Autism severity and motor abilities correlates of imitation situations in children with autism spectrum disorders

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ABSTRACT

Impaired performance in a range of imitation tasks has been described in children with autism spectrum disorders (ASD) and several underlying mechanism have been suggested. This study examined whether imitation abilities are related to autism severity and to motor skills. Furthermore, the performance of children with ASD in four imitation situations (body movements and ‘action on objects’, using meaningful and non-meaningful tasks) was compared. Twenty-five children aged 32–51 months diagnosed with autism (23) and ASD (2) were evaluated for autism severity using the Autism Diagnosis Observation Schedule and for gross and fine motor skills using the Peabody Developmental Motor Scales. Controlling for cognitive level, imitation abilities in all four situations correlated significantly only with autism severity measures and mostly with socio-communication deficits. Motor abilities were below average and did not correlate with imitation abilities nor with autism severity. Comparison of the four imitation situations revealed that performances of meaningful actions were better than non-meaningful actions and imitation of ‘action on objects’ was better than imitation of body movements. The current research supports the fact that socio-communication deficits and not motor abilities are linked to imitation abilities in young children with autism.

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Imitation has a significant role in the early social development of infants and toddlers. Imitation is important for learning complex, goal-directed behavior patterns from others and for social interpersonal communication, social interaction and sharing of intentions (Meltzoff & Moore, 1989; Piaget, 1962; Rogers, Cook, & Meryl, 2005; Uzgiris, 1999). Impaired performance on a range of imitation tasks has been described in children with autism spectrum disorders. Problems with imitation can discriminate between children with autism and other developmental disorders at a very early age (Charman et al., 1997) and continue into adulthood (Rogers, Bennetto, McEvoy, & Pennington, 1996; Stone, Ousley, & Littleford, 1997). Rogers and Pennington (1991) suggested that early deficits in imitation could affect interpersonal connectedness in autism. However, other studies found good correlation between imitation abilities and the age of the child and between imitation and cognitive level (Smith & Bryson, 1998; Williams, Whiten, & Singh, 2004). In addition, improvement of imitation skills with age and learning has been described (Ben-Itzchak & Zachor, 2007; Roeyers, Van Oost, & Bothuyn, 1998; Stone et al., 1997).

Three kinds of imitation tasks have been studied: manual and postural movements, actions on objects and oral–facial movements. Impaired performance has been described in all three types of tasks in autism (Rogers et al., 1996; Rogers, Hepburn, Stackhouse, & Wehner, 2003; Stone et al., 1997). Studies on imitation of actions with objects yielded inconsistent
results with a strong developmental effect. Younger children showed more deficits than did older children on these imitation tasks (Hobson & Lee, 1999; Rogers, 1998). Deficits in imitating body movements have been consistently described in autism. These impairments are considered in several studies to be autism-specific and therefore occurring in a wide range of IQ and language levels (Rogers et al., 2005).

Several possible mechanisms underlying imitation deficits in autism have been proposed and include dyspraxia (Bennetto, 1999; Rogers et al., 1996), deficits in gross and fine motor functions (Hauck & Dewey, 2001; Osterling, Dawson, & Munson, 2002), executive function deficits (Dawson, Osterling, Rinaldi, Carver, & McPartland, 2001; Griffith, Pennington, Wehner, & Rogers, 1999) and social deficits (McDuffie et al., 2007; Rogers et al., 2003). Motor problems have frequently been described in autism. Differences in performance in tasks involving standing on unstable surfaces (Kohen-Raz, Volkmar, & Cohen, 1992), lack of typical hand dominance (Hauck & Dewey, 2001), hypotonia, limb dyspraxia (Rapin, 1996) and general motor impairments (Manjiviona & Prior, 1995) have been reported. Many reports examined the contribution of the social-affective and motivational impairments in autism to the occurrence of imitation deficits. At a social level, imitation represents one of the earliest forms of reciprocal interactions between the child and his caregiver (Meltzoff & Gopnik, 1993) and have been associated with social communication, symbolic play and theory of mind deficits (Rogers & Pennington, 1991).

Other major questions regarding imitation deficits in autism have been raised in research. One was whether these deficits represent a delay rather than a deviance in development, suggesting that the development of imitation skills in autism would follow the same pattern as in normal development. Stone et al. (1997) reported that imitation of action with objects was superior to imitation of body movements. In addition, differences were more apparent with non-functional use of objects than with functional use.

