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Understanding the Intentions of Others: Re-Enactment of Intended Acts by 18-Month-Old Children

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Investigated was whether children would re-enact what an adult actually did or what the adult intended to do. In Experiment 1 children were shown an adult who tried, but failed, to perform certain target acts. Completed target acts were thus not observed. Children in comparison groups either saw the full target act or appropriate controls. Results showed that children could infer the adult's intended act by watching the failed attempts. Experiment 2 tested children's understanding of an inanimate object that traced the same movements as the person had followed. Children showed a completely different reaction to the mechanical device than to the person: They did not produce the target acts in this case. Eighteen-month-olds situate people within a psychological framework that differentiates between the surface behavior of people and a deeper level involving goals and intentions. They have already adopted a fundamental aspect of folk psychology—persons (but not inanimate objects) are understood within a framework involving goals and intentions.

A central topic in developmental cognitive science is to investigate how and when children develop a folk psychology or "theory of mind," the understanding of others as psychological beings having mental states such as beliefs, desires, emotions, and intentions (Astington & Gopnik, 1991a; Flavell, 1988; Harris, 1989; Leslie, 1987; Perner, 1991a; Wellman, 1990). It would be a world very foreign to us to restrict our understanding of others to purely physical terms (e.g., arm extensions, finger curlings, etc.). Failure to attribute mental states to people confronts one with a bewildering series of movements, a jumble of behavior that is difficult to predict and even harder to explain. At a rough level of approximation, this may be something like the state of children with autism (Baron-Cohen, Leslie, & Frith, 1985; Baron-Cohen, Tager-Flusberg, & Cohen, 1993). However, normal children give elaborate verbal descriptions of the unobservable psychological states of people, indicating that they relate observable actions to underlying mental states.

Recent research on children's understanding of mind has been focused on two differentiable questions: (a) Mentalism: How and when do children first begin to construe others as having psychological states that underlie behavior? (b) Representational model of mind: How and when do children come to understand mental states as active interpretations of the world and not simple copies or imprints of it (Flavell, 1988; Forguson & Gopnik, 1988; Perner, 1991a; Wellman, 1990). One can be a mentalist without having a representational model of the mind, but being a representationalist entails being a mentalist. One has to understand that there is a mind or something like it before precise questions about the relation between mind and world can arise. A developmental ordering is suggested. It has been proposed that there is not a single "theory of mind," but rather a succession of different theories, in particular, an early mentalistic one that is replaced by a representational one (e.g., Gopnik, Slaughter, & Meltzoff, 1994; Gopnik & Wellman, 1992, 1994; Wellman, 1990, 1993).

The second question listed above has received the bulk of the empirical attention to date. The tasks used to explore it include false belief (Perner, Leekam, & Wimmer, 1987; Wimmer & Perner, 1983), representational change (Gopnik & Astington, 1988; Wimmer & Hartl, 1991), appearance-reality (Flavell, Flavell, & Green, 1983; Flavell, Green, & Flavell, 1986), level-2 perspective taking (Flavell, Everett, Croft, & Flavell, 1981), and others (C. Moore, Pure, & Furrow, 1990; O'Neill, Astington, & Flavell, 1992; O'Neill & Gopnik, 1991). Although a topic of current debate, there is growing consensus that children first adopt a representational model of mind by about 3 to 5 years of age (Flavell, 1988; Forguson & Gopnik, 1988; Perner, 1991a; Wellman, 1990, 1993).

The first question listed above concerns an earlier phase of development and has not received as much attention, but it is equally important. The experimental data that exist seem to suggest that even 2.5- to 3-year-olds are mentalists; they read below the surface behavior to understand the actions of persons. Wellman and Estes (1986) reported that 3-year-olds distinguish between mental and physical entities. Bartsch and Wellman (1989) found that 3-year-old children used beliefs and desires to explain human action. Lillard and Flavell (1990) showed that 3-year-olds have a preference for construing human behavior in psychological terms. In their study a series of pictures was

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shown to children and described in both behavioral and mental state terms. For example, children were shown a picture of a child sitting on the floor (back to the viewer), and this was described as a child "wiping up" and "feeling sad" about his spilled milk. A duplicate picture was then given to the child, who was asked to explain the scene in his or her own terms. The results showed that 3-year-olds were more likely to choose mentalistic descriptions than behavioral ones. This attribution of mental states by 3-year-olds is compatible with research described by Gelman and Wellman (1991) and Wellman and Gelman (1988) showing that 3- to 4-year-old children tend to postulate unobservable "insides and essences" of things earlier than classically believed (Piaget, 1929).

Philosophers have argued that among the varied mental states we ascribe to persons, beliefs are particularly complex (e.g., Searle, 1983). This is because they are the representational states par excellence. As defined by philosophers, beliefs always involve representations or interpretations of the world rather than simply attitudes toward it or relations with it; however, other mental states such as desires and intentions may easily be construed nonrepresentationally and so may be easier to understand (Astington & Gopnik, 1991b; Flavell, 1988; Gopnik & Wellman, 1994; Perner, 1991b; Wellman, 1990, 1993). Mental states such as desire and intention may be particularly good topics to investigate if one is interested in the earliest roots of children's understanding of mind.

Empirical work supports this view. Premack and Woodruff (1978) reported that a language-trained chimpanzee could correctly choose which of two pictures depicted the correct solution to a problem facing an actor, which led them to suggest at least a primitive grasp of the desires and intentions (see also Premack & Dasser, 1991). In everyday language and verbal explanations of problems set to them, children talk about desires ("I want x . . .") before they talk about beliefs ("I think x . . .") (Bartsch & Wellman, 1995; Bretherton, McNew, & Beeghly-Smith, 1981; Brown & Dunn, 1991; Moses & Flavell, 1990; Shatz, Wellman, & Silber, 1983; Wellman, 1990; Wellman & Bartsch, 1994). Moreover, laboratory studies have shown that 3-year-olds can recognize that someone has a desire even if that desire is not actually fulfilled, that is, they can differentiate desires and actions (Astington & Gopnik, 1991b). They can also distinguish between intended, unintended, and mistaken actions (Shultz, 1980; Shultz, Wells, & Sarda, 1980) and know that intentions may remain unfulfilled (Moses, 1993; see also Astington, 1991; Frye, 1991, for relevant discussions). Finally, 3-year-olds understand something about the linkage between desires, actions, and emotional reactions. They know that fulfilled desires lead to happiness and a cessation of searching, whereas unfulfilled ones lead to sadness and a continuance of search (Harris, 1989; Wellman & Banerjee, 1991; Wellman & Woolley, 1990; Yuill, 1984; also Moses, 1993).[1] Marshaling this and related philosophical, linguistic, and behavioral support, Wellman (1990, 1993; Wellman & Woolley, 1990) suggested that a "belief psychology" grows out of a prior "desire psychology," and he and others have pushed back the earliest instances of children's understanding of mind, as measured by way of desire tasks, to 2 to 3 years of age.

