

How Does Children's Theory of Mind Become Explicit? A Review of Longitudinal Findings

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ABSTRACT—*How does theory of mind become explicit? In this article, we provide a brief overview of theoretical accounts and then review longitudinal findings on the development of theory of mind from infancy to the preschool years. Long-term predictive relations among conceptually related measures of implicit and explicit theory-of-mind reasoning support a conceptual continuity view of the transition from an implicit to an explicit understanding of the mind. We discuss alternative, minimalist accounts of infant psychological reasoning (e.g., two-systems models, submentalizing theory) and their implications for the development of theory of mind in light of the evidence. Longitudinal findings further support a developmental enrichment view of joint attention as a foundation of the theory of mind and early social interaction as a powerful mechanism in the development of this ability. Finally, we highlight the importance of longitudinal data for our understanding of conceptual development from infancy to the preschool years.*

KEYWORDS—*infancy; psychological reasoning; conceptual continuity*

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HOW DOES CHILDREN'S THEORY OF MIND BECOME EXPLICIT?

A 5-year-old who talks about what people *want* and *think* when predicting and explaining agents' actions articulates an explicit understanding of mental states, that is, a theory of mind. A 1-year-old who points to an event happening behind an adult's back to attract the adult's attention and interest may also possess a theory of mind, albeit an implicit one, that leads the infant to consider others' goals, intentions, knowledge, and beliefs in preverbal communicative interaction. Is there continuity from the 1-year-old's to the 5-year-old's mentalistic understanding of agency? If so, what needs to develop to make an implicit theory of mind explicit? Or does mindreading begin much later, with a slow and effortful acquisition of explicit mental state knowledge based on language and executive function? In this article, we review the contribution of recent longitudinal studies on the development of theory of mind to answering these fundamental questions. Before turning to the evidence, we briefly sketch the most important current theoretical views on the development of theory of mind from infancy to preschool age.

The Conceptual Continuity View

Explicit theory of mind is characterized by the attribution of beliefs and desires to agents. Desire reasoning precedes belief reasoning by about 2 years. Only around the age of 4 years do children begin to understand explicitly that an agent's beliefs can differ from reality and that beliefs, including false beliefs, are causally relevant for the agent's course of action (Wellman, Cross, & Watson, 2001).

The claim that infants possess an implicit theory of mind is based on a large body of evidence for psychological reasoning in the first and second years of life (Baillargeon, Scott, & Bian, 2016). Infants view others' actions as structured by intentions (Woodward, 2009). For example, when observing a hand reaching for and grasping one of two objects (e.g., a ball, not a bear),

infants as young as 5 months preferentially encode the action goal rather than the spatiotemporal properties of the reaching and grasping action (Woodward, 1998). By 6 months, they keep track of whether the agent who grasped one of the two objects could see both of the objects before choosing (Luo & Johnson, 2009), thus integrating information on agents' perception with goal representation. Starting around 9 months, infants engage in joint attentional interactions, attempting to align their own and their partner's goals and attention (Tomasello, 2018). In the second year, infants read others' intentions proficiently, for instance, when imitating a failed attempt or attempting to help an adult reach a goal (Meltzoff, 1995; Warneken, Gräfenhain, & Tomasello, 2012). Furthermore, results of some 30 studies that used looking time and anticipatory looking, as well as interactive paradigms, suggest that infants can take agents' *false beliefs* into account when forming action expectations (see Baillargeon, Scott, & He, 2010; Sodian, 2016, for reviews). For instance, 15-month-olds expected an agent to act consistently with her or his false belief in a violation-of-expectation paradigm (Onishi & Baillargeon, 2005), and 25-month-olds did so in an anticipatory-looking task (Southgate, Senju, & Csibra, 2007).¹

Interpreting these findings (Baillargeon et al., 2016), researchers have argued that infants have a system of mentalistic action prediction and explanation that is assumed to be conceptually continuous with a later explicit theory of mind. According to this account, 2- and 3-year-olds have a concept of belief but fail traditional false-belief tasks because of response generation and inhibitory demands of these tasks. In fact, in a recent study (Setoh, Scott, & Baillargeon, 2016), children as young as 30 months succeeded in a traditional false-belief task with reduced processing demands.

