

Role Reversal Imitation and Language in Typically Developing Infants and Children With Autism

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Three types of role reversal imitation were investigated in typically developing 12- and 18-month-old infants and in children with autism and other developmental delays. Many typically developing infants at both ages engaged in each of the 2 types of dyadic, body-oriented role reversal imitation: self–self reversals, in which the adult acted on herself and the child then acted on himself, and other–other reversals, in which the adult acted on the child and the child then acted back on the adult. However, 12-month-olds had more difficulty than 18-month-olds with triadic, object-mediated role reversals involving interactions around objects. There was little evidence of any type of role reversal imitation in children with autism. Positive relations were found between role reversal imitation and various measures of language development for 18-month-olds and children with autism.

Children learn many of their most important skills by observing the behavior of other people. However, recent theoretical analyses and empirical research have revealed a wide variety of different social learning processes that might be involved, depending on how the process of observation interacts with children's broader skills of cognition and social cognition—especially their ability to read the intentions of others. Recent reviews have been provided by Want and Harris (2002), Call and Carpenter (2002), and Tomasello and Carpenter (2005). Briefly stated, children are flexible imitators: Instead of copying surface behaviors literally, they do what others are trying to do, not what they actually do. For example, between 12 and 15 months, infants begin to reproduce the action they see the adult intending (trying) to perform, not the bodily movements she is actually performing

(Bellagamba & Tomasello, 1999; Johnson, Booth, & O'Hearn, 2001; Meltzoff, 1995). They reproduce the actions adults produce intentionally, not the ones adults produce by accident (Carpenter, Akhtar, & Tomasello, 1998). They do not reproduce an adult's unusual action when they see a reason for the adult's behavior that does not currently apply to them, whereas they do reproduce it if they see no extenuating circumstances that justify the adult's odd behavior (Gergely, Bekkering, & Király, 2002). They produce different behaviors in attempting to imitate an adult depending on what they perceive as the adult's goal, for example, touching an object versus moving his or her arm in a certain way (Bekkering, Wohlschläger, & Gattis, 2000; Carpenter, Call, & Tomasello, 2005; see also Carpenter, Call, & Tomasello, 2002, for a related finding).

These studies all involve others' intentions toward objects. Yet many of the most interesting and important skills children develop involve a different type of intentions: intentions toward each other. For example, learning language and participating in other collaborative activities requires an understanding of others' intentions toward the self, and an ability to coordinate intentions with others (Tomasello, Carpenter, Call, Behne, & Moll, 2005). There is much evidence that 18-month-old and older children can learn to use pieces of language by discerning what adults are intending to do with them in a wide variety of communicative circumstances, including cases in which the adult has failed attempts and accidents, so the imitative learning of the novel word is not so straightforward (Tomasello & Barton, 1994; Tomasello, Strosberg, & Akhtar, 1996; see Tomasello, 2001, for a review). In this study we asked if younger children also use the same flexibility in imitation involving intentions toward the self.

Specifically, we explored what Tomasello (1999) called role reversal imitation; that is, when the child learns to perform an action toward an adult in the same way that the adult performed it toward him or her. For example, an adult demonstrator might slap his own knee, to which the child might respond by slapping her own knee (self-self role reversal). Alternatively, an adult might pat the child on her head, and the child might reciprocate by patting the adult on his head (other-other role reversal). Finally, a more triadic, cooperative type of role reversal is one that is mediated by objects, as when on one occasion the adult holds out a basket so the child can place toys into it, and on a later occasion the child then holds out the basket to the adult so he can put toys into it, thus reversing roles in this activity. In all of these cases, the child discerns that the adult intends for her to do to or for him what he has done to or for her.

What distinguishes this type of imitation from other forms of imitation is that it is performed on an object that is different from the one the demonstrator performed it on—but not just any object. In straightforward imitation the adult might place a pencil into a cup and the child might follow suit by doing the exact same thing with the exact same objects—or perhaps do something similar with similar yet different objects. However, in role reversal imitation the child does to other people what

they have previously done to her (or else does to herself what others have done to themselves). There is thus a reciprocal substitution between demonstrator and learner. It is important that the child could theoretically mistake the demonstrator's intentions and so she might follow his patting of his own head by patting his head as well, or when the demonstrator pats the child's head she could follow suit by patting her own head. The most well-known example of this "error" occurs in language acquisition when children sometimes make I-you substitutions, saying such things as "Pick you up" when they mean "Pick me up"; that is, on hearing the adult say such things as "Do you want me to pick you up?" they fail to understand that *I* and *you* are referenced to the current speaker and listener in a way that most other words are not (Dale & Crain-Thoreson, 1993).

There are no systematic investigations of children's ability to engage in role reversal imitation. However, in preferential looking studies, typically developing infants are able to recognize changes in others' roles by around 9 months of age (Rochat, Striano, & Morgan, 2004). In their natural social interactions, infants begin to take the adult's role in peek-a-boo and other such games on a regular basis at around 14 months (Ratner & Bruner, 1978), with dramatic increases in the frequency of this behavior between 9 and 18 months (Ross & Lollis, 1987). It is no accident that this is the age at which children are first beginning to learn linguistic symbols, as the same type of reciprocal imitation applies to the learning of a piece of language. Thus, to learn to use a symbol like an adult, children must learn to use it toward the adult in the same way the adult used it toward them (Tomasello, 1999). They must be able to engage in other-other role reversals mediated by a conventional artifact.

There is a special population of children who might have difficulties with role reversals: children with autism. We are aware of one previous study of something like self-self role reversals in children with autism. Peeters, Grobden, Hendrickx, Van den Eede, and Verlinden (2003) asked typically developing 3- to 8-year-old children, 5- to 9-year-old children with autism, and adults to play a series of games in which participants could respond either with a same or a different location response. For example, a red cloth and a blue cloth were lying on the floor. The participant chose a red or blue card and the experimenter took the other card. The experimenter crawled under the cloth of the same color as her card and then asked the participant to "do the same." In most of the games, all but the adult participants chose the opposite object as the adult, that is, they did not choose the same location response. However, in these games, children could have produced this response with a simple understanding of "this object is hers and this object is mine," without engaging in self-self role reversal. In the single game that might have required self-self role reversal—when the experimenter showed the participant a photograph of herself and a photograph of the participant, tapped the photograph of herself, and asked the participant to "do the same"—children with autism chose randomly (although note that all but the youngest group of typically developing

children also chose randomly, and the youngest children chose the experimenter's photograph).

