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# Sensorimotor Skills and Language Comprehension in Autistic Children[1]

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*The objectives of this study were to examine the level of sensorimotor concepts of young autistic children and to relate these concepts to language comprehension. A sample of 16 autistic children with a mean mental age of 24.8 months was administered a standardized scale of sensorimotor intelligence and of receptive language. The autistic children demonstrated surprisingly sophisticated sensorimotor skills, particularly object permanence. While their initial performance was inferior to that of normal controls matched on mental age, particularly in their use of objects in combination, the difference between groups diminished on the second test administration. On the receptive language measure, the autistic children were less able to identify words correctly. The sensorimotor behavior of autistic children who demonstrated language comprehension did not differ from those who showed no language comprehension, except that the former group tended to use an object as an instrument somewhat more frequently. The fact that the autistic children were so impaired in language even with fairly good sensorimotor skills suggests that these skills, particularly object permanence, play a minor role in their language acquisition.*

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The early onset of symptoms and the pervasiveness of the impairment suggest that cognitive functions are disordered in autistic children as early as the first or second year of life (Rutter, 1978). In normal children, sensorimotor conceptualizations of objects and people develop in the first 2 years (Piaget, 1952). Furthermore, sensorimotor development has been closely related to the acquisition of language in normal children. Since autism involves early developmental deficits, the sensorimotor object knowledge of autistic children is likely to be impaired. The deviant pattern of language acquisition in autistic children may be a reflection of their disordered sensorimotor concepts.

The capacity for the mental representation of objects is a major achievement of the sensorimotor period. Mental representation enables the "symbolic evocation of absent realities" and is normally present in infants between 18 and 24 months of age. While one clear indication of such capacity is the understanding of object permanence, other sensorimotor skills also reflect representational thought. For example, the infant gradually comprehends relations between objects so that he can use objects as extensions or in combination to obtain other objects, rather than having to operate directly on every object himself. At first, such skills are simply extensions of circular reactions. As the infant learns to differentiate between means and goals, he employs trial-and-error strategies and then becomes able to represent solutions mentally.

The sensorimotor period has been divided into six stages, with each stage defined in terms of the infant's capacity to separate his actions from his perceptions and to represent solutions to problems without having to use direct action. All the standardized assessments of sensorimotor skills (Casati & Lezine, 1968; Escalona & Corman, Note 2; Uzgiris & Hunt, 1975) currently used allow some description of performance according to stage equivalents. Most measures assess performance in a variety of domains with a focus on Stage 4-, 5-, and 6-level behaviors.

In Stage 4, the infant is able to coordinate schemes and apply these to new situations, indicating the earliest differentiation of means and goals. During Stage 5, the infant becomes capable of inventing new solutions through trial-and-error manipulation. Stage 6 is marked by the infant's ability to invent solutions to problems through mental activity alone.

Theoretically, a child should function at about the same stage level on all tasks since performance in each domain should derive from a unitary cognitive structure. However, the stage levels of performance have been found to vary on tasks commonly used to reflect specific levels of a structure. Thus, there is significant variability in stage congruence across tasks even among normal children (Kopp, Sigman, & Parmelee, 1974; Uzgiris, 1976). Despite this variability, levels of performance on each task can be roughly associated with various stage competencies.

While most considerations of the syndrome of autism include a reference to disordered object use, the level of object concepts in autistic children has rarely been evaluated. Several clinicians have suggested that autistic children do not develop object permanence at the same rate or to the same degree as normal children (Anthony, 1962; Christ, Note 1). Bettelheim (1967) considers that the fourth stage of sensorimotor development typifies the autistic child's functioning. On the other hand, the autistic child is thought to be able to retain the concept of the object if the threat to his existence is not felt too immediately. This is contrasted with the normal infant who cannot conceive of State 6 object permanence when functioning at the fourth sensorimotor stage.

