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Twelve culturally disadvantaged 4-year-olds of borderline normal intelligence were subjects of this study. Its primary purpose was to test further the cognitive learning theory previously developed, as well as the reinforcement system, the facilities, and the experimental-longitudinal methods of research. The study did not include a control group and was conducted in part to assess the possibility that the effects of training on specific intellectual skills would be reflected on standardized tests. These nursery school children participated in 13-minute experimental sessions three times a day in the study of writing, reading letters, and number concept learning with token-reinforcers (accumulated tokens which could be exchanged for toys, etc.) used to stimulate achievement. Data was collected on the child's responses, the reinforcers, and the stimuli that elicited responses. Results of the Stanford Binet and Metropolitan Readiness Tests, administered four times during the study, showed considerable gain in the intelligence measures and in the cognitive skills involved in readiness for school. The findings indicate the need for further research. (DO)

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Technical Report No. 59

REPLICATION OF THE "MOTIVATED LEARNING" COGNITIVE TRAINING PROCEDURES WITH CULTURALLY DEPRIVED PRESCHOOLERS

By Arthur W. Staats

Report from Project Motivated Learning
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Wisconsin Research and Development
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Madison, Wisconsin

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PREFACE

One major program of the Wisconsin R and D Center for Cognitive Learning is Program 1 which is concerned with fundamental conditions and processes of learning. This program consists of laboratory-type research projects, each independently concentrating on certain basic organismic or situational determinants of cognitive learning, but all attempting to provide knowledge and theory which can be effectively utilized in the construction of instructional systems for tomorrow's schools.

In this report Professor Staats describes a continuing effort to apply his theory of cognitive learning to the training of culturally deprived preschool children. Specifically, this research is concerned with training children to count and write. Professor Staats emphasizes appropriately that his methods may be used as easily by the non-professional as by the trained teacher. This general utility, coupled with the demonstrated specific success, suggests that these methods have significant implications for training cognitive abilities of school children, especially children suffering the handicap of a culturally deprived home environment.

Harold J. Fletcher
Director of Program 1

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ABSTRACT

The paper describes a facility and stimulus presentation and reinforcement procedures for conducting long-term, "experimental-longitudinal" research on the cognitive learning of 12 four-year-old culturally deprived children. The children were maintained in a nursery school setting 4 hours per day during the school week. During each day each child participated in experimental sessions in the study of writing learning and number concept learning. Records were kept of each stimulus presented to each child and each response made. It was thus possible to trace the process of learning. Under controlled learning conditions the children who varied 42 points in IQ learned with considerable similarity. Moreover, other aspects of cognitive learning were studied. For example, the author's previous results had shown a strong learning-how-to-learn phenomenon with the cognitive development of preschoolers. This finding also received support in the present study. The children's progress in the two types of cognitive learning is described.

The study showed that cognitive learning in young children may be studied in detail with control approaching the basic laboratory. Moreover, this may be done while the children learn functional repertoires. In addition to the actual observations of the cognitive skills the children actually gained in the training, test results showed a gain in both tested IQ and tested readiness achievement.

I
INTRODUCTION

It has been a primary tenet of the author that when the principles of a science are relevant to problems of the world one of the criteria for evaluating the worth of the principles is in the extent to which they contribute to the solution of those problems (Staats, 1964, 1966, 1968). Following this philosophy one of the major interests of the author has been in extending the basic principles of conditioning to the study of significant, functional, human behaviors. A number of years ago the author began the extension of this work to the study of cognitive learning in children. The formal part of this work first involved study and development of remedial reading procedures using a token-reinforcement system, and an exploratory study in this area was completed in 1959. The author later elaborated his procedures in formal studies (Staats and Butterfield, 1965; Staats, Minke, Goodwin, and Landeen, 1967), as have other researchers.

In addition to this line of research the author also began the study of cognitive learning in young children, where the beginning stages of the learning could be investigated. Some of this research involved work with single children in experimental-naturalistic studies (see Staats, 1968). In addition, however, formal laboratory experimentation was conducted to investigate the major principles of learning involved. Thus, in one study (Staats, Finley, Minke, and Wolf, 1964) 4-year-old children were presented with a controlled reading task subject to two conditions of reinforcement. That is, each child experienced two schedules of reinforcement alternately while in engaged in the task and continuous records were made of the child's reading responses. The research was of long duration, lasting over a six-week period and involving thirty 20-minute training sessions. The results showed that reinforcement schedules were important in the rapidity and consistency of the reading behavior. This work also began to test the author's methods for working with children for long periods while the children were engaged in complex learning tasks. Central to the work was the test of the token-reinforcement system the author had developed for work with children.

Another study (Staats, Staats, Schutz, and Wolf, 1962) showed that when 4-year-old children are reinforced for word, sentence, and paragraph reading responses their attention and work behaviors are well maintained and they learn a good deal. When they are not reinforced their behavior deteriorates and they ask to discontinue the activity. While not of long duration— the study involved eight 40-minute training sessions— it indicated that the principles of learning were relevant to actual reading, and that the preschool children could work and attend well for periods traditionally considered of impossible length.

Prior to this research the author had begun the study of cognitive learning in his infant daughter in various areas of cognitive development. This study was systematically developed in the areas of number concept learning, reading acquisition, and writing learning. The author found that it was possible, for example, to produce an alphabet reading repertoire in the child by straightforward stimulus—response methods, utilizing a functional reinforcement system involving tokens backed up by small "rewards." The same was true of such number concept skills as discriminating numerosity (naming appropriately one, two, or three objects), counting objects in a row, counting randomly arranged objects, and so on. Furthermore, it was also possible to present writing training in straightforward S-R terms, utilizing the same reinforcement system. The procedures, materials, and analyses of these types of cognitive learning have been described by the author (see Staats, 1964, 1965, 1966, 1968; Staats and Staats, 1963).

None of these studies, however, included independent and general measures of intellective skills of the subjects, tested as a function of the children's stimulus— response training experience. The present study was conducted in part to begin to assess the possibility that the effects of training on specific intellectual skills in preschool children would be reflected on standardized tests. In this respect the study was exploratory and did not include control groups. The comparisons of tests given before and after cognitive training are intended to be suggestive concerning whether or not the cognitive training appears to have an effect.

