Understanding “Prior Intentions” Enables Two-Year-Olds to Imitatively Learn a Complex Task

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This study investigated children’s understanding of others’ intentions in a social learning context. Specifically, it investigated whether knowing an adult’s prior intention before the adult gives a demonstration influences what children learn from the demonstration. In the five main experimental conditions, ninety-six 2-year-old children watched as an experimenter (E) pulled out a pin and opened the door of a box. Children in two No Prior Intention conditions saw this demonstration alone or paired with an irrelevant action. Children in three Prior Intention conditions knew what E was trying to do before the demonstration: they first saw E either attempt unsuccessfully to open the door, or visit and open several other containers, or they first saw that the door opened. Children opened the box themselves more often in each of these three conditions than in the two No Prior Intention conditions, even though children in all five conditions saw the exact same demonstration of how to open the box.

INTRODUCTION

Human children acquire many of their most important cognitive skills by observing other persons. Recent research has determined, however, that what is typically called “imitation” in developmental research actually may represent a whole host of different processes of social learning that differ from one another in important ways. For example, children may mimic another person’s behavior without understanding its functional significance, they may emulate an environmental result produced by another person without attending to the behavioral strategies used, or they may imitate both behavior and result in an attempt to reproduce another person’s goal-directed actions. Many of these distinctions were first elaborated in research on non-human primates (for a review, see Tomasello, 1996), and are now being applied more systematically to children’s social learning as well (for a review, see Want & Harris, 2002).

An important discovery of research that has taken this more fine-grained approach to children’s social learning concerns the role of intentional understanding. First, Meltzoff (1995) showed 18-month-old infants an experimenter who was trying but failing to perform some target action on an object. When given the chance to play with the object themselves, these infants performed the action the experimenter meant to do (but never actually did) as often as children who saw a successful demonstration of the complete target action. Bellagamba and Tomasello (1999) found that 12-month-olds did not perform the action the experimenter meant to do in this same way. Second, Carpenter, Akhtar, and Tomasello (1998) showed 14- to 18-month-old infants an experimenter who was performing two actions on an object, one of which was intentional and one of which was accidental. When given the chance to play with the object themselves, infants performed the experimenter’s intentional actions much more often than her accidental ones. Third, Bekkering, Wohlschläger, and Gattis (2000) showed 3- to 6-year-old children an experimenter who was touching a table in one of two locations. In one condition, there were dots on the table in those locations and in another condition there were no dots. In the “no dot” condition, children touched the adult’s behavior exactly—they even copied her crossed or straight arm positions (because there was no other apparent goal to her actions). In the “dot” condition, however, children touched the same locations as did the experimenter but did not match her exact arm positions (because there was a clear external goal: touching the dots). Finally, research on language acquisition has shown that children as young as 18 months take adults’ intentions into account when imitatively learning the meanings of novel words (for a review, see Tomasello, 2000). Together, these studies demonstrate that in social-learning situations, children older than 12 months reproduce what they understand another person to be doing, and this understanding rests crucially on—indeed is constituted by—their understanding of that person’s intentions.

All of these studies concern children’s understanding of what Searle (1983) called “intention in action.” That is, children observe another person, and their understanding of that person’s intentions derives from...
cues immanent in that person’s ongoing behavior. However, Searle also identified “prior intentions” in which an observer knows a person’s goal before that person acts. What little research has been done on children’s understanding of others’ (and their own) prior intentions has been done with children 3 years and older, in contexts other than social-learning contexts (e.g., Astington, 1991; Phillips, Baron-Cohen, & Rutter, 1998; Shultz, Wells, & Sarda, 1980). However, the understanding of prior intentions might be present in younger children and might be important in many aspects of children’s behavior and development, including social learning. Of special importance might be social learning in which a fairly complex set of behaviors is demonstrated for the child (e.g., in a problem-solving situation).