The current study further assesses imitation deficits in various imitation situations. In addition, the study looks at the impact of autism severity, cognitive delays, and gross and fine motor impairments on imitation tasks performance in ASD. The present study focuses on the following questions:

1. Several possible mechanisms underlying imitation deficits in ASD have been proposed. Of these, the extent of social-reciprocal interaction and responsiveness deficits, cognitive level and motor development problems seem to affect imitation development the most. The study examines whether imitation abilities in ASD are correlated to autism severity and to gross and fine motor skills.

2. The study examines imitation abilities in children with ASD by comparing their performance on two imitation types, body movements and 'action on objects', using meaningful and non-meaningful tasks. In addition, whether performance in the four imitation situations is related to severity of autism symptoms or to motor abilities was investigated.

1. Method

1.1. Participants

Twenty-five children, one girl and 24 boys, aged 32–51 months (\(M = 40.0, SD = 5.7\)), diagnosed with autism (\(N = 23\)) or autism spectrum (\(N = 2\)) participated in the current study. All the children underwent clinical evaluation by a neurodevelopmental pediatrician. Children who were enrolled in the study met a clinical diagnosis of ASD based on the cut-off points on the Autism Diagnosis Interview-Revised (ADI–R) (Lord, Rutter, & LeCouteur, 1999) and Autism Diagnostic Observation Schedule (ADOS) (Lord, Rutter, DiLavore, & Risi 1999) and the DSM-IV criteria (APA, 1994). The children were recruited from two center-based intervention programs. The intervention in one center was based on Applied Behavior Analysis (ABA) (\(N = 11\)) and the other used a combination of several treatment approaches (\(N = 14\)), described at length in our previous publication (Zachor, Itzchak, Rabinovich, & Lahat, 2007; Ben Itzchak & Zachor, 2009).

1.2. Measures

**Autism Diagnostic Interview—Revised (ADI–R):** A semi-structured interview administered to parents was designed to make a diagnosis of autism (Lord et al., 1994) according to DSM-IV criteria (APA, 1994).

**Autism Diagnostic Observation Schedule (ADOS):** A semi-structured, interactive schedule designed to assess social and communicative functioning. To assess symptom severity, we calculated the ADOS new algorithm (Gotham et al., 2008). Children with algorithm scores lower than the median (19 points) were defined as the low-ADOS group and children with algorithm scores higher than the median were defined as the high-ADOS group.

Two additional measures of socio-communication and repetitive and restricted behaviors (RRB) were calculated based on the ADOS individual item scores. Scores for the socio-communication measure were calculated by summing the individual scores of all the items included in the communication and reciprocal-social interaction domains (not only the items used for autism diagnosis in the ADOS algorithm). Scores for the RRB measure were calculated by summing the individual scores of all the items in the Stereotyped Behaviors and Restricted Interests domain. Scores for each item ranged from 0 (close to normal) to 3 (most abnormal).

**Motor Imitation Tasks (MITs):** The MITs was comprised of several tasks used in previous research projects (Charman et al., 1997; Roeyers et al., 1998; Rogers et al., 2003; Stone et al., 1997). The MITs consisted of 16 motor imitation tasks. Half the
tasks involved manipulation of objects (actions on objects) and half the tasks involved imitation of body movements. In addition, half the tasks were meaningful actions and the other half involved non-meaningful actions. To each ‘action on object’ task, a similar body movement task was matched. To each meaningful task, a non-meaningful action was matched. The reason for the matching was to prevent differences at the level of complexity or difficulty of action to affect the imitation performance (see Table 1).

Each imitation item was demonstrated by the examiner telling the child “Do what I do”. The examiner repeated each imitation task three times if the child did not imitate the action within 6 s of the examiner’s performance. Appropriate imitation after the first trial granted the child full scoring (3 points); for adequate imitation after the second or the third trials, the child was granted 2 points; for partial imitation (the child did not complete the act or did not perform exactly as demonstrated) the child received a score of 1 point; failure to imitate the action resulted in a score of 0 points. The imitation scale ranged from 0 to 48 points.