The present study is also part of the development of a research methodology. That is, research on complex human behavior— for example, cognitive development— must be conducted over a long period of time. Short-term studies do not allow one to obtain a representative sample of the behavior which is being studied. This places certain restrictions on the research strategy. In the beginning innovational stages it is not feasible or advantageous to work with a group of subjects. Intensive study of one subject is more appropriate. Thus, the author gained his knowledge of the cognitive learning of preschool children in work with his daughter. By the time of the present study the work with the one subject had been conducted for over 3 years.

It should be noted, however, that although such research may commence with a single subject, it is necessary to insure the reliability of the findings. This can be achieved by extension of the findings to additional cases. Thus, the first step in obtaining this generality was to elaborate the sample of children, as well as the sample of experimenters, since idiosyncratic events could also occur in this realm. Following the rationale of these "experimental—longitudinal" research methods (see Staats, 1968), it was possible to conduct several replications of his work with the single subject while the author was still at Arizona State University. For the most part the theory, methods, and reinforcement procedures developed with the author's daughter transferred to additional children when administered by another experimenter. Results of the replications from this study have been reported by the author (Staats, 1966, 1968). However, the need to insure the reliability of these developments called for the use of additional children and additional experimenters, and such extension was the primary purpose of the present study.

One of the primary conditions for the experimental study of cognitive learning is also the development of a facility and set of conditions in which the learning of children can be studied over the long periods necessary. The author recognized this early in the present project and has been concerned with conceptualizing and developing such a facility. The first step, of course, was to study his own children in the home. At the same time the author developed at Arizona State University a laboratory complex consisting of several rooms. These rooms were used (1) as individual experimental rooms, (2) as a room in which to maintain the children when not participating in the experimentation, and (3) as a room for the selection of reinforcers by the children. Several studies were conducted in this complex (Staats, Minke, Finley, Wolf, and Brooks, 1964; Staats, Finley, Osborne, Quinn, and Minke, 1963; and Staats, Finley, Minke, and Wolf, 1964). In a later study, conducted by the author and William G. Heard in 1964 (see Staats, 1968), the present author employed a teacher to assume the responsibility for 6 mentally retarded children. A room was set up for the study, and in this situation the teacher conducted various activities with the children. However, each child, on a schedule, would leave the classroom and go to an adjacent experimental room for the laboratory research.

Another purpose of the present study was thus to test further the feasibility of using this type of facility with preschool children in the study of their cognitive learning. Again, the children participated not only in a traditional preschool class, but also in controlled experimental sessions. In the experimental sessions each child individually received training in which each of the stimuli presented could be recorded, as could each response and each reinforcer given. The design was also to use the token reinforcement system and methods the author had previously developed in 1959 (see Staats, 1964, 1965, 1966, 1968; Staats, Finley, Minke, and Wolf, 1964; Staats, Minke, Finley, Wolf, and Brooks, 1964). In this manner the attention and the participation of the children was to be maintained over a long period of time. This study thus represents a replication in the sense of further testing the previous findings that the methods and the reinforcer system would maintain attention and participation.

II
FACILITIES AND PROCEDURES

SUBJECTS

The 12 four-year-old children were selected from culturally disadvantaged homes to participate in the study. They ranged in age from 3 years and 10 months to 4 years and 9 months. The mean age was 4 years and 4 months. Seven of the children were from black parents, one from white and Polynesian, one from black and white parents, and 3 from white parents. Several of the children had emotional or behavior problems of various degrees of severity. One girl had had severe temper tantrums and had formerly been treated for psychological problems which were still unresolved. She would bite, kick, scream lie on the floor, and so on during a tantrum. One other child would at times feign a comatose state for long periods of time whenever he was dissatisfied with something, for example, when he had been reprimanded. One child was a mild conduct problem. Several children were observed to be very backward in speech development as well as in the comprehension of instructions. They appeared retarded in their cognitive skills and their intelligence test results indicated they were borderline normals.

TOKEN-REINFORCER SYSTEM

The author has described his reinforcer system in detail elsewhere (see Staats, 1964, 1966, 1968; Staats and Butterfield, 1965; Staats, Minke, Finley, Wolf, and Brooks, 1964; Staats, Finley, Minke, and Wolf, 1964; Staats, Minke, Goodwin, and Landeen, 1967). The reinforcer system is based upon tokens which are backed up by material reinforcers which the child selects. In the present case, whenever the child made a correct response he was given a marble. The child could then use the marble to obtain a plastic trinket or an edible such as a raisin, peanut, or M & M candy. Or, the child could use the token to work for a small toy worth approximately 10 cents. It required the accumulation of about 10 marbles to obtain the toy. The marbles were accumulated in a tube that held 10 to 12 marbles. The child would select the toys that he wished to work for.

EXPERIMENTERS (INSTRUCTIONAL-TECHNICIANS)

It is interesting to note that the experimenters were not trained in teaching young children, nor had any of them experience in training children of their own. They were simply given the stimuli to be presented and an opportunity to ask questions concerning the presentation. The author also supervised the training of the children, especially with children who had learning problems.

FACILITIES

The laboratory facility in the present case consisted of a large classroom in the Franklin school in Madison, Wisconsin. Two rooms close by were used for the experimental training. One of the rooms was large enough to contain two apparatus setups; thus 3 children could be run simultaneously.

PROCEDURES

Each child would leave the classroom 3 times a day for training sessions, at regularly scheduled times spaced over the 3 1/2 hours they participated. The periods were scheduled for 13 minutes. During the 13-minute period, however, there were on the average only 5—7 minutes actually involved in the training. The child had to leave the classroom activity and walk to and from the class; and the experimenter had many tasks to perform to prepare for the child.

Data sheets were used with which to tabulate the child's responses, the reinforcers, and the stimuli that elicited the responses. Each child's written responses to the reading materials were kept and represent a graphic record of the child's progress in this cognitive learning.

Number Concept Training

The theoretical analysis of number concept learning and the training procedures developed by the author in research with his daughter (see Staats, 1968; Staats and Staats, 1963) were employed. This was done for replication purposes as well as to test the possibility that training in the skills would effect a change in the children's intellective test results.

The children first learned to discriminate objects on the basis of numerosity. The children also learned to name the number of stimuli.

Following this the children were trained to count objects in a series. This was carried forward in most cases until the child could count to 10.

When the child had learned to count to 10 in this manner, he then learned to count objects when they were presented in an unorganized pile. This required additional training for the children. Only one child did not complete this part of the training.

When the child had learned to count 10 such objects correctly, as well as any lesser number, the child was trained to read and then to write the numbers in order. The child was then trained to read the numbers presented in any order.