The empirical evidence for representational capacity in autistic children is slight and contradictory. Curcio (1978) reported variable performance on different tasks with a sample of male mute autistic children whose mean chronological age was 8 years 1 month. None of his subjects scored below stage 5 on the Object Permanence Scale. Serafica (1971) found that 4- to 8-year-old autistic and schizophrenic children were capable of Stage 6 object permanence, which is indicative of representational thought according to Piaget's definition. On the other hand, Christ (Note 1) cited preliminary evidence suggesting that autistic children are arrested at the second stage of the sensorimotor period.

Thus, the evidence for representational thought in autistic children is equivocal. Furthermore, we do not know if those delays in object concepts that have been observed are specific to autism or reflect the general level of retardation that is frequently associated with autism. None of the previous studies have compared autistic children to controls matched on mental age.

The relation between sensorimotor skills and language development has also not been investigated in autistic children. Mental representation is postulated to be a prerequisite for normal language acquisition. Some studies have shown that object permanence is required for single-word production and comprehension. However, other studies have demonstrated comprehension of single words in the presence of the referent prior to the capacity for mental representation. To some extent, contradictions stem from varying definitions of both language and mental representation (Corrigan, 1979). Several studies have not identified significant correlations between object permanence and normal language acquisition (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Corrigan, 1979), although mental representation as reflected in imitation, play, and tool use was associated with language acquisition (Bates et al., 1979).

The purposes of the present investigation were (1) to assess the level of sensorimotor skills in young autistic children, (2) to compare the level of sensorimotgor intelligence in a group of autistic children and a group of normal children matched on mental age, and (3) to assess the association between sensorimotor behavior and language ability for both groups.

## METHOD

### *Subjects*

The autistic sample consisted of 16 children who were inpatients in the Neuropsychiatric Institute at UCLA and were subjects in the Clinical Research Center (CRC) for the Study of Childhood Psychosis. The experimenters in this study were unaware at the time of assessment whether a child was diagnosed as autistic, mentally retarded, or aphasic. Diagnoses were made independently by several CRC psychiatrists using DSM III (American Psychiatric Association, 1980) as follows: (a) onset before 30 months; (b) pervasive lack of responsiveness to other people; (c) gross deficits in language development; (d) if speech is present, peculiar speech patterns such as immediate and delayed echolalia, metaphorical language, pronominal reversal; (e) bizarre responses to various aspects of the environment, e.g., resistance to change, peculiar interest in or attachments to animate or inanimate objects; (f) absence of delusions, hallucinations, loosening of associations, and incoherence as in schizophrenia.

If the current syndrome fulfilled the criteria of necessary and sufficient symptoms above, but was associated with known organic brain disease, then the patient was not included in the target population.

The 16 children, 15 males and 1 female, ranged in age from 39 to 74 months, with a mean age of 51.7 months. Mean mental ages and developmental quotients are presented in Table I.

In terms of socioeconomic status, the families of the autistic children were a heterogenous group. One-third of the mothers had completed high school, one-third had more than a high school education, and one-third had less. Six children were black, one was from a Mexican-American family, one was Filipino, and eight were Caucasian.

The normal sample consisted of 16 children tested at 24 months of age who were part of a full-term sample followed longitudinally from birth to 2 years. The total sample consisted of 26 infants, but those whose development quotients were below 85 or above 115 were not included in this study. Their family backgrounds were similar to those of the autistic children. While these children were assessed with the Casati-Lezine (1968) at 9 months and 18 months, it is unlikely that their scores were affected

**Table I.** Characteristics of the Autistic and Normal Samples

| | Autistic group | | | Normal group | | |
|---|---|---|---|---|---|---|
| | Mean | *SD* | Range | Mean | *SD* | Range |
| Chronological age in months | 51.7 | 10.7 | 39–74 | 24.4 | 1.0 | 23–25 |
| Mental age in months (general scale) | 24.8 | 5.1 | 18–38 | 24.6 | 2.1 | 21–27 |
| Developmental quotient (general scale) | 48.1 | 8.1 | 35–62 | 100.5 | 8.5 | 88–112 |
| Mental age in months (performance scale) | 33.4 | 7.8 | 23–47 | | | |
| Developmental quotient (performance scale) | 63.9 | 14.9 | 45–90 | | | |

by the testing 6 months prior to the current assessment. Their mean mental age as measured by a general intelligence scale and their mean developmental quotient are given in Table I.

