during the infancy and toddler years, and to determine if certain abilities develop in a predictable pattern, as Wellman and Liu (2004) demonstrated in 3-, 4-, and 5-year-olds. To do so, 18-, 24-, and 30-month-olds completed five ToM tasks. These tasks measured infants' understanding of intentional actions (Meltzoff, 1997), emotions (Svetlova et al., 2009), desire (Repacholi & Gopnik, 1997), and true and false belief (Buttelmann et al., 2009) understanding as measured in interactive, non-verbal, spontaneous-response tasks. Results revealed that 24- and 30-month-olds performed significantly better than 18-month-olds on the intention task, and that 30-month-olds performed significantly better on the emotion task. In addition, 30-month-olds tended to perform better on the false belief task. These results demonstrate significant improvements in performance with age on the intention, emotion, and possibly the false belief task. Overall, the intention task was easiest, followed by the Emotional Helping task, and the Desire and False Belief task. When children's performance was examined using Rasch analysis, results revealed that children did in fact pass these ToM tasks in a fixed pattern, starting with the intention task and ending with the false belief task. In fact, 59% of the sample followed this pattern, confirming success on the earlier and easier tasks in the scale before the later and more difficult ones. The results from Study 2 demonstrate that even when using interactive, non-verbal, spontaneous-response tasks with infants, a significant proportion appears to develop ToM abilities in a predictable and observable sequence, as observed in preschoolers.

It should be noted that a subset of 18-month-old infants participated in both Study 1 and 2. These infants' performance were compared to the rest of the sample and revealed no differences in either study. As such, these infants were included in the analyses for both Study 1 and 2.

Main Contributions

Taken together, the findings from the two studies contribute to our understanding of ToM development in infancy in several important ways. Although there are an abundance of studies examining ToM understanding in preschoolers and school-aged children, many of these studies have exclusively focused on false belief tasks to measure this construct and often used a between-subjects design. The current dissertation adds to our understanding of ToM development in infancy by providing two studies that both examined multiple ToM abilities, across multiple age groups, using a within-subjects design. Moreover, these studies use different paradigms to examine the same critical ToM abilities, including intention, desire, and belief understanding. In doing so, these studies demonstrate developmental patterns in ToM development, but more importantly, extend our knowledge of ToM in infancy beyond false belief understanding. Both Studies 1 and 2 demonstrated that intention understanding emerges earlier than desire, true, and false belief understanding. In addition, both studies demonstrated that even for one single ToM ability there is a progression in infants' and toddlers' depth of understanding. That is, results from Study 1 demonstrated that infants at 14 and 18 months of age understand an actor's intention when reaching for a toy, and find it odd when an actor takes an unnecessary route to retrieve something she wants. Results from Study 2 demonstrated that at 18 months of age, infants understand an actor's intentional actions, but that performance on this task continues to improve until 24 months of age. Both Studies 1 and 2 also demonstrate that desire and false belief understanding are more complex ToM abilities that appear to follow the understanding of more simple ToM abilities, such as emotion understanding and true belief understanding. Additionally, both studies demonstrated that desire and false belief understanding do not appear to be fully mastered during the infancy and toddler period. Notably, when examined together, results from Study 1 and Study 2 reveal that the type of paradigm being used to examine ToM understanding impacts the results of the study. More specifically, using looking time measures based on the VOE paradigm, Study 1 demonstrated that only 18-month-olds demonstrated an understanding of desires. In contrast, when using an implicit interactive paradigm, Study 2 revealed different results for desire understanding. Using the implicit interactive tasks, only at 30 months did infants appear to begin understanding a person's subjective desire. It is important to note however that the implicit interactive desire task created by Repacholi and Gopnik (1997) has been difficult to replicate. Moreover, this task appears to be quite challenging for children above 18 months of age, as it appeared that 30-month-old children perceive this task as a game. Additionally, the implicit interactive task was unlike the VOE task in an important way. During the VOE task, the main experimenter demonstrates a preference and dislike for the food items that was likely consistent with the child's own preferences; however, in the interactive version of the task, the experimenter demonstrated a conflicting preference, which most certainly increased the difficulty level of the task. This again demonstrates, that even within one single ToM ability, there is a progression in the level of a child's understanding. With regard to false belief understanding, results from Studies 1 and 2 are more consistent. Study 1 demonstrated that neither at 14 nor 18 months of age, did infants demonstrate an understanding of false beliefs by looking longer at the incongruent scene. Similarly, results from Study 2 demonstrate that only at 30 months of age did infants tend to understand an actor's false belief in an implicit interactive paradigm. Together, these results do not support previous findings, thereby suggesting that this ability may be fragile and/or only emerging in these age groups. In sum, results from Studies 1 and 2 add to our understanding of the development of ToM in infancy by using multiple tasks, multiple age groups, and a within-subjects design. Taken together, these studies demonstrate the importance of the paradigm being used, but also that infants' ToM abilities develop over time and progress to more complex levels of understanding.