To date, most of the techniques for assessing children's "theory of mind" have relied on verbal report. This makes it difficult to test children before about 2- to 2.5-years old. There is a keen interest among both psychologists and philosophers (Campbell, 1994, 1995; Fodor, 1992; Goldman, 1992, 1993; Gordon, 1994) in the aboriginal roots of children's understanding of mind. Several nonverbal abilities in infancy have been proposed as candidates, including: symbolic play and metarepresentation (Leslie, 1987, 1988), joint attention and social referencing (Baron-Cohen, 1991; Butterworth, 1991; Wellman, 1990), and crossmodal representation of others as "like me" coupled with body imitation (Meltzoff, 1990a; Meltzoff & Gopnik, 1993; Meltzoff & Moore, 1995).

There is a rather large gap between these roots and the abilities examined in standard theory-of-mind experiments with 2.5- to 4-year-olds. This gap is due, in part, to the lack of a technique for exploring the relevant questions in children too young to give verbal reports. One aim of the current research is to develop a nonverbal test that can be used to pose such questions. The issue investigated here was children's understanding of the intentions of others, something more akin to desires than beliefs. The test used was called the *behavioral re-enactment procedure.*

The behavioral re-enactment procedure capitalizes on toddlers' natural tendency to pick up behavior from adults, to re-enact or imitate what they see (Meltzoff, 1988a, 1988b, 1990b, 1995; Piaget, 1962). However, it uses this proclivity in a new way. In the critical test situation in Experiment 1, children were confronted with an adult who merely demonstrated an "intention" to act in a certain way. Importantly, the adult never fulfilled this intention. He tried but failed to perform the act, so the end state was never reached. It remained unobserved by the child. To an adult, it was easy to "read" the actor's intention. The experimental question was whether children interpreted this behavior in purely physical terms or whether they too read through the literal body movements to the underlying goal or intention of the act. The children, who were too young to give verbal reports, informed us how they represented the event by what they chose to re-enact. Another group of children followed the same experimental protocol and were tested in an identical fashion except that they saw the full target act. Various control groups were tested. Children's tendency to perform the target act was compared in several situations: after they saw the act demonstrated, after the target act was intended but not achieved, and after the target act was neither shown nor intended. The results suggest that 18-month-old children understand something about the intentions of others: They performed the acts the adult intended to do even though the adult's acts failed.

Experiment 2 compared children's reactions to a person versus an inanimate object. An inanimate device was built that traced the same movements through space as the human hand.

[1] Other research with more complex tasks and older children also has indicated that understanding desires and intentions emerges before beliefs. Studies directly comparing beliefs to desires have revealed that children understand: (a) desires and intentions can change before they understand that beliefs can change (Gopnik & Slaughter, 1991), and (b) others have desires that differ from their own before they understand that others have beliefs that run counter to their own (Flavell, Flavell, Green, & Moses, 1990; Wellman, 1990).

The dual aims of this study were to test whether these spatial patterns might in and of themselves suggest a goal state and to explore the limits of the types of entities that may be construed as having psychological properties like intentions. The movements of the inanimate device did not lead children to produce the target acts.

Taken together, the experiments show that 18-month-old children already situate people within a psychological framework. They have adopted a key element of a folk psychology: People (but not inanimate objects) are understood within a framework that includes goals and intentions. The issue now raised for theory, and considered in the conclusions, is whether 18-month-olds impute mental states as the causes of behavior or whether they are in a transitional phase that serves to link the newborn's more embryonic notion of person (Meltzoff & Moore, 1995) to the full-blown mentalism of the 3-year-old.

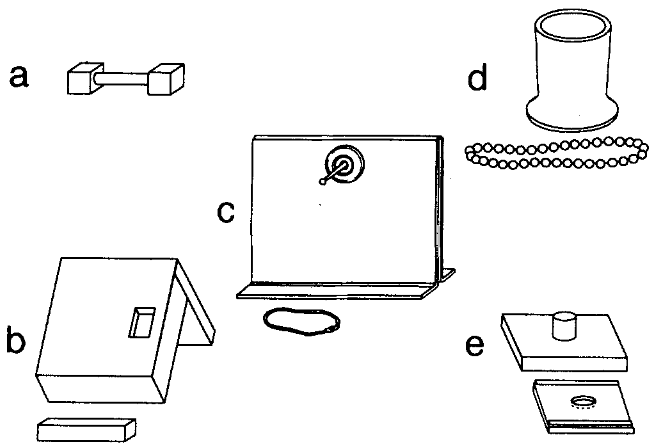

Figure 1. The five test objects: (a) dumbbell, (b) box and stick tool, (c) prong and loop, (d) cylinder and beads, and (e) square and post.

Experiment 1

Method

Children

The participants were forty 18-month-old children (M = 18.02 months, SD = .10; range: 542–554 days old). The children were recruited by telephone calls from the university's computerized subject list. Equal numbers of boys and girls participated in the study; 37 children were White, 2 were Asian, and 1 was African American. Pre-established criteria for admission into the study were that a child be within ±7 days of his or her 18-month birthday, have no known physical, sensory, or mental handicap, be full term (40 ± 3 weeks gestation, by maternal report), and have normal birth weight (2,500–4,500 g). No children were eliminated from the study for any reason.

Test Environment and Apparatus

The test was conducted in a room at the university that was unfurnished save for the equipment and furniture needed for the experiment. The child was tested while seated on his or her parent's lap in front of a rectangular table (1.2 × 0.8 m), the top surface of which was covered in black contact paper. A video camera behind and to the left of the experimenter recorded the infant's head, torso, and a portion of the table top in front of the child where the test objects were manipulated. A second camera behind and to the right of the child recorded the experimenter's stimulus presentations. Each camera was fed into a separate videorecorder that was housed in an adjacent room. The experiment was electronically timed by a character generator that mixed elapsed time in seconds and frames (30th of a second) onto the video records for subsequent scoring.

Test Materials

Five objects served as test stimuli (Figure 1). The child could not have seen or played with these objects before, because they were specially constructed in the laboratory and were not commercially available. (Some parts in the stimuli were store-bought items, but these components were used in unusual ways.)

