Rev.Phil.Psych. (2012) 3:597–625
DOI 10.1007/s13164-012-0117-0

How Theory of Mind and Executive Function Co-develop

Stephanie E. Miller · Stuart Marcovitch

Published online: 24 November 2012

Abstract Theory of mind (ToM) and executive function (EF) have traditionally been measured starting in preschool and share a similar developmental progression into childhood. Although there is some research examining early ToM and EF in the first 3 years, further empirical evidence and a theoretical framework for a ToM-EF relationship from infancy to preschool are necessary. In this paper we review the ToM-EF relationship in preschoolers and provide evidence for early development in ToM, EF, and the ToM-EF relationship. We propose that models of cognitive control (i.e., Hierarchical Competing Systems Model: Marcovitch & Zelazo (Journal of Cognition and Development 7:477–501, 2006), (Developmental Science 12:1–25, 2009)); and Levels of Consciousness Model: Zelazo (Trends in Cognitive Science 8:12–17, 2004) account for the ToM-EF relationship across childhood through domain-general developments in the ability to form and reflect on relevant representations that can guide behavior in both ToM and EF situations. The combination of these models also presents unique, domain-general considerations for interpreting early ToM from infancy to preschool.

Two hallmarks of cognitive development are thought to emerge in the preschool years: theory of mind (i.e., ToM, the understanding that others have internal mental states that guide behavior; e.g., Wellman et al. 2001) and executive function (i.e., EF, the cognitive processes that play a role in the conscious control of thought and action; e.g., Zelazo et al. 1997). Despite the seemingly disparate characterizations of these two abilities, ToM and EF follow a similar developmental progression and share a consistent relationship during the preschool years (e.g., Carlson and Moses 2001;

S. E. Miller (✉)
Department of Psychology, University of Mississippi, 207 Peabody, Lyceum Circle, University, Oxford, MS 38677, USA
e-mail: semille5@olemiss.edu

S. Marcovitch
Department of Psychology, University of North Carolina at Greensboro, 277 Eberhart, Greensboro, NC 27402, USA
e-mail: s_marcov@uncg.edu

Carlson et al. 2002; Frye et al. 1995; Hughes and Ensor 2005, 2007). The strong ToM-EF relationship in preschoolers has prompted productive challenges of domain-specific views of ToM, which have led theorists to consider possible roles of domain-general abilities in ToM (e.g., Frye et al. 1995; Moses 2001). In addition, this relationship has led researchers to contemplate the role of social understanding in the development of EF (e.g., Perner and Lang 2000). However, the ToM-EF relationship has been examined almost exclusively in preschoolers older than 3 years of age, due to established theoretical frameworks (e.g., Gopnik and Wellman 1994; Wellman et al. 2001) and the demanding nature of the tasks. New research paradigms are emerging that examine the early development (i.e., the first 3 years) of ToM, EF, and the relationship between the two (e.g., Baillargeon et al. 2010; Carlson et al. 2004; Garon et al. 2008; Hughes and Ensor 2005; Marcovitch and Zelazo 2006, 2009; Southgate et al. 2007; Tomasello et al. 2005).

The purpose of this paper is to examine the ToM-EF relationship from infancy to preschool. The four specific aims of the paper are to: (1) review evidence for ToM, EF and the established ToM-EF relationship in preschoolers, (2) examine the evidence for ToM, EF and a ToM-EF relationship in infants and toddlers (3) suggest a domain-general representational framework for explaining ToM, EF, and the ToM-EF relationship across early childhood, and (4) discuss the proposed representational framework's consistency with existing data and offer future directions. This framework not only captures the similar developmental progression underlying ToM and EF, but also provides novel, domain-general explanations for early ToM behaviors that have not yet been considered.

1 ToM and EF in Preschool

1.1 ToM in Preschoolers

The majority of ToM research has been conducted with preschoolers in tasks where the understanding of others' internal mental states (e.g., desires, beliefs, knowledge, emotions) is typically inferred through overt behavior (see Wellman and Liu 2004). One of the most researched ToM tasks is the false belief task (e.g., Gopnik and Astington 1988; Wellman et al. 2001; Wimmer and Perner 1983), designed to assess children's ability to detect that others can hold an untrue belief that guides behavior. Although methods vary, in a typical false belief task children watch as the protagonist acknowledges the location of an object (e.g., in the box). The object is then moved to a new location (e.g., in the cupboard) by another character without the protagonist's knowledge. The question of interest is whether children can appreciate that the protagonist will look for the object in the incorrect location. This task is thought to require understanding of diverse beliefs (i.e., the protagonist believes the toy is in the box while the participant believes the toy is in the cupboard) and the understanding of knowledge and ignorance (i.e., the protagonist is ignorant of the true location of the toy, see Wellman, and Liu 2004). Children begin to succeed on this task by 4 years of age.

Researchers have proposed that the ability to pass false belief tasks is driven by domain-specific advancements in conceptual understanding. Specifically, false belief understanding is hypothesized to represent a conceptual breakthrough in ToM development where children now have a concept and framework for interpreting others' beliefs. This is part of the theory-theory account of ToM development (e.g., Gopnik and Meltzoff 1997; Wellman 1990) that postulates that children construct their understanding of people by creating and refining theories on how unobservable concepts influence others' behavior. In this account understanding and concepts for basic internal mental states (e.g., desires, knowledge) emerge earlier, and understanding others' false beliefs comes later in development as children gain experience. Further, abilities like monitoring misinformation in communication have been suggested to contribute to deception and false belief understanding in preschoolers (Mascaro and Sperber 2009).

Wellman and Liu (2004) found a relatively consistent developmental pattern in preschoolers' mental state understanding. The earliest skill to emerge is the understanding of diverse desires, when children display an understanding that one individual can have a desire for something that is inconsistent with another's desires (e.g., child likes ice cream, adult likes broccoli). The understanding of diverse beliefs emerges next as children display awareness that two people can have different beliefs about something. For example, when the location of an object is unknown, children predict that an adult will search in accordance with beliefs different from the children's own beliefs. Importantly, this understanding emerges only for beliefs when the child is unaware of the accuracy of the belief (i.e., it is not the same as false belief understanding). Next, children begin to understand knowledge versus ignorance, in which two individuals can have discrepant knowledge (e.g., an adult might not know something that is true, for example if they did not see a toy put into a drawer they would be ignorant of the toy's location). Finally, false belief understanding emerges followed by the understanding of hidden emotions (i.e., the understanding that individuals' can portray an emotion different from what they feel). Wellman and Liu favor a constructivist approach when interpreting this sequence, where understanding earlier mental states (e.g., desires, diverse beliefs) scaffold understanding of later emerging abilities, such as false belief. Further, small cultural changes in the sequence of ToM development have been found. For example, knowledge-ignorance understanding emerges before discrepant desires in children from China (Wellman et al. 2006), which has been hypothesized to reflect the role of the culture and environment in children's construction of these mental concepts and theories.

1.2 EF in Preschoolers

EF is also widely studied in preschool. Whereas ToM refers to understanding thoughts and behavior in others, EF refers to conscious control of thought and behavior in oneself. EF is perhaps most noticeable in its absence and is typically assessed by presenting children with a problem where control over behavior is difficult because of a conflicting prepotent response (see Zelazo et al. 1997). For example, in the Dimensional Change Card Sort (DCCS; Zelazo et al. 2003) children are asked to sort test cards that vary on two dimensions (e.g., shape and color) to conflicting cards that incorporate one dimension from each of the test cards (e.g., if they are sorting red squares and blue triangles they have to match them to red triangles and blue squares). After sorting successfully according to one dimension (e.g., shape), the experimenter switches the rule and asks children to sort on the other dimension (e.g., color). Three-year-olds typically find it difficult to resist sorting by the previously correct rule (e.g., shape) and fail to use the new rule (e.g., color), but performance improves dramatically for 4- and 5-year-olds.

EF has been conceptualized as involving three component processes (Miyake et al. 2000; see also Garon et al. 2008): working memory (i.e., the ability to hold and manipulate information in mind), inhibition (i.e., the ability to suppress irrelevant responses), and shifting (i.e., the ability to shift flexibly to new responses). Although failures in EF can be due to any of these component processes at any phase of problem solving (e.g., problem representation, planning), performance across a wide range of EF tasks is consistently related (e.g., Carlson et al. 2004; Miyake et al. 2000; Wiebe et al. 2011). Miyake and Friedman (2012) have proposed that EF involves studying what is common across these EF processes, specifically maintaining task relevant information to guide lower level processes toward executing a goal. For instance, the DCCS likely requires working memory (holding the rule in mind), shifting (flexibly switching between sorting rules), and inhibition (suppressing the prepotent response to sort by the first rule). Further, maintaining the goal (e.g., sort by color) should influence working memory, shifting, and inhibition (e.g., Jacques and Marcovitch 2010; Miyake and Friedman 2012). Children exhibit large gains across many different EF tasks throughout preschool (see Carlson 2005), and the study of EF is fundamental to understanding what underlies cognitive control across these different situations.

1.3 The ToM-EF Relationship in Preschoolers

A consistent relationship between ToM and EF in preschoolers has led researchers to examine ToM's relationship to domain-general abilities of cognitive control (e.g., Carlson et al. 2004; Carlson and Moses 2001; Carlson et al. 2004; Frye et al. 1995; Hughes 1998a, b; Hughes and Ensor 2005, 2007; Perner and Lang 1999). According to expression accounts (e.g., Moses 2001), foundational EF abilities may be necessary for children to display their knowledge of others' beliefs and respond accurately on ToM tasks. For example, in the false belief task children may have difficulty holding relevant information in mind (e.g., multiple perspectives), inhibiting a prepotent response (e.g., suppressing selection of the salient correct location), or switching responses (e.g., switching from their own perspective to consideration of someone else's perspective). Moses has proposed that difficulties in EF abilities may prohibit children from displaying actual conceptual knowledge of others' mental states. For example, children may be aware that another person can hold a false belief about a situation but have difficulty displaying this knowledge because it is too difficult to inhibit their own perspective. In support of this hypothesis, children performed better when inhibitory demands are reduced in deception tasks (e.g., Carlson et al. 1998; Hala and Russell 2001) and even very young children are able to pass versions of a false belief task when less demanding versions of the task are employed (e.g., looking time as a response measure and very little inhibition demands, see Onishi and Baillargeon 2005; Southgate et al. 2007).