A second major contribution that the current dissertation makes to the literature on ToM development in infancy is through the investigation of inter-task relations among ToM abilities. By examining multiple abilities using a within-subjects design, it was possible to examine, which, if any, ToM abilities related to one another. Understanding how ToM abilities are related is important for several reasons. To date, much research has examined inter-task relations among these abilities in preschoolers and school-aged children, and much less is known about how these abilities are related in infancy. This is partly due to the fact that there are few studies examining multiple abilities, and partly because there are few tasks available to test these abilities at such young ages. Previous research with toddlers on inter-task correlations is mixed and suggests that only some ToM abilities are related, and may only become interrelated later in development (Carlson, Mandell, & Williams, 2004; Chiarella et al., 20013; Hughes & Ensor, 2004; 2007). The current dissertation examined inter-task correlations in both Studies 1 and 2, and in both studies, only one significant correlation was observed. That is, in Study 1, looking time at the incongruent scene in the intention task was significantly related to looking time at the incongruent looking time during the false belief task. This relation has also been documented in previous research. Specifically, Yott and Poulin-Dubois (2012) reported a relation between performance on Meltzoff's (1997) Behavioral Re-enactment task and looking time at the incongruent scene during the false belief task. Together, these results suggest that during the infancy period, intention understanding and false belief understanding may be closely related, and possibly that intention understanding is an important prerequisite for false belief understanding. However, it is important to note that in Study 2, none of the ToM tasks were related, including performance on the intention and false belief tasks.

The third major contribution that the current dissertation makes to current research on early ToM development was to examine whether or not ToM understanding develops in a predictable sequence, as observed in preschoolers (Wellman & Liu, 2004). Many studies have documented precocious ToM understanding, by measuring false belief understanding with innovative spontaneous-response tasks, however, to our knowledge none have examined whether success on these tasks follows the same developmental pattern observed in preschoolers. Results from Study 2 add to the literature by demonstrating that even when using spontaneous-response tasks, the majority of infants' ToM abilities develop in a predictable sequence. More specifically, Study demonstrated that 18-, 24-, and 30-month-olds develop an understanding of intentions, followed by an understanding of emotions, then desires and false belief. Moreover, this study demonstrated that these young toddlers were unlikely to pass the more difficult tasks (e.g., desire, false belief), if they had not passed the easier tasks (e.g., intention, true belief). Wellman and Liu's (2004) scale has recently been used with both typically and atypically developing children, as well as with children from different cultural backgrounds (Peterson, Wellman, & Liu, 2005; Peterson, Wellman, & Slaughter, 2012; Shahaeian, Peterson, Slaughtr, & Wellman, 2011). The scale was developed for children 3 to 5 years of age, but has been extended to children as old as 13 years of age. And more recently, the scale was extended to 24-month-olds, however, success on these tasks was minimal. That is, the mean age at which the easiest task, Diverse Desires, was passed was 47.26 months of age. Additionally, the youngest child to pass this task in the sample was 26 months of age, suggesting that performance on this easier task by younger infants was minimal. It is important to note that, to our knowledge, there are no other studies to date that have examined a ToM scale in infancy. Extending this scale to infants was essential to determine at what age the Wellman and Liu scale could be reliably used. However, this study also demonstrates the need for a ToM scale developed for infants and toddlers as there is ample evidence suggesting ToM abilities are present earlier than 30 months of age. Study 2 addresses this gap in the literature, by providing such a scale, and demonstrating that even in infancy, ToM development is predictable for some children. Although a ToM scale was not demonstrated in Study 1, results showed a developmental effect providing partial support for the hypothesis that these abilities develop in a predictable sequence.

Taken together, the studies that make up the current dissertation have important implications for current theoretical proposals of ToM development. Supporters of the lean interpretation of ToM understanding in infancy based on looking time measures, have argued that infants can succeed on these tasks on the basis of learned behavioural rules or low-level perceptual processing (Heyes, 2014; Perner, 2014). Results from Study 1 showing a developmental pattern in ToM development using looking times speaks against these theories for two reasons. Firstly, if infants were simply responding to behavioural rules or perceptual processing, we would not expect to find a difference in infants' performances on the true and false belief tasks. However, infants at 14 and 18 months of age looked significantly longer at the incongruent scene in the true belief task, but not in the false belief task. Additionally, no developmental effect would be expected on the desire task. That is, why would 18-, but not 14-month-olds, respond differently to the same scene if simple perceptual skills and behavioural rules accounted for their performance? Study 2 also indirectly speaks against these lean interpretations by demonstrating that infants and toddlers still demonstrate an understanding of intentions and emotions when paradigms other than those based on looking time measures are used. However, Study 2 did not demonstrate desire and false belief understanding in 18-, 24-, and 30-month-olds, suggesting that, at the very least, performance on tasks using looking time measures, is not always reflected in performance on other spontaneous-response tasks. More specifically, while 18-month-olds looked significantly longer at the incongruent trial in Study 1, they did not significantly pass the interactive desire task. Together, these findings suggest that even within spontaneous-response tasks, results may vary depending on a child's level of understanding and/or task demands.

The present findings also speak against rich interpretations of ToM understanding in infancy, which propose that infants in their second year have a representational ToM allowing them to reason about conflicting desires and false beliefs. The fact that infants in both studies did not appear to successfully reason about false belief, suggests that this ability is only emerging during the infancy period. This is in contrast to theories and previous findings proposed by Onishi et al. (2010), who suggested that infants in the second year of life develop a representational form of ToM. More specifically, they propose that young children fail explicit and standard false belief tasks due to limited language and executive functioning abilities. If this were the case, we would expect infants and toddlers to pass these spontaneous-response tasks, as language and executive functioning abilities are lowered considerably in these tasks. In contrast, infants in both Studies1 and 2 appear to develop ToM abilities in a predictable and developmental sequence, as observed in preschoolers. These results suggest that early ToM abilities observed in infancy likely reflect some form of ToM understanding, that may be the foundation for later explicit ToM understanding.