The first object was a dumbbell-shaped toy that could be pulled apart and put back together again. It consisted of two 2.5-cm wooden cubes, each with a 7.5-cm length of plastic extending from it. One tubular piece fit snugly inside the other so that it took considerable force to pull them apart (the dumbbell did not fall apart if banged on the table or shaken). The second object was a small black box (16.5 × 15 × 5.5 cm) with a slightly recessed rectangular button (3 × 2.2 cm) on the top surface. The button activated a buzzer inside the box. The box was supported by a base that tilted 30° off the table so that the front surface was facing the child. The box was accompanied by a small stick tool made of a rectangular block of wood that was used by the experimenter to push the button. The third object consisted of a horizontal prong and nylon loop. The prong was fashioned from an ornamental wooden piece with a bulbous end. It protruded horizontally from a background screen made of gray plastic (17 × 20.3 cm). The loop was made from black and yellow woven nylon tied in a circle with a diameter of 7.5 cm. The fourth object consisted of a yellow cylinder with a flared base (9.5 cm high with a 6.3-cm opening) coupled with a loop of beads (19 cm long when suspended). The fifth device was a transparent plastic square and wooden dowel. The square (10 cm) had a 2.5-cm diameter round hole cut out of the center so that it could fit over the dowel. Thin plastic strips were glued along two edges of the plastic square to raise it slightly from the table so that it could be picked up by the children. The dowel (2 cm high and 1.7 cm in diameter) was in an upright position in the center of a wooden base plate.

Design

The children were randomly assigned to one of four independent groups with 10 children per group. There were two demonstration groups and two control groups: Demonstration(target), Demonstration(intention), Control(baseline), and Control(adult manipulation). Within each group the test objects were presented in five different orders such that each object occurred equally often in each position. One male and one female child were assigned to each order. Thus, order and sex of infant were counterbalanced both within and between groups.

Procedure

On arrival at the university, the children and their families were escorted to a waiting room where they completed the necessary forms. They were then brought to the test room where parent and child were seated at the table across from the experimenter. The experimenter handed the children an assortment of rubber toys to explore. After the infant seemed acclimated with the room and the experimenter, usually about 1–3 min, the warm-up toys were withdrawn and the study began.

Demonstration(target). For the children in this group the experimenter modeled a specific target act with each of the five objects. Each object was kept hidden before it was brought to the table for its demonstration and was returned to the hidden container before the next object was presented. For each stimulus, the target act was repeated three times in approximately 20 s and was then placed on the table directly in front of the infant. A 20-s response period was timed starting from when the infant touched the object. At the end of this response period, the first object was removed, and the second presentation was modeled following the same time procedure, and so on for the five test objects. The demonstrations were presented out of reach of the children so they could not touch or play with the toy but were confined to observing the event. The experimenter never used words related to the task such as "push button," "do what I do," or "copy me," but the experimenter was permitted to gain the child's attention by calling his or her name, saying "look over here," "oh, see what I have," or "it's your turn." The experimenter maintained a friendly demeanor throughout the demonstrations and did not express joy at successfully performing the act.

For the dumbbell, the act demonstrated was to pick it up by the wooden cubes and pull outward with a very definite movement so that the toy came apart into two halves. For the box, the act demonstrated was to pick up the stick tool and use it to push in the button, which then activated the buzzer inside the box. For the square, the act demonstrated was to pick up the plastic square and put the hole over the dowel. For the prong, the act demonstrated was to raise the nylon loop up to the prong and drape it over it. (The screen on which the prong was mounted was put perpendicular to the children on their left side.) For the cylinder, the act demonstrated was to raise the beads up over the opening of the cylinder and then to lower them down into the opening so that they were deposited on the bottom of the container.

Demonstration(intention). For this group the experimenter did not demonstrate the target acts. None of the final goal states was achieved. Instead, the experimenter was seen to try but fail to achieve these ends. The experimenter modeled the intention to perform these acts, but not the target acts themselves. Save for this critical difference, the remainder of the procedure for this group was identical to the group that saw the full target: The intention to produce the act was modeled three times and was followed by a 20-s response period for each test object so that the temporal factors were equated with the children who saw the target. The experimenter did not provide linguistic or facial expressions of failure. To an adult, the multiple, effortful tries effectively conveyed the intention to perform the target act, in line with Heider's (1958) descriptions of cues to intention in adult perceivers.

For the dumbbell, the experimenter picked it up by the wooden cubes, just as he had done in the Demonstration(target) condition. It appeared that the experimenter was trying to pull the ends outward. However, he failed to do so because as he pulled, one of his hands slipped off the end of the object. The direction of slippage alternated from left, to right, to left over the three stimulus presentations (the spatial terms are all referenced from the child's viewpoint). Thus there was no object transformation, and the goal state was never achieved. All that was visible were the experimenter's attempts to pull it apart.[2]

For the box, the experimenter used the stick tool and tried to push the button. However, the experimenter always missed. Thus the affordance of the box was never seen; there was no activation of the buzzer, and the goal state of touching the button with the tool was never witnessed. Each of the three misses was spatially different: First, the stick tool missed off the left, next it missed to the right, and on the third attempt it was too high. In each case the tip of the tool came down on the top surface of the box.

For the prong device, the experimenter tried but failed in his attempt to put the nylon loop over the prong. He picked up the loop, but as he approached the prong he released it inappropriately so that it "accidentally" dropped to the table surface each time. First, the loop was released slightly too far to the left, then too far to the right, and finally too low, where it fell to the table directly below the prong. The goal state of draping the nylon loop over the prong was not demonstrated.

For the cylinder, the experimenter attempted to deposit the beads into the cylinder, but failed. First, he raised the loop of beads over the cylinder and lowered them down so that just the tip of the beads crossed the edge of the top lip. The beads were then released such that they fell to the table outside the cylinder. The second attempt consisted of suspending the beads slightly too far in front of the cup so that they again fell to the table top when released. Third, the experimenter gathered the beads up into his loosely closed hand and scraped his hand over the opening of the cylinder such that the beads fell outside the cylinder instead of into it. The child thus did not see the beads deposited in the cylinder but saw three failed attempts at doing so.

For the plastic square, the experimenter picked it up and attempted to put it on the dowel. However, he did not align it properly. It was tilted slightly toward the child, and the hole was not aligned directly over the dowel. The first time the hole undershot the dowel and remained on the left, the second time it overshot it to the right, and the third time the hole was spatially in front of the dowel. The children never saw the goal state of putting the square over the dowel.

Five different acts were used, providing some assessment of generality. The dumbbell involved an "effort" to pull an object, but the object itself remained completely untransformed. The prong-and-loop device involved moving one object (the loop) in a behavioral sequence that to the adult was explained by an underlying cause—the attempt to drape the loop over the prong. It seemed possible that some tasks might be more easily understood than others. The dumbbell task might rely on perceived effort (which might be amenable to a Gibsonian analysis; Runeson & Frykholm, 1981) and may be more elementary than understanding the intent to bring about object–object relations. Furthermore, the range of stimuli investigated whether certain object–object spatial relations would be easier than others (e.g., the beads went inside the cylinder, the plastic square around the dowel, and the stick was used as an intermediary tool to poke a recessed button). The idea was to test whether any (or all) of these acts could be understood from seeing a failed attempt; the range of acts would help explore whether particular tasks were easier than others at this age.