The mental age scores used for matching the autistic and normal groups were based on a general intelligence scale (Cattell) rather than a performance scale (Merrill-Palmer). The rationale for matching with a performance scale has been that general intelligence tests include a verbal component and therefore may underestimate the mental functioning of the autistic children. However, matching on the basis of a performance mental age results in normal controls whose language abilities are far superior to those of the autistic children. The normal subjects may then perform better than the autistic children because they have advanced language skills, e.g., verbal mediation, which may be especially helpful in solving the experimental tasks. To decrease this disparity in language skills and to select a normal control group more comparable to the autistics in overall intellectual functioning, mental age scores on a general intelligence scale were used for matching.

### *Assessment of Sensorimotor Behaviors*

Sensorimotor behaviors were assessed using the "Stages of Sensorimotor Intelligence in the Child" developed by Casati and Lezine (1968). These authors attempted to construct a series of scales with items that were characteristic of the thinking of each sensorimotor stage rather than with those that isolated particular schemes of development. A longitudinal study of performance on this scale for a small group of infants showed overall progression in stage development from 9 to 18 months of age (Kopp, Sigman, & Parmelee, 1973, 1974). The scale consists of seven subtests, grouped into four categories:

1. "Exploration of objects" examines the child's ability to separate and then integrate components of an object. One task requires that the children rotate a mirror to look at themselves, and the other task requires that the children open and close a matchbox with a sliding-type mechanism.

2. "Search for the hidden object" is a subtest that examines the child's awareness of the existence of an object when it is covered and subsequent to displacements of the object in time and space.

3. "Use of intermediaries" examines the ability to "see" a relationship between two objects. A toy desired by the child is distant to him and is accessible only through manipulation of an intermediary object that is nearby. The intermediaries consist of strings, a cloth or a pivot, and a rake. The three subtests in this area are called "use of extension of the object" (string), "use of relationship between object and support" (cloth or pivot), and "use of an instrument" (rake).

4. "Combination of objects" examines the child's ability to invent a solution to solve a problem. The two subtests in this area are the use of an instrument (rake) to obtain an object from inside a tube and the introduction of a chain into a tube.

The subtests vary in the range of stages measured, so that items in the beginning of each subtest do not necessarily represent the same stage. The hidden object subtest begins at the end of Stage 3, the intermediaries and exploration subtests start with Stage 4 behaviors, and the combination of objects starts with Stage 5 behaviors. All the tests end with Stage 6 behaviors.

The child was seated before a table whose top was covered with gray felt, and the examiner was seated across from the child. The sequence of test administration was in the order as discussed above.

The scoring procedure was as follows: Items were scored with a plus or minus, depending on the child's success or failure with the test item. The child was considered capable of performing a particular subtest item when he demonstrated two successes with that item. If a child was given two trials and demonstrated success on one trial and failure on the other trial, he was then given one additional trial.

No more than three trials were permitted on any item with the exception of some items in the hidden object and string subtests. Scoring criteria were explicitly stated for these items. Termination of testing on each subtest occurred when the child could not pass two successive items on that particular subtest.

The most advanced behavior exhibited by a child in each subtest was given a numerical score. The items in the subtest were ranked so that the least advanced behavior was assigned the lowest score, starting with numeral 1. Each successive level of attainment received a score ranking it 1 point higher than the preceding behavior.

One of three trained examiners presented the items to the child and scored the test. Percentage of agreement on all test items between any two examiners ranged from 97% to 99%.

### *Assessment of Receptive Language*

The child sat on a small chair, facing a wooden box with a 92-cm-wide × 76-cm high mahogany front. The front had two 25-cm-square rearview screens onto which 35-mm slides of real objects or events were projected. The examiner sat next to the child and operated a hand-held remote control that enabled her to change the pairs of pictures appearing on the screens. The initial 12 trials were used for an operant training procedure during which the child learned to touch that picture verbally labeled by the experimenter; correct responses were reinforced verbally. The next 34 paired pictures contained the test stimuli proper.

