

## Understanding of Others' Intentions in Children With Autism

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Many studies have shown that children with autism have difficulty understanding the thoughts and beliefs of other people. However, little research has been conducted on what these children understand about simpler mental states such as intentions. The current study tested the understanding of others' intentions in 2 1/2- to 5-year-old children with autism and a control group of children with other developmental delays. We used Meltzoff's (1995) test of understanding of others' unfulfilled intentions in an imitation context, with an additional "End State" condition. We found no significant between-group differences on any measure involving the understanding of others' intentions. Although within-group patterns suggested that children with autism may have a slightly less complex understanding of others' intentions than do other children, it was clear that any deficits these children showed in this area were not as marked as those they typically show on traditional theory of mind tasks.

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**KEY WORDS:** Intention; imitation; theory of mind; joint attention.

It is well-documented that children with autism have difficulty with tests involving the thoughts, knowledge, and beliefs of other people (see, e.g., Baron-Cohen, 2000 for a review). However, less research attention has focused on the understanding of other mental states in children with autism and, in particular, those mental states that are understood earlier than beliefs and knowledge in typical ontogeny. This is an important oversight. Theory of mind deficits have been used to explain many characteristics of children with autism, for example, peculiarities in their language (Frith, 1989; Tager-Flusberg, 1993) and social behavior (Happé, 1994). However, autism is usually diagnosed (and problems with language and social behavior are evident) long before the age at which typically-developing chil-

dren pass traditional theory of mind tests. Thus, it is important to determine how far back the theory of mind deficits of children with autism extend.

One of the earliest mental states to be understood by typically-developing infants is intentions. Tomasello and colleagues (1993) have proposed that a new-found understanding of other people as intentional agents is what underlies the blossoming of infants' social-cognitive skills in the few months preceding their first birthdays. If this is true, then the study of understanding of others' intentions in children with autism has important implications for our understanding of some of the symptoms of autism, because many of the most robust differences between children with autism and children with other developmental delays are in the areas of joint attention, communication, and imitation—the very social-cognitive skills that Tomasello and colleagues (1993) discuss.

Two recent studies that investigated the understanding of intentions in older children with autism have obtained mixed results. Phillips and co-workers (1998) tested children on a target shooting game and

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found that those with autism were less able than those with other developmental delays to identify which target they had intended to hit in some conditions. However, Russell & Hill (2001) found no differences between children with autism and typically-developing children matched on mental age on this and another task, both when children were asked to report their own and another person's intended target. Other studies have shown an autism deficit in using others' gaze direction to determine their goals (Baron-Cohen *et al.*, 1995; see also Phillips *et al.*, 1992; but see Carpenter *et al.*, in press, and Charman *et al.*, 1997, for non-replications of those results).

In the current study, we used a different, nonverbal procedure to investigate understanding of others' intentions in younger children with autism and children with other developmental delays. A modified version of Meltzoff's (1995; Experiment 1) test of understanding of others' unfulfilled intentions in a "behavioral re-enactment" context was administered. In Meltzoff's study, typically-developing, 18-month-old infants in the Target condition watched as an experimenter (E) performed a target action (e.g., pulled two halves of a dumbbell apart). Infants in the Intention condition watched as E attempted to perform a target action but failed (e.g., pulled on the ends of the dumbbell but his hands slipped off); note that infants never saw the target action performed in this condition. Meltzoff found that infants produced the target action themselves equally as often in the Target and Intention conditions, and more often in these conditions than in two control conditions in which infants either saw no demonstration (Baseline control) or watched as E performed an unrelated action on the object (Adult Manipulation control). In the Intention condition, therefore, infants apparently understood what E meant to do—his unfulfilled intention—and so they performed that intended action, not the action he actually did (e.g., hands slipping off the sides of the dumbbell). These results were replicated by Bellagamba & Tomasello (1999) with 18-month-olds but not 12-month-olds.

A recent study by Aldridge and co-workers (2000) used one condition of Meltzoff's (1995) procedure with young children with autism and found no impairment for these children on this task; however, that study has several limitations. Aldridge and colleagues did not use children with developmental delays as a control group—they compared children with autism to typically-developing infants matched on a nonverbal measure of object concept. However, all but three of these infants were younger than 12 months old and so, based on Bellagamba & Tomasello's (1999) results,

would not be expected to pass this test. Aldridge and co-workers also presented children with only one of Meltzoff's conditions, the Intention condition, and thus could not directly address possible alternate explanations such as stimulus enhancement. In contrast, we used Meltzoff's full procedure and an appropriate control group.