Control(baseline). A baseline control group was included to assess the likelihood that the target acts used in the demonstration groups would occur in the spontaneous behavior of the children independent of the adult model. The adult demonstration was excluded, but all other aspects of the procedure remained the same: The experimenter handed the child the test stimuli one at a time and timed a 20-s response period for each object. This group controlled for the possibility that children of this age would spontaneously produce the target acts. At a more theoretical level, this group controlled for the possibility that the objects themselves have "affordances" or "demand characteristics" that are grasped by seeing the object itself. The degree that infants spontaneously engage in the target acts with these objects is evaluated, because infants are presented the same objects and are allowed to play with them for the identical response period as the other groups.

Control(adult manipulation). In two demonstration groups (both the target and intention) the children saw the experimenter pick up and handle the test objects. It could be argued that children may be more likely to manipulate and explore objects that the experimenter has handled. The baseline group controlled for the spontaneous production of the target actions but would not take care of controlling for any nonspecific effects of seeing the adult manipulate the objects. Therefore, a second control group was also included. In this group, the experimenter manipulated the test objects for the same length of time as in the demonstration groups. The only difference between this group and the two

[2] The experimenter's demonstrations are described as if he was trying to achieve the target act. Of course, he was a confederate, and his actual intent was to give the impression that he was trying to produce the target.

demonstration groups was that he neither demonstrated the target acts nor even the intention to produce them. He picked up and handled the objects but refrained from those activities. If the children produce more target behaviors in the demonstration groups than in this control it cannot be attributed to seeing the adult handle the objects, because handling time by the experimenter was equated. The combination of both baseline and adult-manipulation controls provides an excellent assessment of whether the specific content of the adult demonstration is influencing the behavior of the children.

For the dumbbell, the experimenter picked up the object by the wooden cubes and pushed both hands inward. This was shown three times in the presentation period. For the box, the experimenter held the stick and moved along the top surface of the box, with the tip of the stick passing directly next to and over the recessed button. First he held the stick horizontally and moved it from the lower edge of the surface to the upper edge and back down again, staying centered on the surface. Next, the same movement was made but with the stick aligned on the left edge of the box. Third, the same movement was repeated with the stick aligned on the right edge. For the prong, the experimenter released the loop next to the prong but did so with no evident intention of looping it over the prong. First the loop was slid along the top edge of the gray screen past the prong and was released when it reached the edge of the screen closest to the child. Second, this movement was reversed. Third, the loop was moved along the base of the screen until it was directly below the prong and was then released so that it fell to the table underneath the prong. For the cylinder, the experimenter picked up the beads and lowered them onto the table beside the cylinder (10 cm away) with no evident intent to deposit them inside it. First, the beads were lowered onto the table so that they crumpled about half way and then were released so they fell to the left of the cylinder. Next, they were raised in the air to the height needed to deposit them into the cylinder and were released so they dropped to the right of the cylinder. Third, they were gathered in a loosely held fist and then turned the fist over and released onto the table to left of the cylinder. For the plastic square, the experimenter held the square vertically so that it was standing upright on one edge and moved it along the wooden plate that held the dowel. First, the vertical plastic square was moved along the front portion of the base, then along the back, and finally along the front again. The hole was thus seen to pass directly in front and behind the dowel (the dowel could be seen right through the hole), but there was no obvious intent to fit the hole over the dowel.

Scoring

The response periods for all four groups were identical inasmuch as each infant had a series of five 20-s response periods. To ensure blind scoring of the data, a new videotape was made by deleting all the warm-up and presentation periods. It contained only the response periods and thus contained no artifactual clue as to the children's test group. It was scored in a random order by a coder who was kept unaware of the test group of the children.

The operational definitions of performing the target acts were the following. For the dumbbell a "yes" was scored if the infant pulled the object apart. For the box a "yes" was scored if the infant used the stick tool to push the button and activate the buzzer. For the prong a "yes" was scored if the nylon loop was put over the prong so that the prong protruded through it. For the cylinder a "yes" was scored if the beads were lowered all the way into the cylinder. For the plastic square a "yes" was scored if the infant placed the plastic square over the wooden dowel so that the dowel protruded through the hole. The scorer also recorded the latency to produce each of the target acts, timed from the moment the child first touched the toy. Latencies were measured by reference to the character generator on the video record that recorded time in seconds and frames.

The principal question was how the production of target acts varied as a function of experimental group. However, during the study it had become evident that infants sometimes duplicated the control acts that the experimenter displayed in the adult-manipulation control. The study was not designed to pursue these arbitrary acts in detail, but instances of the adults' control acts were also scored in all trials. These data are informative both for knowing whether infants reenact incidental behaviors and also whether children will perform two different actions on the test objects (one after seeing the target demonstrations and another after these control demonstrations). The operational definitions were the following: For the pull toy the infant strained to push the (unmovable) ends of the assembled dumbbell inwards, just as the experimenter had done. For the box the infant held the stick tool in a horizontal position while moving it against the face of the black box. For the prong the nylon loop was moved along the upper edge of the screen. For the cylinder the beads were suspended vertically off the table and then lowered or dropped all the way onto the table beside the cylinder without touching it. For the plastic square the infant held the piece of plastic square upright on its edge as it was moved on the wooden base as the experimenter had done.

Scoring agreement was assessed by having 25% of the children (50 trials) rescored by both the primary scorer and an independent scorer. Scoring agreement was high: Across the 50 trials, there were no intrascorer disagreements on the production of the target acts or control acts; for the interscorer assessments, there was one disagreement for target acts and one for the control acts. The Pearson r for the latency measure was .98 (mean disagreement < 0.25 s).

Results and Discussion

Main Analyses

The results suggest that 18-month-old children can understand the intended acts of adults even when the adult does not fulfill his intentions. Each child was presented with five objects, and for statistical analyses each was assigned a score ranging from 0 to 5 according to how many target acts he or she produced. Table 1 displays the mean number of target acts produced as a function of experimental group. The data were analyzed with a one-way analysis of variance (ANOVA). The results showed that the number of target acts varied significantly as a function of experimental group, with more target acts in the demonstration groups than the controls, $F(3, 36) = 22.95$, $p < .0001$. Follow-up pairwise comparisons using the Tukey honestly significant difference procedure showed that number of target acts produced by infants in the target demonstration ($M = 3.80$, $SD = 0.92$) and intention ($M = 4.00$, $SD = 1.15$) groups did not significantly differ from each other and that each group produced significantly more target acts than infants in

Table 1
Number of Children Producing Target Acts as a Function of Group

	Number of target acts					
Group	0	1	2	3	4	5
Control (baseline)	4	3	0	3	0	0
Control (adult manipulation)	3	4	3	0	0	0
Demonstration (intention)	0	0	2	0	4	4
Demonstration (target)	0	0	1	2	5	2

the baseline (M = 1.20, SD = 1.32) and adult-manipulation (M = 1.00, SD = 0.82) control groups, which also did not significantly differ from each other. Nonparametric analyses of the data (Kruskal–Wallis and Mann–Whitney Us) yielded identical results.