Two-Systems Views

While high-level (conceptual continuity) accounts propose that infants have a conceptual understanding of belief, two-systems views assume a rudimentary preconceptual (Perner & Roessler, 2012) form of implicit mental state representation in infancy that is restricted by signature limits (e.g., the capacity to represent relational rather than propositional attitudes; Butterfill & Apperly, 2013; Fiske, Butterfill, van de Loo, Reindl, & Rakoczy, 2017). Implicit false-belief processing is assumed to be fast and automatic but inflexible, while explicit processing is slower and effortful, and dependent on language but more flexible. Implicit and explicit mindreading systems may be relatively independent, based on different neurocognitive mechanisms, as is

suggested by findings on implicit mindreading deficits in adults with autism spectrum disorder who are competent in explicit theory-of-mind tasks (see Frith & Frith, 2008).

Developmental Enrichment Views

Developmental enrichment theories propose that theory of mind is rooted in infancy but involves developmental change. Critics of the conceptual continuity view have argued that infants' success on implicit false-belief tasks may not reflect mental state representation, but can be accounted for on a lower level, such as an implicit understanding of behavior that may come from innate capacities for statistical learning, together with biases for attention to eyes, faces, and human motion (Ruffman, 2014). Such an early understanding of action may develop into an explicit theory of mind through executive functions and language-based social interaction (e.g., Devine & Hughes, 2014; Ruffman, Perkins, & Taumoepeau, 2012). Shared intentionality theory emphasizes social and communicative interactions with others, rather than individual cognition as the source of developmental change; this theory traces the development of theory of mind from a beginning coordination of perspectives in joint attention in infancy to an explicit understanding of belief at pre-school age (Tomasello, 2018).

Submentalizing Theory

In a radically minimalist account, Heyes (2014) proposes that infants' performance on implicit false-belief tasks is the result of low-level perceptual features of stimuli (color, shape, or movement). Thus, implicit mindreading is not mindreading at all, but low-level perception-based *submentalizing*, relying on domain-general neurocognitive mechanisms. In this view, explicit theory of mind is not based on an earlier, preverbal, preconceptual form of mindreading, but it emerges, depending on language and executive function, in the third year of life.

Predictions from Theoretical Models

Conceptual continuity theory predicts both cross-sectional and longitudinal interrelations among conceptually related measures of mental state attribution. These relations should be independent of more general cognitive functioning or language ability. In particular, implicit and explicit false-belief understanding should be linked longitudinally. Similarly, developmental enrichment theories predict relations between theoretically relevant behaviors in infancy, such as gaze following, joint attention, or action imitation, and later explicit theory of mind (independent of general cognitive functioning). They also predict long-term effects of preverbal and verbal communicative interaction. Moreover, conceptual continuity and developmental enrichment theories are not mutually exclusive, since continuity on the conceptual level can coexist with enrichment processes. Two-systems theories are also consistent with longitudinal relations of preconceptual implicit responses in infancy and later explicit theory-of-mind reasoning. However, since different

¹A debate has arisen about infants' false-belief understanding because researchers have failed to replicate some findings of original studies on this topic. Whereas the authors of these studies attributed these replication failures mostly to procedural differences (Baillargeon, Buttelmann, & Southgate, 2018), critics have called into question the claim that infants have an implicit theory of mind (Poulin-Dubois et al., 2018). Researchers agree on the need for collaborative, large-scale replication studies that involve many labs and are conceptual, to measure infants' false-belief attribution.

neurocognitive processes are supposed to underlie implicit and explicit theory of mind, strong and systematic long-term longitudinal relations are not predicted. In contrast, submentalizing theory does not predict longitudinal relations of infants' and preschoolers' performance on theory-of-mind tasks.

In the remainder of this article, we review the longitudinal evidence for conceptual continuity and developmental enrichment theories of theory-of-mind development, which reveals some support for both models. Following the predictions of conceptual continuity theory, we look at longitudinal relations between conceptually related measures of mental state attribution. We then turn to specific predictions about the link of implicit and explicit false-belief understanding. With respect to developmental enrichment theories, we focus on predictions about the roots of theory of mind in joint attention and the role of mother-child interaction in the transition from an implicit to an explicit theory of mind.

LONGITUDINAL STUDIES OF THEORY-OF-MIND DEVELOPMENT

Conceptual Continuity: Infants' Reasoning About Goals, Beliefs, and Desires Predicts Explicit Theory-of-Mind Reasoning

