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Effect of Sensory Feedback on Immediate Object Imitation in Children with Autism

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This study examined the effect of sensory feedback (e.g., flashing lights and sound) on the imitation performance of children with autism and typical children group-matched for mental age. Participants were administered an immediate object-imitation task with six novel toys constructed for this study: three with a sensory effect that could be activated by imitating the modeled action and three without a sensory effect. Although overall imitation performance did not differ significantly between the two groups, the imitation performance of the participants with autism was significantly higher with sensory toys than with nonsensory toys. Typical participants' imitation performance did not differ between the two sets of toys. Both groups played significantly more with the sensory toys during free play, indicating that sensory toys were more reinforcing for both groups. Additional results demonstrated that typical children used significantly more social behaviors during imitation than children with autism, but they did not differ in object-oriented behaviors, replicating previous findings. It is argued that children with autism may be less motivated to imitate by social interaction, but may be motivated to imitate to receive a nonsocial reward (sensory feedback).

KEY WORDS: Autism; imitation; sensory feedback; social motivation; joint attention; affect.

INTRODUCTION

A variety of research has found that individuals with autism exhibit imitation deficits when compared with mental age-matched typical and developmentally delayed individuals (see Smith & Bryson, 1994, for review). Imitation deficits have been found on object (DeMyer *et al.,* 1972; Stone, Ousley, & Littleford, 1997), body (DeMyer *et al.,* 1972; Stone *et al.,* 1997), vocal (Sigman & Ungerer, 1984), gestural (Curcio, 1978; Sigman & Ungerer, 1984), and pantomime (Rogers, Bennetto, McEvoy, & Pennington, 1996) tasks. Despite multiple replications indicating imitation as an autism-specific deficit, several studies have not found differences in imitation abilities between children with autism and controls on goal-directed actions (Charman & Baron-Cohen, 1994), simple gestures (Morgan, Cutrer, Coplin, & Rodrigue, 1989), or single-step play schemes (Libby, Powell, Messer, & Jordan, 1997). Although the presence of ceiling effects and the use of much younger control subjects may color these findings, they indicate that children with autism may not exhibit a simple imitation deficit in which imitation of all actions is disrupted, but rather, a more complex deficit that is limited to specific types of actions.

The scope of this deficit, however, is highly debated. For example, several researchers have argued that individuals with autism exhibit specific deficits in the imitation of symbolic actions, whereas the imitation of functional acts is preserved (Charman & Baron-Cohen, 1994; Hammes & Langdell, 1981). In contrast, other researchers have found that children with autism

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exhibit deficits in the imitation of functional acts (Stone *et al.,* 1997) and goal-directed actions when compared with developmentally delayed controls (Whiten & Brown, 1998). In addition, other research has shown that children with autism are impaired in the imitation of arbitrary hand and body postures (Jones & Prior, 1985; Ohta, 1987; Smith & Bryson, 1998) and that symbolic meaning aids rather than hinders the imitation performance of children with autism (Rogers *et al.,* 1996). Similarly, although some researchers have argued that simple object imitation is relatively spared compared to body or gesture imitation (DeMyer *et al.,* 1972; Stone *et al.,* 1997), others have found object imitation to be substantially impaired as well (Charman *et al.*, 1997). Finally, some researchers have found that individuals with autism are most impaired in the imitation of multistep actions (Libby *et al.,* 1997; Rogers *et al.,* 1996), whereas other researchers have found autistic deficits to be most pronounced in the imitation of single-step tasks (Smith & Bryson, 1998).

Many theories on the underlying cause of imitation deficits in autism have been proposed. The most commonly held theories have suggested that deficits in certain underlying cognitive skills, such as working memory (Rogers *et al.,* 1996), symbolic functioning (Baron-Cohen, 1988; Hammes & Langdell, 1981), and self–other representation (Rogers & Pennington, 1991), are responsible for the imitation deficits observed in this population. However, there is also support for the involvement of perceptual-motor difficulties such as problems with body schema (Ohta, 1987) and motor planning impairments (DeMyer *et al.,* 1972; Rogers & Bennetto, 2000).

