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Understanding the experimenter's intention improves 16-month-olds' observational learning of the use of a novel tool

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ABSTRACT

Our aim was to investigate why 16-month-old infants fail to master a novel tool-use action via observational learning. We hypothesized that 16-month-olds' difficulties may be due to not understanding the goal of the observed action. To test this hypothesis, we investigated whether showing infants an explicit demonstration of the goal of the action before demonstrating the action would improve observational learning compared with a classic demonstration of the target action. We examined 16-month-old infants who observed a tool-use action consisting of grasping a rake-like tool to retrieve an out-of-reach toy, under five conditions. Only when infants were shown the goal of the action before demonstration did they show some success.

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Infants' capacity to imitate simple object-directed actions as early as 6 months has been demonstrated in many studies (for reviews see [Elsner, 2007](#); [Elsner, Hauf, & Aschersleben, 2007](#); [Poulson, Nunes, & Warren, 1989](#)). Generally, however, the simple actions involved in these studies were actions already in the infant's motor repertoire. Few studies, however, have investigated situations in which infants acquire an action not already in their repertory via observational learning. Most such studies involve means-end actions and show that infants become very good at observational learning of novel actions in their second year of life. At 12 months, for instance, infants can learn by observation how to bimanually manipulate a rolling drum to produce music ([Fagard & Lockman, 2010](#)). At 15 months,

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infants can learn by observation how to turn a bottle upside down to retrieve a small peg inserted in it (Esseily, Nadel, & Fagard, 2010). Also at 15 months, infants can learn a complex action connecting means (e.g., pushing on a button) and end (e.g., producing music; Elsner & Aschersleben, 2003).

When the means-end action involves tool use (e.g., use of a rake to retrieve a desired object), however, infants are able to learn by observation only after about 18 months (O'Regan, Rat-Fischer, & Fagard, 2011; Rat-Fischer et al., 2012). Chen and Siegler (2000) showed that even well after 18 months, infants may still be unable to learn how to use a tool following observation. Between 18 and 35 months, some infants used the tool appropriately to retrieve a toy after observation, but others still used indirect strategies such as reaching with their hands, asking for their mother's help or simply staring at the toy without trying to reach for it.

What is special about tool use that makes it so much harder to learn by observation compared to other types of observational learning? When infants observe performance of this means-end action, they must form a representation of what connects the tool and object. The two are spatially separated, likely making the task of relating means and end difficult for an infant (Bates, Carlson-Luden, & Bretherton, 1980; Rat-Fischer et al., 2012; van Leeuwen, Smitsman, & van Leeuwen, 1994). Few studies have taken into account the problem of understanding the goal when infants observe tool use. Here we propose the hypothesis that younger infants do not understand that the model's goal is to retrieve the toy. If infants do not understand the goal, they may not be able to relate the action they have observed to that goal and thus are unable reproduce it.

This hypothesis may seem surprising, since the ability to understand goals has been shown to arise very early in infants. Evidence from violation-of-expectation studies, using looking time measures, suggests that from 6 months on, infants perceive actions in terms of the intended goal of the agent (Csibra, 2008; Kamewari, Masaharu, Takayuki, Hiroshi, & Kazuo, 2005; Southgate, Johnson, & Csibra, 2008; Woodward, 1998, 1999). For instance, in Csibra's study, infants are familiarized with a box moving by itself from A to B. Infants thus attribute to the box the goal of reaching location B. Infants then see the box move either with an obstacle present in its path or not. Infants are surprised if the box makes a detour to reach location B when no obstacle is present. The authors conclude that infants perceive actions in terms of their goals.

Imitation studies also provide evidence of infants' ability to interpret an action as goal-directed (Carpenter, Call, & Tomasello, 2005; Gergely, Bekkering, & Király, 2002). Meltzoff (1995) showed that when 18-month-olds observed an experimenter who was trying unsuccessfully to separate a dumbbell-shaped object into two halves, they performed the experimenter's intended action as often as those who saw the target action successfully performed. Bellagamba and Tomasello (1999) replicated these results with 12-month-olds. Carpenter, Akhtar, & Tomasello (1998) showed that infants are able to differentiate between intended actions and accidental actions. Infants saw an experimenter perform two actions that can lead to the same goal. While performing the actions, the experimenter said either "There" to show that her action was intentional or "Oops" to show that her action was accidental. The infants reproduced twice as many intentional actions as accidental ones.

These studies show that infants below 18 months can understand that an agent performing an action intends to achieve a goal. But in some situations, when the task is complex, it is necessary for the experimenter to explicitly indicate the goal prior to the demonstration in order for the infant to benefit. Thus, Carpenter, Call, and Tomasello (2002) showed two-year-olds an experimenter performing a target action in order to open the door of a box. Before the demonstration, the experimenter either provided information about her intention to open the box, gave no information at all, or gave other irrelevant information. Infants opened the door more often if they had been informed about the experimenter's intention. Southgate, Chevallier, and Csibra (2009) showed that when information about the goal of the action is provided before demonstration, infants no longer imitate the means used by the model, but use their own means to attain the same goal, thus imitating the goal but not the action itself.

Tool use is thus a complex task because it entails a means-end action and means and the end are spatially separated. Infants must simultaneously pay attention to tool and object, and relate them to each other. In contrast in other means-end actions, the two objects involved are often spatially connected. Thus, our hypothesis appears plausible: one of the reasons infants do not learn tool use via observation before 18 months of age is that they are unable to understand the model's goal. In the

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