Two rules governed the selection of test stimuli. The pictured objects and events were selected from the everyday meaningful experience of most 17- to 30-month-old children. The selections were consistent with empirical findings concerning the acquisition of productive language. That is, the specific objects or events and the functional categories to which they belong (food, animals, toys, vehicles, household objects, clothing, parts of the body, people in action) predominate in the first 50 words children speak; the vocabulary consisted of names and action words in proportions roughly equivalent to those found in children's initially spoken 50 words (Nelson, 1973). Modifiers corresponding to adult classifications of adjectives, adverbs, and prepositions were included at a higher ratio in order to extend the level of difficulty to older and more skilled children. Pictures were paired so that the test items and the foils sometimes belonged to the same functional category (for example, foot-hand) and sometimes not (for example, cracker-boat).

Difficult items were interspersed with easier ones to facilitate completion of the entire test by every child regardless of skill. Current choices were randomly arranged between the right and left screens. The order of presentation and the position of each stimulus were predetermined and invariant for all subjects.

In order to begin the assessment, subjects had to respond correctly on 8 of 12 pretrials. If a child did not touch or point to one of the pictures on the pretrials, the child's hand was guided to a picture and he was reinforced verbally for several trials. The pretrial series was repeated for those subjects who failed to meet the criterion.

The child's first response was scored plus or minus. Only one response to each item was requested since pilot testing indicated that children tended to alternate responses if an item was repeated. For this study two measures were derived. The first measure was whether the child passed or failed the pretest. This measure was applicable only to the autistic children because all the normal children passed the pretest. The second measure was the total number of pictures identified correctly for the 34 pairs. The measure was designed by Beckwith and Thompson and used with several normal samples with high test-retest reliability ($r$'s = .87 and .94) and high item reliability (KR 20 = .91) (Beckwith & Thompson, 1976).

### *Procedure*

The children were tested in a small playroom. The Casati-Lezine was administered first, and the receptive language measure followed and was scored by a different experimenter.

The skills of autistic children are difficult to assess reliably because their readiness to perform varies and they are not motivated by the activities and toys that are attractive to normal children. In order to maximize the performance of the autistic children within the framework of the standardized testing procedures, two strategies were employed. First, food was substituted for the small objects and toys that usually serve as lures in sensorimotor assessments. Second, the items failed by the autistic children were readministered in a second testing so as to ensure that the children's maximal level of skills was displayed. Items were not readministered that were demonstrated by the experimenter on the first test. The mean length of time between tests was 12.8 days. Thus, each autistic child received two scores on each subtest of the sensorimotor scale. Normal children were administered the scale only once based on previous evidence that the sensorimotor assessments show test-retest reliability with normal children (Uzgiris, 1976). Our own pilot data on seven normal children tested twice within 2 weeks showed an overall change of only 1 point in total raw score.

## RESULTS

### *Assessment of Sensorimotor Stage*

The first issue was whether autistic children were capable of Stage 6 performance on the sensorimotor scales.

**Table II.** Number of Children at Each Stage on the Subtests of the Sensorimotor Scale

| | Stages 5 and 6 | | | Stage < 5 | | |
|---|---|---|---|---|---|---|
| | Autistic | | Normal | Autistic | | Normal |
| Subtest | Test 1 | Test 2 | | Test 1 | Test 2 | |
| Exploration | 15 | 16 | 16 | 1 | 0 | 0 |
| Search for a hidden object | 16 | 16 | 16 | 0 | 0 | 0 |
| Use of intermediaries | | | | | | |
| String | 13 | 15 | 16 | 3 | 1 | 0 |
| Object and support | 8 | 13 | 14 | 8 | 3 | 2 |
| Rake | 9 | 11 | 14 | 7 | 5 | 2 |
| Means-end | | | | | | |
| Tube and rake | 5 | 6 | 13 | 11 | 10 | 3 |
| Tube and chain | 9 | 13 | 16 | 7 | 3 | 0 |
| Total | 75 | 40 | 105 | 37 | 22 | 7 |
| % of all subtests | 67% | 80% | 94% | 33% | 20% | 6% |

The stage equivalents of the autistic and normal children's behaviors on each subtest are shown in Table II. The scores for both tests are given for the autistic children.