Results from the current dissertation support theories proposing a gradual, incremental progression of ToM development. Results from Study 2 demonstrate that even young children can reason using simple ToM understanding, specifically understanding intention and emotions. However, Study 2 also demonstrates that understanding conflicting desires and false beliefs is not yet mastered by 30 months of age. The fact that implicit theory of mind abilities appear to develop in a developmental sequence suggests that infants possess some level of ToM understanding, Similarly, results from Study 1 demonstrate that infants do reason about ToM abilities implicitly, again showing a similar pattern of development. It stands to reason that when examined together, the tasks in Study 1 made fewer demands on the infants, allowing for the demonstration of ToM understanding. In contrast, the tasks in Study 2 placed higher demands on the children, as they require a behavioural response. Although Study 2 tested older children, there still appears to be a difference in the level of ToM understanding from Study 1 to Study 2, suggesting that the type of paradigm, tasks, and dependent measures used have many implications for the type of results one should expect. Furthermore, it suggests that infants' and children's ability to demonstrate their understanding may develop gradually in tasks that are more and more demanding. These findings are consistent with Apperly and Butterfill (2009), who have proposed that infants' belief understanding is initially rigid and inflexible. That is, with the development of this earlier system, infants can solve some ToM tasks, but cannot solve more difficult ToM ones. The current findings support this theory by demonstrating infants' understanding of intentions and true beliefs, but only an emerging understanding of desires and false beliefs in Study 1. Study 1 supports this theory by demonstrating that children do not reason about desires and beliefs when the tasks are slightly more demanding, suggesting that these young children's abilities to reason about desires and false beliefs are rigid and inflexible. Apperly and Butterfill (2009) proposed that children begin to reason about desires and beliefs gradually as they develop language, executive functioning, and an understanding of psychological concepts. The development of these related abilities may allow for a more flexible system, which makes possible the attribution of desires and false beliefs. Taken together, results from these two studies both demonstrate some ToM understanding in infancy, but also highlight some of the limits to young children's understanding of mental states.

Results from the current dissertation have implications for parents and educators. Firstly, results provide parents and educators with the understanding that ToM begins to develop very early on in an infant's life. That is, infants are active observers of their social environment and develop some form of ToM concepts that appear to be related to later more explicit ToM understanding. In addition, with the knowledge that young children have emerging ToM abilities, appropriate scaffolding of these abilities can be provided as well as realistic expectations of children's abilities in social situations. Lastly, knowing that young children develop early ToM abilities may help parents and educators have a better understanding of their young child's behaviours.

Limitations and Future Directions

The present dissertation includes two studies on the development of ToM in infancy using two paradigms, multiple age groups, and multiple tasks. Together, the studies demonstrate ToM understanding in infancy, but also a development in ToM understanding from 14 to 30 months of age. Results from Study 2 demonstrate a predictable pattern of ToM development using interactive spontaneous-response tasks for some children, however results from Study 1 only showed a developmental effect, as opposed to a developmental sequence. That is, in Study 1, when looking time measures were converted to pass/fail scores for 14- and 18-month-old infants, infants did not appear to look at incongruent scene significantly above chance, nor were any age difference observed. These findings made it difficult to order tasks in terms of difficulty level, which did not allow for the examination of a scale using spontaneous-response tasks based on looking time measures. Looking time measures can be quite sensitive and easily influenced by external variables such as fussiness, distractions, and fatigue. Moreover, converting these scores into pass/fail likely removed much of the variability in scores. Not being able to examine if a ToM scale could be developed using looking time measures was one of the major limitations to the current study. Future studies may wish to examine if such a scale could be developed by using different age groups and other tasks such as those based on the anticipatory looking paradigm instead of the VOE paradigm. Using an anticipatory looking paradigm, would likely make this conversion easier, and more reflective of infants' understanding, as well as allow for testing to be completed in one session. Moreover, using this paradigm would also likely lower attrition rates, as fussiness during one test trial (incongruent scene) of a task excluded a child's performance on the second test trial (congruent scene) in the present study, as these scenes were being directly compared. Using such a paradigm might then allow for the examination of a ToM scale in infancy based on looking times.

A second limitation to the dissertation was that several of the tasks yielded findings that were inconsistent with previous research. More specifically, in Study 2, children's performance on the desire task was inconsistent with the original study (Repacholi & Gopnik, 1997). That is, although Repacholi and Gopnik (1997) demonstrated that 18-, but not 14-month-olds were able to pass this task successfully, 18-, 24-, and 30-month-olds did not successfully complete this task in the present research. Similarly, Buttelmann and colleagues (2009) demonstrated that both 18- and 30-month-olds could successfully pass a helping false belief task, however, slight methodological changes to the task in Study 2, may have prevented replication of these findings. Lastly, although Onishi and Baillargeon (2004) demonstrated true and false belief understanding using a VOE paradigm, the findings were not replicated using a within-subjects design in the present dissertation. More specifically, it was found that both 14- and 18-month-olds formed expectations about the actor's behaviour based on true beliefs, but not false beliefs.

The fact that the current dissertation did not replicate previous findings using these tasks has two important implications for research in this field. Firstly, it highlights the need for replication of findings in multiple settings, to be certain that children perform similarly on these tasks. Moreover, slight changes in methodology should not be expected to change children's performance if they possess a flexible understanding of the ToM. If these slight changes do lead to different findings, then it suggests one of two things. Firstly, it is likely that the task is not measuring only ToM abilities, but other cognitive abilities as well. And secondly, it is possible that these ToM abilities are not fully developed and are perhaps fragile in the early years of development. If other abilities are involved, even when using spontaneous-response tasks, it would be important for future research to identify these abilities and the role they play in children's performance in ToM tasks in infancy.

