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Motor Imitation Abilities and Neurological Signs in Autistic Children

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Autistic children were compared with chronological and mental age-matched normal children on two tests of motor imitation and on the Herzig Battery for Non-Focal Neurological Signs. The results indicated that autistic children have significant handicaps in the neurodevelopmental area, with very poor performance on motor imitation tasks and a universal and significant excess of soft signs of neurological dysfunction. Such "dyspraxias" may underlie the failure of these chlidren to learn to use gesture.

In contrast to the comprehensive study of cognitive and language abilities in autistic children, there has been a relative lack of research concerned with their motor development. Early assumptions that a diagnosis of autism implied normal motor development were probably based on the observation of no overt signs of motor impairments and the apparent grace and skill in spontaneous movements in many autistic chldren. However, there is some evidence that when actually tested, autistic children do not show motor development consistent with their chronological age level (DeMyer, Hingtgen & Jackson, 1981). Wing (1969) reported that at least a third of autistic children were reported to be "clumsy" and that they had difficulty in carrying out organized movements in an "imposed conventional pattern" (for example, in riding a tricycle). She further noted that autistic children cannot handle more than one motor task at a time; i.e., there are difficulties programming movement patterns (Wing, 1976). The most systematic studies of motor performance in autistic children have been reported by DeMyer and her colleagues (DeMyer, Barton, & Norton, 1972; DeMyer,

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1972). Their comparative studies of autistic and subnormal children found that autistic children were below chronological age level on tasks requiring physical integration skills, and below the level of subnormal children on motor-object and motor imitation tasks. Particularly poor performance characterized autistic children in body imitation tasks. A recent unpublished study (Van Smeerdjik, 1981), however, found that imitation skills in autistic children were consistent with their mental age level; i.e., there was a general delay in the development of these skills.

Both Tubbs (1966) and Prior (1977) reported poor performance in low-functioning autistic children on the Manual Expression subtest of the Illinois Test of Psycholinguistic Abilities. Failure to use gesture to communicate is an often reported characteristic of autism (Rutter 1974; Bartak, Rutter, & Cox, 1975), and although this has been interpreted as indicating withdrawal or lack of intent to communicate, an alternative explanation of this deficit may be that poor body imitation skills preclude the adequate learning of communicative gesture. It is an open question whether the impoverished gestural abilities of autistic children are a function of the deficits in symbol comprehension and use that are central to the disorder (Rutter, 1974; Ricks & Wing, 1975; Prior, 1979, 1984) or of some impairment in the development of the motor skills necessary to execute communicative gestures. If motor impairments were found in a broad range of areas, it could be argued that they would severely handicap the learning of gestural communication with associated consequences for symbolic functioning. Data on the development of imitative abilities of autistic children is scarce, although Hammes and Langdell (1981) have reported a study of imitation using objects in which autistic children were able to imitate at a basic level and to demonstrate deferred imitation, which the authors claimed implied the ability to form mental images. However, symbolic gesture and representational play with objects was minimal. This study is of limited relevance to the investigation reported here, though, since our focus is on imitation related to the individual's own body.

The difficulties with complex coordinated motor tasks that are found even in high-functioning autistic children seem to be indicative of central nervous system dysfunction. Although the nature of this underlying dysfunction is unclear, recent arguments concerning the presumed biological origins of autism have brought together various kinds of converging evidence that support CNS dysfunction at some level as of major etiological significance (e.g., Prior, 1984). Although few children with a primary diagnosis of autism show overt signs of organic damage, it may be suggested that systematic testing will uncover "soft" signs of CNS impairment. Such signs, together with indications of impaired motor performance, would provide support for the influence of biological factors in the genesis of the disorder.

In this study our aim was to examine systematically the motor imitation abilities of young autistic children and to test for the presence of soft signs of CNS dysfunction using a test battery that has proven useful in such assessment with children with other handicaps. Although there are few data in this area to provide any theoretical basis, it was our prediction that autistic chldren would show both deficient motor imitation abilities and an excess of soft signs when compared with normal children matched on the basis of chronological and developmental age.