Moses (2001) also proposed that EF may play a more fundamental role as a prerequisite for the emergence of ToM. For example, to have an understanding of others' mental states, children must first be able to disengage from the consideration of salient information, such as their own mental states (e.g., Russell 1996). Moses suggested that results from Wellman et al.'s (2001) meta-analysis on false belief provide evidence that manipulations related to EF are important in ToM (e.g., salient mental states which are more difficult to inhibit influence ToM performance). Further, when analyzed longitudinally, EF at 24 months was shown to be predictive of ToM at 39, while ToM at 24 months was typically not predictive of EF at 39 months (Carlson et al. 2004). Although this suggests that EF may contribute to the emergence of ToM, one potential issue in studying the early ToM-EF relationship lies in establishing age appropriate measures of toddlers' ToM. Carlson, Mandell, et al. had difficulty establishing a ToM-EF relationship at 24 months and have suggested that this may be due to difficulties in establishing age appropriate measures of toddler ToM. For example, the authors adapted intention and desire understanding tasks for 24-months-olds when this ability has already been established in younger children. However, when different measures of ToM are presented at 24 months (e.g., false belief, deception), the concurrent ToM-EF relationship is present (Hughes and Ensor 2005, 2007) and the longitudinal relationship of EF contributing to later ToM holds across ages 2 to 4 years of age, while there is limited evidence that ToM predicts EF (Hughes and Ensor 2007). These results support an emergence account of the ToM-EF relationship and demonstrate the need for further examining precursors to ToM and the early ToM-EF relationship.

In contrast to EF expression and emergence accounts, Perner and Lang (2000) suggested that understanding underlying mental states and their influence on behavior in ToM might support children's EF development. For example, in the hand game (Luria et al. 1964), children are asked to make the opposite gesture of what the experimenter is showing them (e.g., if the experimenter shows a flat hand they are asked to make a fist, if the experimenter makes a fist they are asked to make a flat hand). Perner and Lang (1999) suggested that the understanding of the natural tendency to produce the same gesture as the experimenter allows children to recognize the problem and exhibit inhibition over the prepotent response (also see Lang and Perner 2002; Perner et al. 1999).

Relatedly, Carruthers (2009) suggested that ToM deficits in children with autism could contribute to EF impairment in this population. Indeed, several studies have shown that children with autism display deficits on EF tasks (e.g., Ozonoff and McEvoy 1994; Ozonoff et al. 1991; Rumsey 1985; Rumsey and Hamburger 1990). However, the relationship between ToM and EF in children with autism has also been hypothesized to relate to an underlying disability in cognitive control (e.g., Bowler et al. 2005; Frye et al. 1998; Zelazo et al. 2001; Zelazo et al. 2002). Earlier EF abilities have been shown to predict ToM in children with autism, while there is no evidence that early ToM predicted EF (Pellicano 2010).

One theory that stresses the importance of cognitive control in the ToM-EF relationship is the Cognitive Complexity and Control (CCC) Theory. The CCC theory postulates that although various processes are involved in EF (e.g., inhibition, working memory), the development of consciously controlled behavior is related to a single development in awareness and self-reflection (Zelazo et al. 2003). Frye et al. (1995) suggested this underlying representational ability involved in creating and reflecting upon a higher order rule structure is responsible for the developmental shift in both ToM and EF from 3 to 5 years of age. Specifically, the rule structure necessary to pass EF tasks is also involved in ToM tasks. For example, in the DCCS, successful children flexibly sort cards that vary on two dimensions (e.g., shape and color) because they understand the hierarchical rule structure (e.g., if color game then red goes here and blue goes there, but if shape game then squares go there and circles go here). In the false belief task, a hierarchical rule structure may also be necessary to shift flexibly between settings and consider multiple perspectives (e.g., if I am judging for myself with a true belief and the object is represented at A then search at A, but if I am judging for another with a false belief and the object is represented at B then search at B). Thus, children appreciate that beliefs can be represented in the context of reality (which is the typical case) or falsity where beliefs do not need to correspond with reality. Frye et al. have demonstrated that children's ability to use and understand embedded rules was related to children's performance on ToM tasks. Although this perspective offers a domain-general account of the ToM-EF relationship, rule construction and reflection has been hypothesized to interact with domain specific understanding (e.g., understanding of rules and hierarchical rule structure allows for higher reasoning within a social domain, Frye et al. 1998).

2 ToM and EF in Infants and Toddlers

2.1 ToM in Infants and Toddlers

The toddler years have been referred to as the "dark ages" of cognitive development by several researchers (e.g., Hughes and Ensor 2007; Meltzoff et al. 1999). ToM was rarely studied during this period because the consensus was that children under 3 years of age did not demonstrate a mentalistic ToM (i.e., were not capable of representing internal mental states such as false beliefs, Gopnik and Meltzoff 1997; Wellman 1990). However, the examination of ToM on a continuum with infants and toddlers demonstrating lower level ToM abilities (e.g., understanding of intentionality rather than false belief) is more commonplace (e.g., Wellman 2010). Further, contemporary research suggests that even sophisticated ToM abilities related to false belief representation are present early in life. For instance, Onishi and Baillargeon (2005) argued that 15-month-old infants demonstrate false belief understanding in a nonverbal, violation of expectation (VOE) task. In this task, infants observed a situation where an agent had to search for a toy that was moved to a new location when the agent was not looking. Children looked reliably longer when the agent searched at the correct location, implying that they were surprised that the agent did not search in accordance with her false belief. Other looking time tasks have also provided evidence that children as young as 13 to 14 months expect agents to act in accordance with their false beliefs in similar search paradigms (Song and Baillargeon 2008; Surian et al. 2007). Further, Kovács et al. (2010) provided evidence that 7-month-olds encode another's beliefs automatically. In their object detection experiment, infants watched a movie where they were led to have a belief about a ball's location (e.g., hidden behind a barrier). Infants looked longer when reality was not consistent with their belief (e.g., when they falsely believed the ball was hidden behind the barrier and it was later revealed to be absent). Importantly, Kovács et al. also showed that infants looked longer at an outcome when it was inconsistent with the beliefs of an agent present in the video (e.g., when an agent should have a false belief that an object was hidden behind a barrier and it was later revealed to be absent). This occurred even when the infant held a true belief and was aware of the ball's location and was presented by Kovács et al. as evidence that infants computed the beliefs of an agent present in the video.

Notably, the interpretations based on looking paradigms have been called into question. For example, a number of researchers (e.g., Haith 1998; Perner and Ruffman 2005; Wellman 2010) have argued that longer looking times in these situations do not necessarily mean that children understand and could correctly predict how an individual with a false belief would act, which is a more robust concept than violating expectations. In response to this and similar criticisms, Southgate et al. (2007) used eye-tracking data in a false belief paradigm to demonstrate that 25-month-old children look to the location that corresponds to the agent's false belief, providing evidence of prediction of the agent's action. Southgate et al. (2010) also claimed that 17-month-old infants track the mental belief states of adults and use this information to inform an actor's intentions. In this task (see also Carpenter et al. 2002) infants were shown two unfamiliar objects hidden in two boxes (e.g., one in an orange box and one in a black box). Infants watched as adults were either led to have a false belief (i.e., they did not see the objects switch locations) or a true belief (i.e., they saw the objects switch locations). When an adult with a false belief named a novel object in a box (e.g., the sefo is in the orange box), infants referred to the other box (e.g., retrieved the sefo from the black box). This occurred presumably because infants were aware that the adult held a different belief and was referring to the toy that was in the prior location. Similar behavioral (e.g., Buttelmann et al. 2009) and VOE paradigms in contexts other than false belief search tasks (e.g., Scott and Baillargeon 2009; Scott et al. 2010) provide similar evidence that children in their second year of life appreciate internal belief states.

Understanding internal mental states other than beliefs (i.e., discrepant desires and knowledge vs. ignorance) may emerge before the third year of life as well. For example, Repacholi and Gopnik (1997) demonstrated that 18-month-olds offer food consistent with an adult's desire that is dissimilar from their own and argued this demonstrates an understanding of discrepant desires. Moll and colleagues (Moll et al. 2007; Moll and Tomasello 2007) revealed that 14- and 18- month old infants chose a toy with which an adult was inexperienced when the adult indicated excitement for a new toy in situations of joint play. The authors suggested this was evidence that infants mark the adults as knowledgeable (i.e., having experience with that toy).

In addition to early ToM understanding, some theorists have hypothesized other early developing social cognitive abilities are precursors to ToM (e.g., Wellman 2010). For instance, imitation evident in very young infants (Meltzoff and Moore 1977) has been hypothesized to demonstrate the ability to understand others' actions in terms of one's own behavior, which eventually generalizes to understanding distinct behaviors and intentions (e.g., Meltzoff 2007). Looking time studies (e.g., infants gaze longer when action is at odds with the most efficient means to an agent's goal, Gergely and Csibra 2003; Woodward 1998) and behavioral studies (e.g., 14-month-olds imitate agents' intentions and take into consideration obstacles and barriers rather than copying actions movement for movement, Gergely et al. 2002) suggest that infants appreciate intentionality and goal directed behavior in the first and second year of life (see also Behne et al. 2005). Further, pretend play (i.e., when children generalize new schemas to inappropriate objects, like talking on the phone with a banana, Piaget 1962), is proposed to be one of the first abilities to emerge (i.e., between 18 and 24 months) that demonstrates the ability to process and infer internal mental states of agents (Leslie 1987, 1994). Another early emerging ability hypothesized to reflect early social cognition and understanding of intentionality is joint attention (i.e., behaviors that describe infants' and agents' shared reference to an object, Carpenter et al. 1998). Perspectives on joint attention suggest that more sophisticated or higher levels of joint attention (e.g., active sharing or manipulating others' attention such as pointing to initiate joint attention episodes) may have stronger links to early social cognition (Tomasello et al. 2005) and controlled attention (Mundy and Newell 2007).