There are also suggestions in the literature that children with autism might have difficulties with self–self role reversals in other contexts. These children show pronounced deficits in gesture imitation, which requires self–self role reversals (and they might show somewhat less impairment on tasks involving imitating others' actions on objects, which do not require role reversal because the child acts on the same object as the demonstrator; see, e.g., Rogers, Cook, & Meryl, 2003, for a review). When they do copy gestures, children with autism often show an interesting pattern of errors that further indicates difficulties with role reversals. Ohta (1987), Whiten and Brown (1998), Hobson and Lee (1999), and Smith and Bryson (1998) all reported that children with autism sometimes reproduced gestures exactly as they saw them, without switching perspectives. For example, when the modeled action was “waving with the open palm facing the subject,” some children with autism waved with their own palm facing themselves, as opposed to with their palm facing the experimenter.

We are unaware of any tests of other–other role reversal imitation in children with autism, but some characteristics of these children's language use would suggest that they might have difficulty with this type of role reversal as well. The tendency of children with autism to engage in echolalia (mimicry of others' speech) and to make personal pronoun (e.g., Jordan, 1989) and question–statement (Tager-Flusberg, 1993) reversal errors are well-known, and they might be a reflection of these children's ability to copy surface behavior but not to engage in imitative learning that takes into account the demonstrator's intentions toward them (Carpenter & Tomasello, 2000).

In this study we report initial explorations of all three types of role reversal imitation: the dyadic self–self and other–other role reversals, and the triadic, object-mediated role reversals. We do this for typically developing children of 12 and 18 months of age, as well as for a small group of children with autism and, as a comparison, children with other developmental disabilities. We also investigated interrelations between children's role reversal imitation and their vocabulary development.

We predicted that children with autism (and perhaps 12-month-olds) would have difficulty with role reversal imitation, especially with other–other role reversals and triadic, object-mediated role reversals. We also predicted positive relations between role reversal imitation and language for all children, in particular between other–other role reversal imitation and comprehension and production of pronouns.

STUDY 1

In this study we investigated dyadic self–self and other–other role reversal imitation in typically developing 12- and 18-month-old children. Each type of task had

the same structure: An adult performed a simple action on either herself or the child, then gave the child a chance to perform the action on the person of her choice. Also included was a control task in which the adult performed the action on a third person, to investigate infants' baseline rates of reproducing the actions on themselves or the first adult. In half of each type of task, the adult performed the action with an object and in half she simply performed an action directly on some body part (note that the object in this case was mainly a motivational tool and was not intended to make the interaction triadic). We chose simple, familiar actions because our focus was on role reversals and not imitative learning of novel actions.

Method

Participants. Participants were 48 children of various ethnicities from a large metropolitan area in the United States. Half of the children were 12 months old ($M = 11.7$ months), and the other half were 18 months old ($M = 17.7$ months). There were 12 boys and 12 girls at each age. Three additional children were excluded from the study: 1 due to parental interference, 1 due to lack of participation, and 1 because of equipment failure. Children were recruited from a psychology department database comprised of parents and children who volunteered in various ways.

Materials. In half of the imitation tasks, the experimenter acted on either self, child, or the other adult directly (e.g., tickling), and in the other half she used an object (e.g., rolling a car along the child's leg). Materials for the object tasks included a red foam ball, an orange plastic ring, a small yellow car that looked like a dog, and a foam block with pictures of animals on each side.

Parents of infants at both ages also completed (at the end of the session) the MacArthur Child Development Inventory of Words and Gestures (long form; Fenson et al., 1993), measuring comprehension and production of 396 words. This checklist includes a section of 11 pronouns (e.g., *I, mine, you, this*).

Procedure. Testing took place in a small university playroom. The child, a parent, and two female experimenters (E1 and E2) were in the testing room during the experiment. The entire session was taped by a video camera from the corner of the room.

Following a warm-up "normal" imitation task (dropping a figurine down a chute), the parent was asked to sit in a chair or on the floor in the corner of the room opposite the video camera. The child could choose whether to sit on the parent's lap or stand or sit in front of the parent's knees. E1 sat cross-legged on the floor to the immediate right of the child and E2 sat in a similar fashion to the immediate left of the child. The Es were both close to the child (approximately 5–13 cm away) and were equidistant from the child during all the role reversal tests.

E1 modeled eight different actions in three different ways each, for a total of 24 trials. The order of the actions was determined randomly in advance for each child. E1 demonstrated each action consecutively (a) on her own body, (b) on the body of the child, and (c) on the body of E2, in the same, counterbalanced order for each action. Four of the eight actions involved the use of the objects described earlier, and four of the actions did not involve objects. Actions with and without objects alternated in presentation, with half of the children in each age group being given an object action first and the remaining half being given a nonobject action first. E2 was responsible for coding the responses of the child, and was a passive member of the play group.

After performing each action, E1 gave the child a turn to perform the action. When an object was involved, she did this by handing the appropriate object to the child and saying "It's your turn now." When no object was involved she simply said "It's your turn now." In both cases both E1 and E2 ensured that their own body part on which the action was performed was placed within close reach of the child. For example, if E1 rolled the car on her own forearm (or the child's) she would hand the child the object, tell her it was her turn, and both Es casually ensured that their forearms were close to the child—so that the child could perform the action on either of them or on herself.

The actions modeled were as follows (the first four with objects and the second four without objects):

- *Roll car*: The car was rolled along the arm, shoulder, or leg three times (for actions on the child this depended on which body part was most readily available to E1; for E1's actions on herself the place was random).
- *Tap ring*: The ring was held in one hand and tapped gently against the cheek several times. This was repeated three times.
- *Let block fall*: The block was placed on top of the head with one hand and then was released to fall to the floor. This was repeated three times.
- *Squeeze ball*: The ball was placed under the chin, squeezing the chin to the chest to hold the ball, and then the ball was released by relaxing the chin (or the ball just fell if the child did not squeeze it). This was repeated three times.
- *Poke finger*: The stomach area was poked gently with one finger several times.
- *Tap nose*: The nose was tapped gently with one finger several times.
- *Tickle arm*: The length of the underside of the forearm was tickled with all five fingers several times.
- *Pat face*: The cheek was patted gently with an open palm several times.

Scoring. Each response of the child was coded live during the experimental play session by E2 and was recoded by E1 from the videotape recordings. Each response of the child was coded for: (a) action, whether or not it was the same action

performed by E; (b) body part, whether or not it was performed on the correct body part; and (c) person, on which person the action was performed (self, E1, E2, or other—this included the child's parent and the table or floor). Because children often did not copy the action or the exact body part of E1's actions very closely (and we were interested not in imitation but in role reversal imitation), we included responses that were approximations of E1's actions (e.g., for the tap ring action, rubbing the ring on the chin would count).