Recently, there has been an emphasis on the social role imitation serves in early development (Nadel, Guerini, Peze, & Rivet, 1999; Uzgiris, 1981, 1990). Studies indicate that typical infants use imitation as an early social-communicative strategy for interacting with adults (Kugiumutzakis, 1999; Nadel *et al.,* 1999; Trevarthen, Kokkinaki, & Fiamenghi, 1999; Uzgiris, 1981, 1990), and toddlers use imitation as an early means of interacting with peers (Eckerman & Didow, 1996; Eckerman & Stein, 1990). It is interesting that despite the pervasive social deficits observed in autism, little research has examined the possibility that imitation deficits in this population may be, at least in part, the result of a greater underlying social impairment.

Those few studies that have investigated the possible social factors involved in imitation deficits in individuals with autism have yielded interesting results. Whiten and Brown (1998) found that although individuals with autism were able to perform elicited imitation in which the participant is briefly taught the rule of imitating the experimenter through a series of prompts before imitation testing, they did not spontaneously imitate a goal-directed action as well as young typical and developmentally delayed controls. The authors suggested that the lack of understanding of the other person's intent may contribute to the observed deficit in spontaneous imitation. They argue that individuals with autism are capable of imitation, as evidenced by their imitation performance in the elicited condition, but may lack the social motivation because of poor social understanding, which guides normal individuals into spontaneous imitation.

In another study, Hobson and Lee (1999) found that although children with autism imitated as many goal-directed actions as developmentally delayed controls, they did not imitate the "style" (harsh vs. gentle) in which the experimenter modeled the actions. The authors argued that individuals with autism may be less motivated than individuals with developmental delay to identify with or engage in intersubjective contact with others through imitation.

In a recent study examining joint attention and imitation, Roeyers, Van Oost, and Bothuyne (1998) noted that the participants with autism exhibited an interesting pattern of imitation that was not evident in the developmentally delayed controls. In their study, children with autism and children with developmental delay matched for mental age were given a motor imitation task involving four objects, three of which produced a sensory effect when correctly imitated. Although not the focus of their study, the authors noted that whereas the participants with autism exhibited overall poorer imitation performance, their performance with the toy without a sensory effect was much more impaired than their performance with the toys with a sensory effect. This pattern was not seen to the same extent in the developmentally delayed controls. The authors suggested that, unlike children with developmental delay, who are likely motivated for social feedback, children with autism may be more likely to imitate if their actions are followed by a nonsocial reward. Although this argument is intriguing and offers additional insight into the possible role of social motivation in imitation in autism, the experiment did not control for the difficulty of the modeled actions. It is possible that the poorer imitation performance with the toy without a sensory component was because that toy was more difficult to manipulate than the others. In addition, as the study was not designed to test this question directly, there were no statistical comparisons between groups regarding this behavior.

Despite the fact that imitation often serves a highly social-communicative role in early adult–child (Nadel *et al.,* 1999; Uzgiris, 1981, 1990) and child–child interactions (Eckerman & Didow, 1996; Eckerman & Stein, 1990), the current autism literature has not examined social behaviors in conjunction with imitation. A study examining the use of positive affect during joint attention, another early social-communicative behavior, found that children with autism displayed significantly less positive affect in conjunction with joint attention bids than the typical or developmentally delayed children matched for mental age (Kasari, Sigman, Mundy, & Yirmiya, 1990). Similarly, Dawson and colleagues found that children with autism were less likely to combine positive affect and eye contact in a single act that conveyed communicative intent (Dawson, Hill, Spencer, Galpert, & Watson, 1990). These studies indicate that the social quality of other early social-communicative behaviors may be different in autism than in typical development (Mundy, 1995). However, little is known about the social quality of imitation in children with autism compared with typical children.

The purpose of this study was to address the effect of nonsocial motivation in the form of sensory feedback on imitation performance and the use of social behaviors in conjunction with imitation in children with autism and typical children. In this study, young children with autism and mental age–matched typical children were asked to imitate simple actions with novel objects, half of which involved sensory feedback in the form of lights and sound and half of which had no sensory components. Sensory and nonsensory toys were matched for modeled action.

