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INVITED CONTRIBUTION

Theory of Mind in Infants and Young Children: A Review

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Theory of mind, or mindreading, refers to our uniquely human capacity to infer what is in other people's minds. Recent research suggests that "implicit" elements of this ability can be seen as early as the second year of life, in infants' spontaneous helping, communicative, and eye-gaze behaviours. More "explicit" verbally mediated mindreading skills emerge in the preschool period, and these are positively linked to social competence. Research with typically developing children as well as those with autism spectrum disorders suggests that exposure to conversation about mental states promotes theory of mind development.

Key words: childhood; infancy; mindreading; review; theory of mind; review.

Social cognition in humans is uniquely complex. Unlike other mammals that respond primarily to each other's external behaviours, we look deeper into each other's minds in order to understand one another. For instance, if we meet an acquaintance whose father has recently died, we recognise that lagging behind the conversation and "missing" the jokes are unintentional behavioural consequences of her underlying sadness. Throughout our everyday social interactions, we keep track—consciously and unconsciously—of what other people feel, want, and believe. This is referred to as mindreading, or using our theory of mind. It is a fundamental skill that helps us to understand and get along with other people.

Theory of Mind in Infancy

Up until the late 1990s, most psychologists believed that children became capable of mindreading between the ages of 3–5 years, because that is when the vast majority of typically developing children begin to pass tests assessing their ability to identify someone's mental state (Gopnik & Slaughter, 1991; Wellman, Cross, & Watson, 2001). Whether or not infants and toddlers also have a theory of mind was largely a theoretical debate. But recent research suggests that infants and toddlers possess "implicit" mindreading capacities. Although they cannot explicitly declare what someone else wants or knows, very young children's spontaneous helping and pointing, and their eye-gaze patterns, reveal that they have some insight into other people's minds.

For instance, in one experiment, 12- to 18-month-old infants watched an adult write on a piece of paper with a marker. The marker dropped off the table, unseen by the adult, who began to search randomly for it. Already on the floor were some other items, yet the infants consistently ignored these distractors while pointing at or retrieving the marker for the adult (Liszkowski, Carpenter, Striano, & Tomasello, 2006). This showed that 1-year-olds could work out the specific item that the adult had in mind. In another experiment, 18-month-old infants watched two adults playing with two toys. The toys were put on a shelf and one of the adults left the room. The remaining adult then brought out a new toy, played with it and then put it on the shelf as well. The first adult returned to the room and pointed towards the three toys on the shelf, saying "Oh look! Give it to me please!" In response, the infants retrieved the new toy—the one that particular adult had not yet played with. This shows that the infants interpreted the adult's pointing in terms of what she thought was new and interesting (Moll & Tomasello, 2007).

Another "implicit" aspect of mindreading is anticipating someone's intentions and their resulting behaviour. For instance, if you know your friend likes tomato sauce on his hot chips, then as you sit down to eat, you are likely to shift your eyes to the sauce bottle, anticipating his mental state as well as his next move. Recent eye-tracking research shows that 25-month-olds anticipate in this way, and furthermore, they can anticipate a person's next move even if that person is actually mistaken. In the eye-tracking study, toddlers watched a video in which an actor placed his toy in a box. When the actor was not looking, the toy was moved to a different box. Upon the actor's return, the toddlers anticipated his next move and looked immediately to the first box, where the actor still thought his toy was located (Southgate, Senju, & Csibra, 2007). This experiment shows unmistakable mindreading because the toddlers anticipated the actor's behaviour based on his false belief, rather than on the physical location of the toy. A study using precisely the same set up showed that 6- to 8-year-old children with an autism spectrum disorder (ASD) failed to anticipate the actor's next move; they did not reliably look to the box where the actor thought the toy was (Senju et al., 2010). The same pattern has been observed in adults with ASD (Schneider, Slaughter, Bayliss, & Dux, 2013; Senju, Southgate, White, & Frith, 2009). These findings indicate that implicit,

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Table 1 Six Tests That Make Up the Theory of Mind Scale. Research Shows That Australian, American and European Children Acquire These Concepts Sequentially from Diverse Desires to Sarcasm (from Peterson et al., 2012)

Test	Theory of mind concept assessed	Proportion of 3- to 7-year-old children who pass (%)
Diverse desires	Different people may like and want different things.	92
Diverse beliefs	Different people can hold different beliefs about the same thing.	87
Knowledge access	People who see something also know about it; if they do not see, then they do not know.	85
False belief	People do things based on what they think, even if they are mistaken.	56
Hidden emotion	People can deliberately conceal emotions by facial expression management.	33
Sarcasm	In order to be humorous, people sometimes say the opposite to what they really mean.	23

nonverbal mindreading is disrupted in individuals with ASD, along with, and perhaps contributing to, the more explicit social and communicative problems characteristic of this group.

