Reaching the goal: Active experience facilitates 8-month-old infants' prospective analysis of goal-based actions

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ABSTRACT

From early in development, infants view others' actions as structured by intentions, and this action knowledge may be supported by shared action production/perception systems. Because the motor system is inherently prospective, infants' understanding of goal-directed actions should support predictions of others' future actions, yet little is known about the nature and developmental origins of this ability, specifically whether young infants use the goal-directed nature of an action to rapidly predict future social behaviors and whether their action experience influences this ability. Across three conditions, we varied the level of action experience infants engaged in to determine whether motor priming influenced infants' ability to generate rapid social predictions. Results revealed that young infants accurately generated goal-based visual predictions when they had previously been reaching for objects; however, infants who passively observed a demonstration were less successful. Further analyses showed that engaging the cognitively based prediction system to generate goal-based predictions following motor engagement resulted in slower latencies to predict, suggesting that these smart predictions take more time to deploy. Thus, 8-month-old infants may have motor representations of goal-directed actions, yet this is not sufficient for them to predict others' actions; rather, their own action experience supports the ability to rapidly implement knowledge to predict future behavior.

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Introduction

Infants learn from the rich interactions they engage in with others, building both their physical and social abilities to become adept social partners. Social interactions play out rapidly in real time, and they often demand not only making sense of one's partner's actions but also doing so prospectively and quickly enough to generate an appropriate verbal or behavioral response. To facilitate the continuation of a successful interaction, social partners must attend to each other's intentions and then deploy their understanding to anticipate and respond quickly to the partner's next actions. For example, if you know that your female friend prefers salty food, then you can use this knowledge to predict that she wants to add salt to her meal. But this knowledge is helpful only if you are able to implement it quickly enough to generate a socially savvy behavioral response (i.e., passing her the salt before she requests it). In contrast, if you anticipate that your friend wants salt only as she is about to grasp the salt shaker, then you have not been a very helpful dinner companion. In this example, the understanding of another person's intentions is equally important as the ability to use this knowledge in real time to generate a prediction. The current study examined the emergence of prospective social reasoning and its relation to infants' own action experience.

The ability to anticipate the outcomes of others' actions emerges early in life. Under some conditions, by 8 months of age infants look ahead to anticipate the endpoint of others' reaching actions, moving their gaze to the target object before the reaching hand makes contact, although this ability becomes more robust later in life (Gredebäck & Melinder, 2010; Henrichs, Elsner, Elsner, Wilkinson, & Gredebäck, 2013; Kanakogi & Itakura, 2010; Kochukhova & Gredebäck, 2010; Paulus, 2011). Infants also show covert shifts in attention in response to observed actions, for example, shifting attention in the direction implied by a still photo of a reaching or pointing hand (Bertenthal, Boyer, & Harding, 2014; Daum, Ulber, & Gredebäck, 2013; Rohlfing, Longo, & Bertenthal, 2012). They also visually predict the outcome of familiar movements with tools, for example, looking to the mouth when seeing a person grasp a cup or to the ear when seeing a person grasp a phone (Hunnius & Bekkering, 2010). Furthermore, by 9 months of age, infants can anticipate the target of a reaching action based on kinematic cues in the hand that correspond to the shape or orientation of the target object (Ambrosini et al., 2013; Filippi & Woodward, 2016). These responses play out at different timescales during online action observation, and they seem to be tuned to human, goal-directed actions (Gredebäck & Daum, 2015; Krogh-Jespersen & Woodward, 2016). Taken together, these findings reveal that infants not only are attentive to the details of others' actions but also are skilled at using the physical information present in an action, including movement trajectory, hand posture, and the presence of tools associated with particular targets, to anticipate action outcomes.

Here we considered infants' ability to recruit another source of information to support action prediction, namely information about a person's prior goals. The actions of a social partner over time can provide information about the partner's goals that can support adaptive predictions about her or his likely next actions. In the previous dinner companion example, if your friend has begun reaching in the direction of the salt shaker, then her motor behavior provides fairly obvious cues regarding her goal. However, if she is opening and closing kitchen cabinets, then this may be more ambiguous as to what the goal of her search is; herein lies the opportunity for you to act on your knowledge of her love for salty food and pass her the salt shaker. Although goal-based predictions can occur in the context of motor and movement cues, they can in principle occur independent of these cues. Goal-based predictions require an analysis of a person's prior actions and the generation of predictions based on the current context, and these cognitive demands are likely to make such predictions particularly challenging for infants (Krogh-Jespersen & Woodward, 2014).

Nevertheless, recent findings indicate that in a simple context infants can make goal-based action predictions by the second postnatal year. For example, Krogh-Jespersen and Woodward (2014) presented 15-month-old infants with video events in which a person grasped one of two objects. Then infants were shown events in which the objects' positions had been reversed and the person began to reach, pausing with her hand midway between the two objects. Infants reliably generated goal-based visual predictions, looking to the object that was the person's prior goal rather than the object