A first wave of longitudinal studies, conducted more than 10 years ago, tested for predictive relations between infants' propensity to understand actions as goal directed and these children's false-belief understanding 3–4 years later. Researchers identified a long-term association between goal encoding in infancy and false-belief understanding at preschool age (Wellman, Lopez-Duran, LaBounty, & Hamilton, 2008; Wellman, Phillips, Dunphy-Lelii, & LaLonde, 2004). Reduced attention and differentiation between test trials in the goal-encoding task was associated with false-belief understanding 3 years later, independent of IQ, executive function, and language. Another study found similar results (Aschersleben, Hofer, & Jovanovic, 2008). Yet another study showed that the findings were domain specific: Goal encoding was associated with false-belief understanding, while physical reasoning in infancy was not (Yamaguchi, Kuhlmeier, Wynn, & Van Marle, 2009). These findings support the view of conceptual continuity from preverbal psychological reasoning in infancy to explicit verbal reasoning about mental states at 4–5 years, and suggest that such continuity is not mediated by language acquisition or the emergence of executive functions. However, these early longitudinal studies were limited because researchers studied only relations between developmental endpoints and addressed only one component of infant psychological reasoning—goal encoding.

In a more recent comprehensive longitudinal study, the Theory of Mind in Infancy and Early Childhood (TOMII/TOMEC) study, researchers assessed both social cognition and social responsiveness in infancy, then followed up with theory of mind, executive function, and language measures from 2 to 6 years

(Sodian & Kristen-Antonow, 2015; Sodian et al., 2016). These researchers identified associations over time between infant psychological understanding and later theory of mind. Goal encoding at 7 months, implicit false-belief understanding at 18 months, and desire reasoning at 24 months were all related to theory of mind, independent of verbal IQ (Sodian et al., 2016; see Figure 1).

One task in this study assessed belief and intention understanding in a morally relevant context: An accidental transgressor unintentionally caused damage to another child because of a false belief about a critical object (Killen, Mulvey, Richardson, Jampol, & Woodward, 2011). Infants' tendency at 7 months to encode a grasping action as goal directed and their tendency at 18 months to correctly anticipate an agent's action when the agent held a false belief about the location of an object were associated with 5-year-olds' evaluation of an accidental transgressor's intentions as positive. Intention understanding is a core aspect of both moral reasoning and theory of mind. In particular, the ability to infer an agent's positive or neutral intentions despite the negative consequences of his or her action is critical for moral judgment and psychological reasoning more generally. Thus, these findings indicate that central parts of social understanding in childhood may come from action understanding in infancy. Core elements of mentalistic reasoning, that is, reasoning about goals, beliefs, and desires in infancy, were related to explicit reasoning about intentions and beliefs in early childhood; this supports the idea that a mentalistic system of action prediction in infancy is developmentally continuous with a corresponding conceptual system in early childhood.

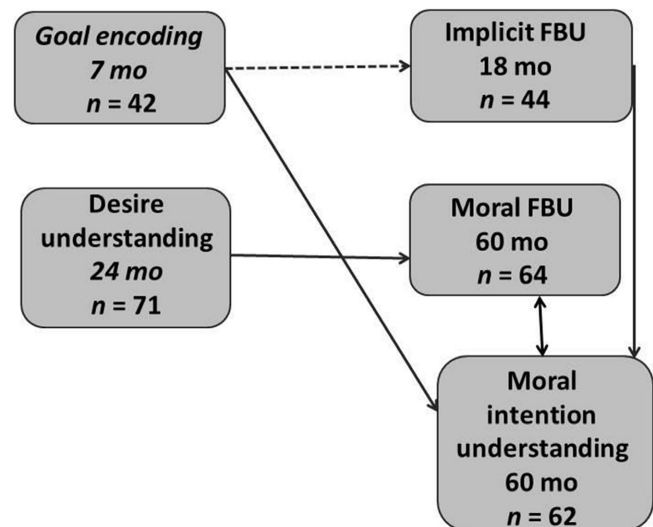


Figure 1. Longitudinal correlations among goal encoding, desire understanding, implicit false-belief understanding (FBU), explicit FBU, moral FBU, and moral intention understanding between 7 and 60 months of age (based on data from Sodian et al., 2016). Note. Controlling for verbal IQ 48 months, working memory 7 months, -- = $p < .10$; - = $p < .05$. - - = $p < .01$.

A high-level interpretation of infant psychological reasoning would further predict intertask correlations in infancy. Yet in the aforementioned study (Sodian et al., 2016), the representation of action goals had only a marginally significant correlation with false beliefs in infancy (independent of working memory). Similarly, in a separate study, intention understanding was associated with false-belief understanding in 14- to 18-month-olds (Yott & Poulin-Dubois, 2016). However, this was the only intertask correlation among intention, true belief, false belief, and desire understanding, indicating that mental state reasoning in infancy may be less well integrated than it is at preschool age. Furthermore, evidence supports convergent validity of different assessments of the same construct for goal encoding (Thoermer, Woodward, Sodian, Perst, & Kristen, 2013), but not for implicit false-belief understanding (Dörrenberg, Rakoczy, & Liszkowski, 2018).

