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Rational Imitation in 12-Month-Old Infants

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Gergely, Bekkering, and Király (2002) demonstrated that 14-month-old infants engage in "rational imitation." To investigate the development and flexibility of this skill, we tested 12-month-olds on a different but analogous task. Infants watched as an adult made a toy animal use a particular action to get to an endpoint. In 1 condition there was a barrier that prevented a more straightforward action and so gave the actor no choice but to use the demonstrated action. In the other condition there was no barrier, so the actor had a free choice to use the demonstrated action or not. Twelve-month-olds showed the same pattern of results as in Gergely and colleagues' study: They copied the particular action demonstrated more often when the adult freely chose to use the action than when she was forced to use it. Twelve-month-olds, too, thus show an understanding of others' intentions as rational choices and can use this understanding in cultural learning contexts.

When children imitate an adult's action they can, in some circumstances, reveal their understanding of the intentional structure of that action. Most famously, Meltzoff (1995) found that in a series of imitation tasks, 18-month-old infants reproduced not the exact bodily motions of an adult, but the result the adult intended to achieve—even though all infants saw was the adult trying and failing to achieve the result. This finding is most often interpreted as revealing that infants understand the goal of the adult's action. Bellagamba and Tomasello (1999) replicated this finding for 18-month-olds (and Johnson, Booth, & O'Hearn, 2001, for 15-month-olds), but not for 12-month-olds.

The fact that 12-month-olds do not reproduce the adult's unfulfilled goal does not mean that they do not understand goals at all. To succeed in Meltzoff's (1995)

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task, infants need first to imagine the adult's unachieved result and then to produce it themselves. In a different imitation paradigm not involving this imaginative component, Carpenter, Call, and Tomasello (2005) found that 12-month-olds reproduced the same adult action differently depending on the adult's goal, not copying it when it was a means to some other end but copying it when it was an end in itself. Evidence from looking time and natural interaction studies also suggests that 12-month-olds, and even younger infants, understand something about others' goals (e.g., Behne, Carpenter, Call, & Tomasello, 2005; Csibra, Gergely, Bíró, Koós, & Brockbank, 1999; Gergely, Nádasdy, Csibra, & Bíró, 1995; Woodward & Sommerville, 2000).

A further question is whether infants understand not just an actor's goal, but also her intention, the plan of action she chooses for achieving that goal, including the rational basis for this choice of plan (see Tomasello, Carpenter, Call, Behne, & Moll, 2005, for more discussion). Gergely, Bekkering, and Király (2002) found that 14-month-old infants do understand this additional component of intentional action, and show this by engaging in "rational imitation." In one of their experimental conditions, the hands-free condition, infants watched an adult place her hands on the table and then use an unusual action to illuminate a light box: She bent over and pressed the box with her forehead. When these infants were given the chance to play with the box a week later, most of them (69%) also used their head to illuminate the light. In the other condition, the hands-occupied condition, infants were shown the adult performing the same unusual action but with the difference that her hands were unavailable during the demonstration (she was holding a blanket around her shoulders). In this condition only very few infants (21%) later used their head to illuminate the light; the majority of them just used the more normal (but undemonstrated) method of pressing the light with their hands.

In the hands-occupied condition, infants thus apparently assumed that the adult only used her head because she had to—she could not use her hands. Because this constraint did not apply to infants, they used their hands. In the hands-free condition, in contrast, infants assumed that the adult could have used her hands—they were free—but chose not to, and that there must have been some reason for this choice, so they copied the unusual action. By 14 months of age infants thus understand others' intentions as rational choices of action plans and, importantly, use this understanding to decide which aspects of a demonstration to reenact in an imitation task (Tomasello et al., 2005; see Gergely, 2003, and Gergely et al., 2002, for a slightly different interpretation involving infants' evaluation of the adult's *actions* in terms of their efficiency or rationality, as opposed to infants' understanding of others' intentions).

It is unclear what younger infants understand about others' intentions. Tasks that are in some ways analogous to that of Gergely et al. (2002) have been presented to younger infants using looking-time procedures (Csibra et al., 1999; Gergely et al., 1995; Kamewari, Kato, Kanda, Ishiguro, & Hiraki, 2005; Phillips & Wellman, 2005; Sodian, Schoeppner, & Metz, 2004). These studies have found that 9- and 12-month-olds, and even 6.5-month-olds in some cases, dishabituate to an actor's movement

when it is not the most rational action possible to reach some goal object. However, to dishabituate in this paradigm all infants need to do is to discriminate normal from abnormal behavior: Goal-directed agents do not usually take circuitous routes to goals. Infants do not need to understand the rational choices behind intentional action. In addition, the looking-time methodology does not test infants' ability to use their understanding in their own action, as, for example, imitation methods do.