Although the current dissertation adds to the literature on ToM development by examining ToM understanding using two distinct paradigms, it is also important to understand how performance on these tasks is related to one another. That is, does performance on the interactive intention task related to performance on the intention task based on the VOE paradigm? If infants at 18 months of age have an understanding of intention, then one would expect these measures to be related. If they are not related, then it suggests that these paradigms may be tapping into different abilities. Similarly, if performance on the interactive false belief task is unrelated to looking times during the test trials of the false belied task based on the VOE paradigm, then we might conclude that these tasks are measuring different abilities. The next step in this line of research would be to examine how these spontaneous-response tasks are related to one another, but then also how they related to later, more explicit ToM abilities. Research in the field of ToM development has begun to address this question, however much more research is warranted. Answers to these type of questions would greatly inform theories of ToM development and help to clarify what level of ToM understanding is present in infants. That is, if performance on the interactive spontaneous response false task is related to performance on the VoE, and both of these predict performance on the explicit false belief task, we can conclude with more certainty that these tasks are measuring the same ability. This would not however answer the question of whether or not performance on these spontaneous response tasks measure the same ability as the explicit tasks do used with older children.

Conclusions

In conclusion, the set of experiments making up the current dissertation examined ToM development in infancy using multiple tasks, a within-subjects design, and multiple age groups. Results from these studies revealed that infants ToM development likely follows a predictable sequence, beginning with intention understanding followed by emotion, desire, and false belief understanding. Additionally, results from these studies demonstrate that these abilities continue to develop throughout the first three years of life. Furthermore, findings from these studies reveal that ToM abilities may not be interrelated during the infancy period, with the exception of the strong relation between intention and false belief understanding. Together, these studies demonstrate the importance of the paradigm used to measure ToM understanding in infancy and highlight the need to understand how performance on these different paradigms are related. Nevertheless, and more importantly, these studies reveal that some level ToM understanding is present in infancy. In sum, these studies allow for a far richer, and more comprehensive understanding of ToM development specifically, and social-cognitive development more generally, during the first years of life.

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Appendix A

Sample Recruitment Letter

(Study 1 – 24 month-olds)

Dear Parents,

The Cognitive and Language Development Laboratory, which is part of the Center for Research and Human Development at Concordia University, is presently conducting a study on infants' understanding of others' mental states, including their desires, emotions and intentions. If you have participated in a study in the past, we would like to thank you for your enthusiasm and commitment to research. Our research has been funded by federal and provincial agencies for the past twenty-five years and our team is internationally recognized for its excellent work on early child development. Our articles are frequently published in prestigious journals, such as "Infancy" and "Developmental Science". You also might have heard about our studies on national radio or on the *Discovery Channel*.

The Commission d'accès à l'information du Québec has kindly given us permission to consult birth lists provided by the Agence de la santé et des services sociaux de Montréal. Your name appears on the birth list of July 2011, which indicates that you have a child of an age appropriate for our study. We therefore invite you to participate in one of our new studies and have the unique experience of learning more about your child and child development, as well as contributing to research in this field!

The present investigation involves **a few short tasks during which your child will interact with the experimenter**. More specifically, your child will observe an experimenter try but fail to complete different kinds of actions with novel toys, and then your child will be given the opportunity to play with these toys. Your child will also be involved in helping an experimenter search for her toy and helping an experimenter who is sad. Lastly, your child will learn about an actor's preference for a specific food in the context of a give and take game, and will then be asked to respond to simple requests. During this activity, your child will be offered small amounts of food, (after consulting you about any possible food allergies) such as broccoli, lettuce, cheerios, and crackers, to determine your child's own preference. During all tasks, your child will either be sitting on your lap or sitting in a child seat while you are seated directly behind him/her. We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality.

Overall, your participation will involve one approximately **1-hour-long** visit to our laboratory at the Loyola Campus of Concordia University, located at 7141 Sherbrooke Street West, in Notre-Dame-de-Grace. Appointments can be scheduled at a time which is convenient for you and your child, including weekends. Free parking is available on the campus and we offer babysitting for siblings who come to the appointment. Upon completion of the study, a Certificate of Merit for Contribution to Science will be given to your child, and you will be offered a financial compensation of $20 for participating. A summary of the results of our study will be mailed to you upon its completion.

For the purposes of this study, we are looking for toddlers who are 23-25 months of age, who are **exposed to either English or French at home**, and who do not have any visual or hearing difficulties. All our studies are independent, so you may choose to participate once, or several times. If you are interested in having your child participate in this study, or would like any other information, please contact Monyka Rodrigues at (514) 848-2424 ext. 2279, or Dr. Diane Poulin-Dubois at (514) 848-2424 ext. 2219. You can also visit our website at http://crdh.concordia.ca/dpdlab. As we are very interested in having you participate, we will try to contact you by telephone within a few days of receiving this letter. We look forward to speaking with you in the near future.

Sincerely,

Diane Poulin-Dubois, Ph.D.	Monyka Rodrigues, B.A.	Jessica Yott, M.A.
Professor	Laboratory Coordinator	Ph.D Candidate D
Department of Psychology	Department of Psychology	Department of Psychology

Appendix B

Sample Consent Form

(Study 1 – 24 month-olds)

Parental Consent Form

This is to state that I understand that I have been asked if my child can participate in a research project being conducted by Dr. Diane Poulin-Dubois, in collaboration with Jessica Yott of Concordia University.

A. PURPOSE

I have been informed that the purpose of the research is to examine infants' early cognitive development, by examining infants' understanding of others' beliefs, emotions, desires, and intentions.

