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ARITHMETIC FUNDAMENTALS FOR THE BRAIN-CRIPPLED CHILD *

By Laura E. Lehtinen, M.A., and Alfred A. Strauss, M.D.
Northville, Michigan

THE general principles underlying the training of brain-crippled deficient children were presented before this association at last year's meeting. We are aware that for those not acquainted with these specific methods, earlier papers on the psychopathology of brain-crippled children should be outlined shortly. Since this is not possible, we shall only restate some of those conclusions most pertinent to the subject discussed today.

By our definition, the brain-crippled child is a child who has a brain lesion acquired by trauma or inflammatory process before, during, or after birth.

The group defined by us as brain-crippled deficient children include those children who do not show gross disturbances in any sensory or motor field, i.e., deafness, blindness, paresis, paralysis, etc. The mental retardation of these children is the result of a brain lesion and the mental impairment is the sign of crippledness, just as spasticity resulting from a brain lesion is another type of crippledness, here in the motor field. That is, the psychological defect in the brain-crippled deficient child is equivalent to the physical defect in the child with motor handicap.

Comparing mentally retarded children of the hereditary, familial endogenous type with children of the brain-injured type leads to the conclusion that the mental structure, intellectual impairment, emotional disturbances and personality deviations are fundamentally different in both groups. These conclusions lead to the assumption that the training of brain-crippled deficient children should be different from the training of the mine-run feebleminded child. This assumption has been substantiated by clinical experiences and experimental research. Out of this research crystallize the following directives which should be taken into consideration in the academic training of brain-crippled deficient children.

1. The brain-crippled deficient child does not profit from methods derived from the concept that the mentally retarded child is a slow learning child with normal abilities in lessened degree. This statement is the consequence of our research findings which indicate that the intellectual impairment of the brain-crippled child is qualitatively different from that of the mentally retarded or slow learning child.

2. The brain-crippled deficient child needs training which takes into account his general disturbances; some of these are hyperactivity, distractibility, pathological perseveration, etc. The training

* Studies in the Psychopathology of Childhood and Mental Deficiency, supported by a grant from the McGregor Fund, Detroit, Report No. 67.

From the Wayne County Training School, Northville, Michigan, Robert H. Haskell, M.D., Medical Superintendent.

of these general disturbances require special methods and materials to be applied irrespective of the academic tool subject, reading, arithmetic, or writing, which may be taught.

3. The brain-crippled deficient child should be trained in the acquisition of academic skills on the basis of his pathological mental organization which is the result partly of general disturbances and partly of specific deficiencies.

The presentation today deals with the training of a particular academic skill, number work. The material used for the training of general disturbances, therefore, will be mentioned only accessorily. Before presenting our main problem, the teaching of arithmetic fundamentals, the concept of arithmetic readiness as it applies to this particular group should be defined.

It is generally assumed that a mentally retarded child is ready for academic training in number work when he has reached a certain mental age, usually fixed at six and a half to seven years. This assumption is based on experience with thousands of normal and retarded children. It is implied that a child at this mental age has had number experience in a kindergarten, preschool unit or at home; this number experience includes counting up to ten, the adding or taking away of one or two, recognition of some but not all written numbers, understanding of the concepts more and less, larger and smaller, and sometimes some units of money and time.

We are faced with two problems if we must diagnose the arithmetic readiness of the brain-crippled child.

First, he often cannot acquire these pre-academic skills in number work because of his general disturbances or specific deficiencies although he has a mental age of four or five years.

Second, even waiting until he has reached a mental age of six or seven years will often not provide the awaited accumulation of knowledge and experience which is the prerequisite for academic training in arithmetic.

The peculiarity of mental organization which makes a brain-crippled deficient child different from a mentally retarded child of the familial type and which makes the readiness concept not applicable to him should be explained: the mental development and consequent performance of a normal or slow learning child follows well defined stages of genetic succession; readiness can be measured through tests and observations. With a brain-crippled child, however, the actual mental capacity may not be evident because of the general disturbances which befog or overshadow the underlying mental elements. We are prevented, therefore, from its measurement through tests by the barrier of general disturbances (which of itself lowers the test score) and because of failures in achieving skill and accurate experiences due to the handicap of general disturbances in learning situations. If the general disturbances can be removed or remedied or improved, then the real ability and the true developmental period become apparent. Pre-academic work in arithmetic, therefore, or the problem of achieving "readiness" for the child consists of a preparatory period of counting, recognition of figures to ten and a few accurate ideas of number relationships.