2.2 EF in Infancy and Toddlers

Similar to ToM, research and evidence for EF abilities in infants and toddlers appears limited. However, there are indications that children begin to demonstrate controlled, goal-directed behavior within the first years of life. For example, by 6 months of age, most children succeed on the delayed response task where children control behavior to search for a desirable object hidden in one of two locations (Pelphrey and Reznick 2002). In addition, several cognitive and social achievements, such as emotion regulation (Mangelsdorf et al. 1995), delay of gratification (Kochanska et al. 1998), and imitation of complex-sequences (e.g., Alp 1994; Wiebe and Bauer 2005) likely require behavioral control in the first years of life. The A-not-B task and related variants are also hypothesized to require EF (see Marcovitch and Zelazo 2009). In this task, children observe an object hidden at one location (location A) and subsequently retrieve the object. After they have retrieved the object multiple times, the object is moved to a new location (location B) and children's ability to shift search to the new location is observed. Consistent mastery of the classic A-not-B task is observed by 12 months of age, and children begin to tolerate increasing delays between hiding and search (Diamond and Doar 1989; Diamond and Goldman-Rakic 1989).

There is less work examining the toddler years linking the foundational control observed in infancy to the more complex EF in preschool. In the second year, Diamond et al. (1997) observed improvements on a modified A-not-B and working memory tasks (i.e., in which children had to hold in mind locations where they had searched previously to find 3 toys hidden in 3 distinct boxes). However, Wiebe et al. (2010) demonstrated that although there is growth in individual task performance from 15 to 20 months of age, the longitudinal stability and correlations between performance on tasks thought to require EF are generally low. This steadily improves across preschool (Carlson et al. 2004; Hughes and Ensor 2005, 2007) and into childhood (Wiebe et al. 2008; 2011), suggesting that EF ability is limited and less cohesive in the first years of life, and develops across infancy and into childhood.

2.3 The ToM-EF Relationship in Infancy and Toddlers

More work is being conducted examining both ToM and EF in the first few years of life, encouraging us to extend our examination of the ToM-EF relationship before preschool to understand the co-development of the two constructs. Unfortunately, evidence for the ToM-EF relationship before the age of 2 is currently limited to the examination of precursors to ToM. Mundy and colleagues (Mundy et al. 2007; Nichols et al. 2005; Van Hecke et al. 2007) proposed that basic EF abilities (e.g., inhibitory processes, control of attention) underlie and contribute to the development of joint attention abilities and social understanding (e.g., inhibiting irrelevant stimuli is necessary when coordinating attention with others, Van Hecke et al. 2007). The majority of support for this hypothesis comes from examining joint attention and EF in children with autism, and it has been suggested that autistic children's impairment in social understanding is related to a general EF impairment (e.g., Ozonoff and McEvoy 1994; Rumsey and Hamburger 1990). In support of this hypothesis, Dawson et al. (2002) found a relationship between the delay nonmatch to sample task (DNMS, a task hypothesized to require EF abilities) and joint attention abilities in children with autism. Further, Griffith et al. (1999) demonstrated that EF at an earlier time point (mean age of 51 months) was correlated with later initiating joint attention 1 year later, while the reverse correlation was not significant. The study of the joint attention-EF relationship has also been extended to typically developing children and Nichols et al. demonstrated that improvement in the DNMS from 14 to 18 months of age predicted initiating joint attention abilities at 18 months. However, research on the joint attention-EF relationship is limited, because the primary theories in this literature (e.g., Mundy and Newell 2007) have dictated that the relationship be approached from a unidirectional standpoint, suggesting that EF abilities contribute to the development of joint attention. Although this evidence is an important step to understanding the role of cognitive control in ToM, it is important to examine the early ToM-EF relationship more broadly (e.g., examining a bidirectional relationship including tasks of false belief, diverse desires, and larger batteries of EF).

Although research has not yet focused on the early ToM-EF relationship with regard to infant false belief, 3 theoretical approaches to early ToM mention the role and importance of EF in later ToM processing. Mindreading accounts (see Hutto et al. 2011), like Baillargeon and colleagues (e.g., Baillargeon et al. 2010; Lou and Baillargeon 2010; Scott and Baillargeon 2009), proposed that the ability to represent internal mental states is present early in life (i.e., at least by 14 months of age) and older children fail explicit false belief tasks because they demand response inhibition and response selection in addition to false belief representation (whereas implicit tasks only involve representation). In Baillargeon and colleagues system based account infants are born with a psychological reasoning system that is unconsciously executed when interpreting intentional actions (see also Gergely and Csibra 2003; Leslie 1994). Subsystem-1 (SS1) is present in the first months of life and attributes internal motivational states to agents (e.g., goals, desires) and accounts for the agent's knowledge of the environment by linking the agent's perception of the environment to their own (through a masking mechanism). Subsystem 2 (SS2), present in the second year of life, allows the infant to hold divergent representations of the self and other in mind (through a decoupling mechanism). Therefore, in a VOE false belief tasks infants operating in SS1 would show ignorance because the masking mechanism blocks information unavailable to both the agent and infant (i.e., knowledge of the correct location). Infants operating in SS2 detect false belief because they represent both their own and the agent's beliefs through the decoupling mechanism.

Baillargeon and colleagues' framework is distinct because it accounts for infants' demonstrations of false belief recognition by proposing early mentalistic processing (see Scott and Baillargeon 2009 for discussion) that may appear absent in older children because of EF related issues.

The ability to represent sophisticated internal mental states so early in life is not universally accepted (see Hutto et al. 2011 for a review of alternatives to mindreading accounts). Other accounts of ToM hypothesize that early ToM performance can be accounted for without attributing the ability to represent internal mental states to infants. For example, Perner and Ruffman (2005) suggest that infants may focus on behavioral rules when responding to others' actions. Onishi and Ballairgeon's (2005) demonstration of false belief in a VOE task reinterpreted from this perspective suggests that infants construe behavior according to preconceived rules (e.g., agents search for objects at the last location seen). This behavioral rule provides an explanation for why infants look longer when the agent searches at the location they did not last see the object hidden. Wellman (2010) hypothesized that infants possess social cognitive understanding early in life (e.g., goal-directed behavior, intentionality), however children do not demonstrate true false belief understanding and a corresponding representational theory of mind until later in preschool. Wellman suggests that early false belief studies show that infants appreciate agents as goal-directed and track their desires, emotions, and perceptions to predict behavior. Thus, in a VOE false belief task infants would look longer when an agent searches for an object at a location where they did not see the object hidden, because infants acknowledge that the agent did not perceive the object at that location. That is, they are ignorant of it being moved to the new location rather than possessing a false belief of the object's location. The preschool false belief tasks require prediction of agent's behavior, which is not required in VOE tasks. This later emerging ability to represent and predict false beliefs builds on earlier ToM abilities (e.g., such as understanding of intentionality) as children gain more experience and form theories about other's minds. Further, although abilities in EF and language play a role in ToM task performance, domain-specific development in understanding and representing others minds is critical.

However, Scott et al. (2010) has suggested that recent studies demonstrating infant false belief across a wide variety of settings (e.g., Buttelmann et al. 2009; Scott et al. 2010; Song and Baillargeon 2008; Southgate et al. 2010) make it difficult for a behavioral rule or ignorance framework to account for all these findings. Apperly and Butterfill (2009) offered a moderate theory, in which infants possess an early emerging efficient system that allows infants to represent belief-like states and demonstrate false belief in a limited number of situations. This system describes the environment centered on an individual in terms of encounters (i.e., the relation between the individual, object, and location). This system also describes what Apperly and Butterfill term registration, where the encounter is described even when an element is not present (e.g., object is not in field). Registrations do not necessarily have to reflect reality, and when an individual has a registration of an object where it is not located in reality the infant detects this, thus accounting for findings in false beliefs. This theory parallels ToM abilities in infancy to other early seemingly sophisticated cognitive processes, such as the ability to discriminate quantities in number cognition, in which infants perceive and behave with respect to differences in quantities despite their lack of more explicit mathematics knowledge. Importantly, although

Apperly and Butterfill attribute some automatic ability to represent belief-like states, this system is hypothesized to be limited and not equivalent to the later developing ToM system, which is effortful, reason-based, and dependent on EF and language (see also De Bruin et al. 2011; Low and Wang 2011).

3 A Representational Model of the ToM-EF Relationship

Accounts examining EF's role in ToM have focused primarily on how component abilities are required in social cognition (e.g., inhibiting one's own perspective of reality is hypothesized to be important in the case of false beliefs). However, more recent conceptualizations of EF suggest that a common EF ability related to maintaining goals and goal relevant information may be necessary across components (e.g., Miyake and Friedman 2012) and guided by representation (e.g., Jacques and Marcovitch 2010; Zelazo 2004). EF defined and examined more generally has the potential to further inform the ToM-EF relationship. Zelazo and colleagues (e.g., Frye et al. 1995; Zelazo 2004) suggested that the development of domain-general abilities in representation and reflection underlie, ToM, EF, and the ToM-EF relationship. According to these representational frameworks, cognitive control over prepotent responses is driven by the ability to represent information in the environment and reflect on these representations to guide thought and behavior. Although the developments in representation and reflection have been applied to EF (i.e., one's *own* cognitive control), it is likely that representation and reflection is also critical to understanding cognitive control in others. Perhaps most central to the current paper is the fact that these reflection frameworks account for dissociations in EF and can be applied to understand why children appear to demonstrate sophisticated ToM knowledge early in life (e.g., false belief knowledge) despite failure on similar tasks in preschool, by focusing on the representational and reflection requirements of tasks at different ages.

In the following section, these models are expanded upon to provide a developmental model that characterizes the role of representation and reflection in controlled behavior and ToM, drawing on three related theoretical frameworks. The Levels of Consciousness (LoC) is the broadest framework (Zelazo 2004) and suggests that children's EF is influenced by the level at which children can represent and reflect upon their environment. The LoC model provides an account of children's representational abilities, responsible for developmental shifts and dissociations in the control of behavior. The Hierarchical Competing Systems Model (HCSM, Marcovitch and Zelazo 2009) draws on the LoC and details the emergence of EF by focusing on children's early ability to reflect on in their environment (e.g., through language) to overcome habitual responses that also guide thought and behavior. Further, the CCC theory (Frye et al. 1995; Zelazo et al. 2003) expands on the LoC model (Zelazo 2004) and has been applied to the ToM-EF relationship in preschoolers by focusing on the role of rule complexity and use in goal-directed behavior (see Section 1.1). Despite their similarities, these three models are rarely considered simultaneously. By considering these models together, we hope to provide a novel means to interpret early ToM behavior. As all three models focus on underlying abilities in representation and reflection in cognitive control, we refer to the combination of these models as the reflection framework.

