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To get the grasp: Seven-month-olds encode and selectively reproduce goal-directed grasping



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ABSTRACT

Infants need to analyze human behavior in terms of goal-directed actions in order to form expectations about agents' rationality. There is converging evidence for goal encoding during the first year of life from looking time as well as social learning paradigms using imitation procedures. However, conceptual interpretations of these abilities are challenged by low-level motor resonance accounts that propose task-specific lower level sensorimotor associations underlying looking time tasks rather than abstract conceptual knowledge. To test the differential predictions derived from the two accounts, we investigated within-child consistency of performance on different, but conceptually related, tasks requiring goal encoding. This study presented seven-month-old infants with a looking time task and an imitation task, both testing their ability to encode an action goal based on a reaching action, as well as a working memory task to control for the influence of general cognitive capacity. Results showed inter task convergence to be independent of working memory: infants who spent more time looking at goal change events in the looking time task were more likely to selectively reproduce the goal in the imitation task when the model had performed an intentional grasping action rather than a back-of-hand object contact. These findings support the view that low-level motor resonance mechanisms are not sufficient to explain the capacities of action understanding in infants.

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Introduction

The theme of this special issue is the debate between rationality and motor resonance theories of infants' action knowledge. At its core, this debate hinges on whether infants' knowledge about others' actions is abstract and conceptual in nature or instead reflects only lower level sensorimotor associations. To add perspective to this debate, we first briefly characterize the broader literature showing that infants are sensitive to the goal-directed nature of others' actions and then consider how the two accounts would explain this varied set of findings. We then present data that speak to the differential predictions of the two accounts.

A critical aspect of social cognition is the ability to represent others' actions as directed toward goals rather than simply as physical movements through space. Over the past two decades, evidence has accumulated to show that this aspect of social cognition is present during the first year of life. Much of this evidence has come from visual habituation experiments. In a seminal study, Gergely, Nádasdy, Csibra, and Bíró (1995) habituated 12-month-old infants to animated events in which a disk-shaped "agent" jumped over a wall to reach another disk on the other side of the screen. They hypothesized that if infants viewed the agent's movements as goal-directed, they would be surprised to see the disk take the same jumping path when no wall was present. The findings confirmed this hypothesis: when infants viewed test trials on which the agent jumped in the absence of the wall, they looked longer than when they saw the agent move along a straight path to the goal. Across a number of subsequent control conditions and experiments, this group confirmed that these findings did not derive from differences in the salience of the two paths and that they depended on the presence of a rational goal approach (Csibra, Bíró, Koós, & Gergely, 2003; Csibra & Gergely, 1998; Csibra, Gergely, Bíró, Koós, & Brockbank, 1999). That is, infants' responses reflected the expectation that agents will move in efficient paths toward goals (see also Sodian, Schoeppner, & Metz, 2004). From these findings, Csibra, Gergely and their colleagues concluded that by means of an abstract reasoning mechanism, even young infants are able to use information about observed actions, situational constraints, and goal states to generate at first teleological, and ultimately intentional action predictions (Csibra & Gergely, 1998; Gergely & Csibra, 2003).

In a related paradigm, Woodward (1998) demonstrated a simpler aspect of goal understanding in the context of human actions as early as 5 months of age. Infants were habituated to a human hand grasping one of two objects. After habituation, positions of the objects were switched and the hand either followed the old path to grasp a new object or moved through a new path to grasp the old object. Infants selectively reacted with longer looking times to a change in goal object than to a change of motion path, indicating that they represented the grasping action in terms of its relation to the goal rather than in terms of its spatiotemporal features. Infants did not respond in this way when the action was carried out by an inanimate object (Woodward, 1998) or involved an ambiguous human movement (Woodward, 1999), supporting the conclusion that infants' responses were selective for goal-directed actions.

Critically, a number of other studies have revealed that infants' responses in this paradigm are flexible in that infants can recruit contextual information to modulate their interpretation of an action as goal-directed. For example, although infants do not view an ambiguous back-of-the-hand gesture as goal-directed, they can be led to do so when given evidence that the gesture attains a goal, for example, by moving an object to a particular location (Jovanovic et al., 2007; Király, Jovanovic, Prinz, Aschersleben, & Gergely, 2003; Woodward, 1999). In addition, other research using this paradigm has shown that infants' analysis of action goals is modulated by the actor's focus of attention (Luo & Johnson, 2009). Finally, although this habituation paradigm did not directly assess infants' ability to reason about the rationality of actions, later studies involving multi-action events found, consistent with the work of Csibra, Gergely, and their colleagues, that infants use situational constraints and assumptions of rationality to infer the goals of human actions (Henderson & Woodward, 2011; Sodian et al., 2004; Sommerville & Woodward, 2005; Woodward & Sommerville, 2000).

Another source of evidence for infants' understanding of human goal-directed action is infants' imitative behavior. By 12 to 18 months, infants imitate others' goals even when they were attempted, but not achieved, by the model (Meltzoff, 1995), and they avoid imitating actions that were achieved but

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