These are not presented in developmental succession. They are presented with respect to the child's deficiencies and to the difficulties which they impose. These may appear in differing degrees at various developmental levels.

Let us suppose that a child with a chronological age of ten years and a mental age of five years comes to the class. He has already experienced failure in kindergarten, first grade and special class. His counting is accurate to three. Beyond that he runs over a series and counts five as eight, or combines objects so that seven is counted as four. Given another trial he may count 1, 2, 3, 6. When corrected and asked to do it again, he maintains an attitude throughout of "I can count; I did it."

Another child with a chronological age of eleven years, mental age of six and a half years, knows the number names to 50. An energetic teacher capitalizing on the boy's excellent memory has taught him all the doubles combinations to 12 and 12. This boy, however, cannot count concrete objects to 6. He cannot combine and count objects, even the additions of 1 or the drilled doubles.

Another child, a girl, with a chronological age of eleven years and a mental age of six years can count objects accurately to 50. However, she cannot remember which form means 5 and which means 6. She cannot read or make a digit beyond 1.

Our problem then is: How can these children be taught to grasp the elements necessary for beginning number work?

A very distractible child knows the number names but cannot count because of his verbal and motor disinhibition. With a board of screws and blocks to be fitted over the screws he can slow down this verbal and motor disinhibition. The activity of finding the hole in the block and slipping it onto the screw is sufficient to delay him, a result which is not achieved through counting objects or dots by pointing to them. With this board as a means, he can solve written arithmetic problems, and finally succeed with number operations without a concrete aid.

Another child is erratic and confused in his counting. He may count a series of dots and overlook one or he may count one dot in the series twice; he may lose his place and skip back to count an earlier counted dot a second time. For such a child each object in a series of beads or blocks or dots remains an isolated element which never forms part of a total chain. For the purpose, therefore, of achieving this totality the child may make clay balls and place them over the dots drawn on a card. Then he removes the clay balls to the side, so that although they are no longer on the card which formed the whole, they still are a group together. Instead of clay balls, multi-colored dots may be used, because then the color-sequence aids in structuralizing the whole.

A specific deficiency encountered in number recognition and writing of numbers was described in our paper of last year.

These are a few examples of the many methods which must be utilized in order to teach these children the elementary knowledge of number and

counting. We may add that there is an immediate transfer of knowledge gained in formal counting periods to counting in daily life situations.

This preparatory period may be said to have ended and the academic training proper begun when arithmetic is presented in problem form. This is done as soon as the child can count easily and with assurance and recognizes the number forms to 9 or 10, whether his mental age is six years or not. This is possible because the child is asked only to manipulate concrete numbers in all their different combinations within 10; he is not asked to become independent through memory in their use as is the goal in beginning arithmetic work with normal or mentally retarded children. As a matter of fact we wish to stress that the child does not solve his problems by memory in his early number work. When understanding is achieved and concepts are clear, he becomes independent of material aids. The excellent memory of the brain-crippled child may deceive the teacher into a too high estimate of his achievement. Since he often learns easily by rote, he may quickly memorize combinations, apparently having " mastered " them, but without any real knowledge of the process and relationships.

Another general disturbance which must be considered is perseveration. Although it is not conspicuous in all activities, it may become apparent during a learning situation. We mention a few general practices which we have used to keep it at a minimum and to avoid its increase. Perseverations are most easily elicited or increased by activities within the motor field. e therefore do not recommend training the brain-crippled deficient child with counting on his fingers or with tapping. In order to avoid spontaneous use of the fingers as much as possible, the child is first taught the numbers from 1 to 6 rather than from 1 to 5. Neither is there a long delay at the number 10; the series from 11 to 20 is developed as soon as the child can master it. If perseveration exists to an extreme degree, the mechanical aids must be changed frequently during the same arithmetic period. To develop flexibility and to hinder the establishment of strong perseverations, the child may have problems printed in horizontal as well as vertical rows on the same page, problems of addition mixed with subtraction, and dots for counting given in different configurations such as 3 in a triangle and 3 in a row. Very early, even while counting within 10, the child should learn to count backwards. This is important for the disinhibited as well as the perseverative child.