3.1 The HCSM: A Representational Model of Cognitive Control

The HCSM (Marcovitch and Zelazo 2006, 2009) provides a framework for examining the role of representation in thought and behavior and proposes that two foundational systems interact to produce behavior. The habit based system influences behavior automatically and is typically strengthened by previous experience, whereas the representational system impacts behavior through conscious representation and reflection on representations. This model has been extensively applied to EF measures in infancy and toddlerhood by using variants of the A-not-B search task. From a HCSM perspective, in the A-not-B task the critical EF trial occurs when the object is hidden conspicuously at a new hiding location (location B). On B-trials, the two systems of the HCSM work in opposition during search as the motor habit formed toward location A competes with the potentially conscious representation of where the object is now hidden. According to the HCSM, errors on B trials occur if children fail to reflect on their representation of the object at location B, and are unable to override the competing habit to search at location A. The HCSM accounts for many findings in the A-not-B literature (e.g., distinctive locations and labels help form stronger representations to overcome habit, see Marcovitch and Zelazo 2009). Recent studies have suggested that the communicative context of the A-not-B tasks also induces errors (i.e., the experimenter teaches children that objects are hidden at A). Although the HCSM has focused on motor habits, it is possible that habits could be representational, leading to a stronger habit formation when communicative cues are present.

The HCSM is similar to the two-system account proposed by Apperly and Butterfill (2009). Apperly and Butterfill hypothesize two domain-specific, and possibly unrelated systems: one for the efficient belief-state processing of the infant and the other for later effortful ToM processing of the young child and adult. The efficient early emerging system proposed by Apperly and Butterfill may correspond to the habit-based system of the HCSM. For example, in the habit-based system infants' behaviors are primarily guided by habitual behaviors (e.g., when a toy is present in the environment the infant automatically attempts to obtain it). This system may also include infants' automatic attention toward agents (e.g., when an agent is presented in the environment infants automatically link agents to objects, Woodward 1998). However, these accounts differ in generality because the HCSM suggests that the habit-based and the representational system are domain-general and related systems. Although knowledge and experience with ToM concepts is necessary (e.g., children need communication and experience with agents), individuals are only able to develop in their understanding of these concepts to the extent that they can represent and reflect upon this information. From this perspective, ToM processing is re-described with consideration of the domain-general limitations in representation and reflection.

3.2 The LoC Model: Representational Development from Infancy to Preschool

3.2.1 Minimal Consciousness

According to reflection perspectives, developing abilities within the representational system of the HCSM guides behavior in a variety of contexts. The LoC model describes the developing representational system in terms of age related changes of what children are capable of representing and reflecting on in their environment, which influences corresponding EF and ToM abilities (see Table 1). Zelazo (1996, 2004) hypothesized that infants are born with the first LoC (i.e., minimal consciousness), in which low level awareness triggered by environmental stimuli produce automatized action. For example, Zelazo suggested that a representation of a toy telephone might exist in the lowest LoC, experienced in the moment by the infant as "a suckable object", which then triggers the motor schema of sucking. Children could have various representations (e.g., object, quantity) guide their behavior in minimal consciousness, but it is important to note that representations in minimal consciousness are unreflective. Infants are unaware of their representation of the "suckable object" and objects in the environment automatically determine action.

According to the reflection framework, performance on ToM tasks before the first year of life occurs within minimal consciousness. To date, only Kovács et al. (2010) have examined ToM (specifically related to false belief states of others) with VOE tasks during this period. Although they found that infants looked longer when reality was not consistent with the beliefs of the self and other agents, the authors suggest that their study may demonstrate automatic processing triggered by social stimuli. This description is consistent with representational ability in minimal consciousness: although behavior reflects (minimal) awareness of social stimuli, infants are unaware of their representation and representation is limited to the immediate environment. Further, the environment triggers an automatic response (i.e., the infant is unable to control looking time to agents and objects). Behavior in other social cognitive abilities in the first year of life aligns with the hypothesis that social cognition is limited by representational ability. The demonstration of gaze following (Carpenter et al. 1998), imitation (Meltzoff and Moore 1977), and appreciation of agent-object associations (Woodward 1998) provides evidence that infants focus on linking agents to objects. A less mentalistic, reflection framework explanation would require minimal awareness of agents and objects in the immediate environment that again prompt automatic behavior in the infant (e.g., infants automatically follow gaze because gaze of an agent is linked to objects in the environment). These behaviors can be described within the minimal consciousness of the infant.

3.2.2 Recursive Consciousness

According to the LoC model, children begin to form stronger representations of their environment and produce goal-directed behavior at the end of the first year of life with the emergence of recursive consciousness. In recursive consciousness previous representations become themselves the contents of consciousness, and this is defined as a level of reflection. At this level, developments in protodeclarative pointing and labeling may reflect children's ability to represent an object and consciously link a semantic memory to current experience. For example, by labeling or pointing out a toy phone, the object of minimal consciousness is recursive because it is referred to (or reflected upon). This allows children to link their current experience to a semantic label or description in long term memory and represent the phone outside the present environment. At this stage, the action triggered may take into account the linked semantic label and children may now put the phone up to their ear, rather than directly

Table 1 Description of LoC and corresponding EF and ToM abilities

Age	LoC	Description of representational ability and control of action	Examples of EF abilities	Examples of ToM abilities
Birth	Minimal Consciousness	Unreflective, low level awareness of stimuli in environment. Action is triggered automatically by stimuli and infants lack intentionally controlled behavior.	*Search for hidden objects that are partially visible	*Gaze following (responding to joint attention) *Early imitation *Agent-object associations
Year 1	Recursive Consciousness	Previous representations are labeled and become contents of consciousness and stimuli or current experiences are linked (described) in relation to semantic memory. Action is goal directed based on the descriptions of the environment.	*Tolerate longer delays in delayed response task (including A-not-B task) *Begin to inhibit a behavior when asked not do something	*Initiating joint attention *Protodeclarative pointing *Appreciate other's goal-directed behavior in VOE and imitation tasks *Pass VOE and cooperation false belief tasks *Sharing behavior consistent with understanding diverse desires and knowledge versus ignorance
Year 2	Self Consciousness	Children reprocess semantic descriptions in relation to themselves and are aware of their relationship to the environment. Action can be controlled by if-then statements related to the child's ability.	*Follow rules *Tolerate longer delays and search in multiple locations in A-not-B task *Delay gratification *Begin to hold a rule in mind and inhibit prepotent response	*Anticipatory eye movements consistent with false belief understanding *Pretend play
Year 3	Reflective Consciousness I	Children reflect on their previous representation of a rule and consider it in relation to another rule (i.e., two rules can be held and contrasted in working memory). Action can be controlled by a pair of rules.	*Coordinate behavior between two rules *Can hold and manipulate information in mind over a delay *Hold a rule in mind and inhibit habit	Children can answer questions regarding *discrepant knowledge *discrepant beliefs

Table 1 (continued)

Age	LoC	Description of representational ability and control of action	Examples of EF abilities	Examples of ToM abilities
Year 4	Reflective Consciousness II	Children now reflect on rule pairs and can structure rules in a hierarchical fashion (e.g., multiple if then structures). Action controlled by embedded rules.	*Switch between two sets of rules that require hierarchical structure	*Children can answer questions regarding false beliefs.

in their mouth (i.e., behavior is goal-directed as children maintain a goal related to the description of the item; Zelazo and Zelazo 1998). The ability to control behavior on EF tasks like the A-not-B task emerges in tandem with the first LoC (Zelazo 2004). For example, children who label the hiding location (or goal) on the critical B trial of the A-not-B tasks can use this higher LoC to guide search behavior in place of automatically triggered action responses (i.e., search at the previously correct location). However, it is important to note that verbal labels are not required within recursive consciousness. Infants may begin labeling based on action (e.g., gesture) or non-verbal cues (e.g., spatial location or visual representation) to reflect on contents of consciousness and maintain descriptions of the hiding location in working memory (see Bremner and Bryant 2001; Horobin and Acredolo 1986; Zelazo 2004).

With the emergence of recursive consciousness in the second year, children build on the core abilities in domain-specific cognition (e.g., understanding object-directed behavior, Tomasello et al. 2005; Woodward 1998) and now have the ability to label their environment and objects that guide behavior. Take the simple example of watching an agent reach for a ball. In minimal consciousness, the infant would automatically process the association between the two (e.g., the agent is linked to that object) but would be unable to represent the association beyond the immediate context. However, once infants are able to describe objects in their environment (e.g., link the agent to their semantic memory of a ball) they are aware of the object at a higher level and appreciate the agent's goals toward these objects. This may also be reflected in infant's performance on VOE false belief tasks. Similar to the A-not-B tasks, infants watch as an agent retrieves an object multiple times and form an association between the agent and the object in VOE false belief tasks[1]. Next, the infant observes the object hidden in a new location outside the actor's presence. Labeling stimuli in the environment allows children to represent the agent-object relationship outside the immediate context (e.g., the last place the agent is linked to the object is at the old location) and become aware of stimuli driving goal-directed behavior at a higher level. As a result, infants may look longer when agents do not search at the last place the agent saw the object. The timing of the emergence of recursive consciousness also corresponds to the emergence of children's ability to perform goal directed behavior (e.g., Zelazo 2004; Zelazo and Zelazo 1998) and awareness of intentional goal-directed behavior in others in other paradigms (e.g.,

[1] Although similar, there are important distinctions between the A-not-B task and VOE false belief tasks. For example, in the A-not-B task, children must respond to where the object is, whereas in the VOE false belief task infants must respond to where the object is not. These differences in responses are likely due to the different nature of the representations formed within the task. In the A-not-B task, infants link the object to a location (initially at location A), whereas in VOE false belief task infant link the agent to an object (i.e., object directed behavior). After the switch to a new location (A-not-B) or new location outside the actor's presence (false belief), children must continue to either form strong object-location representations in A-not-B tasks (e.g., object is now at location B) or agent-object representations in false belief tasks (e.g., the agent-object relationship is linked to the old location) to overcome prepotent responses. In addition, although both tasks assess infant's actions, A-not-B measures manual search whereas the false belief measures looking time. Current representational ability, habit strength, and mode of response are all important considerations, and can be modeled within the habit based and representational system of the reflection framework (e.g., searching motor habits may be stronger than looking motor habits). Importantly, despite these fluctuations across tasks, important age-related changes still emerge (e.g., they both pass these task around the same age), which the reflection framework suggests can be accounted for via an underlying ability in representation and reflection.

