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Immediate imitation and joint attention in young children with autism

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Abstract
There is growing scientific interest in the precursors to the ability of conceiving other people's minds. The present study investigates two candidate precursors, imitation and joint attention, in young children with autism and a control group of nonautistic children with a developmental delay. Children with autism were found to be impaired or delayed in both abilities. Gestural and procedural imitation were significantly related to mental age and chronological age in subjects with autism. Although the evidence for an autism-specific deficit appears to be stronger in the domain of joint-attention behaviors than it is in the domain of imitation, it seems premature to reject imitation as a possible precursor to the development of mindreading skills. Systematic investigations of the imitation deficit in autism are urgently needed.

It is quite generally accepted that children with autism have an impairment in social–cognitive understanding and that this deficit is associated with a number of cognitive, social, and pragmatic deficits (Baron–Cohen, 1988; Frith, 1989; Hobson, 1993). However, since normally developing children are supposed to display basic mindreading skills between 3 and 5 years of age (Wellman, 1993), the lack of what is called "theory of mind" cannot account for the social–pragmatic deficits that have been reported in children with autism under the age of 3 or in lower functioning children (Klin, Volkmar, & Sparrow, 1992; Mundy, Sigman, & Kasari, 1993; Ozonoff, Pennington, & Rogers, 1990). Hence, there is growing scientific interest in the precursors to the ability of conceiving other people's minds. Following Gomez, Sarria, and Tamarit (1993) and Rutter and Bailey (1993) we prefer to define a precursor as something that constitutes an earlier stage of something else and that, together with other factors, contributes to the growth of the later stage. As such, a metarepresentational "theory of mind" deficit has to be functionally dependent of one or more earlier emerging deficits in subjects with autism.

From about 9 months of age, or even somewhat earlier, normally developing infants begin to engage in a range of joint visual attention behaviors (Bakeman & Adamson, 1982; Butterworth, 1991; Scaife & Bruner, 1975). Baron–Cohen (1994a) recently highlighted the precursor role of what he calls the Shared Attention Mechanism (SAM), which is supposed to give rise to a number of joint-attention behaviors such as gaze following and protodeclarative pointing. He claims that SAM is a necessary condition for the development of a "theory of mind," since the latter is triggered to function by taking triadic representations of the SAM as input. In normal development, SAM is supposed to be universally present by 14 months of age. Mundy (1995) also points to the importance of joint-attention behavior development. He considers joint-attention deficits to be behavioral markers of an impairment in the biological system

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that is responsible for social approach behaviors. In his view, joint-attention behaviors have a social–emotional approach function that affords children intersubjective information and experiences that are essential for the development of social–cognitive understanding.

Another candidate precursor is imitation. Normal infants demonstrate imitative abilities even when they are only a few hours old (Meltzoff & Moore, 1983, 1989). To imitate, a mapping is required from the perceived behavior of others to internal states or sensations (Gopnik & Meltzoff, 1993). This is apparently an innate ability. From 9 months onwards, infants imitate not only gestures but also novel actions on objects. Moreover, they also start to recognize when their own actions on objects are being imitated by others.

It has been suggested that imitation may serve as a motor for the development of the ability to understand the mental states of others, or, in other words, that the capacity for imitation may be a precursor to social–cognitive understanding (Meltzoff & Gopnik, 1993; Rogers & Pennington, 1991). This may first become evident in the simultaneous emergence of the ability to imitate novel actions on objects and of joint-attention behaviors at about 9 months of age (Meltzoff & Gopnik, 1993). According to Gopnik and Meltzoff (1993), this imitation of actions on objects still relies on the basic cross-modal mapping mechanism. However, children gradually achieve the ability to read below the observed behavior of the model (Meltzoff, 1994). Through, for example, mutual imitation games, that are a prominent component of early mother–child interactions, the child develops more sophisticated construals of what the behavior of others is and therefore also of its own internal states (Meltzoff & Gopnik, 1993). The shift from gestural imitation to procedural imitation, from solely actions to actions on objects, may be a natural consequence of the beginning understanding of relations between people and objects (Gopnik & Meltzoff, 1993).