The way this might work is best illustrated with an example. Suppose you observe a person interacting with a plastic cube, with various nooks, crannies, and protrusions. You watch him poke, prod, and manipulate it, with no idea of what he is doing. Suddenly a drawer opens and he takes out some candy. Can you now open the drawer for yourself? To do so you must recall what the demonstrator did, which, at the time, seemed like meaningless motions. Perhaps you can do it, perhaps not. Suppose, however, that you know ahead of time that the cube has a drawer with candy inside, and so you now watch the other person’s poking and prodding with this goal in mind. It is very likely that in this situation you will perceive the pokings and proddings differently—you will see them as intentional, goal-directed behavioral strategies—and thus understand and recall them better when it is your turn to try. Some support for this hypothesis comes from research on toddler memory by Bauer and Hertsgaard (1993) and Travis (1997), who found that 1- to 2-year-olds recall action sequences more accurately when they have enabling or goal-directed structure. In the case of the plastic cube, such structure would be present at the outset only if the learner knew that the cube opened and that the demonstrator’s actions were aimed at opening it.

In the current study, this hypothesis was tested by presenting 2- to 2.5-year-old children with a relatively complex problem that required two distinct steps for its solution: they had to first pull out a pin, and then they could open a hidden door of a box. There were six different groups of children. One group was a No Demonstration (baseline) group: these children were simply given the box with no opportunity to observe others interacting with it. The other five groups of children all saw a demonstrator pull out the pin and open the hidden door to the box. What differed among these groups was what they saw before they saw this demonstration. One of these groups (No Prior: No Pre-Demo) saw nothing prior to the demonstration; thus, they did not know before the demonstration that the demonstrator’s intention was to open the box. Three of the groups received different types of information about the demonstrator’s prior intentions. One group (Prior: End State) saw the adult hold up the already-opened box before the demonstration (this condition was based on the End State condition of Bellagamba & Tomasello, 1999). Another group (Prior: Failed Attempt) saw the adult tug unsuccessfully on the door of the box before the demonstration (this condition was based on the Intention condition of Meltzoff, 1995). The third of these groups (Prior: Context) saw the adult visit and open three other containers in turn, before reaching the target box and performing the demonstration. These other containers did not resemble the target box physically and, more importantly, the actions needed to open them were different from the actions needed to open the target box. This last condition was especially interesting because, like the No Prior: No Pre-Demo condition, children in this condition saw no behaviors on the target box before the demonstration of how to open it. Their knowledge of the demonstrator’s prior intention, if they acquired such knowledge, would have to come from her prior behavior in interacting with the other containers. Finally, because the No Prior and Prior Intention conditions differed not only in whether children knew the demonstrator’s prior intention but also in the absence or presence of a predemonstration, a control condition was included to determine whether any prior action on the box was enough to increase children’s performance, for example, by calling children’s attention to the box or increasing their interest in it. In this condition (No Prior: Irrelevant Action), children did not know E’s prior intention but did watch the demonstrator perform an action on the box before the demonstration of how to open it. The difference was that this predemonstration did not provide any information about her prior intention: the adult raked her fingers down the roof of the box three times before performing the demonstration.

Our main hypothesis was that children in the three conditions in which cues to the demonstrator’s prior intentions were provided (Prior: End State, Prior: Failed Attempt, and Prior: Context) would be better at solving the task than would the children in the three groups in which no such cues were provided (No Prior: No Pre-Demo, No Prior: Irrelevant Action, and No Demonstration), even though in the first two of these three latter groups the children did see a full demonstration. A secondary question (for which we had no definite predictions) concerned whether
children would reproduce the demonstrator’s exact actions in opening the box depending on the experimental condition. That is, we wanted to know precisely which aspects of the demonstrator’s actions children attended to and attempted to reproduce. This would then provide information about the interaction between children’s perception of and memory for bodily actions and their understanding of others’ goals. To investigate this question, a “style” component (Hobson & Lee, 1999; Whiten, Custance, Gomez, Teixidor, & Bard, 1996) was added to the adult’s demonstrations. The adult pulled out the pin either with a distinctive twisting motion or with an equally distinctive series of multiple short, jerky pulls. Both of these distinctive styles were unnecessary to open the box (the most straightforward way of taking out the pin was to pull it straight out in one long pull) and thus they were irrelevant actions.

METHOD

Participants

Ninety-six children (49 boys, 47 girls) participated in this experiment. Half of the 16 children in each condition were 2-year-olds (M = 23.8 months, range = 21–26 months; 22 boys, 26 girls) and half were 2.5-year-olds (M = 29.5 months, range = 27–33 months; 27 boys, 21 girls). The first 64 children were randomly assigned to one of the four experimental conditions. Half of the children at each age in each of these four conditions were American and half were German. Only German children participated in the two control conditions (i.e., No Demonstration and No Prior: Irrelevant Action). Children were recruited from local day-care centers and parents signed informed consent forms in both localities.