This study sought to test three hypotheses. First, this study examined the hypothesis that children with autism have a deficit in the imitation of single-step actions on novel objects. It was predicted that the participants with autism would have a lower overall imitation performance than the typical children. Second, this study tested the hypothesis that children with autism are motivated more by sensory feedback than social feedback. It was predicted that the participants with autism's imitation performance would be better with the sensory toys than nonsensory toys, whereas the typical children would not show this discrepancy in performance. Finally, this study examined the hypothesis that children with autism are less motivated to engage in intersubjective contact with others through imitation. It was predicted that children with autism would use fewer social behaviors during imitation than the typical children, but that the two groups would not differ in the use of object-oriented behaviors.

METHOD

Participants

Fifteen young children with autism (nine boys, six girls) and 14 typical toddlers (five boys, nine girls) participated in this study. Because of noncompliance during testing, three additional participants, one child with autism and two typical children, were excluded. Noncompliance was defined as refusal to engage with warm-up toys or overt verbal or nonverbal protest. Reasons for exclusion did not differ across groups. Ethnic distribution and social economic status did not differ between groups.

All of the participants with autism had been previously diagnosed by at least one professional with expertise in autism who was not associated with this project. Diagnoses were confirmed by the first author using DSM-IV criteria. In addition, the parents of the participants with autism were asked to complete the Gilliam Autism Rating Scale (GARS; Gilliam, 1995), a behavioral checklist of autistic symptoms based on DSM-IV criteria that has been normed on a national sample of individuals with autism. The average GARS score of the participants with autism was 89.9 (range, 72–105), which is in the average range of autism.

The participants with autism ranged in age from 23 to 53 months ($M = 37.4$, $SD = 8.8$). Because of the young age of one participant with autism, her diagnosis of autism was provisional. The typical participants were recruited from area preschools and the university-based subject pool and ranged in age from 16 to 32 months ($M = 23.8$, $SD = 5.4$). Chronological age was significantly higher for the autistic group than the control group [$t(27) = 4.83$, $p < .001$]. The typical participants and participants with autism were group-matched for mental age. Typical children's chronological age was used as their mental age for matching purposes, as seven of the typical children had been administered the Bayley Scales of the Infant Development, 2nd edition (Bayley, 1993) within the previous 6 months and were not retested as specified in the Bayley testing manual. However, all typical children were determined to be developing normally as determined by the mental development index (MDI) on the Bayley (see Table I for sample characteristics).

Table I. Participant Characteristics

Diagnostic groups	n	Chronological age, months	Mental age, months[a]	Autism quotient[b]
Typical	14 (five males, nine females)			n/a
M		23.7*	23.7	
SD		5.4	5.4	
Range		16–34	16–34	
Autism	15 (nine males, six females)			
M		37.4*	22.0	89.9
SD		8.8	5.8	7.1
Range		23–53	15–32	72–105

Note: n/a, not applicable.
[a] MA determined by Bayley Scales of Infant Development (Bayley, 1993) for participants with autism; MA determined by CA for typical participants.
[b] Gilliam Autism Rating Scale (Gilliam, 1995).
* $p < .001$.

Mental age for the participants with autism was assessed by the Bayley Scales of Infant Development, 2nd edition (Bayley, 1993). Mean mental age for the participants with autism was 22.0 ($SD = 5.8$) months (range, 15–32 months). A two-tailed, between-subjects *t*-test indicated no significant difference [$t(27) = -0.84$, n.s.) in terms of mental-age equivalents for the two groups.

Materials

Three pairs of novel test toys matched for modeled action were constructed for the imitation task. For each pair, one toy had a sensory effect (flashing lights and sound) that could be activated by manipulating the object in a specific way. The matching toy of the pair could be manipulated in the same way; however, no sensory effect was present.

Although the actions modeled with the sensory and nonsensory toys were identical, the outward appearance of the toys was dissimilar to minimize the possibility of a carryover effect. All toys were constructed out of wood and were left a neutral color. The sensory components of the sensory toys were taken from preexisting children's toys (see Fig. 1).

Procedure

Imitation Task

Participants were assessed in a quiet room, seated at a small table facing the experimenter. Because of noncompliance, one child with autism and two typical children completed all or a portion of the assessment on the floor. After a brief warm-up period with several toys, participants were presented with six modeled actions with the novel toys. The test toys were presented in random order across participants.