Behne et al. 2005; Gergely and Csibra 2003; Gergely et al. 2002; Tomasello et al. 2005).

It is important to note that although children demonstrate behavior consistent with the representation of a false belief, it may be more of a byproduct of children's focus on goal-directed behavior and the new ability to describe the environment outside the immediate context. These abilities allow behavior to be explained at a lower level that focuses on associations between object, agents, and goals (see also Ruffman and Perner 2005). As previously noted, the fact that young 7-month-old children who cannot label still respond to others' "beliefs" (Kovács et al. 2010) may reflect an automatic response in regard to social stimluli, perhaps akin to recognition of quantities before infants have more sophisticated means to represent this domain-specific knowledge (see Apperly and Butterfill 2009). In the reflection model, children represent physical stimuli in the environment at a higher level, but are not yet aware of the beliefs of others that guide behavior (i.e., they do not label internal mental states).

3.2.3 Self-Consciousness

The emergence of self-consciousness characterizes the next LoC around 2 years of age. In this LoC, children's semantic labels or descriptions are now reprocessed at the next LoC and children consider these labels in relation to themselves (i.e., what they are able to do given their representation of the situation). Zelazo (2004) proposed that means-end behavior and the ability to follow a rule (i.e., if-then statement related to children's abilities) are characteristic of this period. Children are now aware of the relation between themselves and their representation of the environment, and this relationship drives control of behavior. Consequently, children can follow rules.

Once children are aware of how representations are related to themselves and their own abilities, it is likely that they appreciate the labels in relation to other individuals as well. For example, it is during this period that children begin to predict where agents will look in false belief anticipatory looking tasks (e.g., Southgate et al. 2007). Reflection based frameworks would hypothesize that children are aware of agents' representations, and may follow an if-then statement to determine behavior. Importantly, infants do not necessarily need to be aware how agent's representations correspond to reality (i.e., whether the representation is true or false) to use an if-then statement to predict behavior. Rather, the key development in this LoC is that infants are now aware of how representations relate to agents' control of behavior and children should be able to answer questions that correspond to the representation of the if-then statement (e.g., if the agent thinks the ball is here, where will he look?).

Abilities in pretend play and deception also emerge during this period (Carlson et al. 2004; Hughes and Ensor 2005, 2007; Leslie 1987, 1994). Leslie suggested that pretend play demonstrates early ToM abilities and the emergence of metarepresentation, which can likely be described in terms of the emergence of a higher LoC. Metarepresentation requires the ability to represent agents, reality, and pretense and the relationship between them in a pretend play. This may be accounted for in the LoC model through recursive consciousness (e.g., forming descriptions for agents or objects in reality, see Section 3.2.2) and self-consciousness (e.g., representing the self's abilities in relation to these descriptions). Although infants appreciate object based goals and desires earlier in life, the emergence of self consciousness may be the first time that toddlers are aware of and can represent internal mental states that guide behavior (i.e., they now label or have representations of their own or other's representations).

3.2.4 Reflective Consciousness I and II

Later in preschool (i.e., from 3 to 5 years of age) the two levels of reflective consciousness described in the CCC theory emerge (Zelazo 2004; Zelazo et al. 2003, see Section 1.2). In reflective consciousness I, 3-year-olds are able to sort cards by two rules, demonstrating their ability to reflect on the relationship between two rules constructed in self-consciousness (e.g., Zelazo and Reznick 1991). In reflective consciousness II, 4-year-olds can sort cards that vary on two dimensions flexibly in the DCCS (e.g., shape and color), demonstrating reflection on rule pairs in reflective consciousness I and understanding of a hierarchical rule structure (e.g., if color game then red goes here and blue goes there, but if shape game then squares go there and circles go here, Zelazo et al. 2003; Zelazo and Frye 1998).

With the emergence of reflective consciousness I, children are able to think flexibly according to two rules, which likely allows children to consider representations that guide behavior in multiple agents (e.g., the self and other). This may account for the findings that children appreciate diverse desires, beliefs, and knowledge-ignorance before explicit knowledge of false belief during this period (Wellman and Liu 2004). The explicit appreciation of these concepts requires children to represent internal states according to two rules, similar to performance within EF tasks. For example, questions regarding diverse beliefs requires children to reason according to two if-then statements: if an individual represents an object at location A then they will search at A, however if an individual represents an object at location B then they will search at B. Importantly, these abilities do not require the consideration of these rules in situations of reality and falsity, as in false belief tasks.

False belief understanding emerges with reflective consciousness II and the ability to represent sets of rules hierarchically and switch between setting conditions (e.g., Frye et al. 1995). Until this point, children were only able to consider beliefs in one context. For example, even though they appreciate that two people can hold different beliefs, these beliefs are only executed in one setting (i.e., when both agents are ignorant of the location). False belief understanding requires switching between settings of reality and falsity. When children consider agents' actions in settings of reality there can only be one rule (i.e., if in setting of reality, agent believes object is hidden at the location that corresponds to reality then searches there). However in settings of falsity, the agent is not restricted to beliefs that correspond to reality (e.g., if in setting of falsity and agent believes object is in a different location then search there). It is important to note that false belief tasks with infants do not explicitly require infants to consider this hierarchical rule structure. In infant tasks, they do not have to demonstrate knowledge of discrepant beliefs or switch between settings of reality and falsity. Therefore, it is conceivable that infants can pass looking time and implicit behavioral tasks on the basis of a lower level representation that guide behavior.

4 Framework Predictions and Consistency with the Developmental ToM-EF Relationship

4.1 A Reflection Based Account of Dissociations and Failures in ToM

The reflection framework provides an account that emphasizes the role of reflection and representational ability underlying the control of thought and behavior. Children are hypothesized to fail EF or ToM tasks when an automatic or habit-based response guides children toward the incorrect answer and they are unable represent or reflect upon information at a higher level to overcome this prepotent response. Although children are conscious from birth, it is possible for the information children are conscious of to be insufficient to guide behavior and cognition, resulting primarily in automaticity rather than conscious cognitive control over thought and action. This has been most clearly demonstrated in situations of rule execution and behavioral control. For example, Zelazo et al. (1996) demonstrated that children are able to state the postswitch rules on the DCCS (e.g., blue cards go in this box and red cards go in that box), but perseverate with the preswitch rule (e.g., shape) when asked to sort cards that vary on two dimensions. The reflection framework suggests that children who show this dissociation are aware of each pair of rules separately at a lower LoC and can answer questions when considering the rules individually (i.e., reflective consciousness I), but are unaware of the hierarchical structure and do not appreciate the relationship between the pairs of rules in the DCCS context (i.e., reflective consciousness II). When presented with cards that vary on both dimensions in the post-switch trial, the lack of awareness in rules structure make it difficult to appreciate that the cards can be represented and sorted on another dimension and results in difficulty overcoming the habitual response of sorting by the first rule.

The reflection framework can also explain similar patterns of dissociation in ToM. Table 2 applies the reflection framework to dissociations in false belief understanding by describing the ToM tasks that are passed, ToM ability necessary for the task, EF ability necessary for the task, and the ToM-EF relationship. As in the case of rule sorting paradigms, children are hypothesized to be aware of representations guiding agents' behavior at different LoC across childhood. For example, 3-year-olds can typically predict where multiple agents will search when the 3-year-old is ignorant (e.g., if the agent represents the object at location B they will search at B), but answer according to the prepotent response when asked where the agent will search when the agent's representation conflicts with reality (e.g., search where the object is according to their own perspective that corresponds to reality). According to reflection frameworks, children are aware that representations guide behavior, but unaware of the hierarchical structure (e.g., representations that guide behavior can be different in the context of reality and falsity). Further, although 2-year-olds may gaze to the correct location in a false belief tasks, this can be explained by an even lower LoC (self-consciousness) in which infants only need to represent the representations and goal-directed behavior in one agent (e.g., if the agent represents the object at location B they will search at B), but do not yet appreciate diverse beliefs and the knowledge-ignorance distinction. Finally, VOE false belief paradigms may operate in recursive consciousness where infants need to only label the objects that guide agent's behavior to perceive that action does not correspond to the agent's represented goal (e.g., if

Table 2 Description of LoC model applied to demonstrations of false belief

LoC (Age)	False belief ability	ToM ability necessary	EF ability necessary	Relationship between ToM and EF abilities
Recursive Consciousness (Year 1)	Pass VOE False Belief Tasks	Agent object associations Goal-directed behavior in others	Label agent object association (e.g., agent linked to object at location A), to overcome habit to look at last place object was seen	EF related to joint attention abilities
Self Consciousness (Year 2)	Demonstrate False Belief in Anticipatory Eye Movement Task	Acknowledge that agents form representations Intentionality	Reflect on one agent's representations and intentions (if agent represents object at B then will search at B), to overcome habit to look at last place object was seen	EF related to ToM Evidence for EF ➔ ToM
Reflective Consciousness I (Year 3)	Demonstrate diverse belief understanding	Distinguish between different forms of agent representations (e.g., beliefs, knowledge, and desires).	Reflect on two agent's representations and intentions at once, to overcome habit of answering the same for both agents	EF related to ToM Stronger evidence for EF ➔ ToM
Reflective Consciousness II (Year 4)	Demonstrate explicit false belief understanding	Link agent representations to reality	Reflect agent's representations in different contexts to allow for considerations of beliefs in contexts of reality and falsity, to overcome habit of responding only in situations of reality	EF related to ToM Stronger evidence for EF ➔ ToM

infants label the agent-object association at location B they will look longer if the agent searches elsewhere). Thus, the focus on LoC and corresponding habit in the HCSM provides a framework that explains EF and ToM in terms of the level of representation necessary to overcome a prepotent response in each task, and can account for situations in which children appear to demonstrate knowledge when tested in one context but seem to lack the same knowledge when tested in another context (see also Munakata 2001). It is important to note that although representational abilities are critical to ToM (and EF) in the reflection framework, this framework is more than a representational model of ToM. Consideration of the habit-based system combined with representational ability allows us to determine where children and even adults (see Apperly et al. 2010) go wrong, by identifying the habits influencing responses and representations necessary to overcome these habits.