Materials

The experimental apparatus was a converted wooden birdhouse (see Figure 1 for photographs). The birdhouse measured 39 cm × 18.5 cm × 13.5 cm and had a concealed door that opened vertically in front (blue tape was placed on the bottom of the door to facilitate the children’s memory for the opening location). A pin and locking system were added such that a wooden pin on the left side of the birdhouse had to be pulled out fully before the door could be opened. Once the pin was pulled out fully, a wooden block inside the birdhouse fell down and blocked the pin from being pushed back into the birdhouse (to keep the children from playing with the pin and thus being distracted from the task of opening the birdhouse). A small toy (a wind-up train) was placed inside the birdhouse beforehand without the children’s knowledge.

Procedure

Children were tested individually in a quiet room of their day-care center. All sessions were videotaped. After a brief warm-up play period with other toys, the children sat on the floor facing the experimenter (E). In all conditions, the general procedure was as follows: E brought out the birdhouse apparatus (hereafter referred to as the box), interacted with it in a way that was appropriate for the experimental condition (see below), and then gave the box to the children for a response period.

There were five demonstration conditions. All children in each of these conditions saw a full demonstra-
tion of how to pull out the pin, open the door of the box, and obtain the toy inside. What differed across conditions was what (if anything) the children saw before this full demonstration. There were two No Prior Intention conditions in which the children did not know E’s prior intention to open the box, and three Prior Intention conditions, in which information about E’s prior intention to open the box was available to the children before the demonstration.

**No Prior: No Pre-Demo condition.** Children in this condition saw only the full demonstration of how to open the box (with no predemonstration). They thus did not know that E’s prior intention was to open the box. E placed the box on the floor with the door facing the children. She said, “Watch this,” and then pulled out the pin, opened the door, and took out the toy.

**No Prior: Irrelevant Action condition.** This condition was a control condition in which children did not know E’s prior intention but did see a predemonstration. Before the full demonstration, E showed the children an action that was unrelated to opening the box. They thus did not know that E’s prior intention was to open the box. E said, “Watch this,” and then raked her fingers down the roof three times. Then E performed the full demonstration (as described in the procedure for the No Prior: No Pre-Demo condition above).

**Prior: End State condition.** Before the full demonstration, E showed the children the box already opened. The box was empty (the toy was hidden in E’s pocket) during this predemonstration. First, E turned her back to the children and opened the door of the box out of their view (the pin was already pulled out before the children arrived); the children thus did not see any action on the box at this point. E then faced the children, said, “Look at this,” and held up the box with the door open (moving the box around slightly for several seconds so the children could see it from different angles). E then turned around again and quickly put the toy in, set the pin, and closed the box. E then faced the children again and performed the full demonstration (as described in the procedure for the No Prior: No Pre-Demo condition above).

**Prior: Failed Attempt condition.** Before the full demonstration, E physically showed the children—by her actions on the experimental apparatus—her intention to open the box. She said, “Watch this,” grasped the bottom of the door of the box, and tugged on it (unsuccessfully) several times. She then “noticed” the pin and proceeded to perform the full demonstration (as described in the procedure for the No Prior: No Pre-Demo condition above).

**Prior: Context condition.** Before the full demonstration, E showed the children her intention to open the box not by acting on it directly but through the context of the situation. There were three other, different containers (a blue receptacle, a white bucket, and a gray set of drawers) in a row from left to right, with the box at the end of the row. E said, “Watch this,” went to the first container in the row, opened it, and took out and briefly played with the toy inside. She put the toy back in the container, closed it, and went to the next container in the row, opened it, and took out the toy inside and played with it. She repeated this procedure with the third container and its toy. Then she went to the box and performed the full demonstration (as described in the procedure for the No Prior: No Pre-Demo condition above).

Thus, in each of these five conditions, all children saw a full demonstration of how to pull out the pin, open the box, and take out the toy. In each case, after the demonstration E played with the toy briefly, without letting the children touch it. Then she put the toy back in the box, closed it, and placed the box so it was facing the children. She said, “Do you want to play with it now?” or, in German, “Jetzt du” (“Now you”). When children first touched the box, a 60-s response period began. In most cases, if children opened the box during that period, they were given a second response period with no demonstration; if they did not open the box during the first response period, they were given a second full demonstration, without any pre-demonstration, and then a second 60-s response period. Eight children did not receive a second response period due to fussiness or E error (5 opened the box and 3 did not: 1 child each was in the No Prior: No Pre-Demo and Prior: Failed Attempt conditions, 2 were in the Prior: Context condition, and 4 were in the Prior: End State condition).