All this brings us to the issue of autism: compared to matched controls, children with autism show a specific impairment in both responsive and initiating joint-attention behaviors such as following gaze direction, showing gestures, protodeclarative pointing, and eye contact in ambiguous situations. This impairment is quite well documented and nearly universally accepted (see Mundy, 1995; Mundy et al., 1993 for recent overviews). It should be noted, however, that individual differences in joint-attention behaviors have been reported among children with autism (Loveland & Landry, 1986; Mundy, Sigman, & Kasari, 1990) and that at least some joint-attention skills seem to improve with growing age (Baron–Cohen, 1989; Mundy, Sigman, & Kasari, 1994; Stone & Caro–Martinez, 1990).

In addition, there is some evidence for an imitation impairment in children with autism (see Charman & Baron–Cohen, 1994; Meltzoff & Gopnik, 1993; Rogers, Bennetto, McEvoy, & Pennington, 1996; and Smith & Bryson, 1994, for recent reviews). The evidence for an autism-specific deficit in the imitation domain appears to be less robust than it is in the area of joint attention. It should be noted, however, that the ability of children with autism to perform imitation has not yet been investigated in a systematic way (Rogers et al., 1996; Smith & Bryson, 1994). The available research data do not clarify to what extent familiarity (with gestures, actions, or objects) plays a role. As such, it is not always possible to distinguish true imitation from emulation, mimicry, or social facilitation. Emulation can be defined as using one's own execution methods to attain the same goal as the model (Wood, 1989), while mimicry is the opposite: reproduction of the model's behavioral strategies, without understanding the goal (Tomasello, Kruger, & Ratner, 1993). Facilitation, or stimulus enhancement, occurs when modeling facilitates children's performance of actions that were already in their repertoire (Hay & Murray, 1982; Tomassello, Savage–Rumbaugh, & Kruger, 1993). True imitation involves the reproduction of the model's novel behavior in both its form and appropriate functional context (Tomasello, Kruger et al., 1993).

We fully agree with Meltzoff and Gopnik (1993), who suggested to make use of the procedures that have been developed for nor-

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mally developing infants and children to obtain more refined information on imitation competence in subjects with autism.

Charman and Baron–Cohen (1994) were the first ones to do so. In their recent study, subjects with autism demonstrated an intact ability to imitate on both procedural (imitation of novel actions on unfamiliar objects) and gestural tasks (familiar as well as unfamiliar gestures). It should be mentioned, however, that the participating subjects were already quite old: the mean chronological age was almost 12; they had a mean verbal age of almost 4 years and a mean nonverbal mental age of about 7 years. These findings are consistent with those of Morgan, Cutrer, Coplin, and Rodrigue (1989) and can lead to the conclusion that imitation that emerges early in normal development is intact by late childhood in subjects with autism. However, ceiling effects of the different groups on all measures hamper the interpretation of the outcomes of both studies. The data do certainly not rule out the possibility of a delay in the acquisition of the ability to imitate, nor do they imply that joint attention is a more plausible precursor to the development of mindreading skills. Moreover, a recent study that was not compromised by floor or ceiling effects, has demonstrated a specific deficit in motor imitation in high-functioning adolescents with autism spectrum disorders (Rogers et al., 1996).

The present study investigates gestural and procedural imitation as well as joint-attention behaviors in a younger sample of children with autism and a control group of nonautistic children with a developmental delay.

Method

Subjects

We tested 18 young children with autism, all of whom had been diagnosed according to DSM-III-R or DSM-IV criteria (APA, 1987, 1994) by an experienced multidisciplinary team using systematic assessment methods. The control group consisted of 18 subjects with mental retardation of unknown etiology. These subjects were matched to the autistic group as to chronological age (CA) and mental age (MA). Details of the subjects are shown in Table 1. MA was assessed using the Merril–Palmer Scale of Mental Abilities or the McCarthey Scales of Children's Abilities.

Table 1. *Descriptive characteristics of the sample*

	Autism ($n = 18$)	Mental Retardation ($n = 18$)
Chronological age (months)		
M	57.94	57.61
SD	13.40	11.91
Mental age (Months)		
M	37.94	37.94
SD	16.30	14.04
Sex ratio (M : F)	3.5 : 1	2 : 1

Procedure

Subjects were tested in a quiet room, seated at a little table facing the examiner. After a warm-up period, subjects were asked to imitate four modeled gestures and four modeled simple actions with novel objects, in that order. The children were also tested for their ability to engage in gaze following and to use eye contact to disambiguate an adult's ambiguous actions. All the sessions were videotaped.