The center piece of concrete material in arithmetic instruction is the abacus Different types of abacuses are used, varying according to the child's stage of knowledge and the degree of perseveration. The first is an abacus with 10 wires with beads progressing from 1 bead on the first wire to 10 on the last. The beads on a single wire are of the same color, but each row is a different color. Through these color cues, the child learns that 4 is the blue row, for example, 5 is the green, etc. He has 2 additional cues, the separation of each number group from the

others, and the length of the row. In some cases, a fourth cue, the shape of the beads, may be added. The abacus can be varied according to the child's difficulties in learning.

As soon as the child is skilled in adding within 10, he begins work with the next abacus. This one consists of 100 beads, arranged on 10 wires of 10 beads each. The same principle of separating the number groups with colors (here the groups are of 10) is used. Thus the first 10 may be blue, the second row of 10 yellow, the third row green, etc. The color cue is removed in the next abacus, the beads being strung with random colors on the wires.

The child is not given an obligatory system for using the abacus, beyond the limitations imposed by his material, i.e., the abacus is constructed in accordance with our number system and it must be used to coincide with the system; the relationship cannot be obscured. However, he is encouraged to find as many ways of solving a problem as he can. For example, 24+9 may be solved by one child as 29+4, by another as 29+1+3, by another as 24+6+3. One child may solve 7+9 as 7+7+2, another may use 10+7−1. 12−5 may be solved by 10−5+2, on another occasion as 12−2−3. The relationships of a number and its components should be learned rather than the constant quantity value alone.

Pages of arithmetic workbooks are used wherever applicable, but the greater part of the material is hektographed.

At some point in this process it frequently occurs that understanding or insight is lacking and some skill has not been achieved. For these hurdles in learning special material aids have been constructed. These are in the nature of demonstration material, similar, if you will, to the apparatus of a physics or chemistry demonstration lecture. A concrete device illustrates the principle or process involved with an ease and rapidity which is impossible with words alone. A few devices may be mentioned briefly. To illustrate the process of partial counting and to demonstrate its superiority as a method for those children who persist in beginning the counting of any addition with 1, there are little boxes, with 2 or 3 or any number of small sticks up to 10. With these a child builds up a number series to 100 by consecutive additions of 3, for example, each time keeping the last result in mind as the beginning for the next addition. For example, 1+3=4+3=7+3=10+3=13, etc. In subtraction, to demonstrate the reversible process which can be checked by addition, there is a board in which are fixed 10 rows of beads from 1 to 10. A sliding metal strip is used to divide the number subtracted from the remainder of the total group. In this way, the subtraction appears on one side of the strip and the remainder on the other, but the original group is preserved intact.

Story problems, like our other arithmetic work sheets are seldom given to the child in workbook form. We have found it much more successful to paste each problem on a small cardboard piece and to count out a number of them for the child's arithmetic assignment. There are several reasons for this preference. A very distractible child has great difficulty if problems are

presented all on one page in knowing where to put his answer. This is avoided if the problems are on cards. Separate problems have greater flexibility; they can be assorted according to the degree of difficulty for a particular child (not a standard group). Problems can be repeated after a period of time has elapsed, independent of the plan of a workbook. For the ever present problem of the child who does not read or who reads poorly, problem work is oral in a small group.

One word should be added on the question of evaluating the child's success with our methods. One may ask, why are you not satisfied to use generally accepted achievement tests for arithmetic? The Wayne County Training School uses the Metropolitan Battery but there again it has been our experience that the brain-crippled child because of his general disturbances tends to score lower than his performance in the classroom would indicate. Because of the timing of the test he is fundamentally handicapped in comparison with the groups for which these tests are standardized. We have collected data on the results of the Metropolitan Achievement tests and have found strong indications that our clinical observations are correct.* For this reason we have constructed a test similar to a diagnostic test. It is short, without time limit, and the child is tested individually. A card covers the page and the problems appear individually through a slot in the card. This test allows a qualitative diagnosis of the errors and therefore a conclusion as to the understanding of the specific arithmethic process involved. To procure a rough judgment of the effectiveness of our method, we have compared two matched groups, one of brain-crippled deficient children, the other of endogenous children. These two groups were tested at the beginning and end of a school year with the result that although the grade level reached by both groups was only slightly in favor of the brain-crippled group (a fact which in itself might have significance) the group of brain-crippled children had fewer errors which could be interpreted as due to a lack of understanding of the arithmetic processes and the errors in the tests at the beginning of the school year which could be assumed to be produced by general disturbances had largely decreased or disappeared.

* Unpublished investigation by Esther Hatoff.