Writing and Reading Letters of the Alphabet

Again the materials and procedures which the author had previously developed and used in the long term research with his daughter were employed with the present subjects. In the present case, however, the letters to be traced and copied were presented on mimeographed copies to standardize the stimuli. The children were first given training in tracing, then in copying, and finally in free writing the letters of the alphabet.

TESTING

Just prior to the beginning of the research the children were given Stanford-Binet (Terman and Merrill, 1937) Intelligence Tests and Metropolitan Readiness Tests (1948). Seven children were tested by one examiner and 5 by another. The tests were repeated 3 months later, and again about 3 months later. Unfortunately, in the third testing the examiners inadvertently were assigned the children tested before by the other examiner. Consequently, the children were tested a 4th time 1 month later with the examiner with whom they had originally been tested.

III

RESULTS

NUMBER CONCEPT LEARNING

The results replicated the findings previously made by the author with one child. That is, in each case the progress of cognitive development in number concept learning occurred as predicted in accordance with the theory and the previous experimental results. In 11 of the 12 cases the cognitive learning progressed rapidly. In one case with a boy who measured 88 on the IQ test, the training progressed slowly as compared to the others; and the author conducted the training personally to study the requirements of a training program appropriate for children with less well developed cognitive skills, for this child was markedly behind the others in various spheres of behavioral development. In any event the procedures used all followed the straightforward learning analysis, and this child was able to acquire the number concept repertoire up to counting 5 objects, regardless of the arrangement of the objects; a not inconsiderable advance. This training consumed approximately 12 hours.

The results for the other 11 children for 4 1/2 months of the training are presented in Table 1. In the table, under the heading of Learning Tasks, there are three steps listed. This is a somewhat arbitrary breakdown in certain respects but it can be used to characterize the progress of the children's results in the table. The numbers in the cells indicate in each case the number of training sessions involved to that point as well as the number of training trails (individual stimulus—response presentations). The number of sessions is listed on top and the number of learning trials to attain that level of proficiency beneath. The numbers are cumulative, so that the total number of trials or sessions required to attain that proficiency are given. The point at which the child had acquired a particular level of proficiency was taken as the last training trial prior to the introduction of another new learning material.

Thus, for child number 2, who had an IQ of 88, 11 training sessions and 284 training trials were required before the learning of the numerosity discrimination between 1 and 2 objects was surely established. It required 33 additional sessions and 455 training sessions before this child learned to count a series of 10 objects correc'ly. This type of performance is shown for each child, for each of the levels of number concept proficiency indicated.

It is important to note that each of the children appeared to be capable of this type of learning, under the standard circumstances applied. It should be remembered, moreover, that the IQs of the children differed over a range of 42 points. In addition, there appeared to be great similarity in the progress of the children in this cognitive learning task. Thus, the total number of training trials necessary to produce the repertoire dealt with did not vary a great deal among the various children. For example, if the results of the children are considered only up to the point where they learned to count a randomly arranged set of 10 objects, the differences were quite small. That is, the 3 children with the lowest IQs (mean of 89) required 628.7 trials to learn the skill, whereas the 3 children with the highest IQ's (mean of 118.3) required 570 trials to reach the same level of proficiency.

A strong source of variation which does appear, however, is in the rapidity of responding in the training sessions. Thus, the 3 children with the lowest IQ's in the table required a mean of 42.3 training sessions to attain this skill level, whereas the 3 children with the highest IQ's required only a mean of 33.3 training sessions to reach the same level. This suggests that the difference in performance was largely due to difference in the rate of response. This suggestion is supported by previous findings of the author in a study of retarded children (Staats, 1968).

In addition to learning the aspects of the number concept repertoire that have been described,

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Table 1

Summary of the Children's Progress in Number Concept Learning, Children Ranked by IQ

Learning Tasks		Children 2 IQ 88	3 IQ 89	4 IQ 90	5 IQ 93	6 IQ 99
Discriminates 1 and 2 objects	Sessions	11	7	7	9	10
	Trials	284	196	201	245	285
Counts 1–10 objects in series	Sessions	44	49	27	64	19
	Trials	639	738	425	821	449
Counts 1–10 objects randomly arranged	Sessions	48	50	29	67	34
	Trials	676	756	454	839	641

Learning Tasks		Children 7 IQ 100	8 IQ 104	9 IQ 105	10 IQ 108	11 IQ 117	12 IQ 130
Discriminates 1 and 2 objects	Sessions	9	7	11	11	7	8
	Trials	272	215	296	309	241	246
Counts 1–10 objects in series	Sessions	29	28	35	24	28	25
	Trials	488	446	571	471	512	458
Counts 1–10 objects randomly arranged	Sessions	34	31	38	38	31	31
	Trials	546	487	602	613	548	549

most of the children were also trained to write and read the numbers from 1 to 10. Child No. 5 in Table 1 learned to write and read the numbers only from 1 to 5, and child No. 9 from 1 to 9. More detailed data on this type of learning is presented in the next section.

WRITING LEARNING

Each child's set of writing responses was retained and the data are composed of these responses for the various children. This represents a very large number of records, since each child made hundreds of responses during the training period. Thus, some means of summarizing the results of the training had to be devised to characterize the children's progress in the cognitive learning task. The author (see Staats, 1968) had previously handled this by systematically sampling a child's writing responses over the period of his learning. This procedure was repeated in the present case. The major rule followed, after the first few samples, was to take the child's first response of copying following the addition of a new letter to those he could already copy. Then a few trials later the task demanded that the child make a free writing response (with no copying or imitational model). This response, which included writing all the letters the child had previously learned plus the new one, was also sampled for the graphic record.