B. PROCEDURES

The present investigation involves one visit to the Cognitive and Language Development Laboratory. First, you will be asked to complete brief questionnaires on your child's vocabulary, as well as some demographic information (e.g., siblings, education). Next, your child will participate in a few activities with the experimenter. More specifically, your child will watch an experimenter try to complete an action with two objects, after which your child will be given the opportunity to play with these objects. Other tasks will involve helping an experimenter search for her toy and helping an experimenter who is sad or frustrated. Lastly, your child will learn about an actor's preference for a specific food in the context of a give-and-take game, and will then be asked to respond to simple requests. Your child will be offered small amounts of food, (after consulting you about any possible food allergies) such as broccoli, lettuce, cheerios, and crackers to eat so that we can confirm your child's own preference. During all tasks, your child will either be sitting on your lap or sitting in a child seat while you are seated directly behind him/her.

We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality. That means that the researcher will not reveal your child's identity in any written or oral reports about the study. You and your child will be assigned a coded number, and that code will be used on all materials collected in this study. All materials and data will be stored in secure facilities in the Department of Psychology at Concordia University. Only members of the research team will have access to these facilities. Questionnaires and electronic data files will be identified by coded identification numbers, unique to each family. Information collected on paper (questionnaires) or videotapes (observed behaviours) will be entered into computer databases. Raw data will be kept for a minimum of 5 years. When it is time for disposal, papers will be shredded, heard-drives will be purged, and videotapes and computer disks will be magnetically erased. As well, because we are only interested in comparing children's understanding as a function of age, no individual scores will be provided following participation. The entire session is expected to last approximately 45-minutes.

C. RISKS AND BENEFITS

Your child will be given a certificate of merit at the end of the session as a thank-you for his/her participation. Also, you will be offered 20$ for your participation.

There is one condition that may result in the researchers being required to break the confidentiality of your child's participation. There are no procedures in this investigation that inquire about child maltreatment directly. However, by the laws of Québec and Canada, if the researchers discover information that indicates the possibility of child maltreatment, or that your child is at risk for imminent harm, they are required to disclose this information to the appropriate agencies. If this concern emerges, the lead researcher, Dr. Diane Poulin-Dubois, will discuss the reasons for this concern with you and will advise you of what steps will have to be taken.

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at any time without negative consequences, and that the experimenter will gladly answer any questions that might arise during the course of the research. I am entitled to keep the total amount of $20 if I choose to withdraw my participation in the study.
- I understand that my participation in this study is confidential (i.e. the researchers will know, but will not disclose my identity).
- I understand that the data from this study may be published, though no individual scores will be reported.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOUNTARILY AGREE TO HAVE MY CHILD PARTICIPATE IN THIS STUDY.

MY CHILD'S NAME (please print) ____

MY NAME (please print) ____

SIGNATURE ______________________________ DATE _____________________

WITNESSED BY ___________________________ DATE _____________________

I would be interested in participating in other studies conducted through the Centre for Research in Human Development with my child in the future (YES / NO): __________________

If at any time you have questions about your rights as a research participant, you are free to contact the Research Ethics and Compliance Officer of Concordia University, at (514) 848-2424 ext 7481 or by email at ethics@alcor.concordia.ca

____

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____

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Participant # ______________

Appendix C

Sample Demographics Form

(Studies 1 and 2)

Cognitive and Language Development Laboratory Participant Information

Child's Name: ____
First Last

Child's Date of Birth: __________________ **Child's Gender:** ☐**M** ☐**F**
MM / DD / YY

Basic Family Information

Parent A's Full Name: ____ ☐**M** ☐**F**
First Last

Parent B's Full Name: ____ ☐**M** ☐**F**
First Last

Address (including **postal code**):

____

____

Phone numbers	**Where?** (e.g. home, Mom work, Dad cell)
1.	
2.	
3.	
4.	
5.	

E-mail: ___________________________________

Does your child have any siblings?

Name of Sibling	Date of Birth	Gender	Can we contact you for future studies for this child?
		M F	☐**Yes** ☐**No**
		M F	☐**Yes** ☐**No**
		M F	☐**Yes** ☐**No**

Languages Spoken in the Home and at Childcare

What percent of the time does your baby hear **English**? _________ **%**

What percent of the time does your baby hear **French?** _________ **%**

What percent of the time does your baby hear **another language**? _________ **%**
Please specify this language**:**________________________

Has the child lived/vacationed in any country **where s/he would hear a language other than English or French**? □**Yes** □ **No**

If yes, please detail (when, where, and for how long?) _________________________________

Health History

Parent A age: ____________ Parent B age: ____________

What was your child's birth weight? **__ __ lbs __ __ oz** OR **__ __ __ __ grams**

How many weeks was your pregnancy? ____________**weeks**

Were there any **complications** during the pregnancy? □**Yes** □ **No**
If yes please detail ____

Has your child had any major **medical problems**?
If yes please detail____

Does your child have any **hearing or vision problems**?
If yes please detail____

Does your child **currently** have an ear infection? □**Yes** □ **No**

Has your child had any ear infections **in the past**? □**Yes** □ **No**
If yes at which ages____

Does your child have a **cold** today? □**Yes** □ **No**

If yes, does he/she have pressure/pain in ears (if known)? □**Yes** □ **No**

Is there any other relevant information we should know (health or language-related)?