For the actions that E1 did to herself or the child, there were two possible types of role reversal imitation. Self–self role reversal imitation was coded if the child reproduced an action on his or her own body following E1 modeling the action on her own body. Other–other role reversal imitation was coded if the child reproduced an action on the body of E1 following E1 modeling the action on the child's body. The two Es recoded 25% of each age sample independently and computed Cohen's kappa scores for interobserver reliability (with a match of action, person, and location necessary for agreement on a given trial). For the 12-month-olds the kappa was .91 and for the 18-month-olds the kappa was .97.

Results

Because we were interested in role reversal imitation, and not imitation in general, all role reversal scores are reported as a percentage of the total trials in which children imitated the demonstrator's action on some location. However, before focusing on role reversal imitation, we checked to see how often infants copied E1's action regardless of the location. Two 12-month-olds and two 18-month-olds never imitated on a single trial. Some children imitated in E1 trials but not child trials or vice versa (or imitated only in E2 trials). Thus, for 12-month-olds, $n = 18$ for both self–self and other–other role reversal analyses, and for 18-month-olds $n = 20$ for self–self and $n = 19$ for other–other role reversal analyses. Infants in both age groups imitated relatively rarely (for 12-month-olds, mean proportion of trials = .22, $SD = .17$, range = 0–.63; for 18-month-olds, mean proportion of trials = .30, $SD = .21$, range = 0–.79). There was no significant difference between the two age groups on overall imitation, two-tailed, t test, $p = .19$, $d = .38$. All p values are one-tailed except where noted (i.e., when we did not have specific predictions). Effect sizes (following Cohen, 1988) are also reported (for t tests, a d of .2 is a small effect, a d of .5 is a medium effect, and a d of .8 is a large effect; for f s for analyses of variance these numbers are .1, .25, and .5, respectively; for w s for chi-square tests and r s for correlations they are .1, .3, and .5).

Figure 1 shows the mean proportions of each type of imitative response in each demonstration condition, with responses counting as self–self and other–other role reversal specially marked. Different response strategies are apparent for the different ages. In each demonstration condition, 12-month-olds most often reproduced the action on the same location on which E1 had performed it, and 18-month-olds

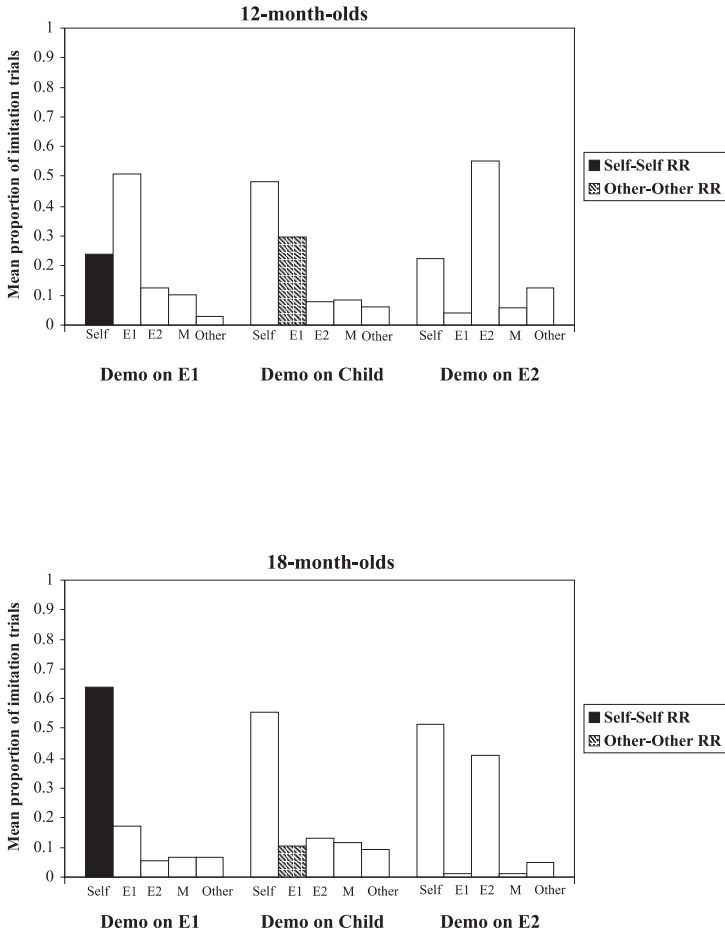


FIGURE 1 Study 1: Mean proportion of each location response in each demonstration condition for each age group. Each type of role reversal imitation is marked.

most often reproduced the action on themselves, and they did so significantly more often than 12-month-olds, $t(28) = 2.47, p = .02$ two-tailed, $d = .91$.

However, there was some evidence of role reversal imitation at each age. The majority of 12- (66.7%) and 18-month-olds (86.4%) who imitated performed at least one type of role reversal on at least one trial; this age difference was almost significant, $\chi^2(1, N = 43) = 2.34, p = .063, w = .23$. Half of the 12-month-olds and 90% of the 18-month-olds who imitated performed self–self role reversals during at least one trial. This age difference was significant, $\chi^2(1, N = 38) = 7.37, p = .003, w = .44$. In contrast, half of 12-month-olds but only 21.1% of 18-month-olds who

imitated performed other–other role reversals during at least one trial. This age difference was also significant, $\chi^2(1, N = 37) = 3.40, p = .033, w = .30$. (Incidentally, children at both ages performed more role reversals in trials in which E1 used an object to perform the action than in trials that did not involve objects, $F(1, 31) = 44.22, p < .0001, f = 1.19$. For 12-month-olds, 74% of role reversals were in object trials and 26% were in no-object trials; for 18-month-olds these percentages were 92% and 8%, respectively.)

Although many children even at 12 months appeared to be doing some role reversal, it could be argued given their responses in other conditions that some of these were not truly role reversals. That is, if E1 performs the action on herself and the child performs it on himself or herself, then in isolation that appears to be role reversal imitation. However, if when E1 performs the action on the child or on E2 the child also performs the action on himself or herself, this raises doubts about what the child is doing in the E1 demonstration condition. As a more conservative measure of role reversal imitation, we therefore compared children's self–self and other–other responses to their responses on the corresponding locations in the third person (E2) demonstration condition. Figure 2 presents for self–self and other–other reversals separately the unadjusted proportions (taken directly from Figure 1) along with proportions that are adjusted for baseline rates; that is, the unadjusted proportion minus responses to that same location (self for self–self and E1 for other–other) in the E2 demonstration condition. Using these adjusted scores, as a group 12-month-olds often engaged in other–other role reversal—their mean adjusted proportion was significantly greater than zero, $t(13) = 2.31, p = .019, d = .62$ —but not self–self role reversal ($p = .36, d = .09$). Eighteen-month-olds showed weak evidence of both types, $t(18) = 1.49, p = .077, d = .34$ for self–self and $t(17) = 1.65, p = .059, d = .39$ for other–other. The difference between 12- and 18-month-olds on self–self role reversal approached significance, $t(32) = 1.32, p = .099, d = .46$, but there was no significant age difference in other–other role reversal ($p = .18, d = .33$).