Conceptual Continuity from Implicit to Explicit Understanding of False Belief

In the TOMII/TOMEK study, researchers found robust longitudinal relations, independent of verbal IQ, between an anticipatory-looking implicit false-belief task at 18 months and explicit false-belief tasks administered in yearly intervals at 4–6 years, as well as one belief-based intention task (Kloo, Kristen-Antonow, & Sodian, 2020; Sodian et al., 2016; Thoermer, Sodian, Vuori, Perst, & Kristen, 2012). Furthermore, implicit and explicit false-belief tasks differed in their relations to executive functions: While explicit false-belief understanding was associated with executive functions, implicit false-belief understanding did not correlate with either one of the executive function tasks administered at different points between ages 2 and 5 years (see Grosse Wiesmann, Friederici, Singer, & Steinbeis, 2017; Low, 2010, for similar findings). The relation of explicit false-belief understanding and executive functioning was independent of

implicit false-belief understanding. Furthermore, the correlation of implicit and explicit false-belief understanding was independent of both earlier and later measures of executive functioning (see Figure 2).

These findings support the idea that false-belief understanding is continuous from infancy to middle childhood and may be masked in 2- and 3-year-olds due to the processing demands of explicit tasks (Baillargeon et al., 2010). However, the sharp division between implicit and explicit false-belief processing with regard to executive functioning may be seen as inconsistent with the idea of a single neurocognitive mechanism and may be better accounted for by a (moderate) two-systems account.

The TOMII/TOMEK study is the only long-term longitudinal study that found correlations between implicit and explicit false-belief reasoning. In two recent studies, researchers found no longitudinal relations of performance in a violation-of-expectation false-belief task in infancy and explicit false-belief performance at 5 years, but one significant correlation of false-belief understanding in an interactive task in infancy and an understanding of diverse beliefs at 4–5 years (Poulin-Dubois, Azar, Elkaim, & Burnside, 2020). Similarly, with respect to concurrent or short-term longitudinal relations, the evidence is mixed. While one study (Low, 2010) found that explicit and implicit tasks were correlated, another (Grosse Wiesmann et al., 2017) reported no significant correlations. Thus, more longitudinal evidence, using more than one method to assess implicit false-belief understanding in infancy, is needed.

Developmental Enrichment: Joint Attention as a Foundation of Theory of Mind

Declarative joint attention in preverbal communication, which carries information about or attitudes toward an object or event, involves a rudimentary representation of another person's current state of information, that is, an implicit theory of mind

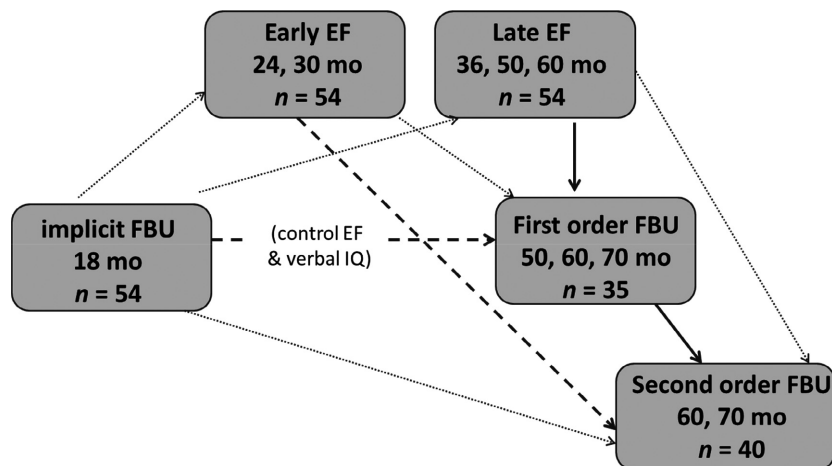


Figure 2. Longitudinal correlations among implicit false-belief understanding (FBU), explicit FBU, and executive functioning (EF) between 18 and 70 months of age (based on data from Kloo et al., 2020). Note. = $p > .05$; – = $p < .05$; - = $p < .01$.

(Camaioni, Perucchini, Bellagamba, & Colomesi, 2004). In experimental work on informative pointing, 1-year-olds conveyed information depending on whether an adult was knowledgeable or ignorant about the location of an object, thus indicating a representation of the other's epistemic state (Liszkowski, Carpenter, & Tomasello, 2008).