Although the role of representation and reflection in the control of behavior is most apparent in situations involving conflict between the habit based and representational system, conscious representation and reflection are also necessary in the absence of conflict. For example, performance on explicit ToM tasks improves when there is little conflict (e.g., when the object driving behavior was absent rather than in a location that conflicts with false belief, Wellman et al. 2001), but a portion of children still fail. Children may fail due to a domain-general inability to form or reflect on rules. Although reducing the salience of reality may allow children to consider representations in a false context more easily, some children may still be unable to switch to a different setting condition. Conversely, it is possible to exhibit failure in domain-specific knowledge required for representing beliefs (e.g., Wellman et al. 2001). In support of the latter point, Wellman and Liu (2004) have demonstrated that abilities that are tested with similar rule structures (e.g., diverse desires, diverse beliefs, knowledge-ignorance) have slightly different onsets that also vary by culture (Wellman et al. 2006). In addition, Sabbagh et al. (2006) demonstrated that superior EF abilities in children from China do not translate to superior ToM compared to children from the U.S. This evidence suggests that domain-general processing in representation cannot entirely account for deficits in ToM performance. This is consistent with both reflection and emergence accounts of the ToM-EF relationship, which suggest that both EF and domain-specific ToM knowledge are required for ToM understanding. However, the fact that EF and ToM abilities correlate, even when EF ability is advanced (as with Chinese children), suggests that further studies must be conducted to understand the relationship between domain-general EF abilities and the acquisition of domain-specific ToM knowledge across cultures.

4.2 The Longitudinal ToM-EF Relationship

ToM and EF should be correlated across the lifespan to the degree that they share the same underlying representational requirements. From this perspective, the development of the ToM-EF relationship may fluctuate and appear interdependent, which conflicts with emergence accounts, expression accounts, and accounts that stress the importance of ToM to EF development. It is likely that the contributions of ToM to EF (and conversely EF to ToM) are dynamic across childhood and dependent on their relationship to the underlying representational ability. For example, early in life, ToM abilities may contribute more to the developing representational system (and indirectly predict EF) because recursive consciousness is thought to emerge when toddlers begin to label their environment, which is likely to develop within a social ToM context. Specifically, episodes of joint attention may provide the first instance in which children are aware of objects at a higher level as they label them for other people, and thus should be predictive of EF tasks requiring representations maintained in working memory. In the next LoC, self-consciousness, early ToM abilities in self-awareness would be predictive of EF tasks that require single rule use. There is preliminary evidence that EF is related to JA in the second year of life (e.g., Nichols et al. 2005) and ToM at age 2 predicts EF at age 4 (Hughes and Ensor 2007, but see Griffith et al. 1999 for a lack of JA ➔ EF relationship in preschoolers with autism), however further evidence is needed to support or refute these predictions. Conversely, there is a wide range of data on the ToM-EF relationship in preschool, much of which generally supports the reflection framework's characterization of the ToM-EF relationship (e.g., Frye et al. 1995; Hala et al. 2003). One consistent finding supporting emergence or expression accounts that may pose a problem for the reflection framework is the fact that several researchers have demonstrated that EF earlier in preschool predicts later ToM, but the reverse relationship is typically not true (e.g., Carlson et al. 2004; Hughes 1998a; Hughes and Ensor 2007; Pellicano 2010). However, as previously mentioned, the ToM-EF relationship likely changes across development. Although ToM and social developments may be important to early instances of representation and reflection, children may eventually learn to represent and reflect on information covertly in their environment and social support may play less of a role (e.g., Vygotsky 1978). This may lead to a reversal in the ToM-EF relationship, in which situations involving self control (EF measures) are now strongly related to the emergence of later LoCs because they provide children with the first instances in which they need to be aware of rules and rule structure. Specifically, domain-general EF predicts ToM because ToM involves domain-specific understanding of mental states in addition to reflection on rules and rule structures. Further, evidence supports the hypothesis that EF tasks requiring more complex rule structures in preschool are more strongly related to and predictive of ToM (Carlson et al. 2002; Carlson et al. 2004; Hala et al. 2003), although Carlson et al. (2004) found that EF tasks measuring response inhibition are also related to later ToM. Future work within a reflection framework should take care in identifying and isolating the representational (rule) structure necessary within each task.

4.3 The Role of Language in the ToM-EF Relationship

The reflection framework also proposes that language is critical in the development of the ToM-EF relationship, which is consistent with theories on EF (e.g., Jacques and Zelazo 2005a; b; Luria 1979), ToM (e.g., Astington and Baird 2005; Newton and de Villiers 2007), and the significant correlations between vocabulary and both EF and ToM (e.g., Carlson et al. 2004; Carlson and Moses 2001; Hughes 1998b; Hughes and Ensor 2005; 2007). In the LoC model, language initially plays a role in the emergence of the second LoC, recursive consciousness, characterized by the ability to represent and reflect on stimuli in one's environment by labeling it. It is likely that verbal labels become the most typical means for labeling and reflecting, thus emphasizing the strong link of language to EF and ToM (although see Section 3.2.2 for nonlinguistic means of representation). Labeling and recursive consciousness are necessary for the emergence of later LoCs. Further, linguistic ability continues to play a role throughout development because verbal labeling allows for reflection on the contents of consciousness at any level (not just reflection on objects in minimal consciousness). For example, representational accounts hypothesize that 3-year-olds improve on the DCCS when asked to label the relevant sorting dimensions (Kirkham et al. 2003) because it helps them reflect on rules represented in reflective consciousness I and appreciate the hierarchical structure typically achieved in reflective consciousness II (see Jacques and Zelazo 2005a; Miller and Marcovitch 2011; Müller et al. 2004 for other labeling manipulations in EF). Similarly, the fact that stating or depicting the protagonist's beliefs results in improved false belief performance (Wellman et al. 2001) is consistent with the hypothesis that verbal labels help children reflect on beliefs and consider how they guide behavior in contexts of reality and falsity. Finally, when the effects of language ability (and other control variables such as age) are partialed out, the strength of the ToM-EF relationship is attenuated (e.g., Carlson et al. 2004; Hughes and Ensor 2007). This is consistent with the reflection framework, suggesting that language ability within the representational system should partially mediate the ToM-EF relationship.

4.4 Competing Representational Theories of EF

Finally, although we have addressed competing theories specifically explaining the ToM and ToM-EF relationship, there are several relevant theories of representational ability and cognitive control that may identify avenues for further research distinguishing the role of representation in ToM, EF, and the ToM-EF relationship. For example, the ToM-EF relationship may also be accounted for by Munakata's (1998) active-latent representational account, which hypothesizes two types of memory traces form graded representations that guide behavior. Children rely on latent memory traces that are tied directly to the stimuli in the environment and are strengthened through repeated experience with these stimuli and active memory traces that are based in abstract representations of stimuli. Children's ability to maintain active representations relevant to the task is hypothesized to guide children's behavior toward controlled rather than habitual responses influenced by latent memory. Munakata's (2001) theory accounts for many dissociations in behavior and can be applied to dissociations in ToM. For example, the representations children rely on for earlier false belief tasks (e.g., looking time tasks) may not sufficient to guide behavior in more complex version of false belief task (e.g., Munakata 2001). Therefore, early evidence of false belief understanding may represent evidence of children's early mental state understanding that is not equivalent to older children's false belief understanding.

Perner et al. (1999) also propose a theory of executive inhibition stating that EF tasks require inhibition over competing responses. However, in some cases inhibition can be automatic, such as in the A-not-B task where stimuli result in a highly activated schema (after seeing object at B search at B) that automatically inhibits the competing response (search at A). Conversely, tasks such as the DCCS require executive inhibition because the stimuli (cards that represent both sorting dimensions) naturally activate the competing response, which children must actively inhibit to switch to the new sorting rule. Contrary to the reflection framework, Perner and colleagues (Perner and Lang 1999; Perner et al. 1999) propose a unidirectional model in which ToM predicts EF. Specifically, children must understand that mental states guide behavior before they can demonstrate executive inhibition.

Competing hypotheses between all three models may be tested within a verbal label paradigm. All of these theories focus on the representations that children form within ToM and EF tasks, and labeling allows one to manipulate the representations formed. For example, the reflection framework hypothesizes that generating a label of the contents of consciousness encourages children to reflect on their representations and should maximize the role of the representational system in the control of behavior (e.g., Marcovitch and Zelazo 2009; Zelazo 2004). The active-latent approach may suggest that although generating labels increases the strength of abstract active representations guiding behavior (e.g., Kharitonova et al. 2009), other manipulations (e.g., having the child and experimenter generate a label) may further strengthen the representation (see Miller and Marcovitch 2011). Finally, the executive inhibition account may hypothesize that labeling how mental states influence action in each paradigm (e.g., understanding the prepotent response conflicting with the correct behavior) would maximize performance. Further, the reflection framework may hypothesize that labeling the prepotent response may not influence habits formed or may even increase the likelihood of reflection and task success, whereas the active-latent account may predict that labeling the prepotent response may actually strengthen latent responses, thus making it more difficult to switch behavior (Yerys and Munakata 2006).

5 Conclusion

The current paper proposes a framework for a ToM-EF relationship from infancy to preschool focusing on children's developing representational ability and its role in the development of conscious control. The related LoC model (Zelazo 2004), HCSM (Marcovitch and Zelazo 2006, 2009), and CCC theory (Zelazo et al. 2003) together form a reflection framework that provides possible explanations for children's success, failure, and dissociations on ToM and EF tasks. We have argued for the importance of considering domain-general representational constraints to domain specific knowledge, which may provide insight into the nature of infants' representation on implicit ToM tasks and the role of reflection in both ToM and EF across childhood.

References

Alp, E. 1994. Measuring the size of working memory in very young children: The imitation sorting task. *International Journal of Behavioral Development* 17: 125–141.

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

Apperly, I.A., Carroll, D.J., Samson, D., Humphreys, G.W., Qureshi, A., and Moffitt, G. 2010. Why are there limits on theory of mind use? Evidence from adults ability to follow instruction from an ignorant speaker. *The Quarterly Journal of Experimental Psychology* 63: 1201–1217.