Table 1 presents the percentages of children who engaged in role reversal (and each type of role reversal) on at least one trial using these adjusted scores. Overall, just over half of infants at each age who imitated performed at least one type of role reversal on at least one trial. There were no significant age differences on any of these measures.

Correlations. We tested for correlations between role reversal scores and several measures of language: overall comprehension (“understands” plus “understands and says” on the MacArthur form), overall production (“understands and says”), and comprehension and production of pronouns. Table 2 presents descriptive statistics for the language measures. For 12-month-olds, no significant positive correlations were found between proportion of self–self or other–other role reversals and any of these measures of language comprehension or production (in

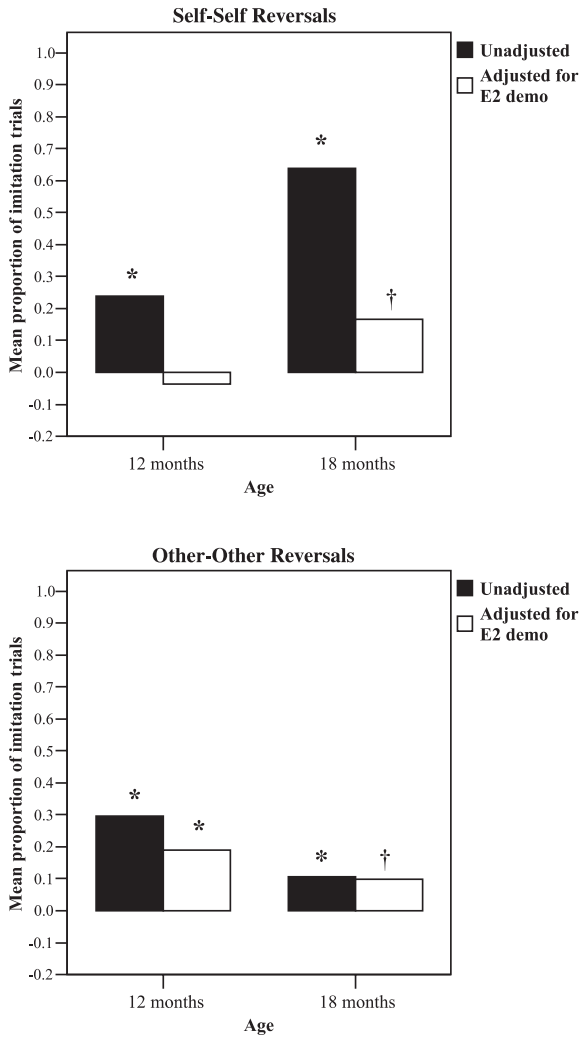


FIGURE 2 Study 1: Unadjusted and adjusted proportions of self–self and other–other role reversals. *Different from zero, $p < .05$. †Marginally different from zero, $p < .08$.

fact, most of the correlations were negative; all r s $< \pm .37$). For 18-month-olds, however, there was a significant, positive correlation between proportion of other–other role reversals and both comprehension and production of pronouns (for comprehension, unadjusted: $r = .61$, $n = 17$, $p = .005$; adjusted for E2 demonstration condition: $r = .53$, $n = 16$, $p = .017$; for production, unadjusted: $r = .47$, $n = 17$, $p = .029$, adjusted for E2 demonstration condition: $r = .49$, $n = 16$, $p = .026$).

TABLE 1
The Percentage of Children in Each Age Group in Study 1 Who Imitated
Who Engaged in Each Type of Role Reversal Imitation
(Using Adjusted Scores)

Type of Role Reversal Imitation	Percentage of Children		
	12 Months	18 Months	Age Comparison (χ^2)
Any	56	55	<i>ns</i> , $p = .47$, $w = .01$
Self–self	33	47	<i>ns</i> , $p = .20$, $w = .14$
Other–other	43	22	<i>ns</i> , $p = .106$, $w = .22$

TABLE 2
Mean Number of Words for the Language Measures in Study 1

	Overall Comprehension	Overall Production	Pronoun Comprehension	Pronoun Production
12-month-olds				
<i>M</i>	113.9	9.6	1.2	.04
<i>SD</i>	80.9	9.8	2.5	.20
Range	31–385	0–40	0–11	0–1
18-month-olds				
<i>M</i>	247.3	92.6	4.7	1.5
<i>SD</i>	80.9	57.9	3.5	1.7
Range	100–396	8–188	0–11	0–6

There were no significant positive correlations between proportion of self–self role reversals and any language measure for 18-month-olds (all $r_s < \pm .16$).

Discussion

We found that some infants at both ages engaged in dyadic role reversal imitation. Although infants had a tendency to perform the same response across different demonstration trials (i.e., on the same location as the demonstration for 12-month-olds and on the self for 18-month-olds), when we used a conservative measure that corrected for this tendency we found that just over half of infants who imitated at each age engaged in some type of role reversal imitation. There were few differences across age in the types of role reversal performed, although 18-month-olds seemed to avoid other–other role reversals. This might have something to do with shyness about performing actions on strangers. This was not a generalized shyness—these infants often acted on E2 after E1 had done so. However, perhaps in that case they saw E1’s action as giving them “permission” or en-

couragement in a way that was not present in the other–other reversal situation in which they had to be the one to initiate an action on a stranger. We thus see 18-month-olds' relatively low rates of other–other role reversals as a performance rather than a competence issue (which perhaps could be ameliorated in future studies by using infants' parents as demonstrators).

We found interesting results with regard to interrelations between infants' role reversal imitation and their language scores. Whereas there were no significant correlations between role reversal imitation and language for 12-month-olds (whose language—and especially pronoun—scores were naturally relatively low), for 18-month-olds, children who produced more other–other role reversals also both comprehended and produced more pronouns. We did not find any significant correlations with overall vocabulary scores, probably because only a low threshold amount of role reversal imitation is needed to enter into bidirectional symbolic communication (and even 12-month-olds already have this threshold amount). In contrast, more advanced role reversal abilities would likely be needed to comprehend and produce pronouns, some of which require a deictic shift, and this is why we find a direct relation between these two abilities. Performance issues might have come into play here, too, as vocabulary measures were maternal reports involving constant observations over long periods of time in familiar settings, whereas our tests took place during a very short period of time with unfamiliar experimenters.