Peabody Developmental Motor Scales (PDMS): Motor skills were assessed using the Peabody Developmental Motor Scales—a task–observation test for children from birth through 5 years of age. The PDMS includes gross and fine motor tasks with subtests. The gross motor scale contains 170 items divided into 17 age levels and grouped into four subtests: reflexes (birth to 11 months), stationary (i.e., static balance and body control), locomotion (e.g., crawling, walking, running, hopping, jumping), and object manipulation (e.g., catching, throwing and kicking a ball). The fine motor scale contains 112 items divided into 16 age levels grouped into four subtests including: grasping, hand use, eye–hand coordination, and manual dexterity. Response accuracy is scored on a 3-point scale: a passing response earns 2 points, a partial response earns 1 point, and a failure earns no points. Performance is summarized and analyzed using the developmental overall performance based on chronological age ($M = 100$, $SD = 15$). (Folio & Fewell, 1983).

Mullen Scales of Early Learning: The test evaluates cognitive abilities in visual reception, fine motor, expressive language and language comprehension domains (Mullen, 1995).

1.3. Procedures

Each child was evaluated with the ADOS, ADI-R and MSEL through the “Autism Center” (a tertiary center for diagnosing ASD) by interviewers and examiners who had previously established reliability on the ADOS and ADI-R as required. A skilled special physical education teacher, expert in teaching children with developmental disabilities, performed the PDMS and Motor Imitation tests. The group means and standard deviations (SD) in cognitive, motor skills and autism severity are presented in Table 2.

The order of the tests for each child was counterbalanced. The MITs was videotaped and then evaluated by the examiner and another colleague.

2. Results

The first question of the study was whether imitation abilities in ASD are correlated to autism severity and to gross and fine motor skills. Partial correlations were conducted in the four imitation situations controlling for cognitive level. It is well known in the literature that imitation abilities are highly related to overall developmental status (Rogers et al., 2003). Therefore, cognitive ability was controlled in all the correlation analyses. Autism severity measures included the ADOS new
algorithm, socio-communication total scores and stereotypes behaviors total scores. Motor skills included gross and fine 
motor PDMS scores (DMQ). MSEL composite standard scores served as a covariate in all the analyses. Results indicated that 
imitation abilities correlated significantly with autism severity measures but not with motor skills. Table 3 shows that the 
ADOS new algorithm that measures overall severity of symptoms in all the autism domains correlated significantly only with 
meaningful imitation situations (‘action on objects’ and body movements). Looking at the relationship between imitation 
abilities and the specific autism domains (socio-communication, RRB), the socio-communication measure showed the 
highest correlations with imitation abilities. The socio-communication measure correlated significantly with performance in 
all the four imitation situations while the RRB measure correlated significantly only with ‘action on object’ tasks.

In order to examine the correlations between autism severity and motor (gross and fine) abilities, the Pearson correlation 
was performed. The autism severity (ADOS algorithm) did not correlate significantly with either the gross motor (\(r = .115, p > .05\)) or with the fine motor (\(r = .173, p > .05\)) DMQ scores.

The next question concerned a comparison of performance on two imitation types, body movements and ‘action on 
objects’, using meaningful and non-meaningful tasks in ASD (see means and SD in Table 4).

Comparison of four imitation situations was assessed by using a 2 × 2 ANOVA with repeated measures [2 imitation types 
(action on objects/body movements) × 2 yes/no meaningful tasks]. Performance of imitation that involved meaningful 
actions was better than imitation of non-meaningful actions (\(F(1,24) = 24.08, p < .001, \eta^2 = .501\)). Imitation of actions on 
objects scored higher than imitation of body movements, almost reaching statistical significance (\(F(1,24) = 3.83, p = .06, \eta^2 = .138\)). No interaction effect of imitation types × meaningful/non-meaningful tasks was found (\(F(1,24) = .04, p = ns, \eta^2 = .002\)).

We further examined whether the discrepancy between the performances in the four imitation situations is related to 
severity of the autism symptoms or to motor abilities. To answer this question, we divided the entire group into two autism 
severity subgroups, low-ADOS group (ADOS new algorithm < median) and high-ADOS group with (ADOS new 

![Fig. 1. Scores in the two imitation types for the high- and low-fine motor groups.](image)
algorithm > median) using a 2 × 2 × 2 MANOVA (2 autism severity subgroups with repeated measures for 2 imitation types × 2 yes/no meaningful tasks). The results revealed a significant autism severity effect (F(1,23) = 4.44, p < .05, η² = .162). The group with less severe impairments had better imitation scores (M = 2.65, SD = .16) than the group with more severe autism symptoms (M = 1.94, SD = .18). No autism severity × imitation situation interaction was found, meaning that the low-ADOS group performed better than the high-ADOS group in all the imitation situations.