In the Target condition of Meltzoff's study, children saw all aspects of the target action: the means by which it was performed (e.g., pulling) and the end result of the action (the two halves of the dumbbell apart). In the Intention condition, they saw only the means. In the current study, following Bellagamba & Tomasello (1999), we added a condition—the End State condition—in which children saw only the end, to investigate whether seeing this information was as helpful to children as seeing the means only.

Given the well-known theory of mind deficits of children with autism, we expected that these children might have some difficulty understanding the mental state of intention. However, of all the mental states, intention may be among the most transparent (i.e., observable in behavior), and understanding of goals and intentions emerges quite early in typically-developing children, long before children are able to pass false belief tests (e.g., Carpenter *et al.*, 1998; Gergeley *et al.*, 1995; Meltzoff, 1995; Woodward, in press). Therefore, we expected that the degree of impairment found on this test might not be as dramatic as that found by other researchers on traditional theory of mind (i.e., false belief) tests.

## METHOD

### Participants

Participants were 11 children with autism and 11 children with developmental delays, matched groupwise on chronological age, verbal mental age, and nonverbal mental age. Table I presents descriptive and matching information. Children were recruited from schools, treatment programs, and children's hospitals. Their disorders had been previously and independently diagnosed using DSM-IV criteria and in addition we administered the Autism Diagnostic Interview-Revised (ADI-R, Short Form; Lord *et al.*, 1994) to parents as part of the current study (see Table I for results). In the children with developmental delays, diagnoses included speech and language delays, fetal alcohol syndrome, and unspecified mental retardation.

All children participated in intervention or therapy programs of some kind and/or attended a special

**Table I.** Participants' Chronological Age (CA), Nonverbal Mental Age (NVMA), and Verbal Mental Age (VMA) in Months and Other Descriptive Information

	Autism (n = 11)		Developmental Delays (n = 11)		Significance (Mann-Whitney, 2-tailed)
	Mean (SD)	Range	Mean (SD)	Range	
CA	49.4 (5.3)	40–57	46.2 (11.2)	31–60	p = .70
NVMA	35.6 (7.8)	28–50	40.9 (9.2)	27–55	p = .22
VMA	26.2 (10.0)	16–45	32.3 (8.3)	24–47	p = .12
Mother's education	some graduate work	some college–professional degree	some college	some high school–master's degree	p = .08
Father's education	college graduate	high school graduated–professional degree	some college	some high school–college graduate	p = .11
Family income	\$40,000–\$50,000	\$20,000–\$50,000+	\$30,000–\$40,000	<\$10,000–\$50,000+	p = .48
Sex	10 male, 1 female		9 male, 2 female		
Ethnicity	10 Caucasian, 1 mixed ethnicity		8 Caucasian, 1 African-American, 2 mixed ethnicity		
ADI-R <sup>1</sup>	10 met all 4 criteria (1 met 3/4)		0 met all 4 criteria (mean = 2.0; for all, one of these was "abnormality evident before 36 months"; 1 met 3/4)		

<sup>1</sup> The administrator of the ADI-R was trained to reliability to use this measure by a colleague who had been trained in Chicago. Also, the parent of one child with autism in the current study was re-interviewed seven months later by another colleague who was trained in Chicago and excellent reliability was obtained: Cohen's kappa was .79.

Note: NVMA consisted of the average of children's scores on the Visual Expressive and Visual Receptive Organization Scales of the Mullen Scales of Early Learning (American Guidance Service, 1984); VMA consisted of the average of children's scores on the Language Expressive and Language Receptive Organization Scales of this test.

preschool. Of the 9 children with autism whose parents returned a questionnaire which asked whether any treatment program they were involved in included work on imitation, 5 said "yes" for imitation (2 children with developmental delays also were working on this skill). Two children with autism were participating in Lovaas- or TEACCH-based programs.

**Materials**

Eight objects were constructed. Five were based closely on Meltzoff's (1995) objects and three additional objects were constructed that were similar in size and general type of action to Meltzoff's original objects. Because results with the first few children tested indicated that children often performed Meltzoff's original target action during the baseline period, for all but these children the objects had additions so that two different actions—the original target action and an alternate action—could be performed on them. The different actions associated with each object are listed in the Appendix and shown in Fig. 1.