Overall in this study we found relatively low rates of role reversal imitation. However, in this task, in contrast to other imitation tasks, the “correct” answer is somewhat ambiguous. Infants were given uninformative feedback no matter on which location they imitated, and were given no cues to the adult's intention (e.g., revealing looks at the correct location), so they could have chosen a strategy and stuck with it across different demonstration conditions with no ill effects. In addition, it is not exactly clear what level of role reversal this task requires. Children performed the same action as E but on a different location, and they could have done so with no interaction with the adult. They could have achieved this type of action reversal at a bodily level. Indeed, when newborn infants copy hand or mouth gestures (e.g., Meltzoff & Moore, 1977) they are doing something similar.

In other types of role reversal involving interaction on objects, in contrast, there are two very distinct roles, which differ from each other in every way. For example, in a hiding game, the hider puts the toy down, covers it, and waits, and the finder removes the cover and retrieves the toy. In this type of role reversal, children might do the same action, on the same location, as the adult, but they must do the action *for* and *with* the adult. This type is truly a *role* reversal, and would likely involve reversal and interaction at a more psychological (as opposed to just action) level. It also is the type of role reversal that would be needed to engage in the shared collaborative activities in which 18-month-old and older children can participate (Tomasello et al., in press). We tested this type of role reversal in Study 2.

STUDY 2

In this study we presented children with two different types of triadic, object-mediated role reversal tasks: a hiding game and an offering game. We used children's looks to the adult's face as evidence of expecting the adult to fulfill her role.

Study 2a: Hiding Task

Method

Participants. The same infants as in Study 1 participated in this experiment, except that one 12-month-old and three 18-month-olds were excluded due to a missing videotape.

Materials. Materials were a small Big Bird figurine and a 41 cm × 61cm cloth as the occluder.

Procedure. This task took place after the dyadic role reversal tasks described in Study 1. E1 placed Big Bird on the floor and then covered him with the cloth. E1 then asked the child "Where is Big Bird? Can you find him?" If the child did not lift the cloth, E1 lifted it to reveal the toy. This procedure was repeated three times. After Big Bird was covered and found a third time, E1 handed the cloth and the toy to the child and said "It's your turn now," and waited.

Scoring. If the child hid Big Bird, E2 coded whether or not the child looked up to E1's (or anyone else's) face in anticipation of their finding response. To assess interobserver reliability, 25% of children's tapes were coded independently. Cohen's kappas for the hiding game (whether or not the child hid the toy and looked up to someone in anticipation) were 1.0 for 12-month-olds and .71 for 18-month-olds.

Results

Table 3 presents the percentage of children at each age who hid the Big Bird toy with (and without) looks to the adult's face. Significantly more 18-month-olds than 12-month-olds hid the toy with a look to the adult's face, $\chi^2(1, N = 44) = 10.96, p = .0005, w = .50$. Only one 12-month-old did this.

Because we had vocabulary and pronoun comprehension and production measures for the children in this study (see Study 1), we again investigated whether there were interrelations between role reversal imitation and language. As in Study 1, for 12-month-olds there were no significant correlations (all r s were negative, and $< -.16$) but for 18-month-olds there was an almost significant positive correla-

TABLE 3
 Percentage of Children Who Performed Triadic Role Reversals With and Without Looks to the Experimenter's Face for Studies 2 and 3

Group	Task			
	Hiding (Study 2a, Study 3)		Offering (Study 2b)	
	With Looks	Without Looks	With Looks	Without Looks
12-month-olds	4.3	17.4	19.2	34.6
18-month-olds	47.6	23.8	26.9	38.5
Children with autism	12.5	50.0	—	—
Children with developmental delays	50.0	37.5	—	—

tion between hiding Big Bird with a look to E1's face (again, a type of other–other role reversal) and production of pronouns, $r = .33$, $n = 20$, $p = .078$ (r s for the other language measures ranged from .09 to .19).

Study 2b: Offering Task

We also tested infants with a different type of role reversal task involving interactions around objects. This task involved two other different roles—offerer and responder—and a more simultaneous interaction (we are doing it together) as opposed to the more sequential interaction of the hiding task.

Method

Participants. Participants were 26 12-month-olds (M age = 12.3 months; 15 boys and 11 girls) and 26 18-month-olds (M age = 18.1 months; 16 boys and 10 girls) from a middle-sized city in Germany. Four additional children were excluded from the study due to fussiness. Children were recruited from a database comprised of parents and children who volunteered in various ways.

Materials. Materials were a Winnie the Pooh figure who went into a wagon, a tiger figure who went on a plate, a cup that went on the head of a dinosaur figure as a hat, and a Lego block that was put in a cup.

Procedure. While sitting on their parent's lap across a table from a female experimenter, infants were presented with a series of four pairs of objects that fit together in various ways. One of each pair of objects was the 'actor' and the other was the 'base'. For each pair of objects, E first put the objects together twice, with-

out letting the child touch them (e.g., she put the tiger on the plate twice). Then E gave the child the actor and held out the base. E waited for 5 sec, looking at the child without speaking, and then, if the child did not respond by putting the actor in or on the base, E encouraged the child to play by saying "Let's play together." If the child still did not respond, E helped the child put the actor with the base. E then detached the toys and repeated the sequence of holding out the base with encouragement if necessary. To test for role reversal, E then gave the base to the child, and held out the actor. Again E waited for 5 sec, looking at the child without speaking, and then, if the child did not respond by holding out the base, E encouraged the child by saying "Let's play together again." If the child still did not respond, E helped the child put the actor with the base.

Scoring. We coded whether children offered the base to E, and whether they did this spontaneously or with some encouragement or help. We also noted whether children looked to E's face during their offer. Interobserver reliability was assessed for 20% of the children: Cohen's kappas were 1.0 for offers, 1.0 for spontaneity, and .65 for looks to E's face.

Results

Table 3 presents the percentage of children at each age who offered the toy at least once (with or without encouragement), with (and without) a look to the adult's face during their offer. Nineteen percent of 12-month-olds and 27% of 18-month-olds offered the toy with a look to the adult's face on at least one trial. This difference was not statistically significant, $\chi^2(1, N = 52) = .43, p = .26, w = .09$.

Discussion

In the hiding task, 18-month-olds were more likely than 12-month-olds to reverse roles and hide Big Bird. Only one 12-month-old hid the toy with a look to E, indicating that this task was somewhat more difficult than the dyadic, bodily role reversal tasks tested in Study 1. The offering task was somewhat easier than the hiding task, at least for the 12-month-olds, almost one fifth of whom offered with a look to E's face. In the first of these two object-mediated tasks, children needed to reverse the roles of hider and finder, whereas in the second they needed to reverse the roles of offerer and responder. Perhaps younger children understood the roles involved in offering and responding better than they understood the roles in hiding and finding; certainly the action of offering is somewhat simpler, and perhaps more familiar to 1-year-olds, than the action of hiding.