The records of several of the children in the group will be presented to indicate something about the nature of the learning process. The records were selected to sample the types of children in the group. The first child whose results will be characterized was the second to lowest child in cognitive skills judged by naturalistic observation and by IQ test. He was the Polynesian–white child and his home was definitely of a culturally deprived type. Fig. 1 presents the summary of the writing learning of this child who first had an IQ of 89 and a Metropolitan Readiness test score in the lowest hundredth (1st percentile). He scored zero on the copying portion of the Metropolitan test which indicated that the beginning skills in the acquisition of writing were not in his repertoire. This child was seen as the second most retarded of the group. His speech was very poor, hardly understandable and very sparse. In terms of home background the child had 5 young siblings and lived in a poor, unkempt home environment

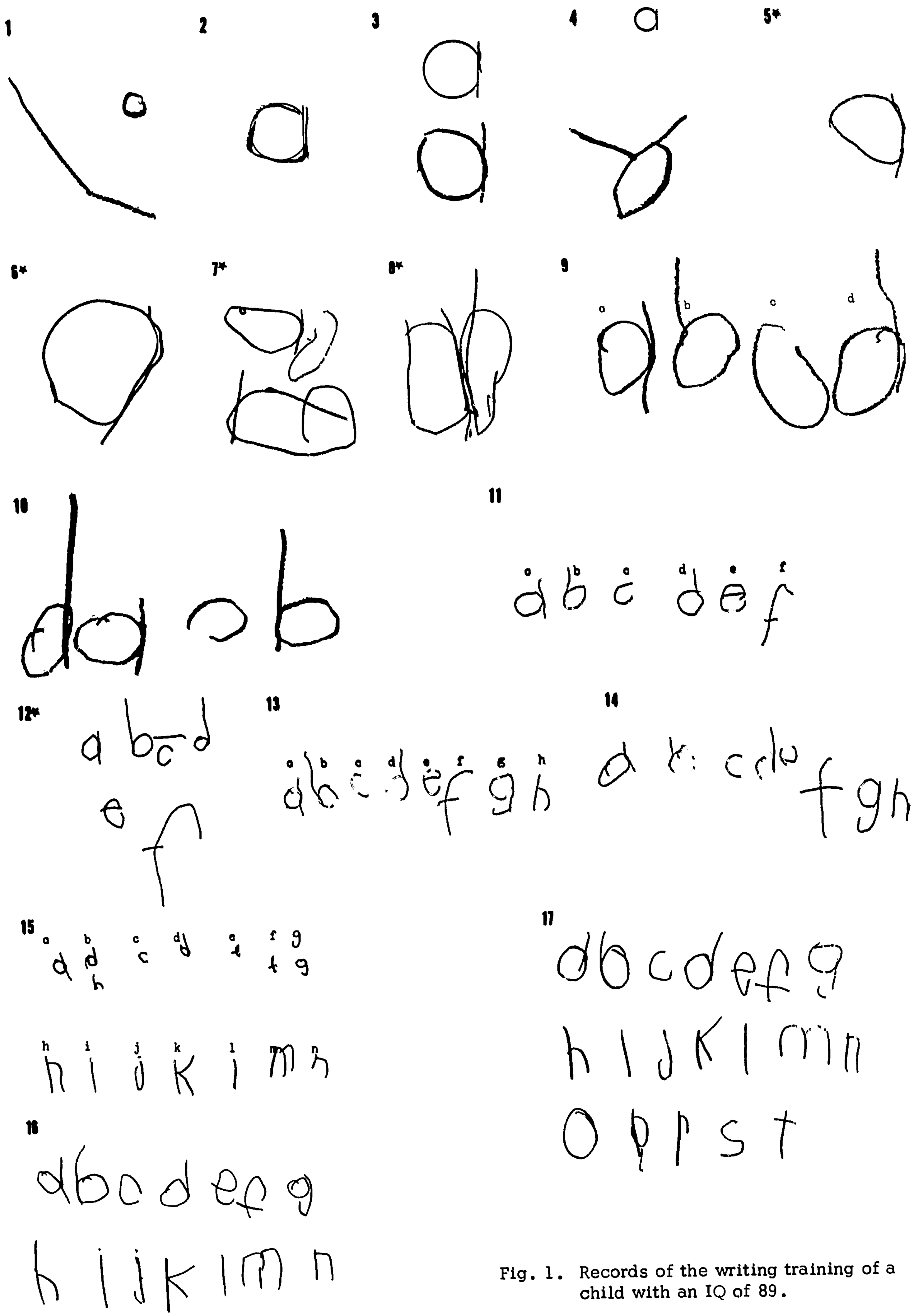

Fig. 1. Records of the writing training of a child with an IQ of 89.

that would be considered disadvantaged. His father was a laborer and the child had previously been selected as a culturally deprived child for participation in a summer Project Headstart program.

The summary of the writing learning of this child is shown in Fig. 1. The first response occurred when the child was asked to write his name. (Each child was tested to see whether he could write his name, or any letters— none could.) The next response was his first tracing of a large letter a. He had had 183 learning trials in tracing lines and circles preceding this response. The third response shown (206) is his first copying of a large a. Response 216 (Sample 4) shows the child's first attempt to copy a middle-sized a, and Response 370 (5) is the first attempt to copy a primary sized a. Response 375 (6) is the child's first attempt to write a with no stimulus present. (This response is starred to indicate that it was reduced in size by one half in comparison to the size of the unstarred responses.) From this point on the child's responses are sampled by taking the first copying response (the model stimuli are primary sized) and the first free writing response which followed, the samples being drawn when a new letter had been added to the preceding series. Thus, the seventh sample (407) is the first copying of a with b added and the eighth sample (419) is the first free writing of these letters. The response numbers of the remaining samples are 527 (9), 533 (10), 595 (11), 599 (12), 631 (13), 640 (14), 788 (15), 792 (16), 892 (17).

The results show that the child had difficulty when he first had to copy the small letter stimuli, and it was not until he had had 527 training trials (sample 9) that he copyed these letters very well. This indicates that the training procedures could have been presented with much smoother sequencing. The records also indicate the child's learning to write the letters in the correct order.

Great improvement is shown by the child's 12th response sample. By the end of the training the child was freely writing the letters with no help. He was at that time able to read the letters that he had written or to read the letters in primary type. The training up to this point entailed 17 hours and 18 minutes, the most time spent with any child in writing training, although other children spent closely comparable amounts of time. The mean time for all the children in this type of cognitive training was 15 hours and 42 minutes.

The samples of the other children, with exceptions that will be noted, follow the same pattern and the description will thus be summarized. The next records are of a child with an IQ of 130. This child, behaviorally as well in testing, was seen as the most advanced child in the group as well as the most popular. One of her parents was white, one black, both had high school educations, and the home appeared to have the values and striving character of the middle class, although economically it had not yet attained that level.

Behaviorally this little girl appeared very well oriented toward the learning task. She and a little girl with an IQ of 117 vied with each other concerning how much they had learned, what they had learned, and so on— forming a characteristic learning oriented, middle class, school interacting group. This was seen as an immediate advantage in the manner in which the two children approached the learning tasks.