Astington, J.W., and J.A. Baird (eds.). 2005. *Why language matters for theory of mind*. Oxford: Oxford University Press.
Baillargeon, R., R.M. Scott, and Z. He. 2010. False belief understanding in infants. *Trends in Cognitive Science* 14: 110–118.
Behne, T., M. Carpenter, J. Call, and M. Tomasello. 2005. Unwilling versus unable: Infants' understanding of intentional action. *Developmental Psychology* 41: 328–337.
Bowler, D.M., J. Briskman, N. Gurvidi, and M. Fornells-Ambrojo. 2005. Understanding the mind or predicting signal-dependent action? Performance of children with and without autism on analogues of the false belief task. *Journal of Cognition and Development* 6: 259–283.
Bremner, A., and P. Bryant. 2001. The effect of spatial cues on infants' responses in the AB task, with and without hidden objects. *Developmental Science* 4: 408–415.
Buttelmann, D., M. Carpenter, and M. Tomasello. 2009. Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition* 112: 337–342.
Carlson, S.M. 2005. Developmentally sensitive measures of executive function in preschool children. *Developmental Neuropsychology* 28: 595–616.
Carlson, S.M., and L. Moses. 2001. Individual differences in inhibitory control and children's theory of mind. *Child Development* 72: 1032–1053.
Carlson, S.M., L.J. Moses, and H.R. Hix. 1998. The role of inhibitory processes in young children's difficulties with deception and false belief. *Child Development* 69: 672–691.
Carlson, S.M., L.J. Moses, and C. Brenton. 2002. How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development* 11: 73–92.
Carlson, S.M., D.J. Mandell, and L. Williams. 2004a. Executive function and theory of mind: Stability and prediction from ages 2 to 3. *Developmental Psychology* 40: 1105–1122.
Carlson, S.M., L.J. Moses, and L.J. Claxton. 2004b. Individual differences in executive function and theory of mind: An investigation of inhibitory control and planning ability. *Journal of Experimental Child Psychology* 87: 299–319.
Carpenter, M., K. Nagell, and M. Tomasello. 1998. Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development* 63: 1–174.
Carpenter, M., J. Call, and M. Tomasello. 2002. A new false belief test for 36-month-olds. *British Journal of Developmental Psychology* 20: 393–420.
Carruthers, P. 2009. How we know our own minds: The relationship between mindreading and metacognition. *The Behavioral and Brain Sciences* 32: 121–182.
Dawson, G., J. Munson, A. Estes, J. Osterling, J. McPartland, K. Toth, L. Carver, and R. Abbott. 2002. Neurocognitive function and joint attention ability in young children with autism spectrum disorder versus developmental delay. *Child Development* 73: 345–358.
De Bruin, L., D. Strijbos, and M. Slors. 2011. Early social cognition: Alternatives to implicit mindreading. *Review of Philosophy and Psychology* 3: 499–517.
Diamond, A., and B. Doar. 1989. The performance of human infants on a measure of frontal cortex function, the delayed response task. *Developmental Psychobiology* 22: 271–294.
Diamond, A., and P.S. Goldman-Rakic. 1989. Comparison of human infants and rhesus monkeys on Piaget's AB task: Evidence for dependence of dorsolateral prefrontal cortex. *Experimental Brain Research* 74: 24–40.
Diamond, A., M.B. Prevor, G. Callender, and D.P. Druin. 1997. Prefrontal cortex cognitive deficits in children treated early and continuously for PKU. *Monographs of the Society for Research in Child Development* 62: 1–206.
Frye, D., P.D. Zelazo, and T. Palfai. 1995. Theory of mind and rule-based reasoning. *Cognitive Development* 10: 483–527.
Frye, D., P.D. Zelazo, and J.A. Burack. 1998. Cognitive complexity and control: I. Theory of mind in typical and atypical development. *Current Directions in Psychological Science* 7: 116–121.
Garon, N., S.E. Bryson, and I.M. Smith. 2008. Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin* 134: 31–60.
Gergely, G., and G. Csibra. 2003. Teleological reasoning in infancy: The naïve theory of rational action. *Trends in Cognitive Science* 7: 287–292.
Gergely, G., H. Bekkering, and I. Kiraly. 2002. Rational imitation in preverbal infants. *Nature* 415: 755.
Gopnik, A., and J.W. Astington. 1988. Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Development* 59: 26–37.

Gopnik, A., and A.N. Meltzoff. 1997. *Words, thoughts, and theories*. Cambridge: MIT Press.
Gopnik, A., and H.M. Wellman. 1994. The theory theory. In *Domain specificity in cognition and culture*, ed. L. Hirschfield and S. Gelman, 257–293. New York: Cambridge University Press.
Griffith, E.M., B.F. Pennington, E.A. Wehner, and S.J. Rogers. 1999. Executive function in young children with autism. *Child Development* 70: 817–832.
Haith, M.M. 1998. Who put the cog in infant cognition? Is rich interpretation too costly? *Infant Behavior & Development* 21: 167–179.
Hala, S., and J. Russell. 2001. Executive control within strategic deception: A window on early cognitive development? *Journal of Experimental Child Psychology* 80: 112–141.
Hala, S., S. Hug, and A. Henderson. 2003. Executive function and false-belief understanding in preschool children: Two tasks are harder than one. *Journal of Cognition and Development* 4: 275–298.
Horobin, K., and L. Acredolo. 1986. The role of attentiveness, mobility history, and separation of hiding sites on stage IV search behavior. *Journal of Experimental Child Psychology* 41: 114–127.
Hughes, C. 1998a. Finding your marbles: Does preschoolers' strategic behavior predict later understanding of mind? *Developmental Psychology* 34: 1326–1339.
Hughes, C. 1998b. Executive function in preschoolers: Links with theory of mind and verbal ability. *British Journal of Developmental Psychology* 16: 233–253.
Hughes, C., and R. Ensor. 2005. Executive function and theory of mind in 2 year olds: A family affair? *Developmental Neruropsychology* 28: 645–668.
Hughes, C., and R. Ensor. 2007. Executive function and theory of mind: Predictive relations from ages 2 to 4. *Developmental Psychology* 43: 1447–1459.
Hutto, D.D., M. Herschbach, and V. Southgate. 2011. Editorial: Social cognition: Mindreading and alternatives. *Review of Philosophy and Psychology* 3: 375–395.
Jacques, S., & Marcovitch, S. 2010. Development of executive function across the lifespan. In *Cognition, biology, and methods across the lifespan*. *Volume 1 of the handbook of life-span development,* ed. W.F. Overton, pp. 431–466, Editor-in-chief: R.M. Lerner. Hoboken, NJ: Wiley.
Jacques, S., and P.D. Zelazo. 2005a. Language and the development of cognitive flexibility: Implications for theory of mind. In *Why language matters for theory of mind*, ed. J.W. Astington and J.A. Baird, 144–162. Oxford: Oxford University Press.
Jacques, S., and P.D. Zelazo. 2005b. On the possible roots of cognitive flexibility. In *The development of social understanding and communication*, ed. B.D. Homer and C.S. Tamis-Lemonda, 53–81. Mahwah: Erlbaum.
Kharitonova, M., S. Chien, E. Colunga, and Y. Munakata. 2009. More than a matter of getting "unstuck": Flexible thinkers use more abstract representations than perseverators. *Developmental Science* 12: 662–669.
Kirkham, N.Z., L. Cruess, and A. Diamond. 2003. Helping children apply their knowledge to their behavior on a dimension-switching task. *Developmental Science* 6: 449–476.
Kochanska, G., T. Tjebkes, and D. Forman. 1998. Children's emerging regulation of conduct: Restraint compliance, and internalization from infancy to the secondyear. *Child Development* 69: 1378–1389.
Kovács, A.M., E. Téglás, and A.D. Endress. 2010. The social sense: Susceptibility to others' beliefs in human infants and adults. *Science* 330: 1830–1834.
Lang, B., and J. Perner. 2002. Understanding of intention and false belief and the development of self-control. *British Journal of Developmental Psychology* 20: 67–76.
Leslie, A.M. 1987. Pretence and representation: The origins of "theory of mind". *Psychological Review* 94: 412–426.
Leslie, A.M. 1994. Pretending and believing: Issues in the theory of ToMM. *Cognition* 50: 211–238.
Lou, Y., and R. Baillargeon. 2010. Toward a mentalistic account of early psychological reasoning. *Current Directions in Psychological Sciences* 19: 301–307.
Low, J., and B. Wang. 2011. On the long road to mentalism in children's spontaneous false-belief understanding: Are we there yet? *Review of Philosophy and Psychology* 3: 411–428.
Luria, A.R. 1979. *The making of mind: A personal account of Soviet psychology*. Cambridge: Harvard University Press.
Luria, A.R., K.H. Pribram, and E.D. Homskaya. 1964. An experimental analysis of the behavioral disturbance produced by a left frontal arachnoidal endothelioma (meningioma). *Neuropsychologia* 2: 257–280.
Mangelsdorf, S.C., J.R. Shapiro, and D. Marzolf. 1995. Developmental and temperamental differences in emotion regulation in infancy. *Developmental Psychology* 66: 1817–1828.

Marcovitch, S., and P.D. Zelazo. 2006. The influence of number of A trials on 2-year-olds' behavior in two A-not-B-type search tasks: A test of the hierarchical competing systems model. *Journal of Cognition and Development* 7: 477–501.

Marcovitch, S., and P.D. Zelazo. 2009. A hierarchical competing systems model of the emergence and early development of executive function. *Developmental Science* 12: 1–25.

Mascaro, O., and Sperber, D. 2009. The moral, epistemic, and mindreading components of children's vigilance toward deception. *Cognition* 112: 367–380.

Meltzoff, A.N. 2007. 'Like me': A foundation for social cognition. *Developmental Science* 10: 126–134.

Meltzoff, A.N., and M.K. Moore. 1977. Imitation of facial and manual gestures by human neonates. *Science* 198: 75–78.

Meltzoff, A.N., A. Gopnik, and B. Repacholi. 1999. Toddlers' understanding of intentions, desires, and emotions: Explorations of the dark ages. In *Developing theories of intention: Social understanding and self-control*, ed. P. Zelazo, J. Astington, and D. Olson, 17–41. Mahwah: Erlbaum.