Because we were also interested in which details of the demonstration children in each condition would remember, a “style” component was added to the full demonstration. Half of the children in each condition saw E pull the pin out using a distinctive twisting motion (i.e., revolving the pin around its main axis with approximately five big twists of the pin, using the wrist, while simultaneously pulling) and half of the children saw E pull the pin out using a distinctive “short pulling” motion (i.e., pulling by approximately eight small, jerky pulls, using the fingertips, with no twisting).

To measure children’s baseline performance, another group of children was tested in a No Demonstration condition. In this condition, children did not see any action at all on the box before the response period. After the warm-up play period, E simply took out the box and put it on the floor facing the children. She said “Look, do you want to play with this?” and
started the 60-s response period when children first touched the box. Children in this condition received two 60-s response periods if they opened the box (with no demonstration in between) and only one response period if they did not open the box.

Data Analysis and Reliability

For each response period, children’s success at opening the box, children’s latency to open the box, children’s reproduction of the two components of a successful response (i.e., pulling the pin out and pulling on the appropriate place on the bottom of the door), the location of children’s first touch of the box, and the style that children used when they pulled the pin (i.e., twisting, jerking, or pulling the pin straight out) were coded. Latency to open the box was operationally defined as the time from when the children first touched the box (i.e., the beginning of the response period) to when the door of the box opened. If children did not open the box they were given a latency of 61 s.

Children’s responses were coded from the videotapes. Coders did not watch the demonstrations and so were blind to style and, in most cases, condition (sometimes the other boxes from the Prior: Context condition were visible or the lack of a demonstration was evident when finding the response periods on the videotapes). Notes from the live session were used occasionally when children’s actions were not observable on the video because they had their back turned or the like. Sessions from 22 children (23%) were coded independently to assess interobserver reliability. Excellent levels of reliability were achieved: Cohen’s ks were 1.00 for open box, .90 for pull pin, 1.00 for pull on door, .78 for first touch, and .93 for action style.

RESULTS

There were no significant differences in the percentages of children from each nationality, $\chi^2(1, N = 96) = 1.7$, ns, or age group, $\chi^2(1, N = 96) = .84$, ns who successfully opened the box, so these variables were collapsed for all further analyses.

Success and Latency

Figure 2 presents the percentage of children who successfully opened the box in the first trial as a function of experimental condition. There were significant differences between conditions $\chi^2(5, N = 96) = 14.3$, $p < .01$, one-tailed. There were no significant differences between the two No Prior Intention conditions, Fisher test, ns, and there were no significant differences among the three Prior Intention conditions, $\chi^2(2, N = 48) = .51$, ns. We thus collapsed across the two No Prior Intention conditions and across the three Prior Intention conditions. A comparison between these two collapsed conditions revealed that children opened the box significantly more often in the Prior Intention conditions than in the No Prior Intention conditions, Fisher test, $p < .001$, one-tailed. It is interesting to note that there were also no significant differences between either of the No Prior Intention conditions and the No Demonstration condition, Fisher test, ns, and that combining the No Demonstration condition with the two No Prior Intention conditions and repeating the above analysis led to the same result. Thus, as predicted, children who knew what E was trying to do before her demonstration did better than children who did not know. Children who did not know E’s prior intention did just as poorly as children who did not see any demonstration.

If children did not open the box in their first response period, they were given a second demonstration and response period. Thus, unlike in Trial 1, children in both No Prior Intention conditions who received a second demonstration knew what E was trying to do before the demonstration in Trial 2. We thus expected that they should do as well as other children in this trial. Children were split into passers and failers in Trial 1 and the Trial 2 results for the failers were looked at. There were 15, 14, 10, 8, and 9 children who failed in the No Prior: No Pre-Demo, No Prior: Irrelevant Action, Prior: End State, Prior: Failed Attempt, and Prior: Context conditions in Trial 1, respectively. As predicted, differences between these five demonstration conditions disappeared in the second trial for these children $\chi^2(4, N = 51) = 1.94$, ns. This result was due mostly to children in the No Prior: No Pre-Demo and No Prior: Irrelevant Action conditions who improved their performance from 6%
and 13%, respectively, in the first trial to 31% and 21%, respectively, in the second trial.