In this study, therefore, we developed a new task in the rational imitation paradigm of Gergely et al. (2002) to investigate whether 12-month-olds understand that actors choose action plans rationally based on an assessment of current reality, and to attempt to extend their findings to a very different type of task. It is important to determine with some precision the age at which infants understand the different components of rational intentional action because this has implications for the developmental processes involved and its relations to other skills. For example, there is evidence that 12-month-olds understand that adults can choose to focus their attention on one part of their current visual field as opposed to others (Tomasello & Haberl, 2003). It is thus important to know whether infants' understanding that actors make choices applies at the same time to the domains of attention and intentional action. Furthermore, it is noteworthy that skills of joint attention, joint action, and communication undergo rapid development during the 9- to 14-month age period (see Tomasello et al., 2005, for a review), and so it is important to know the precise age at which infants understand the rational dimensions of others' attention and action as a basis for their shared interactions with them.

Infants in both conditions of this study watched the same action: An adult made a toy dog enter a house by jumping through the chimney. In one condition (analogous to the hands-occupied condition earlier), the adult first tried to use the more straightforward method of entering the house—the door—but it was locked so she had to make the dog go through the chimney. In the other condition (analogous to the hands-free condition earlier), the door was wide open and the adult apparently freely chose to use the chimney instead. In both conditions, the door was always open during infants' response. We expected infants to put the dog through the door more often in the condition in which the door was closed during the demonstration, because the use of the chimney in that case could be explained away as something the demonstrator had to do given the circumstances. In contrast, in the condition in which the door was open during the demonstration, we expected infants to copy the demonstrated action and put the dog through the chimney.

METHOD

Thirty-two 12-month-old infants participated (*M* age = 12;5, range = 11;26–12;14; gender was counterbalanced). Fifteen additional infants were tested but their data were dropped due to fussiness or lack of attention or interest.

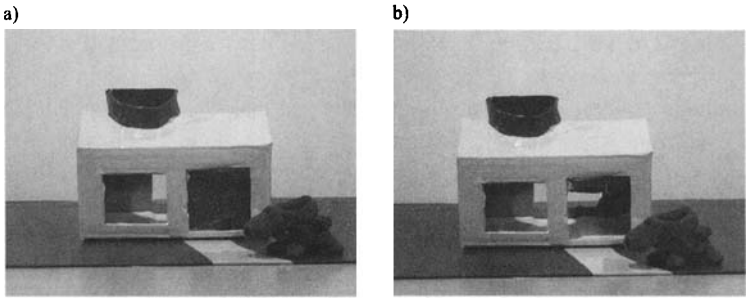

FIGURE 1 The materials: The dog and house (a) with the door closed, and (b) with the door open. (The dog is in the start position in both cases.)

Materials were a small stuffed toy dog (approximately 6 × 4 × 10 cm), a blue mat (50 × 69 cm), and a cardboard house (17 × 25 × 16 cm) attached to the center of the mat (see Figure 1). At the front of the house, in the right corner, there was a lockable, red door (8 × 10 cm) opening to the inside. To the left was a Perspex window (8.5 × 8 cm) that allowed infants to see into the house. The door could be locked closed or locked open from inside. The roof had a broad, red chimney (8 cm diameter) on the left. At the back of the house, on the experimenter's (E's) side, a piece of wall (10 × 7 cm) was missing, giving E access to the door's locking mechanism and the dog when it was inside. A path led from the start position at the front of the mat to the door.

Infants sat on their parent's lap across a table from E. Infants were allowed to play with the dog briefly; then E put the mat on the table with the house facing infants, retrieved the dog, and presented one of the following randomly assigned demonstrations:

- *Door-closed condition.* E drew the infant's attention to the door by saying, "Look, the door is closed" and tapping on the closed door twice. Then E said, "Look," put the dog at the start position on the path, and made the dog walk up the path to the closed door while vocalizing "dadadadadaaa" in a sing-song way. When the dog reached the door, E made it pause for a second, make two short forward motions with its nose practically touching the door (as if testing the door's state), go backward a bit, and with a big leap, jump through the chimney into the house, where E placed it in front of the window so infants could see it inside the house. E accompanied the leap with a "hoeeii" sound.
- *Door-open condition.* E's actions and vocalizations with the dog were identical to those in the door-closed condition. The only difference was that at the beginning, E opened the door, said, "Look, the door is open," and tapped on the open door twice. (Thus when the dog approached the open door, it performed exactly the same actions as in the other condition but to the empty space within the door-frame, as if deciding what to do.)