**Procedure**

Unlike Meltzoff's (1995) study, the current study had a within-subjects design: children participated in all five conditions (i.e., Meltzoff's four conditions plus the added End State condition). For each of the eight objects, before seeing any demonstration, children first participated in a 20-second *Baseline control condition*, in which they played with the object. If children produced or attempted to produce the original target action during the Baseline period, the alternate action was used for the following demonstration and response period. After the baseline period, E demonstrated an action on or showed that object in one of four different ways (Fig. 1). E returned the object to the child and, once the child touched it, a 20-second response period began. This procedure was then repeated with each of the remaining objects.

Children participated in two trials, each with a different object, in each condition. In all but the End State condition, E demonstrated an action three times, and each time the action was done slightly differently (see the Appendix for details). In the *Target* condition,



A



B



C

**Fig. 1.** The objects: (A) The objects in their Baseline state; (B) for the original actions, the objects in their End State and Target end state; (C) for the alternate actions, the objects in their End State and Target end state. 1 = dumbbell, 2 = box and stick, 3 = prong and loop, 4 = cylinder and beads, 5 = square and post, 6 = tape and hinge, 7 = pipe, 8 = sliding rod and end.

E modeled the entire target action three times (using a different grip each time). In the *Intention* condition, E tried to do the target action three times (in slightly different ways), but was unsuccessful each time. In the *Manipulation* control condition, E modeled a set of similar actions that were different from the target action

but were performed in the same general area of the object. In the *End State* condition, for the same approximate amount of time as the other demonstrations, E showed the object already in its target end state without showing how the end state was achieved (i.e., she performed the action behind her back and then held up the object to show the child).

The two trials in each of these four conditions were presented consecutively. The order of the Target and Intention conditions was counterbalanced, as was the order of the Manipulation and End State control conditions. As already mentioned, the Baseline control condition always came first, before the other four conditions. Children were tested on the two control conditions on one day and the Target and Intention conditions on a different day (1 to 15 days apart, mean = 6.6 days). The first three children with autism tested did not participate in the Manipulation control condition. Without these children, groups still matched on CA ( $p = .84$ ) and NVMA ( $p = .18$ ), but children with autism had a marginally lower average VMA than children with developmental delays for analyses involving this condition ( $p = .08$ ). The assignment of objects to conditions was counterbalanced so that each object was used approximately equally often in each condition. E's expression was pleasant throughout. Children were not given instructions or feedback; E said "Here, look at this," or "You can play with it now," when giving the child the object.

#### Scoring and Analyses

The main set of analyses involved children's production of target actions during the Baseline period and the response periods of each of the other conditions. Production of the target action was scored if the child performed the end state of the target action at least once (see the Target column of the Appendix). The latency to produce the target action (i.e., the time from when the child first moved the object to the production of the target action's end state) was also scored, using the time display on the videotapes. When children performed the target action in both trials of a condition, the mean of the two latency scores was used.

In the Intention and Manipulation conditions, an additional type of response was scored: children's reproduction of E's exact actions. In these conditions, children could either produce the target action (which E did *not* demonstrate) or they could copy exactly what E actually did (i.e., a failed action in the Intention condition and an unrelated action in the Manipulation condition). In the Intention condition, exact copying

represented a lack of understanding of E's intentions, but in the Manipulation condition it represented imitation of E's intentional action.

Trials in which children performed both possible target actions during the Baseline period were excluded from all analyses, so proportions of total useable trials were used. If children performed one of the two possible target actions during the Baseline period, the other action was performed by E during the demonstration for that condition. Thus, baseline was always zero for all trials included in analyses. Because of the small sample sizes, nonparametric statistics with exact probabilities were used throughout. We used two-tailed  $p$  values because our hypotheses concerning children with autism were mixed and because we did not know what to expect for children with mental ages older than 18 months.

### Reliability

Sessions were videotaped and coded from the videotapes by the first author. To assess inter-observer reliability, 6 children (27% of each group) were chosen at random and an independent coder, who was blind both to children's diagnosis and to their experimental condition, coded their sessions. The Cohen's kappa for number of target actions (across all conditions) was .96, indicating an excellent level of agreement.