Figure 3 presents children’s latency to open the box in Trial 1 for each condition. An ANOVA on the latency to open the box with condition as the independent factor revealed a significant effect of condition, $F(5, 89) = 3.87, p < .002$. As predicted, children in each of the three Prior Intention conditions opened the box significantly faster than did children in each of the three other conditions, least significant difference (LSD), tests, $p < .05$, one-tailed in all cases. Again, there were no significant differences among any of the three No Prior Intention/No Demonstration conditions and there were no significant differences among any of the three Prior Intention conditions, LSD tests, $ns$ in all cases. A $6 \times 2$ ANOVA with condition as the between-subjects factor and trial number as the within-subjects factor on the latency to open the box in the first and second trials (for those children who had two trials) indicated a significant effect of condition, $F(5, 68) = 2.47, p < .05$, one-tailed, but no significant effect of trial number, $F(1, 68) = 2.56, ns$, one-tailed, or Trial Number $\times$ Condition interaction, $F(5, 68) = .20, ns$. Children thus opened the box equally as quickly in Trial 1 as in Trial 2, with the same pattern of differences between conditions as shown before.

Components of Opening the Box

Because a successful solution was formed by two components (i.e., pull the pin out and pull on the door at the blue strip—either successfully or not) for each condition. There were significant differences between conditions in the percentage of children who produced both components, $\chi^2(5, N = 95) = 23.1, p < .001$. The percentages of children who performed both components corresponded roughly to the percentages of success in the different conditions presented previously (they did not correspond exactly because some children performed both components, but in the incorrect order). More interesting was to analyze each component separately. First, there were significant differences between conditions in the percentage of children who pulled the pin, $\chi^2(5, N = 96) = 15.0, p = .01$. Children in the Prior: Failed Attempt condition pulled the pin more often than did children in each of the other conditions (this included both Pin Only and Pin + Door; see Figure 4). Second, there were also significant differences between conditions in the percentage of children who pulled on the door, $\chi^2(5, N = 95) = 27.2, p < .001$. Children in all three Prior Intention conditions pulled on the door more often than did children in the two No Prior Intention conditions and the No Demonstration condition (this included both Door Only and Pin + Door; see Figure 4). It is interesting to note the difference among these latter three conditions, $\chi^2(2, N = 47) = 7.5, p = .024$. In the No Demonstration condition, children seldom discovered the door. In contrast, children in the two No Prior Intention conditions much more often explored the door, even
though they were mostly unsuccessful. Apparently, children who saw a demonstration without knowing E's prior intention had their attention attracted to the relevant parts of the box, but did not know how to put this information together for a correct solution.

Along the same lines, analyses were also conducted to investigate how directly children went to the relevant locations at the beginning of the response period. Figure 5 presents the percentage of children who contacted each part of the box with their first touch of the box by condition for Trial 1. There were significant differences between conditions ($\chi^2(5, N = 95) = 26.8, p < .001$). With their first touch, children in the No Demonstration and No Prior: Irrelevant Action conditions rarely contacted a relevant part of the box (7% to 19%), whereas children in each of the four other conditions did so significantly more often (range = 60%–75%). Almost a third of the children in the No Prior: Irrelevant Action condition copied the action of raking the fingers down the roof, and 80% did this with their first touch. In general, children who ended up succeeding were more likely to contact relevant elements of the box in their first touch than were children who failed, Fisher test, $p < .001$.

Matching the Demonstrator’s Style

Results thus showed that children benefited from observing the demonstrator in the three Prior Intention conditions. Previous analyses, however, did not provide information with regard to how closely children matched E’s specific actions. This is important because unlike the other components (pull pin, pull door), the style component was irrelevant to opening the box, and thus provided information about what details the children picked up from the demonstration. E used different action styles for different groups of children when pulling out the pin: twisting the pin while pulling (twist-pull), or pulling the pin with small jerking motions and no twisting (jerk-pull).