This child's records are shown in Fig. 2 and are responses to the same stimuli described for the first child. The number of learning trials involved in each level of skill is as follows, with the number of the sample of the skill given in parentheses: 1(1); 178(2); 228(3); 246(4); 263(5); 426(6); 473(7); 485(8); 574(9); 583(10); 641(11); 647(12); 674(13); 681(14); 786(15); 788(16); 914(17).

These results show the same type of progression in sensory-motor and verbal skill in learning to write the alphabet. The time involved in the training was 16 hours and 43 minutes. Thus, in terms of the progression of the learning and the level of skill attained in reading and writing the letters, the two subjects with IQs that differed by 41 points performed very similarly.

The third child's performance which was selected for this more detailed presentation was the emotionally disturbed child. She was Negro and came from a culturally deprived home in which there was to all intents and purposes no father, since he only visited once or twice a year. The child had a history of emotional disturbance; she was described as hyperactive, with strong emotional reaction including tears, screams, withdrawal. The description was made by a clinic to which she had been referred for treatment. The child also had behavioral deficits; she did not talk until she wa three and at the time she entered the experimental program her language behavior was poor and difficult to understand. She was difficult to test and variable in performance. Her IQ's over the four testings, for example, were 105, 87, 94, and 83. This child was also very difficult to work with in the individual training sessions at the beginning. She refused at first to participate in the sessions with one experimenter. Moreover, she did not attend well and engaged in interfering behaviors. However, her behavior improved rapidly and in a few weeks she was participating, except for a few flurries, like the other children.

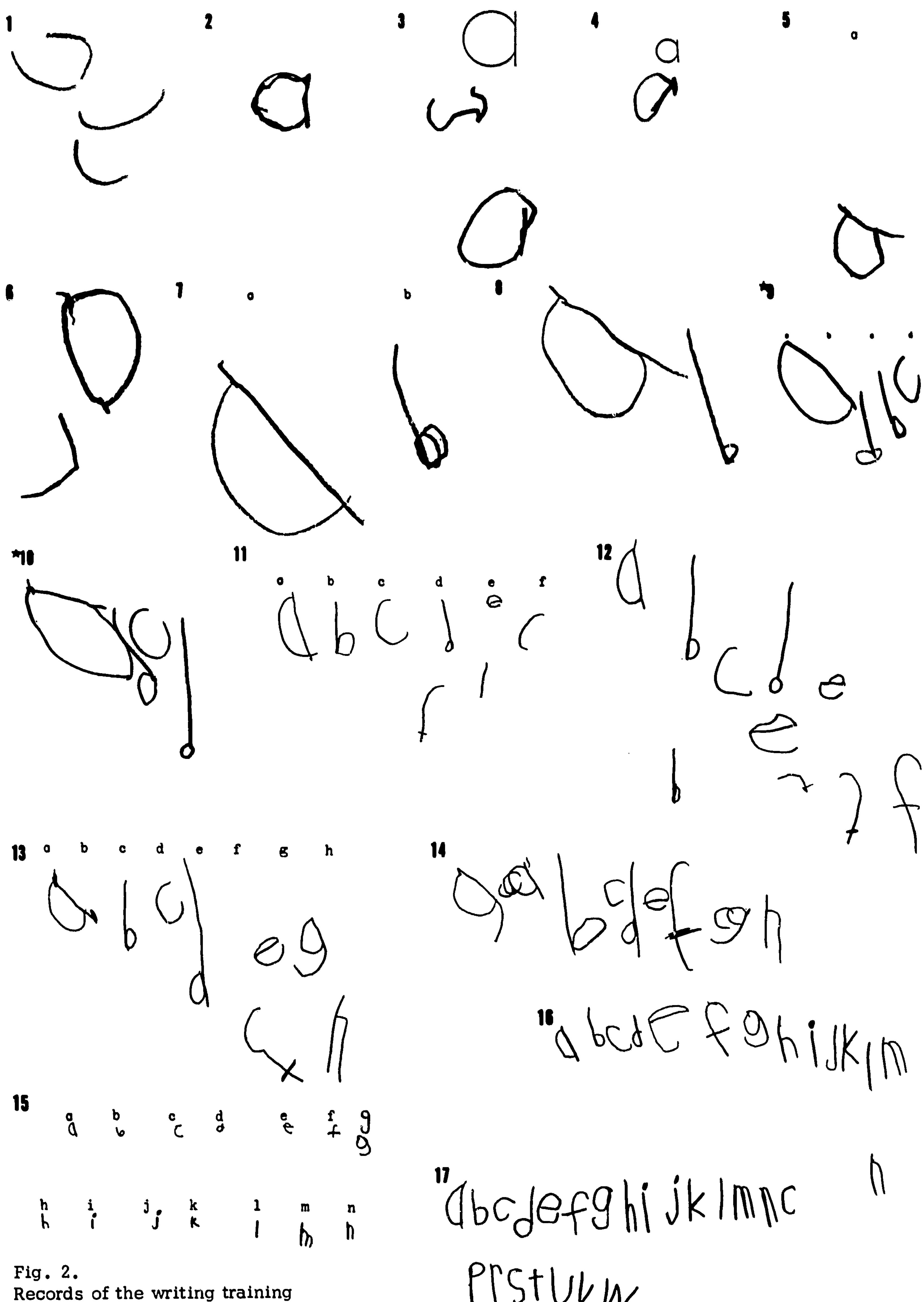

Fig. 2.
Records of the writing training of a child with an IQ of 130.

Fig. 3 presents the results of this child's writing training. The same method of sampling of the child's writing responses is used. It should be noted, however, that there was one deviation from the standard procedure with this child. That is, there was a breakdown of attention and performance when the primary type letters were introduced as the model stimuli. This occurred to some extent with many of the children. In the present case, however, the difficulty persisted, and the experimenter was instructed to write the model stimuli for the child to bring her attention skills better under the control of the letters. These stimuli were gradually made smaller so the step to the primary type did not constitute a large change. Thus, the written letters were employed in samples 7, 9, and 11. The samples (given in parentheses) for this child and the number of learning trials up to that level of skill are as follows: 1(1); 125(2); 151(3); 219(4); 226(5); 228(6); 415(7); 430(8); 534(9); 545(10); 572 (11); 578(12); 649(13); 654(14); 825(15); 840 (16); 853(17).

Again, the results show a similar development of the cognitive skill of writing and reading the letters of the alphabet in the standardized training procedures provided by the reinforcement system. It appears that under these training procedures it is possible to obtain normal cognitive development from even an emotionally disturbed child who has previously shown difficulties in cognitive development. The total time involved in this writing and reading training was 15 hours and 28 minutes during which time the child attained the terminal performance shown in Sample 9 of Fig. 4. The terminal performance of the first child is shown as Sample 3, and that of the second child as Sample 12.