The method for the imitation tasks was adapted from Meltzoff's (1988) procedure. The experimenter modeled each action three times in succession with neutral affect, while the child was verbally encouraged to observe. Unlike Meltzoff's procedure, the child was presented with the toy immediately after it was modeled, rather than at the end of all modeling periods. During the response period the child was given no instructions. If the child did not attempt to manipulate the toy within 10 seconds, he or she was asked, "What can you do with this?" The child had a 20-second period in which to respond, after which the toy was removed and the action for the next toy was modeled. The entire procedure took 3–5 minutes to conduct ($M = 4.5$ minutes). Participants were videotaped during the task for later scoring of imitative performance and social and object-oriented behaviors during imitation.

Free Play Period

After the imitation task was completed, the participants were given a 2-minute free play period during which they were given free access to all of the test toys. During this period, the experimenter acted as a passive observer and did not attempt to interact with the child. If the child initiated an interaction, the experimenter completed the exchange with minimal interaction. The free play period was used to determine toy preference.

Scoring

Scoring definitions for imitative responses were taken from the description provided for Stone *et al.*'s (1997) Motor Imitation Scale. Responses were scored on a 3-point scale: a "2" was recorded if the child produced exact imitation, a "1" was recorded if the child produced an emerging response (e.g., the child attempted to manipulate the test toy in the correct manner, but failed to complete the act exactly as modeled), and a "0" was recorded if the child failed to imitate. Only the first action performed on the test toy was scored to ensure that only true imitative learning was recorded and not emulation (Roeyers *et al.,* 1998). Imitation scores for each toy type (sensory and nonsensory) could range from 0 to 6 (maximum score with three toys), and overall imitation scores could range from 0 to 12 (maximum score with six toys). The

Fig. 1. Photograph of test toys. Set 1: Opening and closing spherical hinge activates blinking red light and siren; opening and closing rectangular hinge produces no sensory effect. Set 2: Sliding door on square box back and forth activates three blinking lights and siren; sliding door on disc back and forth produces no sensory effect. Set 3: Twisting square box on flat surface activates seven blinking lights and song; twisting sphere on cylindrical post produces no sensory effect.

imitation response period was scored from videotape for social and object-oriented behaviors. The behavioral definitions were adapted from Pierce and Schreibman (1995) and include social initiations, coordinated joint attention, directing positive affect towards the experimenter, object engagement, and directing positive affect toward the object (see Table II for scoring definitions). These behaviors were scored for occurrence/nonoccurrence in 5-second intervals; multiple behaviors may have occurred in the same interval. In addition, toy preference was assessed during the free play period by recording which test toys the child was engaged with during 10-second intervals. Sensory and nonsensory toys were then compared for each participant group on the percentage of intervals the children engaged with each toy type during free play using within-subject *t*-tests.

Interrater reliability was calculated for 24% of the observations. Observers (undergraduate research assistants blind to the participants' diagnoses) were considered trained when they achieved 80% reliability on training tapes across three consecutive scoring trials. Both the training tapes and the reliability sessions contained a representative sample of typical children and

Table II. Scoring Definitions

Coordinated joint attention	Child coordinates gaze between object and experimenter for the purpose of sharing.
Positive affect with experimenter	Child accompanies eye contact with positive affect (i.e., smiles, laughs).
Social initiations	Child makes a verbal or nonverbal initiation toward the experimenter that does not include requesting.
Object engagement	Child is manipulating or actively observing the object for the majority of the interval (3 or more seconds).
Positive affect with object	Child directs positive affect toward the object (i.e., smile, laughs).

children with autism. Kappa coefficients for each behavior were .73 for positive affect directed at experimenter, .92 for social initiations, .68 for coordinated joint attention, .83 for object engagement, .71 for positive affect directed at object, .86 for engagement with sensory toys, and .84 for engagement with nonsensory toys during free play. Imitation was scored using exact agreement and yielded .95 reliability.