The majority of subtests were passed at Stage 6 by the autistic children. On the first administration, 53% of their scores were equivalent to Stage 6 responses and this improved to 64% by the second administration. Thus, autistic children showed that they were able to use representational thought in solving these tasks.

Particularly noteworthy is that every autistic child showed Stage 6-level skills on the Search for Hidden Objects subtest. Five children failed the highest level visible displacement problem, where the object is moved under each of three pads, and left in the last location, with the order varying across trials. However, these children went on to pass the *invisible* displacement problems, in which the object is moved invisibly, except for the last sequential invisible displacement. Thirteen of the 16 autistic children and 10 of the 16 normal children failed the invisible sequential displacement, a more advanced Stage 6 skill.

The other important observation is that the autistic children's level of performance improved on several subtests when they were given an additional opportunity to demonstrate their skills. The change in score was significant for two subtests, the use of object-and-support ($t = 2.44$, $df = 15$, $p < .03$) and the combination of tube and chain ($t = 2.33$, $df = 15$, $p < .04$). Five of the 16 autistic children improved from the first to the second testing on the use of object and support, whereas 4 of the 16 showed more skill in combining the tube and chain. Thus, the autistic children needed several opportunities to display their actual competence.

### *Comparison of the Performance of Autistic and Normal Children*

The autistic children performed less well than the normal children on the first administration of the sensorimotor scales. Only 53% of their scores were at Stage 6, as compared to 76% of the scores of the normal children. An analysis of performance by subtest indicated that the autistic children scored significantly more poorly on the object and support subtest ($p < .03$, Fischer's exact one-tailed test), the tube and rake subtest ($p < .01$, Fischer's exact one-tailed test), and the tube and chain subtest ($p < .01$, Fisher's exact one-tailed test). These comparisons were done grouping autistic and normal children into level according to whether their behavior was typical of Stage 5/6 or less than Stage 5 in each subtest. These differences in performance were not maintained on the second test administration. Only on the subtest requiring that the child use a rake to obtain a piece of candy hidden in an opaque tube were the autistic children significantly less likely to score at Stages 5 or 6 ($p < .02$).

The raw scores of the normal autistic children also were compared since these scores are sensitive to differences in performance within stage levels that are obscured in analyses using stage scores only (Table III). On the first administration of the Casati-Lezine, the autistic children per-

**Table III.** Comparison of Autistic and Normal Children on Both Administrations of the Casati-Lezine Scale

| | Unconverted scores | | | | | |
|---|---|---|---|---|---|---|
| | Normal group ($N$ = 16) | | Autistic group | | | |
| | | | 1st test ($N$ = 16) | | 2nd test ($N$ = 16) | |
| Subtest | Mean | *SD* | Mean | *SD* | Mean | *SD* |
| Exploration | 5.50 | 1.10 | 4.97 | 1.51 | 5.25 | 1.13 |
| Search for a hidden object | 10.38 | .50 | 10.03 | .53 | 10.28 | .60 |
| Use of intermediaries | | | | | | |
| String | 5.13 | 1.32 | 4.31 | 2.17 | 5.06 | 1.52 |
| Object and support | 5.94 | .96 | 4.03[a] | 2.71 | 5.28 | 1.86 |
| Rake | 3.63 | 1.54 | 2.44 | 2.34 | 2.94 | 2.21 |
| Combination of objects | | | | | | |
| Tube and rake | 1.81 | 1.22 | .88[a] | 1.36 | 1.00 | 1.37 |
| Tube and chain | 3.00 | .97 | 1.88[a] | 1.78 | 2.44 | 1.63 |

[a]Significantly different from mean for normal group, $p < .05$.