SUMMARY

A method for training fundamentals in arithmetic for brain-crippled children has been presented. We must ask indulgence that the extent of the materials used and the methods applied cannot be explained in the short time allowed. We only wish to emphasize as we did a year ago that the brain-crippled deficient child offers a problem of its own in special education. The observations of clinical experience and the results of psychological experimentation allow us to introduce a curriculum which includes the remedial training of general disturbances as well as the teaching of academic fundamentals.

For references see: Lehtinen, L. E., and Strauss, A. A. A New Approach in Educational Methods for Brain-Crippled Deficient Children. *Am. J. Ment. Def.*, 48:283, 1944.

OBSERVING FOR LEARNING DIFFICULTIES IN A PRE-READING SITUATION FOR HIGHER GRADE MENTAL DEFECTIVES *

By R. Melcher Patterson, Ph.D.
Research Associate

AND

Ethel Louise Curtis, M.A.
Teacher

PREPARATION for rapid academic progress, especially in reading, has been a goal of the Prolonged Pre-academic Program at the Wayne County Training School. In this experimental unit, mentally deficient boys who enter the institution under eleven years of age with mental ages under eight are enrolled. The experiment is designed for the I.Q. range 60 to 80, but children under 10 years of age with I.Q.'s of 80 or over are sometimes enrolled for social adjustment. All are transferred to academic work when a discrepancy of not more than two years between mental age and educational age develops or when they reach 12 years of age.

The children participate in an activity program stressing social living and work habits into which modern techniques of specific preparation for reading are incorporated. Although group results in subsequent academic progress have been satisfactory, there is still much to be desired in exploration of individual differences and in isolation of factors which are prognostic of readiness for reading or which indicate the need for adaptations in method of instruction.

For a number of years, the Monroe Reading Readiness test has been given to the children annually. Mental age has been used instead of chronological age in scoring the tests for percentile levels. In terms of the test's divisions, such as visual and auditory discrimination and memory, ocular-motor control, and so on, the results have shown individual patterns of strength and weakness which corroborated observation and were in turn corroborated by clinical reports from the child's performance on the Binet but as a tool for predicting success in reading or as a basis for recommendations as to method of teaching it has not been useful.

In order to explore the prognostic value of the test, we arranged twenty-nine children who had graduated from the Prolonged Pre-academic Program and whose length of reading instruction ranged from 2.4 through 19.2 months in order of the ratio between months of instruction and months of progress as measured on the Metropolitan Primary Achievement Test. Their mental ages ranged from 6–2 to 8–3 years, I.Q.'s from 53 to 80 except for one child who later had an I.Q. of 92. The differences

* From The Wayne County Training School at Northville, Michigan. Robert H. Haskell, M.D., Medical Superintendent. Department of Research, Thorleif G. Hegge, Ph.D., Director of Research and Education.

between the average Monroe percentile scores of the 15 who had achieved most and the 14 who had acheived least were not significant in any category nor in the average of all the categories. The greatest difference was shown in the motor test section which consists of a tapping test, a motor steadiness test, and writing the name. The correlation between percentile scores on this section and academic progress was .24. Inspection showed that no special pattern of abilities was more prognostic than another.

Actual classroom performance in pre-reading activities, such as matching words and phrases, incidental recognition of words and phrases which had occurred frequently in activities, and concentration for considerable periods of time on work involving symbolical material, appeared to be a better indication of future progress than was the sample of abilities tested by the Monroe or most other reading readiness tests.

The task before the authors, therefore, was to devise a method by which a classroom teacher, handling as many as 45 children in the course of each day, might arrive at some objective estimate of each child's pattern of performance and record it for guidance in transferring him to academic work or in referring him for special clinical study and remedial work before rather than after he had experienced failure in the reading situation. Psychological factors only were to be considered, since in the institution where complete physical examinations are given each child, physical handicaps in vision, hearing or constitutional pathology are known.

The present paper reports procedures used in an initial attack on this problem. The work up to this point can be considered only preliminary to a study which will require several years for completion.

PROCEDURE

In the course of a month's observation, an inventory of the classroom activities specifically directed toward reading readiness was made. Although any inventory at a given period is by no means exhaustive, since the teacher introduces new materials throughout the year, a cross section at any given time represents the types of activities used throughout and directed toward producing certain skills in the children.

The items of the inventory were then classified into groups according to the major element required for responses in each situation. Some items were necessarily listed under more than one heading but there were only a few of these. Following are the group headings:

I. *Matching activities.* These include (A) visual, such as pictures, forms, letters, words and phrases and (B) auditory, such as sounds.