RESULTS

A mixed-model repeated-measures analysis of variance (ANOVA) was used to compare the typical and autistic groups' imitation performance with the sensory and nonsensory toys. Counter to the first prediction, there was no main effect of group diagnosis on overall imitation performance when collapsed across toy type [$F(1, 27) = 0.89$, n.s.), despite a higher overall mean score for the typical participants ($M = 9.50$, $SE = 0.67$) than for the participants with autism ($M = 8.60$, $SE = 0.67$). A main effect of toy type was found [$F(1, 27) = 5.32$, $p < .05$]. However this effect was driven by a significant interaction of group diagnosis by toy type [$F(1, 27) = 4.24$, $p < .05$], indicating that the type of test toy had a differential effect on the two groups' imitation performance. Because of the *a priori* assumptions, four individual comparisons were conducted. A repeated-measures ANOVA was used to examine within-group differences in performance with the two toy types. For the typical participants, imitation performance with the sensory toys ($M = 4.79$, $SE = 0.33$) was not significantly different from performance with nonsensory toys [$M = 4.71$, $SE = 0.40$; $F(1, 13) = .06$, n.s.], indicating that the sensory effects of the toys did not greatly influence the typical participants' imitation performance. However, the scores of the participants with autism on the imitation tasks with sensory toys ($M = 4.93$, $SE = 0.35$) were significantly higher than their performance with the nonsensory toys [$M = 3.67$, $SE = 0.48$; $F(1, 14) = 6.89$, $p < .02$], indicating that the imitation performance of the participants with autism was influenced by the sensory effects of the objects (see Fig. 2).

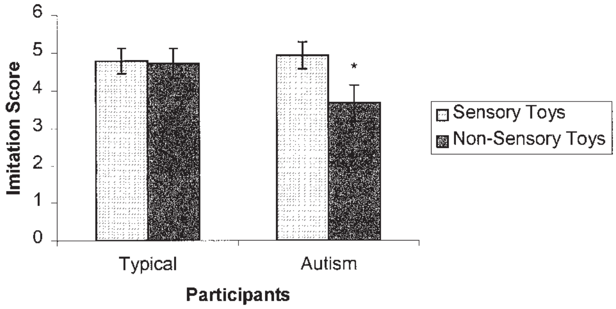

Fig. 2. Mean imitation performance by participant group for sensory and nonsensory toys. Error bars represent mean standard error. * $p < .05$.

A simple ANOVA was used to examine differences in group performance on both the sensory and nonsensory toys. No significant difference was found between the typical participants ($M = 4.79$, $SE = 0.33$) and the participants with autism ($M = 4.93$, $SE = 0.35$) on performance with sensory toys [$F(1, 27) = .09$, n.s.]. A nonsignificant trend was found for performance with nonsensory toys, with typical participants receiving higher imitation scores ($M = 4.71$, $SE = 0.40$) than the participants with autism [$M = 3.67$, $SE = 0.48$; $F(1, 27) = 2.82$, $p = .10$].

The three different actions were compared with each other for difficulty. No significant differences in imitation performance were found between actions for the typical participants [$F(2, 81) = 1.17$, n.s.] or the participants with autism [$F(2, 87) = 2.87$, n.s.].

Social and object-oriented behaviors for each group were compared using two-tailed, between-subjects t-tests. As reported in previous research (e.g., Sigman & Ruskin, 1999), the typical children exhibited higher levels of social behaviors than the children with autism during imitation. The typical participants engaged in significantly more coordinated joint attention behaviors ($M = 27.80$, $SE = 4.67$) than the participants with autism [$M = 2.48$, $SE = 1.20$;

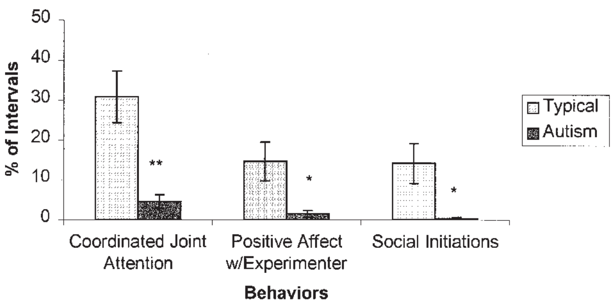

Fig. 3. Mean percentage of intervals participants engaged in social behaviors during imitation by group. Error bars represent mean standard error. * $p < .01$, ** $p < .001$.