formed significantly more poorly than the normal children according to a Hotelling's $T^2$ test ($F = 2.4$, $df = 7, 24$, $p < .05$). While their scores were lower on every subtest, the differences between the two groups were attributable to their poor use of object and support ($t = 2.65$, $df = 30$, $p < .01$) and their limited tendency to combine objects (for rake and tube, $t = 2.05$, $df = 30$, $p < .05$; tube and chain, $t = 2.22$, $df = 30$, $p < .04$). The overall differences between the two groups were not significant when the raw scores from the second administration were used. However, the autistic children did perform somewhat more poorly on the most difficult subtest, the instrumental use of the rake ($t = 1.77$, $df = 30$, $p < .09$). All these results are consistent with the stage score analyses reported above.

Poor performance on the object and support schema can be attributed to several factors. First, the child may not pull the cloth placed within his reach to obtain a distant lure. Second, the child may fail to inhibit pulling the cloth when the lure is placed to the side of the cloth. Third, the child may fail to use a pivot correctly. We postulated that failure on this subtest would be attributable to poor use of the pivot since the autistic children might be likely to enjoy the circular movement and fail to stop the pivot in order to obtain a lure. However, on both test administrations, less than perfect performance was due to all these causes equally, and equal numbers of children showed each deficit. The same distribution of failures was true for the other subtest measuring use of intermediaries; the autistic children were equally likely to fail to pull a string in order to obtain a lure or to fail to inhibit incorrect pulling.

Autistic children are considered to be more variable in their development both within and across major developmental pathways than normal children (Fish, 1979). Within the individual subtests of the sensorimotor series, the variances of the scores from the two groups did not differ significantly. However, the autistic children clearly showed more horizontal decalage, even on the second administration of the sensorimotor series. Eleven of the 16 normal children scored only at Stages 5 and 6, while 15 of the 16 normal children scored at Stages 4 to 6. For the 16 autistic children, only 4 scored exclusively at Stages 5 to 6, while 10 scored at Stages 4 to 6. According to Fischer's exact one-tailed test, these differences in distribution are significant ($p < .02$; $p < .04$). Thus, within the sensorimotor series, autistic children showed greater individual variability in performance than did normal children.

### *The Relation Between Object Concepts and Language Comprehension*

The final question was whether language comprehension was related to level of performance on the sensorimotor scales. Language comprehension was scored in two different ways for the autistic children. First, we determined whether the child manifested sufficient comprehension to perform on the task. The performance of seven autistic children did not meet the criterion of eight correct trials on the pretest, while nine children were able to pass this criterion and identify several more slides. The other measure was an assessment of the number of pictures correctly identified. Children who failed the pretest were assigned a score of zero on this measure.

The mean number of correct responses for the autistic sample was 9.6, with a maximum of 28 and a standard deviation of 11.10. The mean excluding the children who failed the pretest was 17.1 correct. For the normals, the mean correct was 27.1, with a minimum of 22, a maximum of 33, and a standard deviation of 3.84. Only 3 of the 16 autistic children surpassed the minimum number of words comprehended by the normal children. Obviously, the means and variances of the two groups were significantly different ($p < .001$).

Because the distribution was so discontinuous, the sample of autistic children was divided into those who showed evidence of language comprehension and those who did not. Raw scores on all the sensorimotor scales were compared for the two autistic groups for both test administrations. According to a Hotelling's $T^2$ test, the groups were not significantly different on either test administration. However, on the second testing, children with language tended to perform somewhat better on the intermediaries subtest requiring use of an instrument to obtain a toy placed at a distance ($t = 1.87$, $df = 14$, $p < .08$). In addition, the stage scores on this subtest differed somewhat in terms of the children's language comprehension. With only one exception, all the children with some language comprehension were able to use the instrument either immediately or after demonstration; the seven children without demonstrable language were nearly evenly divided in their ability to use the rake as a tool.

As mentioned above, most of the autistic children failed the invisible sequential displacements and they were evenly divided in terms of language comprehension. Of the six who passed on thre second test, only two children showed no language comprehension.