METHOD

Subjects

Three groups of children participated in the study. The 10 autistic subjects, who were diagnosed independently by DSM III criteria (APA, 1980), included 5 males and 5 females, all of whom attended a special school for autistic children. A group of 10 normal children from an inner-city primary school, matched on chronological age to the experimental group, was also tested. A second control group consisted of 10 normal children from a suburban preschool, matched on mental age to the autistic children (as assessed via the Peabody Picture Vocabulary Test). The children in the CA-matched group were selected by their teachers on the basis of their estimated average IQ (i.e., MA = CA). Statistics for the three groups are presented in Table I.

Experimental Tasks

1. Two parts of the Imitation of Gestures Test of Berges and Lezine (1965)—the Imitation of Simple Hand Movements and the Imitation of Simple Arm Movements—were given. This scale was originally designed to measure imitation of gestures in premature and neurologically impaired children and was standardized on a sample of 489 normal children. Care-

Table I. Characteristics of Three Groups

	$\bar{X}$ CA	Range	$\bar{X}$ MA	Range	$\bar{X}$ Verbal IQ	Range
Autistic[a]	8-7	5-9-10-6	4-4	3-3-5-6	49	40-78
CA controls	8-7	5-9-10-6	8-7 (est)	—	100 (est)	
MA controls	3-7	3-4-4-6	4-4	3-3-5-6	111	99-122

[a]Performance IQ as assessed with the Leiter scale was 72 (range 58-91).

fully specified scoring criteria as well as clear and direct instruction for the examiner are provided. Data from a sample of 51 Australian preschool children using this test (Van Smeerdijk, 1981) had shown a clear developmental progression of ability and a significant linear relationship between PPVT IQ and imitation ability.

2. The Test of Imitation of Dynamic Body Movement is a test specially constructed for this study. It includes 12 imitation tasks involving arm rotations, lateral and vertical extensions, swinging movement of arms, legs, and body, and raising and lowering of legs from a prone position! The tasks were designed to be comparable with the Berges and Lezine test in that items were differentiated in terms of the form of the movement pattern and the orientation of the pathways of the limbs. Full details of this test are available from the first author.

3. The Hertzig Battery for Non-Focal Neurologic Signs (1982) was used to test for "soft signs" of CNS dysfunction. Functions assessed include speech, balance, coordination, double simultaneous stimulation, gait, sequential finger-thumb opposition, muscle tone, graphesthesia, asterognosis, and choreiform movements. Performance on individual tasks was rated as being within normal limits, mildly impaired, or markedly impaired. Assessment criteria are supplied by Hertzig (1982).

Procedure

All subjects were tested in their normal school environment in a special room set aside for the purpose. The session began with the Berges and Lezine Imitation of Gestures test, after which the autistic and MA control groups returned to normal class activities for 15 minutes to minimize fatigue and boredom. Thereafter followed administration of the Imitation of Dynamic Body Movement Test and the Hertzig Battery. For the two imitation tests subjects were instructed to watch the examiner and then to copy as exactly as possible. For the Hertzig Battery the balance task, the coordination finger-thumb opposition task, and the position for assessment of choreiform movements were all demonstrated by the examiner. Verbal instructions were kept to a minimum and phrased as simply as possible. No test item was presented until eye contact was established and maintained and the child was attending fully to the experimenter. In instances where the autistic child was temporarily inattentive, the experimenter simply waited until he/she was again oriented to the task requirements. All subjects were rewarded with praise for participation. Autistic children were also given concrete rewards, which were a part of their normal school program procedure.

Interrater reliability was assessed on all three tests by having a second examiner score the responses for subgroups of both autistic and normal subjects. Reliability calculated via the formula of number of agreements divided by number of agreements plus number of disagreements × 100 in all cases was greater than 92%.