II. *Sight recognition and naming.* These include pictured objects, colors, letters, a few words actually taught and incidental recognition of words and phrases occurring frequently in activities.

III. *Responses to literature and music.* These include listening with attention, participation by joining in songs, requests for stories or songs, questions, supplying omitted parts, memorizing poems, interpretation through dramatization, and the like.

IV. *Verbal production.* Activities demanding the correct use of words, sentences and connected sentences in the communication of ideas were classed under this heading.

V. *Non-verbal productions.* Here were classed only those activities which demand some degree of motor skill, such as coloring within bounds, tracing and writing from copy.

VI. *Thinking processes.* These are obviously involved in all activities but there were a few in the inventory which emphasized generalizing and reasoning to an extent which called for a separate heading.

VII. *Following directions.* Activities included here range from carrying a note to a designated individual outside of the classroom to the level where a child may be given a general direction and can follow a series of pictured or printed cues for the detailed steps.

VIII. *Range of information.* In discussion groups, the children have opportunities to show how much they know about a wide range of subjects. For checking, six fields were chosen which are used frequently in first books for children. These are: nature and natural phenomena, household activities, transportation, civic services, family relationships and national and religious holidays.

IX. *Work habits.* Concentration, efficiency, attitude and reactions to frustration were considered. The teacher rated the children on a five-step scale.

For checking the children, a chart was constructed. Under each heading, numbers referred to the specific activities. The present report is limited to a discussion of standards for reading readiness arbitrarily set up for the most mature group of children whose next step will be into academic work. The standards were based on follow-up studies of children promoted from the Prolonged Pre-academic Program. The problem of scoring for specific handicap at any level was more difficult and needs further study.

The situations were selected pragmatically, since the more capable children in the group could succeed in most of them and all members of the group could succeed in some of them. As an example, the situations classed under *Matching Activities* are given below.

(A) Visual. (1) After the news sheet, *Weekly Reader,* has been looked at and discussed, words used in it are printed on the board and the children find the word in the news sheet. (2) After an experience story has been dictated by the children and printed on the blackboard by the teacher, the teacher prints a phrase on the board for the children to find in the story; (3) prints a word, then erases it before the children begin to look for it in the story. (4) The child is given words printed on a card and letters printed on small squares to build up the words. (5) Sentences with word cards are used in the same way as the word and letter cards. (B) Auditory. (6) The teacher says two words and asks if they begin with the same sound. (7) The teacher says two words and asks if they end with the same sound.

To detail all the situations under each heading would require too much time. Instead, a summary of the abilities of a child who cannot read but can succeed in these situations and who, by assump-

tion based on the progress of previous "graduates," will be able to learn to read with the speed approaching that of the average school child, providing his general mental level is between 7 and 8 years, follows.

Given a word or phrase, the child can recognize a corresponding one, whether or not they are in immediate juxtaposition and whether or not the letters are the same size. He concentrates on an individual task involving word matching for 20 minutes or more. He has learned to read a few words through direct teaching and a few through incidental association and he shows the ability to use context and position as cues for immediate recognition of words. He can organize his ideas well enough to give a connected account of an experience or to retell a known story and he can communicate his ideas in connected sentences. He can listen attentively to stories or poems and he shows by questions or by comments or by answers to questions that he has some grasp of the content. He can memorize short poems through group instruction and has a small stock of poems or songs which he can produce upon request. He can follow detailed directions given in pictured or printed cues after a general explanation of the task has been given him. He can think logically to the extent that he can solve a simple problem in mental arithmetic by whatever means are at his command. He can write his own name without copy and can write a few other words from copy. He has a range of general information commensurate with his mental age. He concentrates on a given task which presents a fair degree of difficulty for him and carries it through to completion in a fair amount of time.

All of the situations chosen for checking children in the group whose mental ages are between 7 and 8 years are those in which the child has an opportunity to demonstrate specifically his abilities to do these things.

THE PROCEDURE IN USE

Not every child who is transferred to the academic classes can do all of them. Life age, social maturity, a two-year discrepancy between mental age and educational age, high ability in one field in spite of weakness in another, may lead to transfer of children with different patterns of strength and weakness. The accompanying diagrams illustrate how the checking system, even in its present preliminary stage, shows these differences in patterns of pre-academic achievement.

The height of each column in the diagrams represents the number of items of the degree of difficulty checked for the most advanced group in each classification. The small blocks at the ends of the main figures represent the five-step rating scale on concentration, efficiency, attitude and resistance to frustration in work habits.