The correlations between sensorimotor scale performance and language comprehension. Of the six who passed on the second test, only rectly varied for autistic and normal children. Normal children who were better able to combine objects, particularly the tube and chain, demonstrated comprehension of more words ($r = .61$, $p < .05$). There was also a tendency for those children with good receptive language to use the instruments to obtain other objects ($r = .41$, $p < .11$, use of the instrument; $r = .46$, $p < .07$, use of rake and tube).

For the autistic sample, the only significant coefficients were negative correlations between sensorimotor skills and language. Scores from two of the use of intermediaries subtests were negatively associated with number of words correctly identified ($r = -.55$, $p < .05$, use of the strings; $r = -.66$, $p < .05$, use of the object and support). The negative relation between use of the object and support and receptive language skill was maintained for the second administration of the sensorimotor scale ($r = -.64$, $p < .05$), although the relation between language and use of the strings was no longer significant.

Thus, the autistic children who were able to comprehend more words were not more competent in the use of objects and were less competent in some cases. The causes for failure on the use of the support were diverse. Autistic children with better language failed because of a refusal to pull the pads or an inability to master the pivot without demonstration. Of the nine children who recognized three words or fewer, five used the cloth support appropriately and used the pivot immediately, with no trial-and-error manipulations.

### *Relations of Sensorimotor Skills and Language Comprehension to Mental Age and Chronological Age*

The autistic children varied widely in chronological age and mental age. Since object concepts improve developmentally in normal children, sensorimotor skills might be expected to vary with mental age. Scores on two subtests were correlated significantly with both mental and chronological age. Exploration of objects was related to both variables ($r = .48$, $p < .05$ and $r = .58$, $p < .02$) as was combination of tube and chain ($r = .51$, $p < .05$ and $r = .51$, $p < .05$). One subtest, use of the rake to obtain hidden candy from a tube, was related only to chronological age ($r = .67$, $p < .01$). The language measure was correlated only with mental age ($r = .64$, $p < .01$). The fact that language comprehension was the only factor related to mental age, irrespective of chronological age, corroborated the interpretation that the sensorimotor skills and language skills are relatively independent systems in autistic children.

The correlations between mental age as derived from the Merrill-Palmer developmental quotient and sensorimotor skills were similar to those observed with mental age derived from the Cattell score. However, the correlations were lower so that mental age based on the Merrill-Palmer scale was not significantly related to any sensorimotor subtest scores. On the other hand, mental age as measured by the Merrill-Palmer was correlated with language comprehension ($r = .57$, $p < .05$). These findings indicate that the Merrill-Palmer score actually reflected language ability more than sensorimotor abilities for this sample of young moderately retarded autistic children.

## DISCUSSION

The results indicate that the young autistic children in this sample were capable of representational thought as measured by sensorimotor skills, particularly object permanence. They located invisible displaced objects, used objects in extension, and utilized tools without trial-and-error manipulations. Secondly their sensorimotor skills were not delayed *relative to their developmental level.* The deficiencies in their sensorimotor performance compared to a matched mental age control group were slight as compared to their language deficiencies. In addition, language ability was not related to sensorimotor skills, with the possible exception of the use of an instrument. To some extent, the autistic children who were able to use language were less prone to use objects appropriately.

Autistic children are clearly capable of understanding object permanence. It can be argued that the ability to find objects hidden with a triple invisible displacement is not sufficient to be considered a "true" Stage 6 behavior. Criteria for each stage are defined differently by different experimenters (Corrigan, 1979). The fact that the autistic group performed almost identically to the normal group is evidence that autistic children are not specifically retarded in object permanence, whatever the stage criterion.

Bettelheim (1967) has claimed that autistic children are capable of retaining the concept of the object if they are not too threatened. However, the research evidence suggests that their failures in object permanence are attributable to a refusal to search for objects that are not salient for them. Serafica (1971) reported more consistent success with objects to which the child was strongly attached, as determined by his teacher or therapist, than with neutral objects. In our experience, autistic children refuse to search for most small toys and will cooperate only when food or candy is used. Thus, the failures in object concepts seem attributable to lack of object salience, rather than to any threatening aspect of the object. On the other hand, it is true, as Bettelheim claims, that autistic children typically function at lower levels. When less salient objects were used, the performance of the autistic children in this sample was more characteristic of Stage 4 performance.