Studies 1 and 2 thus show that some typically developing infants at 12 and 18 months of age are capable of reversing roles when imitating, both when acting on

other people directly and also in more triadic interactions involving objects. Infants thus are beginning to be able to engage in role reversals at an age at which they are beginning to engage in productive language, and in fact from Study 1 and Study 2a we now know that there are some relations between role reversal imitation and language. In a third study, we tested children with autism on these same tasks to test the hypothesis that these children are less able to engage in role reversal imitation, and that this might explain some characteristics of these children's language and social interaction (Carpenter & Tomasello, 2000).

STUDY 3

It is well known that children with autism have difficulties with some types of imitation, and that they sometimes make perspective-taking errors that might be indicative of a failure to reverse roles (Ohta, 1987; Smith & Bryson, 1998; Whiten & Brown, 1998). It is also well known that those children with autism who use some language often make pronoun reversal errors, for example, substituting *you* for *I*—an error that might also indicate some specific problems with role reversal. In a third study, therefore, we replicated the role reversal tasks from Study 1 and the hiding task from Study 2a with a small group of children with autism. As controls, we used children with other developmental delays but not autism. Due to difficulties finding children (and, of course, difficulties diagnosing children with autism during infancy), the children in this study were much older than those in Studies 1 and 2a.

Method

Participants. Participants were 16 children attending schools for children with learning difficulties in a middle-sized city in England. Eight of the children (7 boys and 1 girl) had previously been diagnosed as having autism and 8 (5 boys and 3 girls) had previously been diagnosed with various developmental delays—all global delay or specific language disorder—but not autism. Children's diagnoses were obtained from their schools. Children who were known to have Asperger's syndrome or pervasive developmental disorder—not otherwise specified (PDD-NOS) were not included. Unfortunately, further information about diagnostic criteria, symptom severity, and overall cognitive level was not available. Results of this study should thus be treated as preliminary due to the small sample size and lack of further details about diagnoses. The two groups of children were matched groupwise on chronological age and verbal mental age (see Table 4). Informed consent was obtained from the schools and the children's parents.

TABLE 4
Mean Ages in Months and Matching Information for Participants in Study 3

	Mean Chronological Age	Mean Verbal Mental Age (BPVSII Age Equivalent Score)
Children with autism		
<i>M</i>	96.2	53.4
<i>SD</i>	27.3	16.6
Range	63.6–129.1	37–74, plus 3 children who scored below 28 months
Children with developmental delays		
<i>M</i>	107.3	46.2
<i>SD</i>	16.6	19.6
Range	81.4–125.9	33–81, plus 3 children who scored below 28 months
Comparison	$p = .57$	$p = .42$

Note. BPVSII = British Picture Vocabulary Scale.

Materials. Materials for both tasks were similar to those used in Studies 1 and 2a (a plastic airplane replaced the car in Study 1). The British Picture Vocabulary Scale (BPVSII; Dunn, Dunn, Whetton, & Burley, 1997), a measure of vocabulary comprehension, was used to determine the children's verbal mental age. We also attempted to measure children's vocabulary development with the MacArthur Child Development Inventory of Words and Gestures, but only one parent returned the checklist so children's BPVSII scores were used for analyses instead.

Procedure. The testing procedures were identical to those used with infants with the following exceptions. Testing took place in a small playroom at the child's school. Parents were not present, although in one case a teacher accompanied the child. Children, E1, and E2 sat either on chairs or on the floor in a circle within reach of each other.

Following warm-up play with a jigsaw puzzle, E1 administered the BPVSII. Following this, E1 proceeded to the warm-up imitation task, the self-self and other-other role reversal tasks (plus the E2 demonstration control tasks), and then the hiding game, as previously described.

Scoring. Responses were scored as in Study 1. E1 recoded 25% of the children in each group from the videotapes to assess interobserver reliability. Kappas were .95 for the dyadic role reversal imitation tasks (with a match of action, person, and location necessary for agreement on a given trial) and 1.0 for the triadic hiding task.

Results

Dyadic role reversals. As in Study 1, because we were interested in role reversal imitation and not imitation in general, all role reversal scores are reported as a percentage of the total trials in which children imitated the demonstrator's action on some location. Children in both groups imitated on most trials (for children with autism, mean proportion of trials = .72, $SD = .33$, range = .17–1.0; for children with other developmental delays, mean proportion of trials = .75, $SD = .27$, range = .21–1.0) and there was no significant difference between groups on overall imitation, two-tailed t test, $p = .82$, $d = .12$. Thus, differences in imitative abilities across groups (i.e., difficulties with imitation in general in children with autism) could not have affected our results. All p values that follow are one-tailed.

Figure 3 shows the mean proportions of each type of location response in each demonstration condition, that is, when E1 modeled the action on E1, the child, or E2, for each group, with each type of role reversal marked. Like typically developing 18-month-olds in Study 1, the most common response across all demonstration conditions for both groups was to perform the action on the self.

There was some preliminary evidence of role reversal imitation in each group. All children in both groups performed at least one type of role reversal imitation. All of the children with autism and 87.5% of the children with developmental delays performed self–self role reversals during at least one trial. In contrast, only 25% of children with autism and 37.5% of children with developmental delays performed other–other role reversals during at least one trial. There were no significant group differences on either type of role reversal (for self–self, $p = .15$, $w = .26$; for other–other, $p = .30$, $w = .13$). (Incidentally, unlike in Study 1, there were no significant differences for either group in the number of role reversals produced when E1 used an object versus when she did not, $p = .24$, $f = .19$. For children with autism, 48% of role reversals were in object trials and 52% were in no-object trials; for children with developmental delays these percentages were 60% and 40%, respectively.)

However, as in Study 1, as a more conservative measure of role reversal imitation, we calculated adjusted proportions of self–self and other–other role reversals using the third-person demonstration condition as a baseline. Figure 4 presents these unadjusted and adjusted proportions. Using the adjusted scores, as a group, children with developmental delays showed weak evidence of both types of role reversal; that is, their mean adjusted proportion was greater than zero, $t(7) = 1.71$, $p = .066$, $d = .60$ for both self–self and other–other). In contrast, children with autism did not show either type of role reversal (i.e., their mean adjusted proportion was not significantly greater than zero, and in fact for self–self role reversal it was below zero; for self–self, $p = .82$, $d = .35$; and for other–other, $p = .13$, $d = .43$). There was a significant difference between children with autism and children with developmental delays on self–self, t test with unequal variances, $t(8.87) = 1.94$, $p = .04$, $d = .97$, but not other–other role reversal ($p = .22$, $d = .40$).