It is striking that the Demonstration (target) and Demonstration (intention) groups did not significantly differ from one another. Of the 50 trials (10 s × 5 trials each) administered to the Demonstration (target) group, 38 resulted in the target act, which is similar to the 40 for the Demonstration (intention) group. A more qualitative examination of the videotapes supported this point. Infants in the intention group did not go through a period of trial and error with the test objects but directly produced the target act just as those who saw the full target had done. This can be captured by the latency to produce the target acts in the intention and target demonstration groups, which did not significantly differ from one another ($F < 1.0$) and were respectively 5.10 s (SD = 2.74) and 3.97 s (SD = 2.70). These short latencies support the impression gained from the videotapes that infants did not engage in extensive error correction and produced the targets rather directly.

Can children interpret the adult's behavior right from the first encounter? The results show that 80% of the children (8 of 10 for each demonstration group) produced the target act with the first object as compared with only 20% (5 of 20) in the control groups, $\chi^2(1, N = 40) = 10.03$, $p < .005$. These data are informative because they show that prolonged exposure to these displays is not necessary; they can be interpreted even when they occur on the first trial.

Each test object was analyzed individually to assess the generality of the phenomenon and the range of events over which it works. Table 2 provides the complete data set, broken down object by object. For statistical analysis the two Demonstration groups (target and intention) were collapsed and compared with the collapsed Controls (baseline and adult-manipulation) because the expected frequencies were too small for a four-cell analysis (Siegel, 1956). The results from the 2 × 2 contingency tables comparing the number of children who produced the target response for each object (a dichotomous yes or no score) as a function of experimental treatment (Demonstration or Controls) showed that the demonstration was significantly more effective in eliciting the target behavior for each of the objects considered individually. The chi-square values were as follows (all df = 1, N = 40, one-tailed): dumbbell, 12.60, $p < .001$; box, 14.73, $p < .001$; prong, 14.44, $p < .001$; cylinder, 12.22, $p < .001$; and square, 2.98, $p < .05$. If one analyzes the controls versus the intention group alone, a similar pattern emerges for each object, with significance values ranging from $p < .001$ to $p = .056$ (for the square). The results suggest that the phenomenon is not limited to one or two acts but is reasonably general, applying to all five of the acts tested. The only object that seemed to cause any difficulty was the plastic square, and re-examination of the videotapes indicated that this task strained the manual dexterity of the 18-month-olds. The children in both the intention and target act groups had motor skills difficulty in fitting the hole over the dowel (six children failed in the Demonstration [target] group and five failed in the Demonstration [intention] group).

Subsidiary Analyses

In the adult-manipulation control group the adult picked up and handled the toys but did not perform the target acts. The goal of using this control was to equate for the amount of time that the adult handled the toys with the demonstration groups. It was not intended that the infants learn anything from these control manipulations. Nonetheless, my impression was that children were duplicating these arbitrary acts. The data were that 90% (9 of 10) of the children in the adult-manipulation control group produced a control act as compared with only 6.7% (2 of 30) of the children from the other three groups, $\chi^2(1, N = 40) = 22.11$, $p < .0001$. On average, infants in the adult-manipulation group produced 2.60 (median = 3.00) such acts out of the five possible trials, which significantly differed from the other groups (M = .067), $p < .001$, Mann–Whitney test. This result is compatible with previous reports of the imitation of novel and arbitrary acts at this age (e.g., Meltzoff, 1988a, 1995; Piaget, 1962).

Experiment 2

The results of Experiment 1 indicated that young children can pick up information from the failed attempts of human actors. One question that arises is whether the children are responding solely to the physics of the situation (the movements that are traced in space) or whether a psychological understanding of the human actor is involved. What would children do if they saw the same movements produced by an inanimate de-

Table 2
Proportion of Children Producing Target Acts as a Function of Test Objects and Group

	Group			
Test object	Control (baseline)	Control (adult-manipulation)	Demonstration (intention)	Demonstration (target)
Dumbbell	.20	.40	.80	1.00
Box	.40	.10	.90	.90
Prong	.10	.20	.90	.70
Cylinder	.30	.20	.90	.80
Square	.20	.10	.50	.40
M	.24	.20	.80	.76

vice? Do the spatial transformations in and of themselves suggest the target act? A device was built that mimicked the movements of the actor in the Demonstration (intention) group. The device did not look human, but it had a pincer that "grasped" the dumbbell on the two ends (just as the human did) and then pulled outward. These pincers then slipped off the cubes (just as the human hand did). The pattern of movements and the slipping motions were closely matched to the human hand movements, as described below (see Figure 2).

Method

Children

The participants were sixty 18-month-old children (M = 18.08 months, SD = .13; range = 541–555 days old). Equal numbers of boys and girls participated in the study. Fifty-four children were White, 3 were Asian, and 1 each were African American, Hispanic, and Pacific Islander. The recruitment procedures and criteria for admission into the study were the same as in Experiment 1. One potential participant was dropped due to a procedural error.

Test Materials

The test object was the dumbbell shown in Figure 1. For the human model group, the demonstration was performed by a human in the same way as already described in Experiment 1: Demonstration (intention). In the inanimate model group the demonstration was presented by a mechanical device (see Figure 2). This device consisted of a small box with an open back panel. Through this opening the experimenter invisibly controlled two upright mechanical arms. Each mechanical arm consisted of a vertical piece with two horizontal finger/pincers at its end. The dumbbell was held between the pincers in the same way that it was held by the human fingers. The mechanical arms traced the same movements outward as the human arms did. Like the human actor, the mechanical device failed to pull apart the dumbbell, and the pincers slid off the ends of the dumbbell just as the human fingers did. An interesting detail is that the pincers were under slight spring tension. Therefore, when the pincer slid off the end, the two pincers came together just as the human fingers did when the adult's hand slipped off the end of the dumbbell. No machine can exactly duplicate a human, and this certainly was not an attempt to construct a robot (left for future research). However, this device mimicked the pulling and slipping motion of the arms, fingers, and hands at a reasonable first approximation. It tested whether the perception of pincers slipping off the end of the dumbbell suggested the same goal state as fingers slipping off the end.