Of the 12 children, 10 responded in a standard manner to the materials and procedures (with the minor variations discussed above). Two of the children, however, did not make the same type of progress. The terminal performance of each of the 12 children is shown in Fig. 4. Subject 1 was the child who had required special procedures of training in the number concept training. He was far and way the most retarded child in the group. Again in the writing task he required special treatment to first train him in some of the skills which were basic to the actual learning to write the letters. For example, this child's tracing and copying skills were very poor (as were his attention and discrimination skills). Thus, extensive training was given to this child in these repertoires before reintroducing the letters, after it was seen that it would be too difficult for him to progress in the standard materials. The same was true of one other child (5) who also had demonstrated deficits in the number concept learning. In each case, however, the child acquired the basic skills and was progressing into the alphabet training. With Child 5 the training at the end of the study appeared to be rapidly accelerating into a normal rate of progress. This was also true of Child 1, but to a lesser extent. He was, however, able to copy lines well, to copy the letters a, b, and c, and to read the letters.

The emotional and behavior problem children were no. 9, who had the severe tantrums; no. 5 who was intransigent in training at first, took reinforcers he was not supposed to have taken, and displayed the sham comatose state already described; and no. 7 who was unruly, hyperactive, and aggressive. In each case, as in the number concept learning, these children did not perform well in the training sessions at the beginning. However, after a few weeks they began to respond normally in the training situation. After that time their behavior, except for flurries which came less and less frequently, was very much like that of the other children in the training procedure. The results in this training and in the classroom indicated that emotionally disturbed children may be treated for their behavioral problems, and can also receive training which will prevent the development of cognitive deficits, through the use of the present types of facilities and procedures.

With respect to the results of the writing training there are several more points to be made. First, the performance of the children— excluding the two cases requiring special training procedures— was very similar, even though there were wide differences in measured intelligence among them. That is, it took a mean of 655.7 training trials for no. 2, no. 3, and no. 4 children with the lowest IQ's (mean IQ of 89) to learn to write and read the letters from a to n. The 3 children with the highest IQ's (mean IQ of 118.3) required a mean of 652.0 trials to acquire the same cognitive repertoire. Over the entire training the mean number of training trials required to learn each letter was 37.0 for the low IQ children and 37.1 for the high IQ children. Thus, even though the mean IQ difference for these two groups of children was 29.3, the cognitive learning was very similar. The results thus support the previous findings with the educable and trainable mental retardates. (The mean number of trials required for learning each letter of the remaining subjects— the middle group, with a mean IQ of 102— was 50.1. However, this group of subjects included 2 children who had behavior problems that slowed the learning process, especially at the beginning.) The mean number of trials to learn each letter for the

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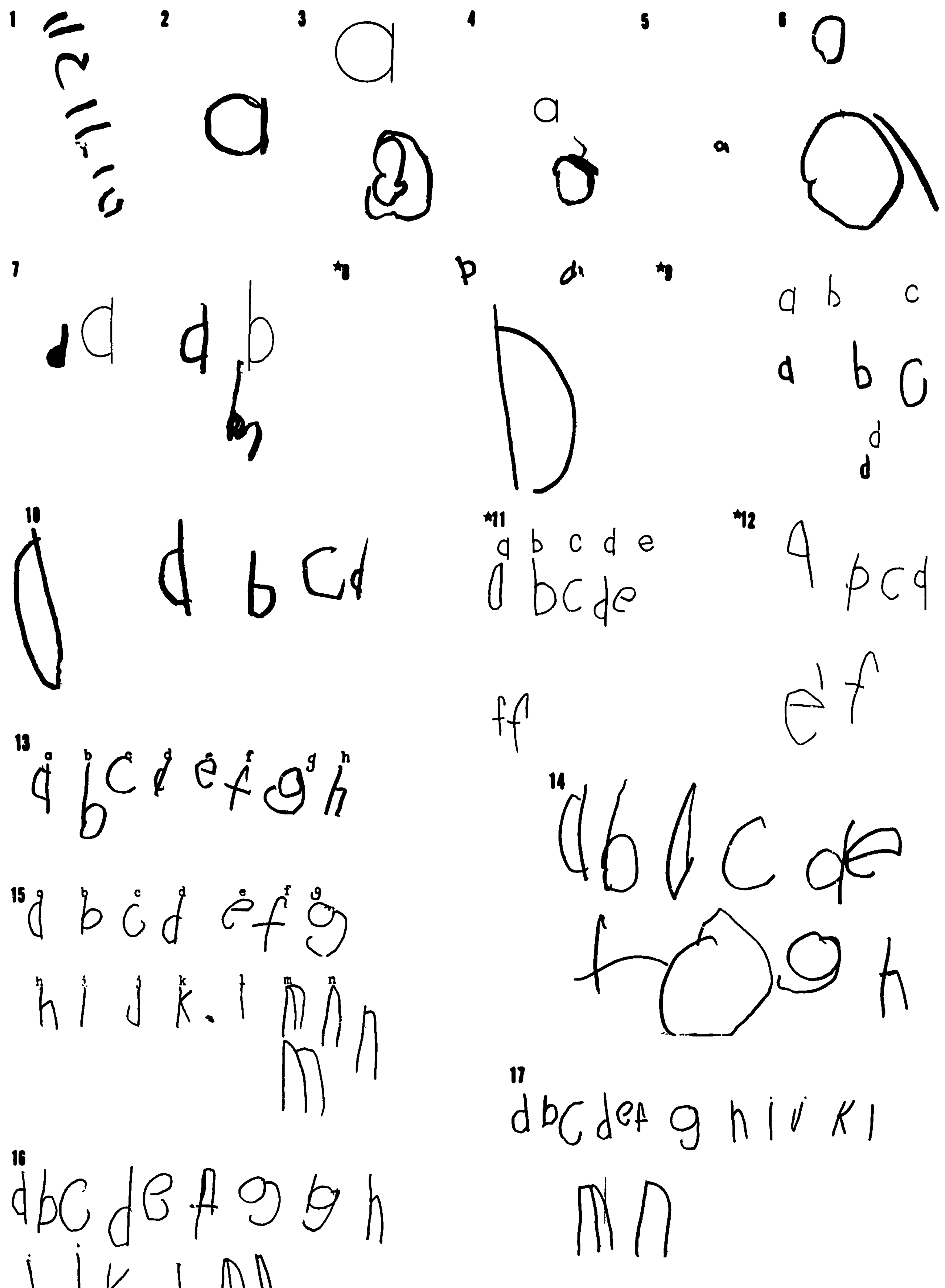

Fig. 3. Records of the training of an emotionally disturbed child with an IQ of 105.