RESULTS

Imitation of Gestures

The maximum attainable score here was 20. It can be seen from Table II that both MA and CA control groups achieved higher scores than the autistic group ($F(2, 29) = 9.62$, $p < .001$). The two control groups did not differ from each other. The high variability within the autistic group is noteworthy.

Imitation of Dynamic Movement Test

The maximum score for this test was 12. Table II shows that results on this test were essentially similar to those for the previous one, with autistic children significantly poorer than both control groups ($F(2, 29) = 9.53$, $p < .005$), who were equivalent. High variance within the autistic group is again apparent.

Hertzig Battery

The maximum number of signs of neurological dysfunction from the Hertzig Battery is 10. (A rating of "markedly impaired" is given a score of 1 on each item.) The autistic children demonstrated significantly more soft signs than either control group ($F(2, 18) = 62.3$, $p < .001$), with no difference between the control groups. All autistic children showed choreiform

Table II. Scores of Autistic and Control Groups on Imitation of Gestures and Imitation of Dynamic Movement Tests

	Gestures (max 20)		Dynamic movement (max 12)	
	X	*SD*	*X*	*SD*
Autistic	15.5	3.17	8.6	2.53
CA controls	19.1	.94	11.3	.90
MA controls	18.5	1.02	11.0	.97

Table III. Qualitative Analysis of Performance of All Subjects on the Hertzig Battery[a]

	Normal			Mildly Impaired			Markedly Impaired		
	Aut	MA control	CA control	Aut	MA control	CA control	Aut	MA control	CA control
Speech	2	10	10	4	0	0	4	0	0
Balance	0	2	10	3	5	0	7	3	0
Coordination	1	8	10	5	2	0	4	0	0
Double simultaneous stimulation	4	10	10	0	0	0	6	0	0
Gait	7	10	10	3	0	0	0	0	0
Finger-thumb	3	1	6	3	8	3	4	1	1
Graphesthesia	5	10	8	3	0	2	2	0	0
Astereognosis	9	10	10	0	0	0	1	0	0
Choreiform movement	0	4	10	0	6	0	10	0	0
Muscle tone	10	10	10	0	0	0	0	0	0

[a]Figures indicate number of ratings for each group.

movements. A breakdown of the findings in this battery is shown in Table III. Scores of "mildly impaired" were not analyzed, but autistic and MA control groups were equivalent in this category.

For the autistic group, rank order correlations were calculated to assess relationships betwen Verbal and Performance IQ and each of the measures and between the measures themselves. None of these was significant. However, the girl with the highest IQ was one of the least handicapped on the three motor tests, and one boy was consistently poorest on all measures (see below). In between these extremes, variability across tests was marked.

DISCUSSION

The results of these motor imitation and neurological dysfunction tests indicate that autistic children have significant handicaps in the neurodevelopmental area. Body imitation ability was impaired for both gesture and dynamic movement when compared to mental age-matched and significantly younger children. That is, in this study 6- to 10-year-old autistic children were not even at preschool level in their ability to perform motor imitation tasks. Cooperation was good for all children, all of whom had previously worked extensively with the experimenter in class and in individual teaching sessions and related well to her. These children had been in the same autistic school for 3 to 4 years on average, were familiar with task orientation procedures, and had developed considerable cooperative skills in structured situations. All were willing to attempt the requested activities, and we are confident that their disabilities can be attributed to inability to perform rather than unwillingness. There was considerable variability within the autistic group, indicating marked individual differences among the children. This variability was somewhat influenced by the performance of one particularly handicapped boy; however, reanalysis of the data omitting this child showed that all the aforementioned differences remained highly significant.