Design

The children were randomly assigned to one of two independent groups with 30 children per group: Human Demonstration (intention) and Inanimate Demonstration (mechanical slippage). Sex of child was counterbalanced within each group.

Procedure

After filling out the necessary forms, one parent and the child were escorted to the test room and acclimated as described in Experiment 1. For children in the Human Demonstration (intention) group the procedure was similar to that already described in Experiment 1, except that a female experimenter was used to present stimuli in this experiment. Briefly, the experimenter brought the dumbbell up from beneath the table with it held in her two hands. The adult then moved her arm horizontally to the left but failed to pull apart the dumbbell, because her hand slipped off (see Figure 2). This movement was repeated two more times, each time alternating the direction of the attempted pull and therefore the direction that the fingers slipped off. The same protocol was followed in the group who saw the demonstration by the mechanical device rather than by a human. The mechanical arm was moved horizontally so that the pincers slid off the dumbbell on the left side (see Figure 2). The mechanical arm was then moved in the opposite direction so that the pincers slid off on the other side and finally in the first direction again. Each time the pincers slid off the end of the dumbbell the pincers came together just as the human fingers did.

At the end of the presentation period, both groups were treated identically. The stimulus material was withdrawn and the test object put on the table directly in front of the child. A 20-s response period was electronically timed from the moment the child touched the object.

Scoring

The primary dependent measure was the number of children who produced the target act of pulling apart the dumbbell. This information was obtained from videotape coding by a scorer who remained uninformed about whether the previous demonstration had been shown by the person or machine. We also sought to evaluate whether children in the machine-demonstration group were frightened by the display (observations suggested not). In a separate pass (also involving "blind" scoring) the stimulus-presentation periods were scored for: infant visual

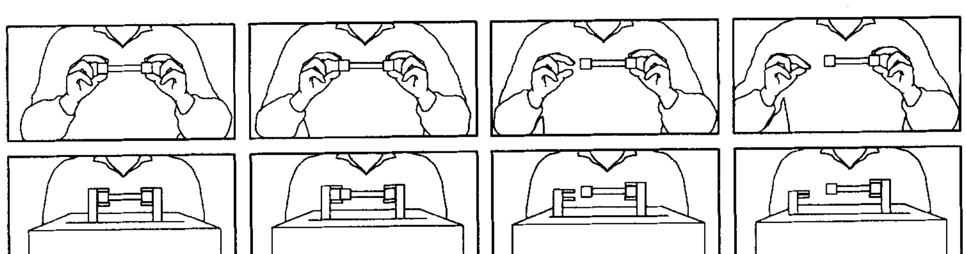

Figure 2. Human demonstrator (top panel) and mechanical device mimicking these movements (bottom panel) used in Experiment 2. Time is represented by successive frames left to right.

attention to the presentation, social referencing to the caretaker (turning around to look at the parent), and fussing. Visual attention was measured in seconds, and the other measures were dichotomous codes of whether or not such an event occurred during the presentation period. Scoring agreement was assessed by having 25% of the children rescored by both the primary and an independent scorer. Agreement was high: There were no disagreements on the dichotomous measures; for visual attention $r = .99$ (mean disagreement < 0.33 s).

Results

The children were visually riveted by both displays; visual attention to the displays exceeded 98% of the presentation period for both treatment groups. The children did not seem to be more frightened by one display than the other. There was no social referencing (turning around toward the parent) and no fussing by any of the children during the presentation periods.

Children did not seem to react differently when watching the human versus machine. The question can now be posed as to whether they interpreted the presentations differently. The data showed that they did. The groups significantly differed in their tendency to produce the target act. The children were six times more likely to produce the target act after seeing the human attempt to pull it apart (60% did so) than they were after seeing the demonstration by machine (10%). The corresponding contingency table analyzing group (human or machine) × response (yes or no) was significant, $\chi^2(1, N = 60) = 14.36, p < .0005$.

General Discussion

The goals of this research were both methodological and substantive. The first goal was to develop a procedure that could be used to pose "theory-of-mind" questions at ages younger than children could be queried through verbal means. The more substantive issues were to investigate (a) whether 18-month-olds understand the acts of others within a psychological framework that includes goals and intentions and (b) the limits of the types of entities that are interpreted within this framework. Is it tied to people?

Behavioral Re-Enactment Procedure

A behavioral re-enactment procedure was developed to pose questions concerning the understanding of intention, but it would seem to have wider applicability than to intention alone. The test mandates that children formulate action plans on the basis of their interpretation of events. The response is a productive measure. Such re-presentation in action is not as informative as a verbal description, but it does entail that the children "tell" us how they saw things (rather than our making inferences from a more passive measure, such as increased or decreased attention in a habituation procedure).[3]

The re-enactment technique capitalizes on past findings that toddlers can be induced to reproduce adult's behavior (Meltzoff, 1988a, 1988b, 1993, 1995; Piaget, 1962). The normal task was modified to differentiate between a surface versus more abstract construal of an event. It asked whether infants could go beyond duplicating what was actually done and would instead enact what the adult intended to do. By analogy, if adults are asked to repeat what was said, they often paraphrase rather than quote, and we glean much from what they leave out, magnify, and transform. Like adults, infants are not little tape-recorders or videorecorders. The re-enactment procedure uses infants' nonverbal reconstructions of events to investigate their interpretive structures, here to explore their folk psychological framework.

Understanding Intention in Infancy

In Experiment 1, one group saw the adult perform a target act, Demonstration(target), and as expected, they re-enacted the same target. Another group provided a more novel test. They never saw the adult perform the actual target act. For example, the adult tried to pull apart a toy but failed to do so because his hand slipped off as he attempted to pull it apart. In another case the adult strove to push a button with a stick tool but failed in his attempts. In a third, the adult intended to put a loop over a prong but under- and overshot the target, and the loop ineffectually fell to the table.

The terms "tried," "strove," and "intended" are used because that is how adults would code the behavior. This is a mentalistic way of describing things. The question is whether the infants also construe it this way. Or do they see things in a less psychological manner? Perhaps in more purely physical terms?

In Experiment 1, two control groups were included. These controls assessed the likelihood that infants would produce the target acts spontaneously, through chance manipulation, or because the objects had demand characteristics that called out the response even when it was not modeled. The results showed that the target acts were not high baseline behaviors; they were not called out by the test objects themselves, or even by watching the adult perform control actions with the same test objects. Nonetheless, in the treatment groups infants accurately produced the targets. The significant difference between the treatment and control groups shows that infants' behavior was based on their perception of the adult's acts. They used the adults as a source of information about what to do with the objects, and their behavior was guided by the nature of the particular acts the adult did.