Miller, S.E., and S. Marcovitch. 2011. Toddlers benefit from labeling on an executive function search task. *Journal of Experimental Child Psychology* 108: 580–592.

Miyake, A., and N.P. Friedman. 2012. The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science* 21: 8–14.

Miyake, A., N. Friedman, M. Emerson, A. Witzki, A. Howerter, and T.D. Wager. 2000. The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology* 41: 49–100.

Moll, H., and M. Tomasello. 2007. How 14- and 18-month-olds know what others have experienced. *Developmental Psychology* 43: 309–317.

Moll, H., M. Carpenter, and M. Tomasello. 2007. Fourteen-month-olds know what others experience in joint engagement. *Developmental Science* 10: 826–835.

Moses, L.J. 2001. Executive accounts of theory-of-mind development. *Child Development* 72: 688–690.

Müller, U., P.D. Zelazo, S. Hood, T. Leone, and L. Rohrer. 2004. Interference control in a new rule use task: Age related changes, labeling, and attention. *Child Development* 75: 1594–1609.

Munakata, Y. 1998. Infant perseveration and implications for object permanence theories: A PDP model of the AB task. *Developmental Science* 1: 161–211.

Munakata, Y. 2001. Graded representations in behavioral dissociations. *Trends in Cognitive Sciences* 5: 309–315.

Mundy, P., and L. Newell. 2007. Attention, joint attention, and social cognition. *Current Directions in Psychological Science* 5: 269–274.

Mundy, P., J. Block, C. Delgado, Y. Pomarez, A.V. Van Hecke, and M.V. Parlade. 2007. Individual differences and the development of joint attention in infancy. *Child Development* 78: 938–954.

Newton, A.M., and de Villers, J.G. 2007. Thinking while talking: Adults fail nonverbal false-belief reasoning. *Psychological Science* 18: 574–579.

Nichols, K.E., N. Fox, and P. Mundy. 2005. Joint attention, self-regulation, and neurocognitive functions in toddlers. *Infancy* 7: 35–51.

Onishi, K.H., and R. Baillargeon. 2005. Do 15-month-old infants understand false beliefs? *Science* 308: 255–258.

Ozonoff, S., and R.E. McEvoy. 1994. A longitudinal study of executive function and theory of mind development in autism. *Development and Psychopathology* 6: 415–431.

Ozonoff, S., B.F. Pennington, and S.J. Rogers. 1991. Executive function deficits in high-functioning autistic individuals: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry* 32: 1081–1105.

Pellicano, E. 2010. Individual differences in executive function and central coherence predict developmental changes in theory of mind in autism. *Developmental Psychology* 46: 530–544.

Pelphrey, K., and J. Reznick. 2002. Working memory in infancy. *Advances in Child Development and Behavior* 31: 173–227.

Perner, J., and B. Lang. 1999. Development of theory of mind and executive control. *Trends in Cognitive Sciences* 3: 337–344.

Perner, J., and B. Lang. 2000. Theory of mind and executive function: Is there a developmental relationship? In *Understanding other minds: Perspectives from autism and developmental cognitive neuroscience*, ed. S. Baron-Cohen, H. Tager-Flusberg, and D. Cohen, 150–181. Oxford: Oxford University Press.

Perner, J., and T. Ruffman. 2005. Infants' insight into the mind: How deep? *Science* 308: 214–216.

Perner, J., S. Strummer, and B. Lang. 1999. Executive functions and theory of mind: Cognitive complexity or functional dependence? In *Developing theories of intention: Social understanding and self control*,

ed. P.D. Zelazo, J.W. Astington, and D.R. Olson, 133–153. Mahwah: Lawrence Erlbaum Associates, Inc.
Piaget, J. 1962. *Play, dreams, and imitation in childhood*. New York: Norton.
Repacholi, B.M., and A. Gopnik. 1997. Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology* 33: 12–21.
Ruffman, T., and J. Perner. 2005. Do infants really understand false belief? *Trends in Cognitive Science* 9: 462–463.
Rumsey, J.M. 1985. Conceptual problem-solving in highly verbal, nonretarded autistic men. *Journal of Autism and Developmental Disorders* 15: 23–36.
Rumsey, J.M., and S.D. Hamburger. 1990. Neuropsychological divergence of high-level autism and severe dyslexia. *Journal of Autism and Developmental Disorders* 20: 155–168.
Russell, J. 1996. *Agency: Its role in mental development*. Hove: Erlbaum.
Sabbagh, M.A., F. Xu, S.M. Carlson, L.J. Moses, and K. Lee. 2006. The development of executive functioning and theory of mind: A comparison of Chinese and U.S. preschoolers. *Psychological Science* 17: 74–81.
Scott, R.M., and R. Baillargeon. 2009. Which penguin is this? Attributing false belief about object identity at 18 months. *Child Development* 80: 1172–1196.
Scott, R.M., R. Baillargeon, H. Song, and A.M. Leslie. 2010. Attributing false belief about non-obvious properties at 18 months. *Cognitive Psychology* 61: 366–395.
Song, H., and R. Baillargeon. 2008. Infants' reasoning about others' false perceptions. *Developmental Psychology* 44: 1789–1795.
Southgate, V., A. Senju, and G. Csibra. 2007a. Action anticipation through attribution of false belief by 2-year-olds. *Psychological Science* 18: 587–592.
Southgate, V., C. van Maanen, and G. Cisbra. 2007b. Infant pointing: Communication to cooperation or communication to learn? *Child Development* 78: 735–740.
Southgate, V., C. Chevallier, and G. Cisbra. 2010. Seventeen-month-olds appeal to false belief to interpret others' referential communication. *Developmental Science* 13: 907–912.
Surian, L., S. Caldi, and D. Sperber. 2007. Attribution of beliefs by 13-month-old infants. *Psychological Science* 18: 580–586.
Tomasello, M., M. Carpenter, J. Call, T. Behne, and H. Moll. 2005. Understanding and sharing intentions: The origins of cultural cognition. *The Behavioral and Brain Sciences* 28: 675–735.
Van Hecke, A.V., P.C. Mundy, C.F. Acra, J.J. Block, E.F. Delgado, M.V. Parlade, J.A. Myers, A.R. Neal, and Y.B. Pomares. 2007. Infant joint attention, temperament, and social competence in preschool children. *Child Development* 78: 53–69.
Vygotsky, L.S. 1978. *Mind in society: The development of higher psychological process (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, trans).* Cambridge, MA: MIT Press (Original work published 1930–1935).
Wellman, H.M. 1990. *The child's theory of mind.* Cambridge: MIT Press, A Bradford Book.
Wellman, H.M. 2010. Developing a theory of mind. In *The Blackwell handbook of cognitive development*, ed. U. Goswami. Oxford: Blackwell.
Wellman, H.M., and D. Liu. 2004. Scaling of theory-of-mind tasks. *Child Development* 75: 523–541.
Wellman, H.M., D. Cross, and J. Watson. 2001. Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development* 72: 655–684.
Wellman, H.M., F. Fang, D. Liu, L. Zhu, and G. Liu. 2006. Scaling of theory-of mind understanding in Chinese children. *Psychological Science* 17: 1075–1081.
Wiebe, S.A., and P.J. Bauer. 2005. Interference from additional props in an elicited imitation task: When in sight, firmly in mind. *Journal of Cognition and Development* 6: 325–363.
Wiebe, S.A., Espy, K.A., and Charak, D. 2008. Using confirmatory factor analysis to understand executive control in preschool children: I. latent structure. *Developmental Psychology* 44: 575–587.
Wiebe, S.A., A.F. Lukowski, and P.J. Bauer. 2010. Sequence imitation and reaching measures of executive control: A longitudinal examination in the secondyear of life. *Developmental Neuropsychology* 35: 522–538.
Wiebe, S.A., T. Sheffield, J.M. Nelson, C.A.C. Clark, N. Chevalier, and K.A. Espy. 2011. The structure of executive function in 3-year-olds. *Journal of Experimental Psychology* 108: 436–452.
Wimmer, H., and J. Perner. 1983. Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition* 13: 103–128.
Woodward, A.L. 1998. Infants selectively encode the goal object of an actor's reach. *Cognition* 69: 1–34.
Yerys, B.E., and Y. Munakata. 2006. When labels hurt but novelty helps: Children's perseveration and flexibility in a card-sorting task. *Child Development* 77: 1589–1607.

Zelazo, P.D. 1996. Towards a characterization of minimal consciousness. *New Ideas in Psychology* 14: 63–80.

Zelazo, P.D. 2004. The development of conscious control in childhood. *Trends in Cognitive Science* 8: 12–17.

Zelazo, P.D., and D. Frye. 1998. Cognitive complexity and control: II. The development of executive function in childhood. *Current Directions in Psychological Science* 7: 121–126.

Zelazo, P.D., and S.J. Reznick. 1991. Age-related asynchrony of knowledge and action. *Child Development* 62: 719–735.

Zelazo, P.R., and P.D. Zelazo. 1998. The emergence of consciousness. In *Consciousness: At the frontiers of neuroscience: Advances in neurology*, vol. 77, ed. H.H. Jasper, L. Descarries, V.F. Castellucci, and S. Rossignol, 149–165. New York: Lippincott-Raven Press.

Zelazo, P.D., D. Frye, and T. Rapus. 1996. An age-related dissociation between knowing rules and using them. *Cognitive Development* 11: 37–63.

Zelazo, P.D., A. Carter, J.S. Reznick, and D. Frye. 1997. Early development of executive function: A problem-solving framework. *Review of General Psychology* 1: 198–226.

Zelazo, P.D., J.A. Burack, J.J. Boseovski, S. Jacques, and D. Frye. 2001. A cognitive complexity and control framework for the study of individuals with autism. In *Development and autism: Perspectives from theory and research*, ed. T. Charman, J.A. Burack, N. Yirmiya, and P.R. Zelazo, 195–217. Mahwah: Erlbaum.

Zelazo, P.D., S. Jacques, J.A. Burack, and D. Frye. 2002. The relation between theory of mind and rule use: Evidence from persons with autism-spectrum disorder. *Infant and Child Development* 11: 171–195.

Zelazo, P., U. Müller, D. Frye, and S. Marcovitch. 2003. The development of executive function in early childhood. *Monographs of the Society for Research in Child Development* 68: 1–137.