Has another university contacted you to participate in one of their studies? □**Yes** □ **No**
If yes, which university? __________________________________

Family and Child Background Information (optional)

Parent A marital status:____________________Parent B marital status:_______________

Parent A's Current Level of Education
Check any/all that apply:

- ☐ Primary School
- ☐ Some High School
- ☐ High School
- ☐ Some College/University
- ☐ College Certificate/Diploma
- ☐ Trade School Diploma
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Doctoral Degree
- ☐ Professional Degree
- ☐ Not Applicable/Unknown
- ☐ Other (please specify):

____
____

Parent B's Current Level of Education
Check any/all that apply:

- ☐ Primary School
- ☐ Some High School
- ☐ High School
- ☐ Some College/University
- ☐ College Certificate/Diploma
- ☐ Trade School Diploma
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Doctoral Degree
- ☐ Professional Degree
- ☐ Not Applicable/Unknown
- ☐ Other (please specify):

____
____

Parent A's Occupational Status (optional)
Check any/all that apply:

- ☐ Employed Full-Time
- ☐ Employed Part-Time
- ☐ Stay-at-Home-Parent
- ☐ Student
- ☐ Unemployed
- ☐ Not Applicable/Unknown
- ☐ On Temporary Leave (e.g., maternity, paternity, sick, etc
- ☐ Other (please specify):

____

- ☐ Occupation

____

Parent B's Occupational Status (optional)
Check any/all that apply:

- ☐ Employed Full-Time
- ☐
- ☐ Employed Part-Time
- ☐ Stay-at-Home-Parent
- ☐ Student
- ☐ Unemployed
- ☐ Not Applicable/Unknown
- ☐ On Temporary Leave (e.g., maternity, paternity, sick, etc.;
- ☐ Other (please specify):

____

- ☐ Occupation

____

Income bracket for the entire household (per year/before tax):

- ☐ < $22 000
- ☐ Between $22 000 and $35 000
- ☐ Between $35 000 and $50 000
- ☐ Between $50 000 and $75 000
- ☐ Between $75 000 and $100 000
- ☐ Between $100 000 and $150 000
- ☐ > $150 000

What language community do you (and your partner) identify with?
Check any/all that apply:

- ☐ Anglophone
- ☐ Francophone
- ☐ Allophone
- ☐ Other (please specify): ____

What are your child's ethnic origins?
Check any/all that apply:

- ☐ Aboriginal
- ☐ African
- ☐ Arab
- ☐ West Asian
- ☐ South Asian
- ☐ East and Southeast Asian
- ☐ Caribbean
- ☐ European
- ☐ Latin/Central/South American
- ☐ Pacific Islands
- ☐ Not Applicable/Unknown
- ☐ Other (please specify):
  ____

What culture do you (and your partner) identify with?
Check any/all that apply:

- ☐ Aboriginal
- ☐ African
- ☐ Arab
- ☐ West Asian
- ☐ South Asian
- ☐ East and Southeast Asian
- ☐ Caribbean
- ☐ European
- ☐ Latin/Central/South American
- ☐ Pacific Islands
- ☐ Canadian/American
- ☐ Not Applicable/Unknown
- ☐ Other (please specify):
  ____

Appendix D

Coding for Intention Task

(Study 1)

Behavioural Re-enactment Task (18 – Months)

Subject Number:____________ Sex: F M Lap Baby: Y N

Comments:____

____

Test Day: A B **Order: ____** **Include: Yes No** **Reason for Ex ________________**

Order	Task	Completed Action	Latency (from when child touches toy)
	Dumbell	Yes No	
	Box and Button	Yes No	
	Bracelet and Prong	Yes No	
	Cup and Beads	Yes No	
	Dowel and Plastic Square	Yes No	

Score out of 5 ______________

Percentage________________

Order: A B

Appendix E

Coding for Emotional Helping Task

(Study 1)

1. Emotional Helping

Cues to help E (perform the target behaviour):

TOY BEAR	**Score**
1) Facial/vocal cues of sadness	8
2) "I am sad"	7
3) "I need something to make me happy"	6
4) "A teddy bear!"	5
5) Alternate gaze	4
6) Reaches toward the teddy bear	3
7) "Can you help me?"	2
8) "Can you give me my teddy bear?"	1
9) NO RESPONSE	0

Toy Duck	**Score**
1) Facial/vocal cues of sadness	8
2) "I am sad"	7
3) "I need something to make me happy"	6
4) "A duckie!"	5
5) Alternate gaze	4
6) Reaches toward the duckie	3
7) "Can you help me?"	2
8) "Can you give me my duckie?"	1
9) NO RESPONSE	0

Order (Circle) H1: Bear, Duck **H2: Duck, Bear**

Appendix F

Coding for Desire Task

(Study 1)

Desire Task (18 – Months)

Subject Number:____________ Sex: F M Lap Baby: Y N

Comments:____

____

MATCH

Test Day: A B **Order: ____** **Include: Yes No** **Reason for Ex ________________**

Baseline Preference:

Cracker: Taste _____ Touch _____ Side_______

Broccoli: Taste _____ Touch _____ Side_______

First touch (C/B) _______ Task refusal: _____

Child: Food Desired:

Cracker ______ Broccoli ______

Experimenter Food Desired

Cracker _________ order __________ Broccoli _________ order___________

Response:

First food touched ________________

First food given __________________

Task refusal _____________________ Score: Pass Fail

MIS MATCH

Test Day: A B **Order: ____** **Include: Yes No** **Reason for Ex _________________**

Baseline Preference:

Cereal: Taste _____ Touch _____ Side_______

Lettuce: Taste _____ Touch _____ Side_______

First touch (C/L) _______ Task refusal: _____

Child Food Desired:

Cereal ______ Lettuce ______

Experimenter Food Desired

Cereal _________ order __________ Lettuce _________ order___________

Response:

First food touched ________________

First food given __________________

Task refusal ______________________ Score: Pass Fail

Appendix G

Coding for False Belief Task

(Study 1)

Belief Task (18 – Months)

Subject Number:___________ Sex: F M Lap Baby: Y N

Comments:____

____

FALSE BELIEF:

Test Day: A B **Order: ____** **Include: Yes No** **Reason for Ex ______________**

Did child open the boxes during training?	Colour and location of box where E1 first places toy (from child's p.o.v.)	Colour and location of box where E2 hides toy (from child's p.o.v.)	Response	Score
Orange: Yes No Green: Yes No	Colour: Orange Green Location: Left Right	Colour: Orange Green Location: Left Right	First reach: __________ First touch: __________	Pass Fail

Appendix H

Sample Recruitment Letter

(Study 2- 14 months)

Dear Parents,

The Cognitive and Language Development Laboratory, which is part of the Center for Research and Human Development at Concordia University, is presently conducting a study on infants' understanding of others' mental states, including their desires, beliefs and intentions. If you have participated in a study in the past, we would like to thank you for your enthusiasm and commitment to research. Our research has been funded by federal and provincial agencies for the past twenty-five years and our team is internationally recognized for its excellent work on early child development. Our articles are frequently published in prestigious journals, such as "Infancy" and "Developmental Science". You also might have heard about our studies on national radio or on the *Discovery Channel*.

The Commission d'Accès à l'Information du Québec has kindly given us permission to consult birth lists provided by the Agence de la santé et des services sociaux de Montréal. Your name appears on the birth list of December 2013, which indicates that you have a child of an age appropriate for our study. We therefore invite you to participate in one of our new studies and have the unique experience of learning more about your child and child development, as well as contributing to research in this field!

The present investigation involves a few short tasks, during which, your child will watch an experimenter act out different scenes inside of a puppet theatre. These scenes involve understanding the experimenter's beliefs, desires, and intentions. During these activities, we are interested in what your child will look at, as well as for how long they attend to the scene. In addition, where are interested in your child's reaction to these events. Your child will also participate in a short activity with the experimenter, where he/she will be able to play with some novel toys. During all tasks, your child will either be sitting on your lap or sitting in a child seat while you are seated directly behind him/her. We will record your child's responses and all videos will be treated in the strictest of confidentiality.

Overall, your participation will involve two approximately 45-hour-long visit to our laboratory at the Loyola Campus of Concordia University, located at 7141 Sherbrooke Street West, in Notre-Dame-de-Grace. Appointments can be scheduled at a time which is convenient for you and your child, including weekends. Free parking is available on the campus and we offer babysitting for siblings who come to the appointment. Upon completion of the study, a Certificate of Merit for Contribution to Science will be given to your child, and you will be offered a financial compensation of $20 per session for participating. A summary of the results of our study will be mailed to you upon its completion.

For the purposes of this study, we are looking for toddlers who are 13-15 months of age, who are exposed to either English or French at home, and who do not have any visual or hearing difficulties. All our studies are independent, so you may choose to participate once, or several times. If you are interested in having your child participate in this study, or would like any other information, please contact Josée-Anne Bécotte at (514) 848-2424 ext. 2279, or Dr. Diane Poulin-Dubois at (514) 848-2424 ext. 2219. You can also visit our website at http://crdh.concordia.ca/dpdlab. As we are very interested in having you participate, we will try to contact you by telephone within a few days of receiving this letter. We look forward to speaking with you in the near future.

Sincerely,

Diane Poulin-Dubois, Ph.D.
Professor
Department of Psychology

Josée-Anne Bécotte, B.Sc.
Laboratory Manager
Department of Psychology

Jessica Yott,
Ph.D Clinical Psychology Student
Department of Psychology

Appendix I

Sample Consent Form

(Study 2 -14 months)

Parental Consent Form

This is to state that I understand that I have been asked if my child can participate in a research project being conducted by Dr. Diane Poulin-Dubois, in collaboration with Jessica Yott of Concordia University.

A. PURPOSE

I have been informed that the purpose of the research is to examine infants' early cognitive development, by examining infants' understanding of others' beliefs, desires, and intentions.

B. PROCEDURES

The present investigation involves two visits to the Cognitive and Language Development Laboratory. You will first be asked to complete brief questionnaires on your child's vocabulary, as well as some demographic information (e.g., siblings, education). Each visit will involve a few short activities. For these activities, your child will watch an experimenter act out different scenes inside of a puppet theatre. More specifically, these scenes involve understanding the experimenter's desires, intentions and beliefs. During these activities, we are interested in what your child will look at (e.g., face, hands), as well as for how long they attend to the scene. In addition, we are interested in your child's reaction to these events. Lastly, your child will watch an experimenter try to complete an action with two objects, after which your child will be given the opportunity to play with these objects. During all tasks, your child will either be sitting on your lap or sitting in a child seat while you are seated directly behind him/her.

We will videotape your child's responses and all tapes will be treated in the strictest of confidentiality. That means that the researcher will not reveal your child's identity in any written or oral reports about the study. You and your child will be assigned a coded number, and that code will be used on all materials collected in this study. All materials and data will be stored in secure facilities in the Department of Psychology at Concordia University. Only members of the research team will have access to these facilities. Questionnaires and electronic data files will be identified by coded identification numbers, unique to each family. Information collected on paper (questionnaires) or videotapes (observed behaviours) will be entered into computer databases. Raw data will be kept for a minimum of 5 years. When it is time for disposal, papers will be shredded, hard-drives will be purged, and videotapes and computer disks will be magnetically erased.