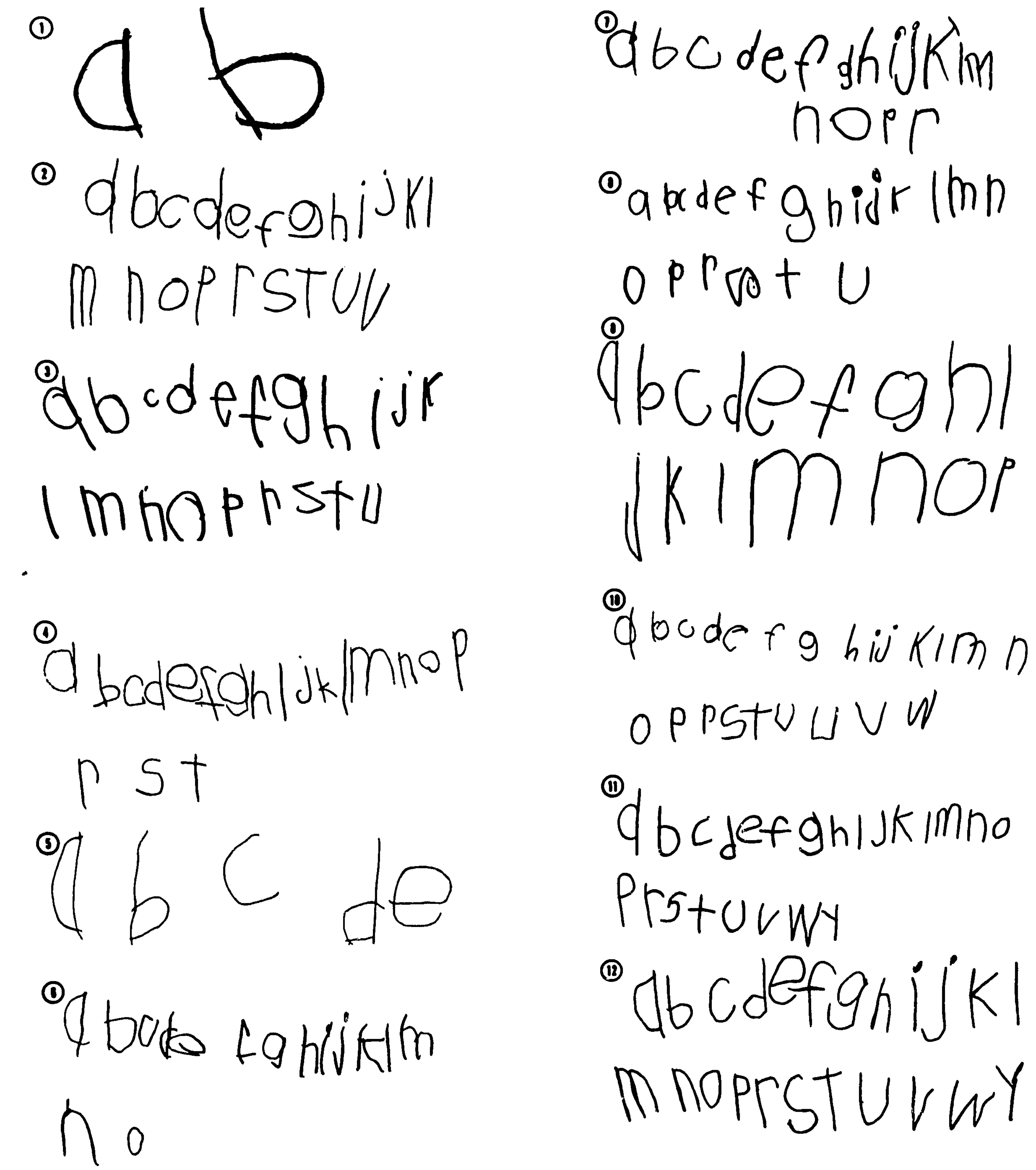

Fig. 4. Children's Terminal Performance in Writing Training

12 children, with the IQ of each child written in parentheses, are listed as follows: 430.5 (88), 35.7(88), 46.4(89), 28.9(90), 196.0(93), 61.1(99), 48.7(100), 34.5(104), 56.0(105), 37.9(100), 33.2(117), 40.3(130). (The correlation between these learning scores and the IQ scores will be discussed further on.)

It has been implicitly suggested several times already (Staats, 1968) that there is an acceleration of rate in cognitive learning; that is, the first part of a cognitive learning task is more effortful and requires more time and more learning trials than does later learning. This hypothesis was supported by the present writing training results. The number of trials required to learn the first half of the children's writing and reading repertoires was tabulated and compared to the number required to learn the other half of the letters. The mean number of trials required was 409.4 trials for the first half and only 221.7 trials for the remaining letters. An even sharper learning acceleration can be seen by comparing the trials to learn the first 4 letters versus the trials to learn the last 4 letters. The first 4 letters required a mean of 287.8 training trials; the last 4 letters required only a mean of 76.4 training trials.

These results again suggest that it is to the benefit of the child's cognitive development to begin his training early. Not only does the child through such training acquire important cognitive skills, but he also becomes better at acquiring additional cognitive skills. In the negative case, children who are deprived of cognitive training at an early age can be expected to suffer in both of these ways.

TEST RESULTS

Just prior to the beginning of the research the children were given Stanford-Binet Intelligence Tests (Terman and Merrill, 1937) and Metropolitan Readiness Tests (1948). About 3 months later the tests were repeated, and they were repeated again about 3 months after the first repetition. They were given for the last time 1 month later. The mean scores for the group of children are shown in Table 2. The score for the Stanford-Binet tests is an IQ. The score for the Metropolitan is a percentile; that is, the child's position in a group of children is given in terms of percentages of children that score less. A score at the fifth percentile indicates that 5 percent of the norm group had a lower score. The children in the norm group were about 2 years older than the present children, being in the first month of starting the first grade.