Based on the PDMS, the group was divided into a low-gross motor group (scores < median) and a high-gross motor group (scores > median) and into a low-fine motor group (scores < median) and a high-fine motor group (scores > median). Investigating the differences in imitation abilities of the different motor groups, no gross and fine motor ability effects were found in both MANOVAs. However, a significant fine motor ability × imitation type interaction was noted (F(1,23) = 5.02, p < .05, η² = .179) (Fig. 1).

The group with better fine motor abilities obtained better scores in imitation that involved ‘actions on objects’ and worse scores in imitation of body movements than the group with inferior fine motor abilities. Simple effect tests showed that the differences in the fine motor groups were not statistically significant in any of the imitation types. However, the two fine motor groups showed opposite trends in their performances on the two imitation types.

3. Discussion

This study examined specific aspects of the imitation deficits in young children with ASD. Several possible mechanisms underlying imitation deficits in ASD have been proposed. In this study, the correlations between imitation abilities and autism severity and motor (gross and fine) abilities were investigated. Of the developmental measures studied here, only autism severity was found to be an important factor that was highly related to imitation abilities. These findings are in accordance with previous studies reporting that imitation skills were strongly correlated with autistic symptoms (McDuffie et al., 2007; Rogers et al., 2003). An interesting question was whether specific autism domain deficits are related to imitation abilities. The current study found that deficits in the socio-communication domain had the strongest correlation with imitation abilities in all the situations. The RRB significantly correlated only with the ability to imitate ‘actions on objects’. One possible explanation for this finding is that the involvement of objects in the imitation tasks might increase the stereotyped tendencies in children with more severe RRB affecting the ability to imitate the action.

The second question focused on whether imitation performance in children with autism is affected by the specific imitation situation. The study found that imitation of ‘action on objects’ is superior to imitation of body movements. The present results support previous work on imitation in autism suggesting that imitation of body movements is more difficult than ‘action on objects’ (Stone et al., 1997; reviewed in Rogers et al., 2005). Several studies documented autism-specific deficits in imitation of simple ‘actions on objects’ in a sample of young children with autism (Charman et al., 1997; Rogers et al., 2003). Stone et al. (1997) found that this pattern is not unique to autism, but was observed in typically developing and in developmentally delayed children. We found that meaningful imitation, regardless of the type of imitation (body movement, action on objects), was better than non-meaningful imitation in autism. Previous studies reported the same trend of better performance in imitation of meaningful versus non-meaningful actions in autism (Roeyers et al., 1998; Rogers et al., 1996). Some studies reported that this pattern occurs in typically developing children as well (Aldridge, Stone, Sweeney, & Bower, 2000; Killen & Uzgiris, 1981; Stone et al., 1997). Observation of a meaningful ‘action on objects’ or of a meaningful gesture might elicit a previously learned motor program that leads to proper imitation. One can conclude that children with autism can learn rehearsed and functional actions that depend on previous daily experiences. The “pure” ability to imitate can more likely be reflected by assessing copying of non-meaningful ‘actions on objects’ and gestures. In addition, we found that having more severe autism symptoms was related to worse performance in all the imitation tasks.

Gross and fine motor abilities were below average in this study and did not correlate with autism severity. One of the research questions was whether motor abilities are linked to imitation abilities in autism. In this study, motor skills measures did not correlate significantly with imitation abilities in all the studied situations. However, better fine motor abilities were associated with better imitation that involved ‘actions on objects’ but with worse imitation of body movement. It is not surprising that children with better fine motor skills will perform well on imitation tasks that involved objects. However, the reverse pattern is difficult to explain.

Imitation is a complex developmental skill that requires intact motor, cognitive and social abilities. The mechanism that can explain why children with autism have imitation deficits is still an open question. The current research suggests that out of several possible mechanisms that might underlie imitation deficits in ASD, the social reciprocal impairments are the most prominent factor related to imitation performance. The complex interaction between social impairments and imitation abilities are still not well understood. Future research should address the question of whether one of these dimensions is the primary deficit, or whether there is another underlying neurobiological mechanism that is responsible for the occurrence of both deficits.

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