Mindreading in Young Children

Soon after children begin to use language, they also begin to talk about what is in their own and other people's minds. By the age of 4 years, up to 10% of typical children's utterances make reference to mental states using terms like *want*, *think*, *know*, *pretend*, and *dream* (Furrow, Moore, Davidge, & Chiasson, 1992; Shatz, Wellman, & Silber, 1983). Perhaps surprisingly, among verbally able children with ASD, the spontaneous production of mental state terms is about equivalent to that of typical peers (Bang, Burns, & Nadig, 2013). Children's capacity to talk about mental life is the basis of a wide variety of explicit, verbal tests of mindreading. The standard paradigm involves describing a social scenario, sometimes using cartoons or puppets, and then asking test questions about what the protagonists feel, want, or know, or what they will do next. A subset of these tests has recently been made into a developmental scale. Research using the Theory of Mind Scale has revealed that Australian, North American, and European 3- to 8-year-olds gradually master different mindreading concepts in a reliable sequence, as outlined in Table 1 (Peterson, Wellman, & Liu, 2005; Peterson, Wellman, & Slaughter, 2012). This developmental pattern differs slightly among children in China and Iran, who reliably pass the knowledge access task before the diverse beliefs task (Shahaeian, Peterson, Slaughter, & Wellman, 2011). These cross-cultural differences in mindreading development may be related to Western versus non-Western families' socialisation practices. In Australia, children with ASD tend to pass mindreading tasks at a later age and also in a slightly different sequence from their typically developing peers, by mastering hidden emotion before false belief (Peterson et al., 2012). This finding reinforces the long-held conclusion that false belief is a particularly difficult concept for people with an ASD.

Individual Differences in Mindreading—Implications for Children's Social Lives

Within the reliable developmental sequence outlined in Table 1, children vary in the ages at which their mindreading skill emerges. For instance, in the same preschool class, one child may pass only the diverse desires task while another passes all tasks up to hidden emotion. These individual differences have been linked to some specific consequences for children's everyday social life. Although the effects are typically small, children who perform relatively well on theory of mind tests also tend to have relatively sophisticated social skills and effective social relationships in their daily lives.

For instance, studies have shown that mindreading is related to social competence in 3- to 8-year-old children. That is, those children who are good at working out what others feel, want, and think are nominated by their teachers and/or peers as being most popular (Slaughter, Imuta, Peterson, & Henry, under review) and socially mature (Peterson, Slaughter, & Paynter, 2007). It is important to note that these findings are correlational, so we do not know if acquiring a theory of mind early causes children to be socially competent and popular, or if those qualities put them in the best position to develop their mindreading skills.

Other studies indicate that 3- to 8-year-old children who perform well on theory of mind tests are skilled communicators, being particularly good conversationalists (de Rosnay, Fink, Begeer, Slaughter, & Peterson, 2013), adept at coming up with arguments to persuade someone to do something (Slaughter, Peterson, & Moore, 2013), and convincing liars (Talwar & Lee, 2008). This third point highlights that mindreading enables children to participate effectively in a wide range of social interactions, including potentially negative ones. Acquiring a theory of mind does not necessarily make for a well-adjusted child; indeed, more than one study has revealed that playground bullies, who are often somewhat popular as well as being feared for their manipulative and aggressive interpersonal tactics, generally do well on theory of mind tests (Gasser & Keller, 2009). Mindreading helps children to understand their social world, but it appears that individual children's temperament and life experiences, among other things, determine how they use that understanding.

Individual Differences in Theory of Mind—Where Do They Come from?

Although it is human nature to look past external behaviour and into each other's minds, the few genetic studies on theory of mind development to date suggest that nurture is a more important determinant of individual differences. For instance, a

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behaviour genetic study comparing 1,116 monozygotic and dizygotic 5-year-old twin pairs revealed that the majority of individual variation in the children's mindreading was attributable to environment rather than to genes (Hughes et al., 2005). This finding contrasted with an earlier, smaller scale study of 3-year-old twins, which revealed significant genetic influences on mindreading (Hughes & Cutting, 1999). More research is necessary to reconcile these findings; however, one possibility is that genes play a role in early theory of mind development, but by the age of 5 years, children's mindreading is shaped primarily by their personal experiences.

One environmental variable that is crucial for theory of mind development is the regular exposure to language and conversations about mental states (Dunn & Brophy, 2005). This may explain the finding that preschool-aged children with one or more siblings at home have an advantage in mindreading relative to only children (McAlister & Peterson, 2006; Perner, Ruffman, & Leekam, 1994). The hypothesis is that siblings are a constant source for learning about others' mental perspectives. In the daily course of teasing, instructing, comforting, disagreeing, playing tricks, and arguing, brothers and sisters provide exposure to others' mental states. For children with ASD, the presence of siblings is less straightforward: A recent study indicated that the presence of one or more older, but not younger siblings, was associated with ASD-diagnosed children performing relatively poor on mindreading tests (O'Brien, Slaughter, & Peterson, 2011). This finding requires further investigation, but one interpretation is that older brothers and sisters may well meaningly "protect" their younger sibling with ASD by refraining from conflictual interactions such as arguing or teasing, which are actually valuable for acquiring a theory of mind.

The most well-documented environmental influence on children's mindreading is their parents' propensity to talk about the mind. Observational and experimental studies indicate that the more frequently parents discuss and explain what they and others feel, want, and think, the better their children understand those concepts. This has been shown in disciplinary encounters (Ruffman, Perner, & Parkin, 1999; Shahaeian, Nielsen, Peterson, & Slaughter, 2014), mutual reminiscences (Taumoepeau & Reese, 2013), and book-reading (Adrian, Clemente, Villanueva, & Rieffe, 2005; Slaughter, Peterson, & MacKintosh, 2007) as well as in everyday family conversation (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991). It is important to note that the positive link between children's theory of mind and parents' talk about mental states extends to children with ASD (Slaughter et al., 2007). While not yet translated into formal interventions, training studies have shown that exposure to such talk boosts mindreading skill in typically developing children (Guajardo & Watson, 2002). Therefore, parents should be encouraged to take the time to discuss feelings and thoughts with their young children; not only will it make for engaging conversation, but it is likely to benefit their children's theory of mind.

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