## RESULTS

### Production of Target Actions

Fig. 2 presents the mean proportion of target actions produced in each condition for each group of children. There were no significant group differences between children with autism and children with developmental delays in the proportion of target actions produced in the Intention or any other condition (all Mann-Whitney  $U$  tests  $n.s.$ , all  $p$ 's  $> .15$ ).<sup>1</sup>

<sup>1</sup> With one minor exception. Although the most appropriate baseline for analyses was zero, we also calculated the proportion of trials in which children performed any one (or both) of the two possible target actions during the Baseline period to enable a between-group comparison on this measure. There was a significant group difference in this measure: children with developmental delays ( $M = .62$ ) were more likely than children with autism ( $M = .38$ ) to perform at least one of the two possible target actions (usually the original one) during the baseline period,  $z = 2.59$ ,  $p < .01$ . However, we believe that this finding strengthens our finding of no autism deficit—if children with developmental delays were more likely to perform target actions spontaneously, this makes the autism results more convincing because those children were thus performing target actions without this added boost.

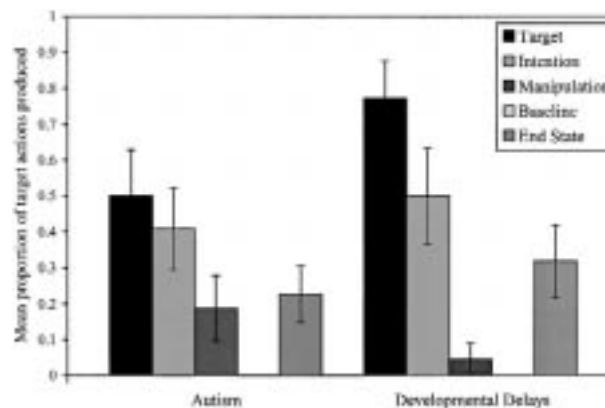


Fig. 2. The mean proportion of target actions produced in each condition for each group.

The pattern of within-group differences was also similar across groups (see Table II for statistical results). Most important, for children in both groups there was no significant difference in the proportion of target actions produced in the Intention and Target conditions. Both groups produced the target action more often in the Target condition than in the Manipulation, Baseline, and End State conditions, and both groups produced the target action more often in the Intention and End State conditions than in the Baseline condition (although some of these results were only marginally significant for children with autism). The only differences in patterns of responding across groups were the following: Children with developmental delays produced the target action significantly (or marginally significantly) more often in the Intention and End State conditions than in the Manipulation condition, whereas these differences were not statistically significant for children with autism.

The pattern of individual differences was almost identical across groups, too. An equal percentage of children with autism and children with developmental delays (63.6%) produced as many or more target actions in the Intention condition than they did in the Target condition. There was no significant difference between the percentage of children with autism (37.5%) and children with developmental delays (54.5%) who performed more target actions in the Intention condition than the Manipulation control condition, and the same percentage of children in each group (63.6%) performed more target actions in the Intention than the Baseline control condition. The same percentage of children in each group (81.8%) produced as many or more target actions in the Intention condition than in the End State condition.

**Table II.** Results of Wilcoxon Tests\* Investigating Within-Group Differences in the Proportion of Target Actions Produced in Each Condition

	Autism	Developmental Delays
Target compared with:		
Intention	$z = 1.00, p = .44$	$z = 1.86, p = .13$
Manipulation	$z = 1.73, p = .09$	$z = 2.81, p = .004$
Baseline (zero)	$z = 2.43, p = .02$	$z = 2.92, p = .002$
End State	$z = 2.12, p = .06$	$z = 2.64, p = .008$
Intention compared with:		
Manipulation	$z = 1.73, p = .25$	$z = 2.27, p = .03$
Baseline (zero)	$z = 2.46, p = .02$	$z = 2.43, p = .02$
End State	$z = 1.27, p = .30$	$z = 1.27, p = .30$
Manipulation compared with:		
Baseline (zero)	$z = 1.73, p = .25$	— (not enough non-ties)
End State	$z = 0.38, p = .81$	$z = 1.90, p = .08$
End State compared with:		
Baseline (zero)	$z = 2.24, p = .06$	$z = 2.33, p = .03$

\**p*'s are two-tailed.