A previous study of imitation using the Berges and Lezine test with nine somewhat younger autistic children ($\overline{X}$ *CA* = 6-4, $\overline{X}$ IQ = 48) (Van Smeerdjik, 1981) had shown a level of ability that was consistent with mental age. Imitation ability was at a 2- to 3-year-old level, and there was a correlation of .96 between this ability and mental age. The relatively poorer performance of our group of older children suggests that there may be little further development among autistic children from a low level of skill similar to that of 2- to 3-year-olds. The data from this study are similar to those reported by DeMyer et al. (1972), who found autistic children to be below the level of subnormal controls. DeMyer hypothesized that the impairment might have been the result of poor visual memory, a defective body image, or both. Imitation ability was poor for all except one autistic child in our study, and here visual memory was not necessary since the model remained visible. We would suggest that a more parsimonious explanation of the disability than poor body image might be inadequate neuromotor development. The autistic children seemed literally unable to coordinate their limbs in some of the tasks.

There were five items in the Berges and Lezine test on which autistic children did well. Four of these required extension of one arm only; the other, extension of the arms with closed fists; i.e., all of these were very simple movements. The most difficult items for all subjects were two requiring appreciation of both height and depth in the placement of both arms. Two additional items produced errors particularly for autistic and MA control children relating to incorrect orientation of both arms. Integration of positions of both arms was extremely difficult for all but one autistic child. Imitation of dynamic movement was relatively more difficult, with particular problems for autistic children in arm movements requiring perception of both direction and orientation and coordination of both arms simultaneously. Two items involving leg movements produced a high proportion of failures relating to orientation problems and incomplete movement of the whole leg.

We agree with DeMyer et al. (1981) that the poor performance of autistic children on motor imitation tasks may be due to motor dyspraxia. In reviewing data on developmental milestones in autistic children, they noted reports of delay not only in the usually noted milestones but additionally in such skills as use of eating utensils, drawing, dancing, rhythm, and music. They concluded that these children show "visual-motor dyspraxia which precludes the learning of pantomine and body imitation at levels sufficient to participate in everyday non verbal communication" (p. 410). This contention is supported by our results with the soft signs battery where autistic children showed an average of almost four soft signs (i.e., well beyond the norm for their age. All subjects showed two or more signs, which is considered to be prima facie evidence of CNS dysfunction (Hertzig, 1981). The most frequent sign was choreiform movements, followed by balance, extinction to double simultaneous stimulation, coordination, finger-thumb opposition, and speech. This latter was rated in terms of articulation and word production and does not reflect functional language. If the severe language disabilities of all of these children were considered, the soft sign index would be even higher.

Performance on the choreiform movement test was characterized not only by small jerky movements of the arms and fingers but also by large movements of the arms, which seemed to occur without the subject's awareness. Impairments of graphesthesia and asterognosis were less frequent, and no autistic child showed impairment of gait or muscle tone.

Although the origin and significance of soft signs remains obscure and contentious (see, e.g., Rutter, 1982), the presence of these signs seems to reliably distinguish between cognitively/educationally handicapped and normal children (Hertzig, Bortner, & Birch, 1969). Presence of soft signs seems additionally to be related to prenatal complications in low-birth-weight babies, whereas hard signs more frequently relate to postnatal trauma (Hertzig, 1981). The significant excess of soft signs found in this sample of autistic children is not easily explained as a developmental phenomenon (Rutter, 1977) since the excess is very marked and universal and out of step with mental age as deduced by comparison with mental age-matched controls. There is, however, continuing and considerable controversy in the scientific literature concerning the interpretation of soft signs, and the unresolved problems in the area preclude confident conclusions. As Hertzig (1982) has noted, "the clinical significance of anatomically non-specific deviations in motor, sensory and integrative functions remains obscure" (p. 231). A number of different problem groups show various non-focal signs, and such signs are sometimes observed in normally developing children. A further difficulty is the lack of true normative developmental data in this area.

While we would not disagree with Rutter's (1982) assertion that behavioral diagnosis of brain damage is invalid, we would argue that, taken together with other existing biological data, the results from this study, albeit with a small sample, provide consistent evidence for CNS dysfunction in autistic children, although not permitting conclusions regarding the source of such dysfunction. It provides further support for the belief in the biological basis of the disorder, and suggests that further assessment of motor development and neurological integrity might provide helpful material in the search for systematic, etiologically relevant data.

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