As the results show, there appears to be a considerable gain both in the intelligence measures and in the cognitive skills involved in readiness for school. It may be pointed out that these results are tentative— there may be practice effects in the intelligence tests, at least for the last time it was given. Nevertheless, the indication is that the training in the areas of cognitive development had effects that were reflected on the children's general intelligence measure. This finding is enhanced because the general expectation is that culturally-deprived children fall progressively behind on intellective measures as they grow older.

It should be noted again that the third time the intelligence test was given the examiners were inadvertently mixed and the examiner that systematically tended to give lower scores tested 7 of the children rather than the 5 this examiner tested the other three times. This may well have resulted in the lowness of the mean score relative to those of the other testings.

It is also of interest to examine the children's progress in cognitive readiness as measured by the Metropolitan. The Metropolitan tests the areas of Word Meaning, Sentences, and Information as well as the areas of Matching, Numbers, and Copying. The results show that the children's overall scores increased considerably in these important areas of cognitive development. Moreover, examination of the children's improvement in the 6 areas showed that the major increases came in the areas of Matching, Numbers, and Copying. This is especially interesting since it was in these areas that the children received the cognitive training in the study. That is, the area of Matching tests the child's ability to discriminate stimuli. The Numbers area tests the child's number concept development, and the Copying area tests the child in the types of skills he received training on in the writing procedures.

In any event, the rate of the children's improvement on this test was marked and, if continued, would have made this group of children superior by the time they entered the first grade, about 1 year and 4 months after the final testing. In view of the fact that children such as these may be expected to lose ground in intellective development as measured by tests, the results on both of these intellective tests were very encouraging.

Intelligence test measures are considered by many people to be indices of some basic personal attribute of intellectual quality such as a rate of learning (that is, ability to learn). According to the view, two children with different basic learning rates who are subjected to the same training circumstances will have different rates of cognitive development. With respect to this it was interesting to correlate the rapidity of learning to write with the children's intelligence

Table 2

Intelligence and Readiness Test Scores During the Study

		September	December	Beginning April	End April
Stanford-Binet (1937)	(IQ)	100.9	106.3	104.2	112.5
Metropolitan Readiness Tests	(%tile)	2.3	4.5	14.3	23.8

measures. This was done by computing the mean time consumed per letter in learning to write and then relating these scores to the children's IQ's. The Pearson correlation was .377, which means that 14 percent of the variation of the children's cognitive learning in this case could be accounted for by the differences in IQ scores. It should be noted that this statistic included the results for 2 children who actually worked for the greater part of the time on different materials aimed to prepare them to learn to write, and these children's scores contributed heavily to the size of the correlation.

A correlation was also computed for 11 of the 12 children in the number concept learning task by taking the number of responses required to learn all the skills up to the writing of the numbers 1–5. The Pearson correlation was .398, which means that 16 percent of the variation in this cognitive learning could be attributed to IQ score. In both of these cases it should also be pointed out that the children with the higher IQ's were better learners, especially at the beginning of the study, because of skills that had nothing to do with learning rate, for example, such things as rate of response and the quality of their attention.

IV
DISCUSSION

With respect to the points raised in the introduction, the present study made initial explorations of the possibility that the training in the cognitive repertoires would affect the children's performance on intellective tests. The results indicated that there were increases in the mean IQ scores and the mean scores on the Metropolitan Readiness test. These findings can only be considered to be exploratory, but the results were encouraging and suggest the need for more systematic research of this type.

The primary purpose of the study was to additionally test the learning theory of cognitive learning previously developed by the author, as well as the reinforcement system, the facilities, and the experimental—longitudinal methods of research. The results of the number concept training appear to clearly suggest that this important cognitive repertoire is acquired according to the stimulus-response analysis. The various children, including the child with the most difficult learning problem of them all, were trained to count objects regardless of the arrangement of the objects. The progress of this training occurred as predicted from the S—R analysis.

Moreover, nine of the children learned to count unarranged objects up to 10. The child with the most difficult learning problem learned to count 5 unarranged objects. Eight of the children also learned to write and read the numbers from 1 to 10, another child could do this from 1 to 9, and another from 1 to 5. There is no reason to doubt that the children could be presented with training methods of the present type that would give them full mathematical cognitive repertoires. This, of course, would require additional years of training, and further research is necessary to test this hypothesis.

Thus, the present results have wide implications for a consideration of cognitive development in general and of mathematics concepts in particular. It may be suggested that this type of cognitive development can be dealt with in very straightforward learning terms. This conclusion in turn suggests that learning analyses and experimental procedures of the present type should be elaborated and extended to provide a full and detailed treatment of this type of learning. It may be confidently expected that such a development would provide a complete scientific theory of this type of cognitive development which would give us understanding, as well as have much practical value in terms of developing teaching materials— beginning, as in the present case, from the very onset of the acquisition of the repertoire. The author plans to conduct this type of research in a long term project and has already set up the necessary laboratory—classroom complex at the University of Hawaii.

The same types of results appeared to be true in the area of writing acquisition. The various children appeared to learn this cognitive repertoire in a straightforward stimulus—response manner, progressing similarly, at about the same rate, except for two children who required additional training in copying. It was possible to employ simple stimulus materials in a standard manner— administered by individuals not trained in working with children or in teaching.

In addition to providing support for the learning theory of cognitive development, the study also indicated the value of experimental—longitudinal research and the ability of the methods to produce replicable findings. That is, the theory and procedures developed with the one child and employed successfully with several additional children, produced the same types of results with the 12 additional culturally deprived children. Furthermore, the procedures also appeared to have cognitive and social therapeutic value for the children. As suggested in the introduction to the present chapter, the fact that the theory and methods could be used effectively in the child's own interests has implications for the further development of a science of complex human behavior. That is, long term research with children cannot be conducted unless the children also benefit from the research. This requirement appeared to be met by the procedures and general laboratory facility that have been described herein.

One of the most important developments of the present line of the author's long term research plans is methodological, that is, in the general strategy of research, the development of the general procedures (especially the reinforcement system), and in the general laboratory–classroom complex. This topic will not be discussed fully here (see Staats, 1968). However, it may be suggested that this development represents a breakthrough in the experimental study of human intellective behavior. Using these methods and the learning theory it should be possible to investigate with the precision approaching that of the laboratory some of the most complex types of cognitive development. The present studies may be considered to have only touched upon the various possibilities of the development as a general research method. The author's planned research will be concerned with these general methodological developments, with the theoretical elaborations of the learning conception, as well as with the use of these two developments in the innovation of curriculum materials.

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