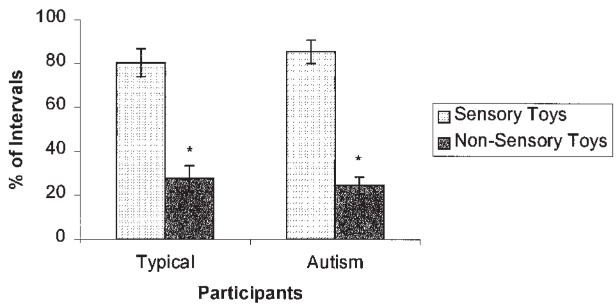

Fig. 5. Mean percentage of intervals participants engaged with sensory and nonsensory toys during free play. Error bars represent mean standard error. * $p < .001$

$t(27) = -5.14$, $p < .001$], and typical participants directed significantly more positive affect toward the experimenter ($M = 14.52, SE = 4.91$) than participants with autism [$M = 1.38$, $SE = 0.78$; $t(27) = -2.73$, $p < .01$]. The typical participants also made significantly more social initiations ($M = 14.09$, $SE = 5.06$) than the participants with autism [$M = .28$, $SE = .27$, $t(27) = -2.82$, $p < .01$; see Fig. 3].

In contrast, there were no significant differences in object-oriented behaviors between typical participants and participants with autism [object engagement: $M = 82.88$, $SE = 4.06$ for typical participants, $M = 84.02$, $SE = 2.51$ for participants with autism, $t(27) = .24$, n.s.; directing positive affect toward the object: $M = 15.71$, $SE = 6.17$ for typical participants; $M = 8.97$, $SE = 4.90$ for participants with autism, $t(27) = -.86$, n.s.], indicating that participants with autism were as engaged with and enjoyed the test toys as much as the typical children during the imitation task (see Fig. 4).

To assess toy preference, the percentage of intervals participants engaged with each toy type during the free play period was recorded in 10-second intervals. The percentage of intervals the participants engaged with sensory toys was compared with the percentage of intervals the participants engaged with nonsensory toys using a two-tailed within-subjects t-test. Sensory toys were played with significantly more than nonsensory toys by both typical participants [sensory: $M = 80.21$, $SE = 6.41$; nonsensory: $M = 27.50$, $SE = 5.83$; $t(13) = -5.03$, $p < .001$], and participants with autism [sensory: $M = 85.53$, $SE = 45.34$; nonsensory: $M = 24.33$, $SE = 4.02$; $t(14) = -8.12$, $p < .001$; see Fig. 5]. Furthermore, the toy each child engaged with most was a sensory toy. Thus, the sensory toys were more motivating than the nonsensory toys for both typical participants and participants with autism.

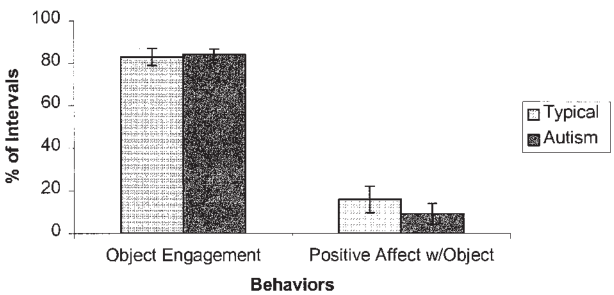

Fig. 4. Mean percentage of intervals participants engaged in object-oriented behaviors during imitation by group. Error bars represent mean standard error.

DISCUSSION

The purpose of this study was to investigate the influence of an extrinsic, nonsocial reward in the form of sensory feedback on the imitative performance of children with autism. Results indicated no difference in overall imitative performance between the two groups. However, the sensory effect positively influenced the imitative performance of the children with autism, whereas it had no effect on the typical children. Both groups strongly preferred the toys with a sensory effect as determined by length of play during free access to the toys; thus, it is unlikely that a lack of preference for sensory toys affected the typical children's performance. During imitation, the typical children displayed many more social behaviors with the experimenter than did the children with autism, indicating that the typical children were far more motivated by the social properties of the imitative environment than the children with autism. However, the groups did not differ in the number of object-oriented behaviors, indicating that interaction with the objects was equally motivating for the children with autism and typical children.