Child 1, who has already been transferred to academic work, was a rare example of near-perfection. He could do everything required in the pre-academic program and by our present standards was somewhat limited only in his range of information. His work habits were excellent. As a matter of fact, he already had some reading achievement and he is included here to show how a child with some demon-

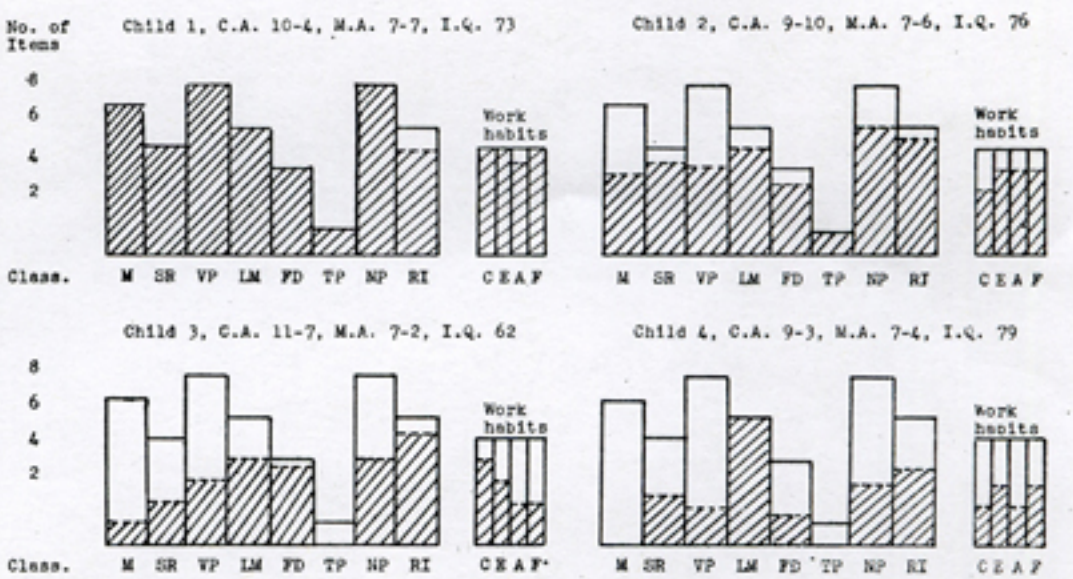
strated success in reading succeeds when checked on this pre-academic chart.

Child 2, whose mental age is only one month lower than that of Child 1, is nearing readiness for transfer. He is still rather low in verbal production and in matching activities. He may not succeed in all items of these two classes even when he is otherwise ready, but he thinks logically, has good work habits, has already learned to recognize quite a few words and seems likely to learn when given formal reading instruction.

Child 3 was chosen as one of the less successful members of the group. He is older than the others, his I.Q. is lower, his work habits are poorer, but according to institution procedure he will have to go into academic work next term when he is twelve years old. He cannot solve simple problems in mental arithmetic; matching activities are particularly low, and he is beneath the class average in sight recognition, verbal productions and non-verbal productions. He succeeds best in activities where his longer life experience has given him more practice, namely: following directions and range of information. This child is also known to have an astigmatic visual defect, corrected by lenses but still possibly a factor in his poor showing on the work in matching. However, he succeeds to some extent in most classifications and the problem seems to be one of general slow development with a possible slight peripheral handicap in the visual field.

Child 4 is younger than the others, has the highest I.Q. of the four, and is distinguished by his total absence of success in matching activities at his group level and by his high success in responses to literature and music. There is no known visual defect. He is poor in concentration and he does not appear to take his work seriously. The pattern

ITEMS PASSED BY FOUR CHILDREN ON THE PRE-ACADEMIC ACHIEVEMENT CHART



suggests a special disability and the necessity for further analysis to isolate it specifically.

When enough children who have been thoroughly checked have demonstrated their ability or lack of it to progress after transfer to academic work, the data can be used to revise both the checking chart and the curriculum. In like manner, the children in the two younger groups can be checked for readiness to move into the older groups and for special difficulties. The development of the charts throughout will be based upon the experience of the teacher and the records of the children. Eventually a practical tool should emerge which should help a pre-academic teacher of mentally deficient children to know what things are important for a child to master before he starts academic work, whether or not each child in her group can do these things and what recommendations to make or procedures to adopt if he cannot do them.