Although the sensorimotor skills of the autistic children were clearly deficient for children of their age, their abilities were only slightly delayed in contrast to the skills of normal children matched on mental age. The major differences in performance disappeared when the autistic children were retested. This suggests that their deficiencies are due to performance variables rather than to true incapacity. The subtest in which the autistic children performed more poorly on the second testing was one that requires that the child continue to remember the hidden object and to manipulate another object in a complex way to solve the problem. Failure on this subtest can be attributed to a variety of deficiencies, including the inability to tolerate delay of gratification.

The demonstration of a capacity for object permanence does not imply that the autistic child has formed a representation of other people even though person permanence is usually more advanced than object permanence in normal infants (Bell, 1970). In this regard, it would be interesting to determine whether autistic children show person permanence with familiar and unfamiliar adults. The social behaviors of autistic children suggest either that person permanence is delayed or that the internalization of an image of a cathected object, with the affective qualities applied by psychoanalytic models (Decarie, 1967; Mahler, Pine, & Bergman, 1975), is absent.

The associations between sensorimotor skills and language comprehension were quite loose for the autistic sample. Children who manifested some language comprehension were able to use the rake as a tool effectively. Only one child who showed language comprehension did not make use of the rake. Thus, some form of tool use may be a necessary if not sufficient base for language use. The reason why this subtest, rather than the one requiring more sophisticated skill, bore a relationship to language may be that only the simplest comprehension of tool use is critical for language comprehension. Curcio (1978) has reported that advanced nonverbal communication in mute autistic children depended on Stage 5 performance on equivalent subscales of the Uzgiris-Hunt scale.

On the other hand, the autistic children who were able to use language tended to demand the distant lure verbally rather than using objects as intermediaries. It is difficult to believe that these children were incapable of using the string, cloth, and pivot appropriately. Rather, they may depend only on the most effective means of getting what they want so that verbal requests and demands replace their efforts to use objects.

An important implication of these data for normal child development is that the results call into question the hypothesized relations between sensorimotor achievements and language development. Sensorimotor skills in the autistic children were no more impaired than their general level of mental ability—but both were quite substantially retarded. However, language comprehension was even more delayed. The fact that their sensorimotor development was relatively intact in comparison to their language acquisition suggests that the two systems are somewhat independent. This calls into question the hierarchical relationship between sensorimotor skills and language development.

Of course, the data cannot be interpreted to claim that object permanence is unnecessary for language acquisition. All the subjects in this study were capable of some Stage 6 behaviors, if not the highest level, the invisible sequential displacement. In our experience with autistic and mentally retarded children, only one boy has demonstrated language comprehension without object permanence at the Stage 6 level. Thus, object permanence may be a necessary prerequisite for language comprehension.

However, the fact that the autistic children were so impaired in language even with good object permanence suggests that object permanence plays only a small role in language acquisition. Other manifestations of representational thought may be more critical. For example, imitation (DeMyer, Alpern, Barton, DeMyer, Churchill, Hingtgen, Bryson, Pontius, & Kimberlin, 1972) and symbolic play (Rutter, 1978; Ungerer & Sigman, in press Wing, Gould, Yeates, & Brierly, 1977) are clearly deficient in the autistic children. These systems may be more closely tied to language acquisition (Bates, 1979).

Thus, representational thought may be reflected in two different systems, one more advanced than the other (Wolf & Gardner, in press). The development of sensorimotor skills and, particularly, object permanence may reflect the child's increasing capacity to recall information that is then accessible for problem solving. The capacity to translate experience into symbols that are then manipulated independently may reflect a second system. For the normal child, the two systems may develop together, so that a child who is quick to represent absent objects may also form symbols at an early age, although neither system is dependent on the other. For the autistic child, these systems may not cohere. It is in the second system, the ability to form and manipulate symbols, that the autistic child has his major impairment.

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