As well, because we are only interested in comparing children's understanding as a function of age, no individual scores will be provided following participation. Each session is expected to last approximately 45 minutes.

C. RISKS AND BENEFITS

Your child will be given a certificate of merit at the end of the session as a thank-you for his/her participation. Also, you will be offered 20$ for your participation.

There is one condition that may result in the researchers being required to break the confidentiality of your child's participation. There are no procedures in this investigation that inquire about child maltreatment directly. However, by the laws of Québec and Canada, if the researchers discover information that indicates the possibility of child maltreatment, or that your child is at risk for imminent harm, they are required to disclose this information to the appropriate agencies. If this concern emerges, the lead researcher, Dr. Diane Poulin-Dubois, will discuss the reasons for this concern with you and will advise you of what steps will have to be taken.

D. CONDITIONS OF PARTICIPATION

- I understand that I am free to withdraw my consent and discontinue my participation at any time without negative consequences, and that the experimenter will gladly answer any questions that might arise during the course of the research. I am entitled to keep the total amount of $20 if I choose to withdraw my participation in the study.
- I understand that my participation in this study is confidential (i.e. the researchers will know, but will not disclose my identity).
- I understand that the data from this study may be published, though no individual scores will be reported.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARILY AGREE TO HAVE MY CHILD PARTICIPATE IN THIS STUDY.

MY CHILD'S NAME (please print) ___________________________________
MY NAME (please print) ____
SIGNATURE __________________________ DATE ___________________
WITNESSED BY ________________________ DATE ___________________

I would be interested in participating in other studies conducted through the Centre for Research in Human Development with my child in the future (YES / NO): __________
If at any time you have questions about your rights as a research participant, you are free to contact the Research Ethics and Compliance Officer of Concordia University, at (514) 848-2424 ext 7481 or by email at ethics@alcor.concordia.ca

____
Diane Poulin-Dubois, Ph.D.
Professor
Department of Psychology
848-2424 ext. 2219
diane.poulindubois@concordia.ca

____
Jessica Yott, M.A.
Ph.D. Student
Department of Psychology
848-2424 ext. 2279
j_yott@live.concordia.ca

Participant # ____________   Researcher: __________________

Appendix J

Coding Sheets

(Study 2)

VOE BELIEF 1 Empty

ID: ____________________ Sex: **M / F** Date Tested: ____________________

Order: **First / Second** Lap Baby: **Yes/ No** Date Coded: ____________________

Coded By: ____________________ **Comments:** ____________________

____

TRIAL	EXP/SCREEN	LEFT	RIGHT	BOX (TOTAL)	OUT	TOTAL
1. Familiarization Demo						
1. Familiarization Still						
2. Familiarization Demo						
2. Familiarization Still						
3. Familiarization Demo						
3. Familiarization Still						
4. Induction FB Demo						
4. Induction FB Still						
5. Test FB Inc Demo						
5. Test FB Inc Still						
6. Induction TB Demo						
6. Induction TB Still						
7. Test TB Con Demo						
7. Test TB Con Still						

VOE BELIEF 2 Full

ID: ____________________________ Sex: **M / F** Date Tested: ______________________

Order: **First / Second** Lap Baby: **Yes/ No** Date Coded: ______________________

Coded By: ________________________ **Comments:** ____

____

TRIAL	EXP/SCREEN	LEFT	RIGHT	BOX (TOTAL)	OUT	TOTAL
1. Familiarization Demo						
1. Familiarization Still						
2. Familiarization Demo						
2. Familiarization Still						
3. Familiarization Demo						
3. Familiarization Still						
4. Induction FB Demo						
4. Induction FB Still						
5. Test FB Inc Demo						
5. Test FB Inc Still						
6. Induction TB Demo						
6. Induction TB Still						
7. Test TB Con Demo						
7. Test TB Con Still						

VOE INTENTION

ID: ____________________________ Sex: **M** / **F** Date Tested: ______________________

Order: **First / Second** Lap Baby: **Yes/ No** Date Coded: ______________________

Coded By: ________________________ **Comments:** ____

____

TRIAL	Direct/Indirect	LEFT	RIGHT	OUT	TOTAL
1. Familiarization Demo					
1. Familiarization Still					
2. Familiarization Demo					
2. Familiarization Still					
3. Familiarization Demo					
3. Familiarization Still					
4. Test A Demo					
4. Test A Still					
5. Test B Demo					
5. Test B Still					
6. Test A Demo					
6. Test A Still					
7. Test B Demo					
7. Test B Still					

VOE DESIRE MATCH

ID: ____________________________ Sex: **M / F** Date Tested: ______________________

Order: **First / Second** Lap Baby: **Yes/ No** Date Coded: ______________________

Coded By: ________________________ **Comments:** ____

____

TRIAL	LEFT	RIGHT	OUT	TOTAL
1. Familiarization Demo				
2. Familiarization Demo				
3. Familiarization Demo				
4. Test Demo				
4. Test Still				

VOE DESIRE MISMATCH

ID: ______________________ Sex: **M / F** Date Tested: ______________________

Order: **First / Second** Lap Baby: **Yes/ No** Date Coded: ______________________

Coded By: ______________________ **Comments:** ______________________________________

____

TRIAL	LEFT	RIGHT	OUT	TOTAL
1. Familiarization Demo				
2. Familiarization Demo				
3. Familiarization Demo				
4. Test Demo				
4. Test Still				