Gestural imitation. To test the gestural imitation, we used a series of four actions similar to those that were used by Charman and Baron–Cohen (1994)[1]

1. Familiar visible gesture: Experimenter models clapping one's hands.

2. Unfamiliar visible gesture: Experimenter models bringing the tips of index fingers together in front of the face. The gesture employed by Charman and Baron–Cohen was not used because preliminary investigations revealed that it was too difficult for some children of this age and because the interrater reliability was insufficient.

1. Charman and Baron–Cohen (1994) based their actions closely on the Uzgiris and Hunt Scales (1975) and on descriptions by Wetherby and Prutting (1984).

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3. Familiar invisible gesture: Experimenter models pulling down on both earlobes with index fingers and thumbs.[2]

4. Unfamiliar invisible gesture: Experimenter models clapping both hands once onto the back of his head.

The experimenter modeled a given gesture a total of 3 times in rapid succession for about 5 s each time. At the end of each modeling period, the child was given a response period of 20 s, with the verbal prompt, "Can you do that too?" If the same gesture was carried out within the 20-s period, the response was counted as imitation. To pass an item, the child had to match exactly the experimenter. The use of only one hand in gesture 3 or 4 was scored negatively. Each subject was assigned a gestural imitation score ranging from 0–4, according to the number of gestures produced.

Procedural imitation. The method for the procedural imitation tasks followed Meltzoff's descriptions (1985, 1988). Four objects that were unfamiliar to the children were employed. Each object involved a different manipulation. In a preliminary investigation with 12 nonparticipating subjects (6 with autism, 6 with mental retardation) none of the target behaviors was produced in a baseline condition (i.e., the children were presented the objects in the same way as in the imitation condition (see below) but without a modeling period).

1. Action without sensory effect: The first object was a tree with three removable branches. A ring was attached to one of the branches by means of a rope. The action demonstrated was to remove this branch and to hang the ring on another branch.

2. Action with auditory effect: The second was a dog with a remote control unit that was presented upside down on a distance of 1 m of the dog. This unit had a salient button which produced slow walking of the dog and a recessed button which produced a barking sound. The action demonstrated was to push the recessed button.

3. Action with predominantly visual effect: The third was a mother turtle carrying a baby turtle. The action demonstrated was to pull the mother and the baby apart, which produced running of the mother, as well as some mechanical sounds.

4. Action with predominantly auditory effect: The last object was a star on a stick with two little holes. The target action was to put the tips of the thumb and the index finger on the holes which produced music and twinkling of the star.

Again, each act was performed three times in succession. At the end of the four modeling periods, the objects were, one after the other, placed onto the table in front of the subjects. The response period was 20 s per object. If the child did not manipulate the object, the prompt "What can you do with this?" was given once. To pass an item, the child had to produce the target action without other preceding manipulations. Each subject received a procedural imitation score ranging from 0–4, according to the number of actions imitated. Except for the second object, it was possible to reproduce the end without exactly reproducing the means (e.g., by pushing the turtle or by covering the holes of the stick with the palm of the hand). Subjects were only judged to pass an item if they exactly reproduced both means and end (i.e., true imitative learning).

Joint attention. Was tested by assessing whether or not the child followed the gaze direction of the experimenter once eye contact was established (based on Scaife & Bruner, 1975) and by analyzing whether or not the child made eye contact in ambiguous situations (teasing and hand blocking). The procedure for this was borrowed from Phillips, Baron–Cohen, and Rutter (1992). Although other interpretations are possible (e.g., Happé, 1994; Heyes & German, 1994), it can be argued that both tasks require the capacity to process triadic representations (see Baron–Cohen, 1994b, for further discussion).

1. *Gaze following*: The experimenter made

2. Since this is part of the accompanying gestures of a well-known and popular song for children in our country, the gesture was familiar to all the children.

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eye contact with the child and then silently turned his head through 90° to fixate a picture for 5 s. Two trials were given, one involving a turn to the right and one a turn to the left. A positive response was scored if the child looked in the same direction and appeared to be fixating on the same picture within 5 s. Scores ranged from 0 to 2.