It is interesting that, despite overwhelming evidence indicating autism-specific deficits in imitation (e.g., Smith & Bryson, 1994), the overall imitation performance of the participants with autism did not differ significantly from the typical participants in this study. A handful of previous studies have also failed to show significant differences in overall imitation performance between participants with autism and mental age–matched typical (Stone *et al.,* 1997) or developmentally delayed participants (Charman & Baron-Cohen, 1994; Hobson & Lee, 1999; Morgan, Cutler, Coplin, & Rodrigue, 1989). Several possibilities could explain the lack of a significant difference in overall imitation performance in this study as well as in the other studies. First, it is possible that ceiling effects could have masked differences in group performance (Charman & Baron-Cohen, 1994; Hobson & Lee, 1999; Morgan *et al.,* 1989). Perhaps, had the modeled actions been more complicated, the participants with autism may have exhibited a poorer performance than the typical participants. It has been argued that children with autism do not exhibit deficits in simple imitation tasks, but rather in more complicated tasks such as object substitution (Hammes & Langdell, 1981) or multistep imitation tasks (Libby *et al.,* 1997).

Second, imitation performance with objects may be more preserved in autism than other imitation skills because range of possible motion is constrained by the objects (DeMyer *et al.,* 1972; Stone *et al.,* 1997). Third, the use of significantly younger typical controls may have given the participants with autism an advantage because the younger age of the typical children may have resulted in fewer opportunities for imitative learning and less exposure to demand situations in general (Stone *et al.,* 1997). Finally, the fact that some of the participants with autism had received structured behavioral imitation training (i.e., discrete trial training) before participation in this study may have positively influenced their imitation performance. These findings support the possibility that children with autism do not exhibit a simple imitation deficit but, rather, an imitation deficit that is more complex. Additional research is needed to address whether young children with autism exhibit imitation deficits on simple goal-directed actions with objects when compared with mental age–matched controls.

What might explain the difference in the children with autism's performance with the two sets of objects? It is possible that the sensory feedback made the modeled actions more salient. Previous research has indicated that children with autism exhibit attentional deficits in social situations (Pierce, Glad, & Schreibman, 1997). These deficits may make it difficult for children with autism to attend to relevant components of others' actions, thus disrupting imitation. It is possible that the sensory feedback may have helped direct the participants with autism's attention to the modeled action. This possibility is in line with research by Abravanel, Levan-Goldschmidt, and Stevenson (1976), which found that typical infants were more attentive to modeled actions involving sound. Although autistic and typical participant groups in this study were matched for mental age, it is possible that the participants with autism were more delayed in their ability to direct attention to relevant actions. Thus, they may have needed the increased saliency of sensory feedback provided by the sensory toys, whereas the typical children were able to perform well with either set of objects. It is also possible that the addition of sensory feedback created a goal, thus making the imitation of those actions more interpretable, and easier, for the participants with autism (Hobson & Lee, 1999). An alternative explanation may be that the typical children's imitation performance may also be enhanced by sensory feedback; however, the simplicity of the imitation tasks produced a ceiling effect in the typical children's performance and thus masked differences in their performance with the two types of test toys.

Another speculative interpretation of the results is that children with autism may not be motivated by social feedback the way typical children are. Both Roeyers *et al.* (1998) and Whiten and Brown (1998) have suggested that low social motivation may adversely affect imitation performance in individuals with autism. Hobson and Lee (1999) found that children with autism were less likely to imitate the style in which a modeled action was performed than were children with developmental delay. Although this finding might be in part the result of an attentional deficit (Pierce *et al.,* 1997), it also indicates that identifying with the model may be a motivating factor in children with developmental delay, but not in children with autism. A similar explanation might explain the higher number of social behaviors observed during the typical participants' imitation in the present study. It is possible that the typical children used social behaviors to identify or connect with the adult during imitation, whereas the children with autism, who were not motivated to identify with others, exhibited far fewer social behaviors. In contrast, sensory feedback, which is motivating to children with autism, as shown by the high preference for these objects during free play, may have enhanced their motivation to imitate the modeled action, rather than to perform any random action with the presented object.