Thus, the children with developmental delays in the current study, like the typically-developing infants in Meltzoff's (1995) study, performed the target action most often in the Intention and Target conditions (which did not differ significantly), and more often in these two conditions than in Meltzoff's original two control conditions (i.e., the Manipulation and Baseline conditions). Children with autism showed the same pattern, except for a nonsignificant difference between the Intention and Manipulation conditions. Both groups of children performed the target action equally as often in the Intention condition as in the End State condition.

### Latency to Produce Target Actions

Table III presents the mean latencies to perform the target action for each group in the Target, Intention, Manipulation, and End State conditions. There were no between-group differences for any of these measures, all *p*'s > .46. Because no children in either group performed a target action in all four conditions,

in order to make comparisons across conditions possible, in the following analyses we gave children a latency score of 20 seconds if they did not produce the target action. Using this measure, for children with autism, there were no significant within-group differences in latency between any conditions (Wilcoxon tests, all *p*'s > .14). Children with developmental delays took significantly longer to produce the target action in the Manipulation condition than in the Target ( $z = 2.55, p < .01$ ) and Intention ( $z = 2.03, p < .05$ ) conditions. The difference between the End State and Target conditions ( $z = 1.96, p < .06$ ) was marginally significant for these children.

### Exact Copying

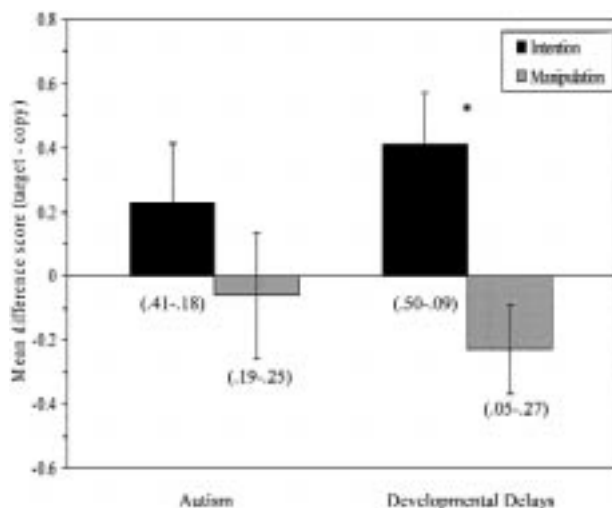
Recall that if children were reproducing E's intended actions, in the Intention condition they should have performed the target action more often than they copied E's actual demonstration, and in the Manipulation condition they should have shown the opposite pat-

**Table III.** The Mean Latency in Seconds to Produce the Target Action in the Target, Intention, Manipulation, and End State Conditions for Each Group

Condition	Autism		Developmental Delays	
	<i>n</i>	Mean (range)	<i>n</i>	Mean (range)
Target	6	4.6 (1.3–12.0)	9	4.8 (1.7–10.7)
Intention	7	5.6 (0.7–19.2)	7	6.6 (2.2–18.9)
Manipulation	3	3.0 (2.2–3.5)	1	4.2
End State	3	4.8 (2.2–9.9)	6	7.7 (1.6–16.7)

tern: They should have copied E's demonstration more often than they produced the target action. We calculated a 'target - copy' difference score for each of these two conditions by subtracting the proportion of copied actions from the proportion of target actions for each condition (thus, positive difference scores reflect higher proportions of target actions, whereas negative difference scores reflect higher proportions of copied actions). Fig. 3 presents these difference scores, and the target and copy scores from which they were derived, for each group. Trials in which children both produced the target action and copied E's action in the same trial are not included in these analyses. Children with autism performed both actions in 9.1% of trials and children with developmental delays did this in 22.7% of trials in the Intention condition; no child did this in the Manipulation condition.

There were no between-group differences for difference scores in either the Intention or Manipulation condition (both  $p$ 's > .49), and the patterns of individual differences were similar across groups. In the Intention condition, 36.4% of children with autism and 45.5% of children with developmental delays had positive difference scores (45.5% of children in each group had a difference score of 0). In the Manipulation condition, 37.5% of children with autism and 36.4% of children with developmental delays had a negative difference score (25% of children with autism and 54.5% of children with developmental delays had a difference score of 0). However, for children with developmental



**Fig. 3.** The mean difference score (target minus copy) in the Intention and Manipulation conditions for each group. \*Conditions are significantly different,  $p < .02$ . Note. Numbers in parentheses under each bar are the mean target and copy scores, respectively, for that condition.

delays, there was a significant difference between the two difference scores (Wilcoxon test,  $z = 2.33$ ,  $p < .02$ ), whereas for children with autism there was not a significant difference,  $z = 1.00$ .