2. *Blocking task*: The experimenter encouraged the child to play with a series of toys. When the child was doing so, he prevented any further activity by covering the child's hands for 5 s. It was noted whether or not the child immediately looked at the experimenter's eyes in this period. Because this was repeated three more times, the child received a score between 0 and 4. It could be argued that this and the subsequent task are tapping social referencing[3] instead of joint attention. However, we agree with Baron–Cohen (1994) that the child searches for eye contact to find out whether or not he is the goal to which the adult is attending during the performance of the action. Therefore, only unambiguous eye contact was measured.

3. *Teasing task*: The experimenter teasingly withdrew an object, after offering it to a child who began to reach for it. The object was held out of reach for 5 s. Again, the child's gaze behavior was noted. Since this was also repeated three more times, the child again received a score between 0 and 4.

Coding of imitation and joint-attention behaviors was first performed in "real time" by the experimenter. The exception to this was the gaze monitoring which was scored after viewing the videotape, immediately after the session. All the videotapes were coded afterwards by two naive observers. Interrater agreement with the experimenter, measured by Cohen's κ, ranged from 0.76 to 1.00. Since the experimenter was the only person who could reliably judge whether eye contact was made in the blocking and teasing tasks, interrater reliability was somewhat lower for joint-attention tasks ($M = .79$) than for imitation tasks ($M = .94$).

3. This is the capacity to monitor another person's emotional expression when faced with ambiguous objects or situations and to respond appropriately (see Campos & Stenberg, 1981).

Table 2. *Number of acts of gestural and procedural imitation produced by the autism* ($n = 18$) *and mental retardation group* ($n = 18$)

	0	1	2	3	4	*M*	*SD*
Gestural							
Autism	7	0	2	3	6	2.00	1.75
Mental retardation	1	0	0	1	16	3.72	0.96
Procedural							
Autism	4	1	5	4	4	2.17	1.47
Mental retardation	0	0	4	5	9	3.28	0.83

Results

Table 2 shows the summaries of the number of target acts imitated and the mean scores for both procedural and gestural imitation (maximum = 4). There were significant differences between the mean scores of two groups on both gestural (Mann–Whitney $U = 61.5$, $p < .0005$) and procedural imitation (Mann–Whitney $U = 90.0$, $p < .05$). To identify subjects who reliably imitated we used a cutoff of imitation of three or more out of four acts.

In the control group, only one subject failed to imitate reliably in the gestural tasks. In the autism group half of the subjects imitated unreliably. The largest difference was found for the invisible unfamiliar gesture (6 in the autism group versus 17 in the control group). The smallest difference for the two familiar gestures (11 versus 17). The performance of passers in the autism and control group was judged to be similar with respect to both latency and the quality of response execution. The majority of failures involved absence of an appropriate response (all gestures) or patting a different part of the head (Gesture 4).

Four control subjects failed to imitate reliably on the procedural tasks. In the autism group, 10 subjects failed to pass the cutoff. Here, the best discriminator was the object without effect (5 vs. 13); the smallest difference was found for the object with a predomi-

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Table 3. *Number of joint-attention behaviors produced by the autism* (*n* = *18*) *and mental retardation group* (*n* = *18*)

	0	1	2	3	4	*M*	*SD*
Gaze following							
Autism	16	2	0			0.11	0.32
Mental retardation	0	6	12			1.33	0.97
Teasing							
Autism	13	3	0	1	1	0.56	1.15
Mental retardation	0	1	1	3	13	3.56	0.86
Blocking							
Autism	14	2	2	0	0	0.33	0.69
Mental retardation	2	0	2	1	13	3.28	1.37

nantly visual effect (13 vs. 16). Prompts were given to four subjects (two of each group). All the subjects manipulated at least two out of four objects. Execution problems were not observed. Mistakes made by the children with autism involved wrong manipulations that failed to reproduce the end (e.g., with the dog, pushing the wrong button) and reproductions of the end only (emulation learning; e.g., pushing the turtle).

The difference between performances on the gestural and procedural tasks was not significant for both groups (Wilcoxon test, both $p > .10$). In the autism group, procedural imitation and gestural imitation were significantly related to both MA (Spearman $\rho = .71$, $p < .01$ and $\rho = .59$, $p < .05$, respectively) and CA (Spearman $\rho = .48$, $p < .05$ and $\rho = .61$, $p < .05$, respectively). In the control group, no significant correlations were found, most probably due to the limited variance in this group.