Very few children ever jerk-pulled the pin (only 2 children did this, in their second trial). One possible explanation for this is that in the jerk-pull demonstration, E may have looked as if she were having difficulty pulling out the pin (i.e., the pin looked hard to pull out). If children tried to jerk-pull the pin but did it with some force, the pin would have come straight out. (Alternatively, children simply may not have noticed this style.) In any event, because so few children jerk-pulled the pin, focus was placed on twist-pulling versus pulling the pin straight out.

Table 1 presents the number of children who copied E’s action in Trial 1 as a function of which action style they witnessed. Taken together, the results suggest that children learned to inhibit their natural tendency to twist after witnessing E use the jerk-pull motion, but they did not learn to twist more after observing E twist the pin. That is, first, looking only at those children who pulled out the pin (see the boldfaced columns in Table 1), analyses were performed to determine whether children who saw the twist-pull demonstration only twist-pulled the pin and children who saw the jerk-pull demonstration only pulled the pin straight out (with or without jerk-pulling). In Trial 1, 50% of children who saw the twist-pull demonstration twist-pulled the pin (and never pulled the pin straight out) and 69% of children who saw the jerk-pull demonstration pulled the pin straight out (and never twisted the pin), $\chi^2(1, N = 49) = 1.79, ns$. Children who witnessed E jerk-pull the pin were more likely to pull the pin straight out (and never twist it) than children who had not witnessed any demonstration (i.e., 0% in the No Demonstration condition), Fisher test, $p < .001$, but children who witnessed E twist-pull the pin were as likely to twist-pull the pin (and never pull the pin straight out) themselves as those who had not witnessed any demonstration (i.e., 63% in the No Demonstration condition), Fisher test, $ns$.

Interesting results were found when these children’s tendency to copy E’s action style was compared across the different demonstration conditions. Children in the two No Prior Intention conditions (88%) copied E’s action style significantly more often than did children in the three Prior Intention conditions (48%), Fisher test, $p < .02$.

A similar pattern of results was found when all children were considered, and not just those who had
pulled the pin. Analyses were performed to determine whether children who saw each type of demonstration twisted (i.e., either twist-pulled, twisted only, or twisted + pulled) or not. Most children (87%) who witnessed the twist-pull demonstration twisted the pin at some point, whereas few children (32%) who witnessed the jerk-pull demonstration twisted the pin, $\chi^2(1, N = 79) = 24.5, p < .001$. Again, children who witnessed E jerk-pull the pin were less likely to twist than were children in the No Demonstration condition (81%), Fisher test, $p = .001$, but children who witnessed E twist-pull the pin were as likely to twist the pin themselves as those who had not witnessed any demonstration, Fisher test, ns. There were no significant differences on this measure between children in the No Prior (84%) and Prior Intention (72%) conditions, Fisher test, ns.

A similar pattern of results was found for Trial 2, but with no differences between the No Prior and Prior Intention conditions, Fisher test, ns.

DISCUSSION

In this study, all children in all five demonstration conditions saw a full demonstration of how to pull out a pin, open the door of a box, and obtain the toy inside. What differed across conditions was what children saw before this full demonstration. The results showed that children who were presented with information about the adult's intention before the full demonstration opened the box themselves significantly more frequently and more quickly than did children who were not presented with such information. Interestingly, in both conditions in which children did not know E's prior intention, children did as well as the children in the three Prior Intention conditions in their second trial, after having watched an additional demonstration while knowing E's intentions. Thus, children who knew what the adult was trying to do as she began her demonstration learned more from that demonstration than children who did not know what she was trying to do. Children picked up information about E's prior intention equally well in each of the three Prior Intention conditions (whether the information was presented through knowledge about what the box could do, E's previous actions on that box, or the context of the situation). They did equally poorly in each of the two conditions in which they did not know E's prior intention (i.e., whether they saw no previous information or an action that was uninformative), thus ruling out a possible alternative explanation of the results based on differences in attention or interest. It is important to note that even though children in both No Prior Intention conditions saw a full demonstration of how to open the box, they were just as unsuccessful at opening it themselves as were children who did not see any demonstration at all (in the No Demonstration condition).