Incidentally, occasionally during testing we noted that children copied E's actions exactly in the Target and End State conditions, too. For example, in the Target condition, children sometimes reproduced E's action in exactly the same manner, using exaggerated similar motions and timing. Likewise, in the End State condition, sometimes children tried to perform the action behind their back, as E had done. Two of the 11 (18.2%) children with developmental delays copied E's actions in the Target condition exactly (once each) and three of them (27.3%—all different children from those in the Target condition) copied E's actions in the End State condition exactly (once each). One (9.1%) child with autism copied E's actions in the Target condition exactly; none did so in the End State condition.

### Correlations With Chronological and Mental Age

To determine whether there were relations between children's performance on this task and their chronological and mental ages, we tested for correlations between these measures and (1) the number of target actions produced in the Target and Intention conditions; (2) a score comprising children's relative performance in the Target and Intention conditions (i.e., children received a score of 0 if they performed fewer target actions in the Intention condition than in the Target condition, 1 if they performed equal numbers of actions in the two conditions, and 2 if they performed more target actions in the Intention condition than in the Target condition); and (3) the target-copy difference score for the Intention condition. For children with autism, only the second, relative score was significantly, positively correlated with chronological age ( $R = .81$ ,  $p < .01$ ); no correlations with verbal or nonverbal mental age were significant. For children with developmental delays, the correlations between the number of target actions produced in the Target condition and both verbal and nonverbal mental age were significant (both  $R$ s = .64,  $p < .05$ ), and the correlation between the Intention difference score and verbal mental age was marginally significant ( $R = .60$ ,  $p = .050$ ).

### DISCUSSION

In this study, we tested children's understanding of others' unfulfilled intentions. We thus tested a relatively high level of understanding—one that in some

ways is to intentions as false belief is to belief. That is, instead of simply testing whether children can recognize goal-directed behavior, we presented them with an adult's action for which the intention did not match the reality of the situation (just as the belief of the protagonist in a false belief story does not match the reality of that situation). The pattern of results for children with developmental delays replicated that of the typically-developing infants in Meltzoff's (1995) study: Children performed target actions most often in the Intention and Target conditions (which did not differ significantly), and performed more target actions in these two conditions than in two control conditions. There were no significant differences between children with developmental delays and children with autism on any direct measure of intentional understanding. In addition, in one important respect, the within-group pattern for children with autism was the same as other children: For them, too, there was no significant difference in the proportion of target actions produced in the Intention and Target conditions. Thus, even though in the Intention condition children only saw E's unsuccessful attempt to perform the target action, children with autism were just as likely as children with other developmental delays to perform the target action themselves in this condition (and each of the other experimental conditions), and they did so equally as quickly as other children. An equal number (almost two-thirds) of children in each group produced as many or more target actions in the Intention condition as in the Target condition (in which they saw the complete action), an indication that most children in each group understood what E was trying to do in the Intention condition.

Further evidence of children's understanding of E's intentions comes from their performance in the Intention condition, compared with the Manipulation condition. In both these conditions, children could have performed the target action, which was not demonstrated, or they could have copied exactly what the adult did (in the Intention condition this was a failed attempt and in the Manipulation condition it was an unrelated action). In the Intention condition, children in both groups tended to produce the intended target action more often than they copied the action the adult actually performed, whereas in the Manipulation condition they reproduced the action the adult performed more often than they produced the target action. Although children in both groups copied E's exact action in the Intention condition in about one-fourth of their trials, on average, this is consistent with what typically-developing 30- to 40-month-olds do (Charman & Huang, 1999). Many children performed both actions—

copied E's action and did the target action—as if they were not sure what was expected of them. Nevertheless, in each condition, children more often produced (or reproduced) the action E meant to do, regardless of whether that was the action she actually did.