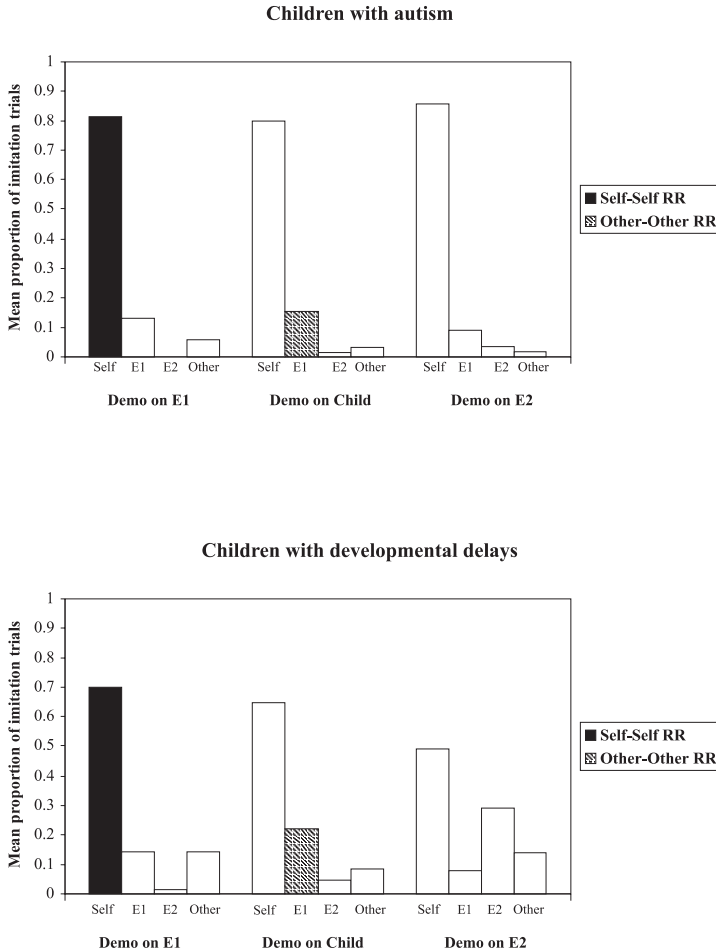


FIGURE 3 Study 3: Mean proportion of each location response in each demonstration condition for each group. Each type of role reversal imitation is marked.

Table 5 presents the percentages of children who engaged in role reversal (and each type of role reversal) on at least one trial using these adjusted scores. Overall, twice as many children with developmental delays (75%) as children with autism (37.5%) performed at least one type of role reversal on at least one trial. This group difference was almost significant, $\chi^2(1, N = 16) = 2.29, p = .066, w = .38$. A minority of children with autism and half of children with developmental delays performed some self–self role reversal (i.e., their adjusted difference scores were greater than zero) and a quarter of children with autism (two of the same children who performed self–self role reversal) and 37.5% of children with developmental

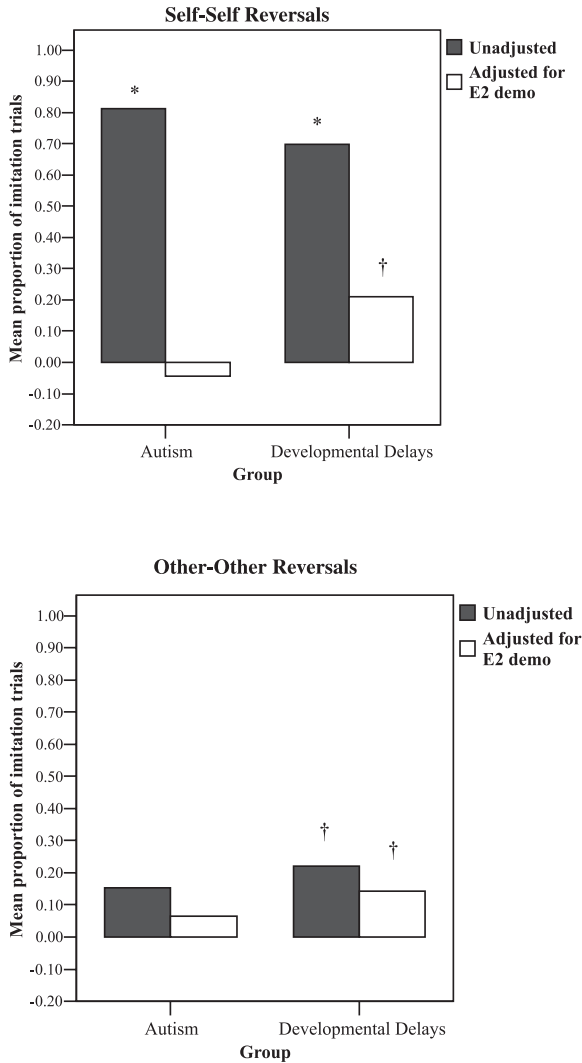


FIGURE 4 Study 3: Unadjusted and adjusted proportions of self–self and other–other role reversals. *Different from zero, $p < .05$. †Marginally different from zero, $p < .07$.

delays performed some other–other role reversal. There were no significant group differences on either type of role reversal.

Correlations. Because children’s chronological ages varied widely, we used partial correlations controlling for chronological age to determine the relation between role reversal imitation and language. For children with autism, there were

TABLE 5
 Percentage of Children in Each Group in Study 3 Who Imitated Who
 Engaged in Each Type of Role Reversal Imitation (Using Adjusted Scores)

Type of Role Reversal Imitation	Percentage of Children		Group Comparison (χ^2)
	Autism	Developmental Delays	
Any	38	75	$\chi^2(1, N = 16) = 2.29, p = .066, w = .38$
Self–self	38	50	<i>ns</i> , $p = .31, w = .13$
Other–other	25	38	<i>ns</i> , $p = .30, w = .13$

positive correlations between the overall (yes–no) role reversal score and the general language comprehension measure (the raw score; no measures of production or pronouns were available), $r(5) = .69, p = .043$ for unadjusted, and $r(5) = .81, p = .013$ for adjusted scores. More specifically, there was a significant positive correlation between the adjusted self–self role reversal proportion score and the language measure, $r(5) = .72, p = .035$. For other–other role reversals the correlations were positive but not significant: $r(5) = .54, p = .105$ for unadjusted, and $r(5) = .51, p = .119$ for adjusted proportion scores. Note that we do not have enough power to say that there is no correlation between other–other role reversals and language. Using a Fisher’s *Z* transformation, we compared the two adjusted (i.e., self–self and other–other) correlations and found no significant difference between them ($Z = 0.55, p = .60$, two-tailed). In addition, both other–other correlations had a large effect size ($r_s > .5$).

For children with developmental delays, the correlation between the unadjusted overall role reversal score and the language measure approached significance, $r(5) = .59, p = .083$ (this is a large effect size), but there were no other significant correlations. All the other r_s were $< \pm .40$. The highest of these, $r(5) = .39, p = .19$, a medium effect, was for the correlation between unadjusted other–other role reversals and language. Note that this pattern of findings is consistent with that of typically developing 18-month-olds, because there was no measure of pronoun comprehension or production available for the former children.