It thus appears that 2-year-old children have some understanding of others' prior intentions and can use this information in a social-learning situation. However, there is another possible explanation that needs

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<td>0</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total (without the No Demonstration condition)</td>
<td>Twist-pull</td>
<td>10</td>
<td>1</td>
<td>15</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: Boldface type indicates children who pulled the pin.
$^a$Twist-pull = twist-pull or (twist-pull + twist only).
$^b$Twist and pull = (twist-pull or twist only) and pull only separately.
$^c$All three = twist-pull + pull only + twist only.
$^d$One child's style was not visible on the videotape.
to be addressed. Perhaps all that children acquired in the Prior Intention conditions was some extra information about the box, not E’s prior intentions. That is, in the Prior: End State condition, children saw the box opened, so they had extra information about its opening location (i.e., they saw the box open twice, as opposed to once in the No Prior Intention conditions). Likewise, in the Prior: Failed Attempt condition, children’s attention was called to the pin more than in the other conditions. In this condition, E tugged on the door, then suddenly “noticed” the pin, and then performed the full demonstration. Thus, children in this condition saw extra information about both the opening location and the importance of the pin. However, this argument cannot explain children’s success in the Prior: Context condition because children saw exactly the same actions on the box (a single full demonstration with no predemonstration) in the No Prior: No Pre-Demo and Prior: Context conditions. Yet seven times more children succeeded in the Prior: Context condition compared with the No Prior: No Pre-Demo condition.

Thus, children’s performance in the Prior: Context condition (compared with the No Prior: No Pre-Demo condition) is the most convincing evidence that young children understand something about others’ prior intentions. However, there are still two other possible explanations for this result. One possibility is that children in the Prior: Context condition gathered from the context that E was opening containers, so they were able to predict that that was what she was going to do with the box as well. In other words, children were not understanding E’s intentions but were simply predicting E’s behavior. That would be possible if E were acting on the same box over and over, but not, we believe, when she was acting on different containers. Each of the three previous containers opened in a completely different way than the box (e.g., taking off a lid, or opening a drawer), so children could not learn anything extra about the box’s opening location in this condition. Moreover, only the box required a two-step action to open. Children thus moved beyond predicting specific motor patterns and abstracted something about E’s general purpose—opening containers to get toys out—and this helped them succeed at opening the box themselves.

A second alternative explanation for children’s success in the Prior: Context condition is that children did not predict E’s behavior, but instead predicted the “behavior” of the apparatus. In other words, children predicted the “openability” of the box, based on the end state of the other containers previously opened. However, this explanation alone does not seem sufficient for two reasons. First, to reiterate, all the containers opened in different ways. This means that children could not have directly matched the end state of any of the predemonstration containers with the box. Second, this explanation cannot account for the children’s accuracy in reproducing E’s style and the components of the two-step action required to open the box.

Therefore, the joint results from each of the three Prior Intention conditions were consistent with the hypothesis that 2-year-old children have some understanding of others’ prior intentions and can use this information in a social-learning situation. We are unaware of any other demonstrations of understanding of others’ prior intentions in children this young. This finding is important because understanding intentions-in-action is based on directly perceivable information in the demonstrator’s behavior (and may even be accomplished by some nonhuman primates; Call & Tomasello, 1998), whereas understanding prior intentions must be based, to a much greater extent, on the understanding of goals or intentions as mental entities. One likely reason that the present study found evidence of this understanding earlier than did other studies is that the task was more implicit and had more direct implications for immediate child action than the tasks in other studies (e.g., Astington, 1991; Phillips et al., 1998; Shultz et al., 1980), in which children had to answer explicit verbal questions and talk about their understanding. In any case, it is clear from the current results that 2-year-olds understand something more mental than intentions-in-action and thus have already taken a big step on the road from the understanding of others as intentional agents to the understanding of others as mental agents (Tomasello, 1999).

Along with providing information about children’s understanding of others’ prior intention, this study also provides important information about children’s social learning itself and, in particular, what types of information children gather from a complex demonstration. Call and Carpenter (2002) have proposed thinking about children’s (and other organisms’) social learning in terms of three sources of information that are potentially available in any demonstration: goals, actions, and results. It is known from previous studies that young children have a strong tendency to copy other people’s actions, as opposed to reproducing the result of a demonstration using their own actions (e.g., Bellagamba & Tomasello, 1999; Call, Carpenter, & Tomasello, 2002; Nagell, Olguin, & Tomasello, 1993). In fact, in problem-solving situations, young children copy others’ actions, even when this results in less efficient use of a tool (Nagell et al., 1993). However, the studies by Meltzoff (1995), Carpenter et al. (1998), and Bekkering
et al. (2000) indicate that children do not always copy exactly what they see adults do; instead they copy what they perceive to be the adult’s intended action or goal (even if this was never actually demonstrated). The present study showed that children are able to determine this intended action or goal on the basis of various kinds of indirect evidence prior to the demonstrator’s actual execution of the demonstration.