However, there were two findings that limited what we can conclude about the intentional understanding of children with autism. First, whereas children with developmental delays performed the target action more in the Target and Intention conditions than in both the Manipulation and Baseline control conditions (as Meltzoff's [1995] typically-developing 18-month-olds did), for children with autism the difference between the proportion of target actions produced in the Intention and Manipulation conditions did not reach significance. Second, there was also no significant difference for these children between the "target-copy" difference scores in the Intention and Manipulation conditions (although the pattern of results was similar to that of other children). Thus, it is possible that any random manipulation of the object was enough to make children with autism produce the target action. Still, there were no between-group differences and both the means and the individual patterns for the Intention and Manipulation conditions were in the right direction for children with autism—the mean number of target actions produced in the Intention condition was more than two-fold that in the Manipulation condition and no children produced more target actions in the Manipulation condition than in the Intention condition. Further research is needed to determine what influence stimulus enhancement has in the social learning of children with autism.

For most analyses, children with autism resembled children with other developmental delays, both as a group and when individual patterns of responding across conditions were considered. It is important to note that this was the case, despite the difficulties most children with autism have with imitation (for reviews, see Rogers, 1999; Smith & Bryson, 1994) and despite the fact that children with developmental delays were more likely than children with autism to perform the target actions spontaneously. Unfortunately, not many data exist on how older, typically-developing children perform on this task. When we informally compare our results with those of Charman & Huang (1999), who tested typically-developing 30- and 40-month-olds, we find that children in both our groups performed fewer target actions than did the 30- and 40-month-olds in each condition. Thus, our finding of no autism-specific deficits in this understanding may be a result of relatively poor performance by our control group.

Still, if indeed Meltzoff's (1995) procedure measures children's understanding of others' intentions,<sup>2</sup> then the results of the current study support those of Russell & Hill (2001) and Aldridge and colleagues (2000), who also found no autism-specific deficits in understanding of others' intentions. Indeed, this study extends those results to much younger children—children in the current study had a much younger verbal mental age (mean VMA = 2 years, CA = 4 years) than in previous studies that used appropriate control groups (mean VMA = 6 years, CA = 9–13 years in Phillips *et al.*, 1998, and Russell & Hill, 2001). It is important for future researchers to try to replicate these results with a larger sample. It is also important to test even younger children, because it is possible that there are indeed autism-specific delays in the development of this understanding which the children in this study had already out-grown. In support of this idea, we did find a positive correlation between chronological age and a measure of intentional understanding for children with autism (although there were no such relations with mental age).

However, if there are no autism-specific delays or deficits in understanding of others' intentions, then this has important implications for theories of social-cognitive development in children with autism and, perhaps, typically-developing infants. Long before children with autism show theory of mind deficits on false belief tasks, they show deficits in joint attention, attention following, and declarative gestures (e.g., Baron-Cohen *et al.*, 1996; Osterling & Dawson, 1994). An understanding of others' intentions is thought by some (e.g., Tomasello *et al.*, 1993) to underlie these early social-cognitive skills, but the current results suggest that this may not be the full story, at least for children with autism. That is, whereas the children in the current study appear to have no major deficits in understanding of others' intentions, in another study of these same children, we show that these children do have deficits in various joint attention skills (Carpenter *et al.*, in press). This pattern of results leads to the conclusion that there must be something else involved in joint attention skills. We agree with others (e.g., Hobson, 1993; Mundy *et al.*, 1993; Rogers &

Pennington, 1991) that one likely possibility is the ability or motivation to share affect, interest, and attention with others. If understanding of others' intentions is involved in joint attention skills, it may be a necessary but not sufficient factor.

In a similar fashion, the success of children with autism on the current task calls into question the relation between intention and other mental states. If children with autism have little or no difficulty with tasks involving others' intentions but fail tasks involving perception, emotions, desires, and beliefs, then this means there is something special about these other mental states (see Russell & Hill, 2001, for further discussion). This advantage for understanding of intentions is seen in typical development and, to some extent, in animals (Call & Tomasello, 1998).

One final note: We added the End State condition to Meltzoff's (1995) original design to investigate what types of information (i.e., means, end, or both) were most useful to these children in an imitation context. Children in both groups produced the target action most often in the Target condition, when they observed both the means and the end (e.g., pulling the dumbbell and the two separated parts of the dumbbell, respectively). When presented with only half of that information—either the means (the Intention condition) or the end (the End State condition)—they produced the target action almost equally often (with a nonsignificant advantage for means), and somewhat less often than when they observed both. These results are consistent with those for typically-developing 12- to 40-month-old children (Bellagamba & Tomasello, 1999; Charman & Huang, 1999). However, although children with autism used these sources of information equally as well as other children, they rarely copied the "style" (Hobson & Lee, 1999) of E's actions, as many children with developmental delays did. It is important for future research on children with autism (and other children) to investigate these aspects of social learning in more detail (for further discussion, see Call & Carpenter, in press).

