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## Connecting the dots from infancy to childhood: A longitudinal study connecting gaze following, language, and explicit theory of mind



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### ABSTRACT

This longitudinal study tested the same children at three time points: infancy (10.5 months of age), toddlerhood (2.5 years of age), and early childhood (4.5 years of age). At 10.5 months, infants were assessed experimentally with a gaze-following paradigm. At 2.5 years, children's language skills were measured using the MacArthur–Bates Communicative Development Inventories. At 4.5 years, children's explicit theory of mind was assessed with a standard test battery. Analyses revealed that infants with higher gaze-following scores at 10.5 months produced significantly more mental-state words at 2.5 years and that children with more mental-state words at 2.5 years were more successful on the theory-of-mind battery at 4.5 years. These predictive longitudinal relationships remained significant after controlling for general language, maternal education, and nonsocial attention. The results illuminate the bridging role that language plays in connecting infants' social cognition to children's later understanding of others' mental states. The obtained specificity in the longitudinal relations informs theories concerning mechanisms of developmental change.

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## Introduction

By 4 or 5 years of age, children exhibit an explicit understanding of the representational nature of beliefs (e.g., [Gopnik & Astington, 1988](#); [Perner, 1991](#); [Wellman, Cross, & Watson, 2001](#)). At younger ages, they understand interrelationships among perception, desire, and intentional action, which are also integral to the development of a “theory of mind” (ToM) or “mentalizing” (e.g., [Flavell, 2004](#); [Meltzoff, 1995](#); [Repacholi & Slaughter, 2003](#); [Wellman, Phillips, & Rodriguez, 2000](#); [Williamson, Brooks, & Meltzoff, 2013](#)). In this article, we focus on even earlier development—infant gaze following and children’s talk about the mind. Studying gaze following and its downstream effects provides insights into mechanisms of change in development and also informs discussions about the early identification and treatment of children with autism spectrum disorders who have deficits in gaze following ([Jones & Klin, 2013](#); [Mundy, Sullivan, & Mastergeorge, 2009](#); [Toth, Munson, Meltzoff, & Dawson, 2006](#)). Here, we report a longitudinal study with typically developing children that connects the dots between early gaze following, mental-state language use, and later ToM as measured by a standard test battery ([Wellman & Liu, 2004](#)).

At a theoretical level, gaze following has been argued to relate to a child’s concept of mind via at least two routes. First, it has been thought of as a front-end ability that triggers or enables further growth along the ToM trajectory ([Baron-Cohen, 1995](#)). Second, gaze following promotes early word learning ([Baldwin, 1993, 2000](#); [Brooks & Meltzoff, 2005, 2008](#); [Carpenter, Nagell, & Tomasello, 1998](#)), and this verbal advantage has been argued to support and engender perspective taking and mentalizing. On the other hand, it has been suggested that infant gaze following may be unrelated to conceptualizing mental states because gaze following during early infancy could simply be an orienting response to physical movement or spatial cues (e.g., [Corkum & Moore, 1998](#); [Doherty, 2006](#); [Doherty & Anderson, 1999](#)).

### *Understanding visual perception and ToM*

Children’s understanding of visual perception is a key aspect of their grasp of others’ mental states (e.g., [Gopnik & Astington, 1988](#); [Lohmann & Tomasello, 2003](#); [Meltzoff & Brooks, 2008](#); [Pratt & Bryant, 1990](#); [Wellman et al., 2000](#)). Intervention studies provide the strongest evidence; training preschoolers on perception tasks improves their understanding of false belief ([Slaughter & Gopnik, 1996](#)). It may be that learning about other people’s visual perception (which has a bodily component in terms of head and eye direction) gives children leverage to understand deeper, less visible mental states such as beliefs.

A nascent reaction to the direction of people’s gaze begins during early infancy. At 6 to 9 months of age, infants turn in the same direction that a person orients ([Butterworth & Jarrett, 1991](#); [Corkum & Moore, 1998](#); [Gredebäck, Fikke, & Melinder, 2010](#)). By 9 to 12 months of age, infants connect the looker to a focal object ([Carpenter et al., 1998](#); [Johnson, Ok, & Luo, 2007](#); [Sodian & Thoermer, 2004](#); [Woodward, 2003](#)). By 10 to 12 months of age, infants selectively follow the head turns of a person who has open eyes more often than closed eyes, suggesting that infants recognize that people see with their eyes and that infants are not simply responding to salient head movement cues ([Brooks & Meltzoff, 2002](#)). By 12 to 18 months of age, a randomized control training study demonstrated that infants use their own visual experiences (with a visual barrier) to interpret when another person can and cannot see an object ([Meltzoff & Brooks, 2008](#)), providing strong evidence for construing gaze in a mentalistic framework.

### *Language development and ToM*

Children’s language has consistently been shown to influence ToM development ([Milligan, Astington, & Dack, 2007](#); [Peterson, Wellman, & Liu, 2005](#)). Many of children’s conversations with adults and peers concern mental states ([de Rosnay & Hughes, 2006](#)). Based on their social interactions in everyday settings, children increase their mental-state vocabulary and enrich their understanding of others’ desires, emotions, and beliefs ([Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991](#);

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