In both conditions, after leaving the dog in the house for several seconds, E retrieved it through the opening in the back, quickly opened the door (from within), and fastened it open. She drew attention to the open door by saying, "Look, the door is open," and tapping on the door twice. Then E put the dog in the start position on the path in front of infants and told them, "Now you." Infants were given approximately 30 sec to respond. If they put the dog in the house during that period, E retrieved it through the back of the house and returned it to them. At the end of the response period, E retrieved the dog, closed the door, and repeated the entire demonstration and response sequence for a second trial. In both conditions the door was always open for infants' response.

Response periods were scored from the videotapes, blind to condition. We coded whether infants put (or clearly attempted to put) the dog into the house using the chimney, the door, or both (and if both, in which order). For interobserver reliability, 12 randomly chosen infants (37%) were independently coded blind to condition. Perfect agreement was achieved on all measures. Proportions of trials in which infants put the dog into the house were used for analyses because not all infants responded in both trials (4 infants did not put the dog into the house or show any other relevant behavior in Trial 1 and 1 infant did not do this in Trial 2). Exact, one-tailed values were used for all analyses.

RESULTS

Our main measure of interest was whether infants copied the demonstrated action and put the dog through the chimney. Results were very similar to those of Gergely et al. (2002). In the door-open condition (analogous to their hands-free condition), 13 of the 16 infants (81%) used the chimney in one or both trials. In the door-closed condition (analogous to their hands-occupied condition), in contrast, only 7 of the 16 infants (44%) used the chimney. This was a statistically significant difference, $\chi^2(1, 32) = 4.80$, $p = .03$. In a group comparison, infants used the chimney in a significantly greater proportion of trials in the door-open than the door-closed condition (Mann–Whitney $U = 74.5$, $n_1 = n_2 = 16$, $p = .02$; see Figure 2 for means).

Although infants copied the demonstrated action significantly more often in the door-open than the door-closed condition overall, this difference was mainly a result of infants' second trial performance. In the first trial, there was no significant difference between conditions in the number of infants who used the chimney, $\chi^2(1, 28) = 0.44$, $p = .39$ (see Figure 3). In the second trial, however, significantly more infants used the chimney in the door-open than the door-closed condition, $\chi^2(1, 31) = 9.31$, $p = .003$.

Whether they used the chimney or not, most infants in both conditions put the dog through the door. Fifty-six percent of infants did this (in 53% of trials) in the

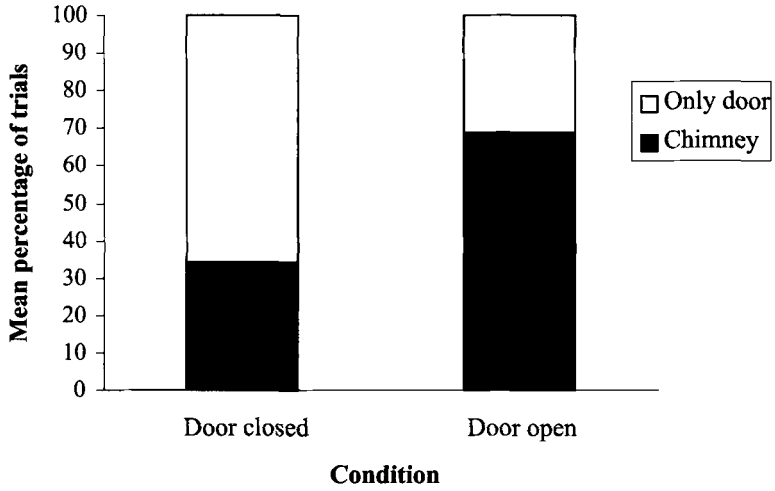

FIGURE 2 The mean percentage of trials in which infants used the chimney in each condition (along with the mean percentage of trials in which infants did not use the chimney, i.e., used only the door).

door-open condition and 81% did this (in 78% of trials) in the door-closed condition (for both the χ^2 and the Mann–Whitney U, $p > .09$). Eight infants used both the chimney and the door during a single trial at least once, in 18.6% of trials overall (25.0% of door-open and 12.9% of door-closed trials). When they used both methods of putting the dog in the house in the same trial, infants always used the door first.

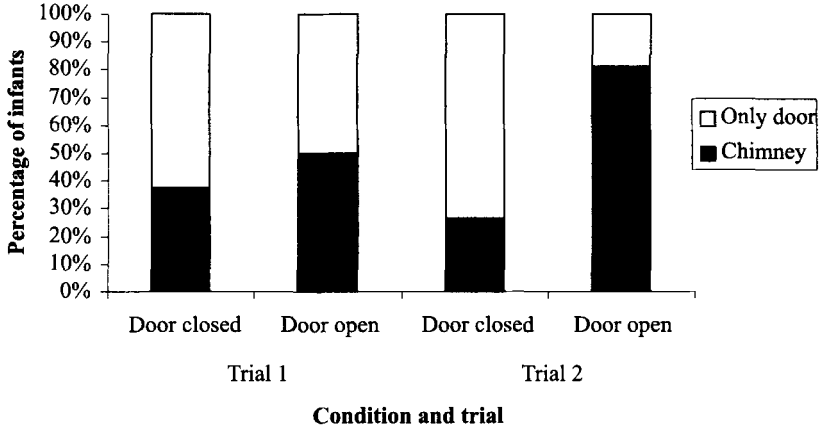

FIGURE 3 The percentage of infants who used the chimney in each condition (along with the percentage of infants who did not use the chimney, i.e., who used only the door) for each trial separately.