Summaries of the number of joint-attentions behaviors shown by both groups are given in Table 3. In the control group, 12 subjects obtained a maximum score for gaze following; in the autism group, none of the subjects had two successful trials. Obviously, this difference was significant (Fisher's exact probability test, $p < .0001$). There were also significant differences between the two groups for blocking (Mann–Whitney $U = 24$, $p < .0001$) and for teasing (Mann–Whitney $U = 16.5$, $p < .0001$).

To identify subjects who reliably showed joint-attention behaviors, we counted up the scores on the different tasks and used a cutoff of 7 or more behaviors out of 10 with at least 1 successful trial out of 2 for gaze following. Twelve control subjects gave evidence of sufficient joint-attention behaviors. In the autism group, however, none of the subjects passed this criterion. This difference was statistically significant (Fisher's exact probability test, $p < .0001$). Fifty percent of the children with autism obtained a bottom score. In the control group, only two children had a score lower than 5.

There were no significant correlations between joint-attention and MA, CA, procedural, or gestural imitation, for either group. It should be noted, however, that the results of the autism group are unreliable given the high number of children with bottom scores.

To get some information on the relationship between imitation and joint attention, the success of the two groups across the two different sets of tasks was compared. However, since the cutoffs for reliability are arbitrary, these data should be approached with some reservation. As depicted in Table 4, three patterns were common: twice unreliable (mainly in the autism group), twice reliable (only in the control group), and reliable for imitation but unreliable for joint attention (both groups). The combination of unreliable for imitation and reliable for joint attention was only seen in two subjects (both from the control group) for procedural imitation.

Discussion

Because sample sizes were still relatively small and because the number of data points per child was quite limited, care must be taken in interpreting this study and generalization of the results to cover all children with autism should be approached with caution.

The performance of young children with autism on imitation and joint-attention tasks differs significantly from the group with mental retardation. Children with autism appear impaired or delayed in both abilities. In nor-

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Table 4. *Association between imitation and joint attention*

	Gestural Imitation		Procedural Imitation	
	Unreliable	Reliable	Unreliable	Reliable
Autism				
Joint attention				
Unreliable	9	9	10	8
Reliable	0	0	0	0
Mental retardation				
Joint attention				
Unreliable	1	5	2	4
Reliable	0	12	2	10

mal development, the most complex of the gestural actions can certainly be imitated by 20 months (age norm 14–20 months on the Uzgiris & Hunt [1975] Sensorimotor Scale), while procedural imitation of novel actions on objects (Meltzoff, 1988) is supposed to emerge between 9 and 14 months. Gaze following is already present in 2- to 4-month-old infants and is clearly in place between 11 and 14 months of age (Scaife & Bruner, 1975). Phillips et al. (1992) demonstrated that normal infants, aged 9–18 months, made eye contact in ambiguous situations. Although no real normative data exist for the majority of the tasks we employed, it can be argued that the degree of difficulty of imitation and joint-attention tasks is roughly comparable.

The evidence for an autism-specific deficit appears to be stronger in the domain of joint-attention behaviors than it is for imitation. This may support the contention that joint-attention is an important early precursor in the development of a concept of mind. It should be mentioned, however, that this study confirms earlier findings of impaired joint-attention behaviors in young children with autism (Phillips et al., 1992; Sigman, Mundy, Sherman, & Ungerer, 1986) but that it does not provide new evidence for the relationship of these behaviors with other metarepresentational abilities.

The results for imitation are consistent with the majority of studies on this topic where imitation in autism was found to be poor. They differ, however, from the comparable study of Charman and Baron–Cohen (1994), who tested an older sample. Unlike these authors, we found a significant difference between the two clinical groups on both gestural and procedural imitation. On the other hand, we should not lose sight of the fact that 7 of 18 subjects with autism showed an intact ability to imitate on both the gestural and procedural tasks. Since we found some evidence for an association of the ability to imitate with CA and MA in the subjects with autism, this could lead to the conclusion that some of our subjects were developmentally advanced enough to imitate. This is in line with the ideas of Rogers and Pennington (1991) who argued that autism is a developmental disorder and that we do not expect to find specific deficits in young children that are maintained throughout development. It is possible that impaired imitation ability is a primary deficit in autism—as suggested by Meltzoff and Gopnik (1993) and by Rogers and Pennington (1991)—or one of the first signs of a deeper underlying deficit—as argued by Smith and Bryson (1994)—but that it no longer stands out in a part of our population. It should be mentioned, however, that this hypothesis assumes a developmental continuity that still needs to be demonstrated. In fact, we do not know anything about neonatal imitation in autism, nor do we know if the children with autism in our sample who show imitation behaviors between the ages of 4 and 5 years were previously impaired in this ability.