Previous research has found that children with autism use fewer social behaviors in general than typical or developmentally delayed children matched for mental age (Sigman & Ruskin, 1999). Thus, the finding that the participants with autism in this study used fewer social behaviors during imitation than the typical participants is not surprising. However, it may offer some insight to the social motivational pattern associated with imitation in autism. Despite the fact that both groups of participants were imitating actions, the social component of their behavior appeared qualitatively different. It was common for the typical children to imitate the action, look at the experimenter and smile, and immediately return the object to continue the interaction with the next object. Participants with autism, however, were often observed engaging with the object until the allotted time was up, never having looked at the experimenter. The low rate of joint attention behaviors used during imitation by the participants with autism may be an indication of a lack of interest in sharing the imitation experience with the adult. In addition, the fact that the children with autism directed significantly less positive affect toward the experimenter indicates that they were not as reinforced by the social aspect of the imitative interaction as were the typical children. Children with autism may exhibit a disturbance in the tendency to initiate affective intersubjectivity or share affective states with others through imitation as well as joint attention (Mundy, 1995). Interestingly, the participants with autism did not differ in the amount of positive affect they used while interacting with the toy. This finding indicates that the children with autism were interested in the objects, despite the fact that they were not motivated to imitate as much with the toys for which imitation did not provide a nonsocial reinforcer (i.e., sensory feedback). Additional research specifically aimed at addressing the role of social motivation in the imitation performance of children with autism is needed.

Several limitations of this study are acknowledged. First, the significant finding that the children with autism imitated significantly better with the sensory toys than with the nonsensory toys was found using one of four follow-up analyses of the significant group by toy type interaction. Although the obtained *p*-value ($p < .02$) is highly significant, it does not reach the .0125 ($\alpha = .05/4$) necessary to protect the alpha for the four follow-up analyses. Therefore, this finding should be interpreted cautiously.

Second, the children with autism and typical children were matched using the Bayley, a developmental assessment that includes imitation and direction following. These items make up a minority of the assessment, and although it is unlikely that it biased the matching procedure, it is possible that the participants with autism represented a more imitative group than is usually found in the autistic population. Third, the children with autism and typical children were not matched for language age. Several researchers have suggested that, because of the close association between imitation and language, matching for language age may be a more appropriate strategy (Smith & Bryson, 1994; Stone *et al.,* 1997). This study included young and lower-functioning participants with autism, several of whom were nonverbal. If the participants in this study had been matched on language age, several of the typical children would have been too young to properly manipulate the objects. Thus it was decided that overall mental age would be a more appropriate matching strategy. Fourth, the GARS was not administered to the typically developing participants. Although clinical observation during the assessment and parental report indicate that all of the typical children were developing normally, the possible presence of some autistic behaviors in the typical sample cannot be conclusively ruled out.

Another limitation of this study is the lack of inclusion of a group of developmentally delayed controls. However, Roeyers *et al.*'s (1998) original observation included children with developmental delay and found similar results. The young age of the participants prevents generalization to the autistic population as a whole. It is possible that as children age, different deficits contribute differentially to imitation problems. Replications of this finding including both typical and developmentally delayed language age–matched controls of varying ages would offer more convincing support.

It should be noted that during the imitation task, only the first action with the test toy was scored. This scoring procedure was used to prevent accidentally including a correct action produced through trial and error rather than true imitation. If the participants were scored for their best attempt rather than their first attempt, it is possible that the results may have differed. However, this seems unlikely, given that the children were only given 20 seconds to interact with the test toys. With such a short amount of time, the children tended to either imitate the action right away or not at all.

This study attempted to examine the role of social and nonsocial rewards on imitative behavior in a structured setting. Although it likely captured imitative behaviors that the participants with autism were capable of producing, it does not address how these children imitate in the natural environment. Studies that look at spontaneous imitation in naturalistic settings may provide additional information on the possible effect of low social motivation on imitation deficits in autism.

The findings of this study do offer several treatment implications. First, if children with autism are more likely to imitate actions with objects that are intrinsically reinforcing, imitation training programs should begin with teaching children to imitate interesting and possibly goal-directed actions. Current imitation training programs usually rely on arbitrarily selected actions (often body actions such as clapping or raising arms) rather than focusing on actions the child is likely to be interested in or to use (e.g., Maurice, Green, & Luce, 1996). Second, treatment programs should focus on increasing the social motivation for imitation. They should target other social behaviors used during imitation by typical children, such as directing positive affect towards the therapist, joint attention, and social initiations.

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