The current study also extended these previous findings of interactions between goals, actions, and results. An interaction was found between children’s understanding of adults’ goals and their ability to reproduce adults’ results: children were only able to reproduce the result when they knew something about E’s goal. This study also found an interaction between children’s understanding of adults’ goals and their reproduction of adults’ actions. When children did not know that the adult was trying to open the box, they copied her action style more often than when they were aware of her intentions. As in the study by Bekkering et al. (2000), children who thought that the adult’s actions were a goal in and of themselves copied those actions more exactly than children who knew they were a means to a different end.

An interesting area for future research would be to determine whether this is due to a difference in encoding or retrieval. That is, while watching the demonstration, children might have attended to, perceived, and understood the demonstration differently depending on what they assumed the adult’s goal to be. On the other hand, perhaps children’s interest in doing things like E hindered them in that because they remembered irrelevant details (of the first intentional action they saw), they did not have enough memory to reconstruct the steps necessary to open the box. Children in the present study copied the unimportant detail of E’s action style in the No Prior Intention conditions, but they were unable to remember the more important components that were necessary to solve the problem. They picked up information about the importance of either the pin or the door (see the first touch results), but most were unable to perform both components. Many children in these conditions pulled out the pin and then spent the rest of their response period searching in vain for the opening location of the door—they knew that it opened but could not remember where. Other children pulled and pulled on the door but forgot about the pin. It would be interesting in future studies to manipulate the sequence of the components and style to find out whether any memory problems were due to children’s tendency to copy others’ actions exactly, the primacy of the style action, or the interference of the surprise of the door opening, and so forth.

It is also interesting to note that all three Prior Intention conditions provided information about E’s intention, but each did so in a different way. The Prior: Failed Attempt condition provided extra information about one of the actions (pulling the door), and the fact that the action was a “mistake” may have helped children learn what they should do (see similar findings for 3-year-olds by Want & Harris, 2001). The Prior: End State condition provided extra information about one of the results (the box opens), and the Prior: Context condition provided extra information about the main goal (getting the toy). This study found that children did equally well with each of these three sources of information. The results for the Prior: End State condition thus differed somewhat from those of previous studies (Bauer, 1992; Bellagamba & Tomasello, 1999; Call et al., 2002) in that the children in this study benefited substantially in this condition. However, in the previous studies children were presented with only the end state, whereas in the current study showing children the end state was merely a predemonstration, which was then followed by a full demonstration. Our interpretation is that although showing children the end state alone is not very helpful in many problem-solving situations, showing them the end state as a prelude to a demonstration helps them to comprehend the adult’s prior intentions and thus to learn useful things from that demonstration.

The findings of this study have important research and educational implications. The task that children were presented with in the No Prior: No Pre-Demo condition is similar to the task in most “normal” imitation studies: E puts a novel object on the floor or table, performs some action on it that achieves some result, and then gives the object to the children for their turn. The current study found that this normal situation is not very helpful to children when the task is relatively difficult—perhaps especially when it requires a sequence of multiple steps. Children only succeeded at this task when they knew before the demonstration started what E was trying to do. Therefore, one research implication of this study is that researchers may be underestimating children’s imitative skills, at least in difficult tasks, because in the normal situation, children may not understand what E is trying to do until it is too late. It thus may be that multiple demonstrations in experiments are helpful to children not because children can watch the same actions over and over, but because they allow children to see the later demonstrations in an intentional way and thus make sense of the information provided by the demonstrator’s behavior. (Perhaps the normal situation can provide enough information...
for children in tasks in which E’s intention is easily discernable from the first demonstration.) Finally, we would like to call more attention to a striking finding that has important educational implications. This study found that with regard to success rates (although not with regard to repetition of components of the task), watching a demonstration without knowing what the adult was trying to do was just as unhelpful as watching no demonstration at all. Thus, a main educational implication is simply that when teaching young children new activities, setting up the situation so that they know ahead of time what the demonstrator is trying to do may facilitate or in some cases enable children’s social learning.

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