In conclusion, this study found that the development of understanding of others' intentions is largely intact in young children with autism, who also have marked deficits in joint attention. If replicated in other samples—especially younger samples—this dissociation poses serious problems for both the theory of mind (e.g., see Baron-Cohen *et al.*, 1993) and executive theories (e.g., Russell, 1996) of autism, both of which posit early deficits in the understanding of intentionality, and it suggests that we need to test other hypotheses to explain the robust, early joint attention deficits found in this disorder.

<sup>2</sup> We thank an anonymous reviewer for pointing out that Meltzoff's pattern of results could conceivably be obtained if children prefer to produce—or find it easier to produce—prototypical actions than partial or atypical actions. Another important area for future research is to use different nonverbal measures of intentional understanding with children with autism (see, e.g., Call & Tomasello, 1998; Carpenter *et al.*, 1998).

## APPENDIX

## Actions

The first five objects resembled those used in Meltzoff's (1995) study. The original action (i.e., for

the first five objects, the one Meltzoff performed) is listed first; our alternate action is listed second. In the End State condition, the experimenter (E) performed the target action behind her back and then showed the child the end state of the action (see Fig. 1B and 1C).

Object	Condition		
	Target	Intention	Manipulation
Dumbbell	1. pull halves apart 3× 2. put separated ends together 3×	1. pull one end but hand slips off (3×, alternating ends) 2. move separated ends toward each other 3× but miss each time	1. push each end in turn (for a total of 3 pushes) 2. place halves parallel 2× (once each side), then perpendicular once
Box and Stick <sup>3</sup>	1. put end of stick in hole 3× 2. put stick through space between box and base 3×	1. move end of stick toward hole 3x but miss each time 2. move end of stick toward space between box and base 3× but miss each time	1. pass pointing stick across box horizontally, vertically, diagonally 2. pass horizontal stick along top, bottom, and middle of box
Prong and Loop	1. put loop on prong 3× 2. put loop on corner 3×	1. move loop toward prong 3× but miss each time (drop loop on ground instead) 2. move loop toward corner 3× but miss each time (drop on ground instead)	1. slide loop across top of object both ways and then across bottom, releasing loop at end each time 2. slide loop along base both ways, releasing it in middle, then slide diagonally from top to bottom and release
Cylinder and Beads	1. drop beads into cylinder 3× 2. encircle cylinder with beads 3×	1. move beads toward opening of cylinder 3x but miss each time (drop on ground instead) 2. move beads in a circle toward top of cylinder but miss each time (drop on ground instead)	1. drop beads to each side of cylinder (3 drops) 2. put beads on floor in a circle to left, right, and front of cylinder
Square and Post	1. put square on post 3× 2. put square vertically into side holder of base 3×	1. move square toward post 3× but miss each time 2. move square vertically toward side holder of base 3× but miss each time (hit ground or base instead)	1. move square vertically along front, back, and side of base 2. move square horizontally along front, back, and side of base
Tape and Hinge	1. pull tape out 3× 2. move hinge down 3×	1. start to pull out tape but fingers slip off 3× 2. start to pull down on hinge but finger slips off 3×	1. push on top and bottom of handle attached to tape, then put finger through handle 2. push in on hinge 3×
Pipe	1. take capped (yellow) end off 3× 2. take open (green) end off 3×	1. start to pull on capped (yellow) end but hand slips off 3× 2. start to pull on open (green) end but hand slips off 3×	1. trace finger around yellow mark on cap twice, then push cap 2. trace finger around green mark twice, then put finger into hole
Sliding Rod and End	1. pull inside part out 3× 2. take black end off 3×	1. start to pull on loop connected to inside part but fingers slip off 3× 2. start to pull on black end but fingers slip off 3×	1. bend loop backward, forward, then put finger through loop 2. trace finger around black end twice, then push on it

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<sup>3</sup>Meltzoff's (1995) "box" had a buzzer; there was no buzzer in the current object.

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