Triadic role reversals. Table 3 presents the percentage of children in each group who hid the Big Bird toy with (and without) looks to the adult’s face. Four times as many children with developmental delays as children with autism hid the toy with a look to the adult’s face (only 1 child with autism did this). This difference was almost significant, $\chi^2(1, N = 16) = 2.62, p = .053, w = .40$.

Again, the pattern of correlational results matched that for the dyadic other–other imitation tasks: no significant correlation for children with developmental delays and a positive but nonsignificant correlation between hiding the toy

with a look to E1's face and the language measure for children with autism, $r(5) = .46$, $p = .148$.

As a comparison across studies, it is interesting to note that fewer children in both groups engaged in triadic than dyadic role reversal imitation. Only those children who had performed some dyadic role reversals did the triadic type (note that this was not the case for typically developing infants in Study 1 and Study 2a).

Discussion

Like the typically developing 18-month-olds from Study 1, on the dyadic, bodily role reversal imitation tasks both groups of children in this study had a strong tendency to perform the action on the self regardless of where E1 demonstrated the action. When we used a conservative measure that corrected for this tendency we found that the performance of children with developmental delays was very similar to that of typically developing 18-month-olds (except that a larger percentage of the former children performed other–other role reversals). In contrast, for children with autism there was very little evidence of role reversal imitation: As a group, they did not perform more role reversal imitation than in the E2 control condition, and only about a third of these children performed some type of role reversal during the session. When they did perform role reversal it was usually self–self reversal.

Interestingly, it was those children who were most adept at role reversals who had higher scores on the language measure. We thus did find some support for Carpenter and Tomasello's (2000) hypothesis concerning relations between role reversal imitation and language, although contrary to predictions (and contrary to the findings with typically developing infants) it was with self–self and not other–other role reversals (although with a larger sample we might also have found a significant correlation between other–other role reversals and language). It would be interesting for future studies to attempt to relate both types of role reversal imitation in more detail to language development (especially correct usage of pronouns) in a larger sample of younger children with autism with confirmed diagnoses. Still, already our finding of relations between role reversal imitation and vocabulary (in typically developing infants as well as in children with autism) has potentially important clinical implications: Therapists who are hoping to improve the language of children with autism might consider specifically targeting role reversal imitation (along with other types of imitation) in their interventions.

As with typically developing infants, the triadic, object-mediated task was more difficult for children with autism than the dyadic role reversal imitation tasks. Whereas children with autism were able to perform the adult's actions, they usually did not do so in interaction with the adult, at least if looks to the adult's face after hiding are used as an indicator (only 1 child did this). They might thus have

simply mimicked the adult's action in this task rather than understanding her intentions toward them and reversing roles.

GENERAL DISCUSSION

One-year-old infants are able to engage in some types of role reversal imitation. At least half of both 12- and 18-month-olds who imitated showed clear evidence of dyadic, bodily role reversals. The more cooperative, triadic role reversals involving interactions around objects were somewhat more demanding for the younger infants, but nevertheless some infants at both ages engaged in this type of role reversal as well. This study thus provides further evidence that typically developing infants imitate flexibly, interpreting adults' actions before copying them: When the adult's intention in giving a demonstration is that the infant reverse roles when it is her turn, infants quite often discern this and respond appropriately. This study also extends findings of intention reading in infants in the same age range beyond intentions toward objects to intentions toward the self (see also Behne, Carpenter, Call, & Tomasello, 2005).

The developmental timing of the emergence of this ability also fits well with the developmental timing of children's ability to share intentions with others in collaborative engagement (see Tomasello et al., *in press*, for a review). Indeed we believe that the type of role reversal imitation we have studied here, especially in the object-mediated task, is itself a simple form of collaboration. The role reversal imitation game requires that we understand the social interaction between us holistically, from a "bird's-eye view" as it were, in which both of our roles are conceived in the same representational format—and so they therefore are interchangeable (Tomasello, 1999).

This timing also fits well with the emergence of infants' first comprehension and production of linguistic symbols. Because the ability to conceive of an interaction holistically is necessary to learn to use bidirectional communicative symbols, we expected that there would be relations between infants' ability or tendency to engage in other–other role reversal in imitation and their language skills. We found that this was the case for 18-month-olds, at least for comprehension and production of pronouns. The nature of this relation is a complex one. For language acquisition in general, we might propose a threshold model in which infants need to be able to reverse roles to begin to comprehend and produce linguistic symbols. However, our data suggest that more than this is going on in the case of pronouns. The positive correlations between the amount of other–other role reversal imitation in which infants engage and their comprehension and production of pronouns—some of which are explicitly deictic in nature—suggests that stronger skills in understanding social interactions holistically are especially important for these special words.

For children with autism, we found little clear evidence of role reversal imitation. This is consistent with suggestions in the literature that these children might have difficulties with role reversals in various areas, including imitation and language (e.g., Jordan, 1989; Ohta, 1987; see preceding review). Given that currently findings with regard to intention understanding in children with autism are mixed (see Carpenter, Pennington, & Rogers, 2001, for a brief review), it might be no surprise that these children have difficulty reading this type of intention. Even so, we found positive correlations between role reversal imitation and vocabulary comprehension, in this case involving mainly self–self reversals. Further research is needed in this area but the finding of correlations with self–self reversals is consistent with the idea that these children use language in a way that is less bidirectional and more mimetic than typically developing infants, as shown by other characteristics of these children’s language use such as echolalia and personal pronoun reversals. If there is also a correlation between other–other role reversals and vocabulary comprehension in these children, it might be because their language is more fragile than that of other children and they need this extra support. Whether these children’s deficit in role reversal imitation is a cognitive or a motivational difficulty is another question for future research.

In summary, role reversal imitation is present when children are first starting to learn language, and it is related to language development. Thus by age 12 months, children not only see themselves and others as interchangeable (I am like them, they are like me; Meltzoff & Gopnik, 1993; Tomasello, 1999) but also actively use this understanding, in both directions. This is important for cultural learning and involvement, in several different ways. First, self–self role reversals are cultural transmission at work, in the direction of the child soaking up knowledge from others (the child is literally incorporating the others’ behavior into the self). Second, other–other role reversals are the child more actively entering into the culture and reciprocating with others. Finally, the more triadic, object-mediated role reversals are the beginnings of collaboration with others. Children with autism have difficulty with each of these and this has cascading detrimental effects for their cultural involvement. Future research should focus on the complex interrelations among intention reading, collaboration, role reversal, and symbolic communication in both typically developing children and children with autism.

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