The adult's modeling of failed attempts led to a systematic effect, and the effect was extremely strong: Infants were as likely to perform the target after seeing the adult "trying" as they were after seeing the real demonstration of the behavior itself. In Experiment 1, children in the intention group performed 4.0 out of a possible 5 target acts and did so with a mean latency of 5.01 s, whereas those in the target-demonstration group performed 3.8 out of the same 5 acts with a latency of 3.97 s (statistically, these slight differences did not approach significance on either measure). These numbers are in line with my impressions in conducting the study. I did not see infants in the Demonstration(intention) condition groping toward the goal. This could have happened, and we scoured the videotapes for it, but

[3] The habituation paradigm could be used to investigate infants' perception of intention by adapting Dasser, Ulbaek, and Premack's (1989) study of older children; converging studies using both the re-enactment and habituation procedures would enrich one's understanding of infants' notion of intention.

it did not occur. It was as if children "saw through" the surface behavior to the intended act or goal.

The analysis showing that children re-enacted the incidental acts of the experimenter in the control group confirms that 18-month-olds can and do imitate fairly "meaningless" action sequences (see also Piaget, 1962). They had the motor skills to imitate the surface behavior of the adult in the Demonstration (intention) group. They could have poked the stick on the surface of the box or dropped the loop next to the prong. However, they did not re-enact what the adult literally did, but rather what he intended to do.[4] This nonverbal finding is reminiscent of Lillard and Flavell's (1990) discovery that 3-year-old children preferred to verbally describe an event in terms of underlying desire or intention rather than surface behavior ("he wants to get the cupcake" instead of "he's on tiptoes by the cupcake").

To underscore why the results reported here are relevant to the development of folk psychology, it is helpful to distinguish between seeing the behaviors of others in purely physical versus psychological terms. The former will be called *movements* or *motions* and the later human *acts*. The behavior of another person can, of course, be described at either (or both) of these levels. We can say "Sally's hand contacted the cup, the cup fell over" or "Sally intended to pick up the cup." Strict behaviorists insist on the former because what is in the respondent's mind is unobservable. Cognitive and social psychologists prefer the latter description. The current research suggests that by 18 months of age children are not strict behaviorists. They do not see the behavior of others merely in terms of "hold the dumbbell and then remove one hand quickly" but rather see an "effort" at pulling. They do not see the demonstration as "loop falls to one side of prong and then the other side," but rather as an attempt to drape it over the prong. They show us how they see or interpret these events by re-enacting them for us. Infants apparently represent the behavior of people in a psychological framework involving goals and intended acts, instead of purely physical movements or motions. Borrowing language from perceptual psychology, one might say they code human behavior in terms of the "distal stimulus" (the intended act) instead of the "proximal cues" (the surface behavior and literal limb movements). Human behavior is seen as purposive.

Experiment 2 investigated whether there was something special about a person, or whether 18-month-olds would make similar attributions to the movements of an inanimate device. It is central to our adult conceptions of the world that there are two differentiable causal frameworks: (a) a physical causality for explaining the behavior of things and (b) a psychological causality for explaining the behavior of people. We can make errors in our attributions, and inanimate devices can be built that strain our normal distinctions (can computers have intentional states?). However, one doesn't generally ask the desk to move across the room—one shoves it. One doesn't believe the car key was "trying" to hide (even if it's absent whenever there is an important appointment). Similarly, one doesn't think that an errant arrow was actually trying to hit the bullseye but failed (that ascription is made of the archer), or that the pendulum of a grandfather clock is attempting to strike the side of the cabinet but missing. Intentions and goals are the types of things that are used to explain the behavior of persons, not things. In my terms, we see the bodily movements of people and interpret them in terms of acts, and we see the movements of things and interpret them as such, as movements or motions. Explanations for the latter lie in the domain of physics and for the former in the domain of psychology.

The outcome of Experiment 2 was that the 18-month-olds did not tend to produce the target act when a mechanical device slipped off the ends of the dumbbell, but they did produce the target act when the human hand slipped off the ends of the same toy. Evidently the goal, or to use more careful language, the end state ("dumbbell apart") was not suggested by the movement patterns alone when considered from a purely physical perspective. The findings provide evidence that 18-month-olds have a differentiation in the kinds of attributions they make to people versus things.

How might this tendency to treat humans within such a psychological framework arise in the child? Two accounts can be suggested. The first is rooted in Fodor's (1987, 1992) conjecture that humans have an innately specified belief–desire psychology. This was elaborated in Leslie's suggestion that there is a "theory of mind module" (Leslie, 1987, 1988, 1991; Leslie & Roth, 1993). Armed with the data reported here showing "intention-reading" in 18-month-olds, it could be proposed that there is an innate tendency for attributing intentions to humans (see also Premack, 1990). Fodor would certainly be comfortable with intention-reading as part of the innate belief–desire psychology. It would be interesting if children with autism, that is, children who have profound deficits in other aspects of understanding the minds of others (Baron-Cohen, 1990; Baron-Cohen et al., 1985; Harris, 1993; Leslie & Roth, 1993), showed deficits on the kinds of tasks reported here.

I have previously tested newborns' reactions to human faces and discussed innate aspects of social cognition, their initial construal of what a person is, and how persons differ from things (Meltzoff & Moore, 1983, 1992, 1994, 1995). Like Fodor, I am a nativist; but I prefer a special brand of nativism that has been called starting-state nativism versus Fodorian final-state or modularity nativism (Gopnik, 1993; Gopnik & Wellman, 1994; Meltzoff & Gopnik, 1993). Starting-state nativism embraces innate psychological structure, but it also embraces develop-

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[4] It can be asked whether the infants performed the target by accident in the course of trying to duplicate the model's surface behavior. This seems unlikely for four reasons: (a) It was easier to miss the goal than to achieve it; for example, it's motorically easier to have the plastic square-with-hole miss the post and slide off (the observed surface behavior) than have the hole fit over the post. (b) Children succeeded on all five tasks and did so with extremely short latencies manifesting generality and speed that belie accidental behavior. (c) In the case of the dumbbell, seeing mechanical pincers slide off the toy and come together like fingers didn't prompt infants to pull apart the dumbbell, indicating that the target is not suggested simply by friction on the end of the dumbbells and movement away from the center. (d) Even in the Demonstration (intention) group, children often firmly wrapped their fingers around the ends of the dumbbell (in preparation for pulling) and visually concentrated on pulling it apart. If the dumbbell failed to come apart and the children's hands slipped off, as occasionally happened (the snug fit necessitated a considerable yank), they immediately redoubled their efforts to pull it apart. Accomplishing the target act is what terminated their behavior.

ment (Gopnik et al., 1994; Gopnik & Wellman, 1994; Meltzoff, 1990b; Meltzoff & Moore, 1995).