What does this study teach us on the developmental relationship between the two candidate early precursors? Of particular interest are the subjects who are impaired in only one

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ability. Fourteen subjects of our sample (9 with autism, 5 controls) showed intact gestural imitation and impaired joint-attention behavior. This is not surprising, since three out of four items involve simple and/or familiar gestures. For in normal development unsophisticated gestural imitation is thought to precede joint attention (Tomasello, Kruger et al., 1993). Less expected was the finding that 12 subjects (8 with autism, 4 controls) were reliable for procedural imitation and unreliable for joint attention and that the reverse combination was found in 2 control subjects. It has been suggested that normally developing children begin to use people as sources of information on the environment by 9 months of age and that object-directed imitation and joint-attention behaviors, both reflecting a shared attitude towards objects, seem to appear simultaneously around that age (Meltzoff & Moore, 1994; Tomasello, Kruger et al., 1993). The disassociation of seemingly related skills that was observed in the two clinical groups of our study should remind us that this link is an unsupported hypothesis rather than an empirical finding (Heyes, 1993). Our data seem to indicate that, in children with autism, the two skills are on a different timetable: growth in imitation may precede growth in joint attention. However, to confirm this hypothesis, longitudinal data will be of critical interest.

It is of particular importance that some imitation tasks more clearly distinguished children with autism from the control group than others. Apparently, novelty of the gestural act is more important in this respect than invisibility: the two unfamiliar gestures proved to be more difficult for the children with autism than the familiar action schemes. Among the unfamiliar actions on objects, the presence of an effect or reward seems to influence imitation. Both clinical groups showed better imitation when the act was followed by a combined auditory and visual effect. This is in line with the findings of Abravanel, Levan–Goldschmidt, and Stevenson (1976) who reported that infants were more attentive to modeled actions involving sounds. In the autism group, however, the absence of any effect at all had a more negative impact on the performance of the subjects than in the control group. Because we used strict criteria to distinguish between imitation and emulation, it is unlikely that subjects passed these tasks by adopting a goal-oriented solution without recourse to imitation (Charman & Baron–Cohen, 1994). The modeling period is also too short to allow for what Heyes (1993) describes as action–outcome contingency learning. It may be more important, as suggested by Mundy (1995), to consider motivational processes. He argues that the disassociation between requesting and joint-attention behaviors in children with autism may be due to the nonsocial rewards that are yielded by the former. The social repercussions of joint-attention bids may be less rewarding for children with autism. A similar mechanism may be of importance here: unlike their nonautistic peers, children with autism may be much more likely to imitate if their actions are followed by a nonsocial reward. In that case, the apparently worse performance of the target subjects on the joint-attention tasks could, at least for a part, be accounted for by the higher attractiveness of the imitation tasks.

In sum, the present data confirm earlier findings on joint-attention deficits in children with autism. At the same time, they do not provide strong support for the hypothesis that imitation disturbance is fundamental to the subsequent social–cognitive disturbance of autism since a substantial minority of the young children with autism in this study displayed imitation skills. However, it may be premature to reject the imitation hypothesis until other factors such as timing, motivation, or procedural issues are fully explored. Systematic investigations of the imitation deficit in autism with controlled manipulation of parameters such as familiarity and rewards and using procedures developed for normally developing children (including deferred imitation procedures) are urgently needed. In addition, it once again became clear that there is a need to test very young children with autism or children who are suspect for a pervasive developmental disorder and to follow them over time. This will not only increase our un-

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derstanding of the relationships among early emerging deficits and the role they may play in the pathogenesis of the syndrome, but may also have important implications for differential diagnosis in early childhood and for the development of early intervention programs (Ozonoff, 1995).

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