DISCUSSION

In summary, 12-month-olds in this experiment showed a very similar pattern of results to 14-month-olds in the study by Gergely et al. (2002) using a different behavioral reenactment test. In both studies, each involving different types of actions and constraints, infants copied the demonstrated, unusual action more often when the demonstrator had no physical constraint—when she apparently freely chose to use that action—than when the demonstrator did have a physical constraint that barred her from performing a more "normal" action. Twelve-month-olds, too, are thus capable of rational imitation, and have some understanding of others' plans of action or intentions along with an understanding of others' goals. They do not just understand *what* others are doing to pursue their goals; they also understand at least some aspects of *why* others have chosen to do it this particular way.

Understanding the rational dimensions—the why dimensions—of intentional action enables infants to predict the behavior of others not just in familiar situations but in totally novel situations as well. Infants do this through an understanding of the *organization* of different aspects of observed action: Actors strive to bring about environmental results, and they do this by choosing action plans, based on their perception of the possibilities and constraints in the current situation. Infants do not make the assessment of rational action egocentrically with respect to their own situation only; rather, they make different assessments for the actor and themselves if there are different exigencies involved.

We think that these findings in combination with other recent findings suggest a fairly rich interpretation of infants' social-cognitive understanding in general. First, combining these current findings with those of Gergely et al. (2002), infants showed that they understood rational action involving two different kinds of constraints, suggesting a fairly flexible understanding of the relation of goals, plans of action, and environmental constraints. Second, infants in this same age range understand such things as failed attempts and accidents in other experimental paradigms (e.g., Behne et al., 2005), which supports the claim that instead of just seeing others' surface behavior, infants go deeper and interpret others' behavior in terms of their internal goals that may or may not match external reality. Finally, as mentioned earlier, Tomasello and Haberl (2003; see also Moll, Koring, Carpenter, & Tomasello, 2006) showed that 1-year-olds understand that others choose to focus their attention on some things to the neglect of others in their current perceptual field. In the rational imitation studies, infants seem to understand physical constraints on adult action, whereas in the attention studies, they seem to understand some more mental dimensions of choice. In both cases, then, 1-year-olds apparently understand something about the reasons underlying others' actions and respond accordingly. We thus believe that these studies are most appropriately interpreted in a fairly rich manner: 12-month-olds understand something about others' intentions and attention as rational choices among plans of action and perception.

The importance of understanding the rational dimensions of action and perception cannot be overestimated. First, and most obviously, beyond the ability to read others' goals in social learning situations—which tells learners *what* a demonstrator is doing and thus enables some flexible, selective reenactment of the demonstration—the ability to read others' intentions tells learners *how* the demonstrator is achieving his or her goal and *why* he or she is doing it in this way. Even if they do not always understand the *particular* reasons why the actor chose an action—exactly why he or she performed this action even though he or she could more easily have performed another one instead—at least they understand that there must have been some reason underlying the actor's choice (cf. Gergely & Csibra, 2005). This is especially important in human cultural learning, when sometimes it is necessary to do things the way others do (e.g., when learning the conventional use of artifacts or communicative symbols; see Gergely & Csibra, 2006; Tomasello, 1999) and sometimes it is not. This is thus an important ability for 1-year-old infants as they begin to participate in earnest in the cultural activities around them.

Second, during this same developmental period infants also begin to engage with others in acts of joint attention, joint action, and intentional communication, which all involve the sharing of goals and perceptions with others. It is possible, although currently undemonstrated, that coming to understand the rational dimensions of others' action and perception may enable these new kinds of collaborative activities as infants are able to understand why their partners are doing what they are doing in more flexible ways than previously. It is even possible that this new understanding transforms earlier forms of joint action and perception into true joint intentions and joint attention, which leads to a qualitative shift in the nature of the collaborative activities in which children participate. Other kinds of studies will be needed to establish such a relation.

In any case, this study has demonstrated that infants as young as 12 months of age have some understanding of others' intentions and can engage in rational imitation. The early emergence and flexibility of infants' skills of rational understanding and imitation present a challenge to theories of early social-cognitive development that attempt to explain early competencies in a leaner, less cognitively rich manner.

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