Why suggest development? First, the rudimentary understanding of human goals and intentions does not entail a grasp of more complex mental states such as "belief" (Searle, 1983), and hence not a full-blown belief–desire psychology. Others have reported a developmental progression from understanding desires to understanding beliefs (Astington & Gopnik, 1991b; Gopnik, 1993; Perner, 1991b; Wellman, 1990, 1993). The present results would add that there is some understanding of intention at 18 months, and that like the case of simple desires, this could be accomplished without understanding beliefs per se. Moreover, there are two sides to intentional action, and there may be developmental changes in understanding both. One involves the nature of the goals that are brought about, that is, the causal consequences on the world; the other involves the relation between the mind and actions.

Regarding the former, it seems likely that there are three major developmental changes within infancy in the kinds of acts that can be viewed as intentional—a progression from: (a) simple body acts, to (b) actions on objects, to (c) using one object as tool to act on a second object. At the first level, infants understand only intentions involving simple body movements such as trying to raise one's hand or making particular facial movements. Such simple actions do not refer to anything outside themselves, they are not "about" anything else. Newborns imitate simple body movements (Meltzoff & Moore, 1977, 1983), which shows an innate proclivity for re-enacting the acts of others. It is not yet known whether newborns could succeed on the type of task presented here, which distinguished between the actor's intended acts versus literal behavior—that is, whether newborns would produce the whole target after seeing a failed attempt. However, even if this were the starting state, newborns would probably not understand such tasks if they involved actions on objects, the second level described above. Younger infants attend to people, or attend to things, but not to the person–thing relation. The shift to being able to consider people in relation to things has been labeled secondary intersubjectivity (Trevarthen & Hubley, 1978), triadic interaction (Bakemen & Adamson, 1984), and other terms (Piaget, 1952, 1954). Data relevant to this transition are that at about 9 to 12 months of age infants begin to seek others as sources of information in evaluating novel objects (Campos & Stenberg, 1981; Sorce, Emde, Campos, & Klinert, 1985), perform object-related imitations (Meltzoff, 1988b), and succeed on other tasks (Baldwin & Moses, 1994; Tomasello, Kruger, & Ratner, 1993). Younger infants probably could not understand an adult's attempts to perform an action on an object because this relies on understanding a person–thing relation. Concerning the third level described above, Experiment 1 involved the intention to use a stick to push a button. There is a sharp change in infants' understanding of tools at around 15 to 18 months of age (e.g., Piaget, 1954). Because tool use itself undergoes developmental change in the child, it is likely that the understanding of tool use in others develops. Seeing another's attempt to use a tool may not be construed that way by very young infants, who would be more focused on the body transformations per se (both the arm and finger movements) than on the whole means–ends plan involving the tool. In sum, even if intention were an ontological category available to the newborn, there could still be a developmental progression in the content of this category.

Regarding the other aspect of intentional action—the relation between mind and action—a distinction needs to be drawn between (a) the end states of a purely physical pattern, (b) goals of acts, and (c) intentions as mental states. The present data allow us to infer more than (a), but do not allow us to say with assurance whether infants were using (b) or (c). Let us see what is at stake in these distinctions.

Young infants can "go beyond the stimulus," using past information to project the future. They visually extend the trajectories of moving objects in anticipating re-encounters with them (Bower, 1982; Meltzoff & Moore, 1995; M. K. Moore, Borton, & Darby, 1978; Spelke & Van de Walle, 1993). They anticipate where to look when shown an alternating pattern of flashing lights (Haith, Hazan, & Goodman, 1988). One wonders whether the infants in the experiments reported here were merely projecting the next step of a physical sequence.

The findings indicate more than this, although the argument is a delicate one. The actions in the Demonstration (intention) group did not, strictly speaking, form a progression. The infants were shown three failed attempts, but each failed in a different way (usually equidistant from the desired end) that was not incrementally related to the target act (by experimental design). This is different from anticipating that an object that was seen along a trajectory at a, b, c, will next be at d; or that a light with the alternating pattern of a, b, a, b will next flash at a. Thus, in Experiment 1 the stick missed to the left, then the right, and then too high. Couldn't the next step be a miss that was too low, to complete the pattern? If the movements qua movements specified the next step, why wasn't it suggested when the movements were traced by the mechanical device? The infants in this experiment not only went beyond the surface stimulus, but they also went beyond the stimulus in a particular way that relied on human goals or intentions, not solely physics.

We now need to consider more closely what is meant by *intention.* Searle (1983) differentiated at least two broad types of intentions. He called *prior intentions* those mental states that occur in the mind of the actor in advance of the action being performed that can be described in the form "I will do *x*." One can have a prior intention but not perform any behavior at all (e.g., if the prior intention is not actually fulfilled). These are to be distinguished from *intentions in action,* which are what is involved at the moment of purposely performing a particular bodily movement (vs. when it happens accidently or reflexively). One can have a spur of the moment intention in action, without a prior intention to have it. Every purposeful bodily movement involves an intention in action, but only some intentions in action involve prior intentions. Searle has argued that one needs at least these two varieties of intention to describe adult understanding. Astington (1991) showed that both are entailed in the 5-year-old's understanding.

It seems doubtful that 18-month-olds, let alone newborns, contemplate the prior intentions of others. These mental states are very far upstream, as it were. It is possible, however, that the 18-month-olds in these studies were manifesting an understanding of intentions in action. Infants' understanding of intention in action would allow them to make sense of what would otherwise be rather odd behavior on the part of the adult. It would organize the surface behaviors and allow the infant to see them as "failed attempts" that stemmed from one underlying cause.

However, a thoroughgoing developmental analysis must recognize that even intentions in action are, for the adult, invisible mental states imputed to the mind of the actor. Children in these studies may have imputed such states, or they may have stopped short and simply interpreted the goals of the actions. Infants may think that human acts have goals without yet ascribing underlying mental states in the mind of the actor as the cause of these goals. The results from Experiment 2 demonstrate that physical movements performed by a machine are not ascribed the same meaning as when performed by a person. Therefore, even a weak reading of the data suggests that infants are thinking in terms of goals that are connected to people and not to things. This is tantamount to saying that the infants are construing behavior in terms of a psychological framework including goals of acts, if not the intentions of actors.

The raw fact that 18-month-old children can succeed on the tasks reported here, that they can make sense of a failed attempt, indicates that they have begun to distinguish the surface behavior of people (what they actually do) from another deeper level. This differentiation lies at the core of our commonsense psychology. It underlies fluid communication (Baldwin & Moses, 1994; Bruner, 1983; Grice, 1957; Tomasello & Barton, 1994) as well as our moral judgments. This distinction is also important for understanding even very simple human behaviors. The current experiments suggest that 18-month-olds also understand the actions of others in terms of psychology, not solely physics. In this sense, 18-month-olds have already adopted the basic tenet of folk psychology.

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