Few longitudinal studies of joint attention and theory of mind have spanned the age range from infancy to 4 or 5 years. In two studies, infants' comprehension of gaze (Brooks & Meltzoff, 2015) or pointing (Kristen, Sodian, Thoermer, & Perst, 2011) at 9–10 months was associated with the production of mental state language at 2–3 years, independent of general language abilities. In the first study (Brooks & Meltzoff, 2015), mental state language at 30 months, in turn, was related to theory-of-mind reasoning at 4½ years, independent of control variables. These findings suggest that a preverbal implicit representation of mental states in joint attention may be accessed explicitly only when mental state terms are available, which may be a crucial factor in developing a representational theory of mind.

However, in the TOMII/TOMEC study, a direct path from joint attentional skills at 12 months to false-belief understanding at 50 months emerged, independent of mental state language: Declarative point production (in which infants pointed to an object out of the experimenter's sight) at 12 months predicted false-belief understanding at 50 months, independent of imperative pointing (in which infants demanded an object from an experimenter) and more general cognitive functioning. Although both mirror self-recognition and level 1 visual perspective taking were also associated with joint attention, the relation of declarative pointing and later false-belief understanding was not mediated by these correlates (Sodian & Kristen-Antonow, 2015). The specificity of declarative joint attention as a precursor to theory of mind was also seen on the neural level (Kühn-Popp, Kristen, Paulus, Meinhardt, & Sodian, 2016). Thus, perspective-taking abilities appear to be rooted in joint attention (see Moll & Meltzoff, 2011).

Developmental Enrichment: Early Social Interaction and Theory of Mind Development

How do engagement experiences in joint attentional episodes promote the development of theory of mind in children? According to shared intentionality theory (Tomasello, 2018), sharing information and emotion from different perspectives in preverbal declarative joint attention, which is followed by language-based interactions that involve the expression of different perspectives or attitudes toward a situation or an event, lead eventually to a reflective understanding of one's own or others' misrepresentations of reality.

Toddlers' joint engagement experiences with their mothers were related to preschoolers' theory-of-mind abilities (Nelson, Adamson, & Bakeman, 2008). Higher false-belief scores at preschool age were associated with more time in coordinated joint engagement at 18–21 months, and in symbol-infused joint engagement at 27–30 months, independent of language

comprehension. Even at 10 months, looking-time responses in a goal-encoding task were related to infants' engagement in joint attention in a mother–infant play session (Brune & Woodward, 2007). In the TOMII/TOMEC study, as early as 7 months, looking times in a goal-encoding task were related to maternal emotional availability, assessed in mother–infant play interaction, independent of children's temperament, infants' working memory, and maternal education (Licata et al., 2014). Longitudinally, mothers' emotional availability when their infants were 7 months was associated with children's theory-of-mind abilities at 4 years, when controlling for children's temperamental and cognitive characteristics, as well as mothers' emotional availability at 4 years (Licata, Kristen, & Sodian, 2016). Further analyses revealed that maternal cognition talk when children were 24 months mediated the influence of early emotional availability on false-belief understanding at preschool age (Kristen-Antonow, Licata-Dandel, Müller, & Sodian, 2018). Thus, highly emotionally available mothers may promote their toddlers' engagement by adapting to the cognitive needs of the children by using cognitive language to highlight perspectives and thereby promote theory-of-mind abilities (Slaughter, Peterson, & Carpenter, 2009). In summary, recent longitudinal evidence indicates that infants' early interaction experiences with their caregivers affect children's development of theory of mind, and that this impact is largely mediated by caregivers' use of mental state language in interactions with their toddlers.

CONCLUSIONS

The longitudinal evidence we reviewed in this article supports the idea that a mentalistic system of action prediction in infancy is conceptually continuous with an explicit theory of mind at preschool age. Goal encoding, declarative joint attention, and implicit false-belief understanding, as well as desire reasoning in infancy were associated, individually and jointly, with explicit theory-of-mind abilities at preschool age, independent of more general cognitive functioning. In particular, the link between implicit and explicit false-belief understanding was not only independent of verbal ability but also of executive functioning. These findings are consistent with a high-level conceptual continuity account, but also with the view that a preconceptual implicit mindreading system precedes an explicit theory of mind. They also provide evidence against strictly nonmentalistic accounts of infant psychological reasoning. Longitudinal evidence further supports developmental enrichment theories that propose joint attention as the foundation of theory-of-mind development and shared intentionality in caregiver–child interaction as a powerful mechanism. However, we still lack longitudinal evidence on implicit-to-explicit theory-of-mind development. Longitudinal data are needed to resolve controversies on foundational issues of the development of mindreading, and they can help us understand interrelations among fundamental processes of social cognitive development.

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