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ABSTRACT

A study was initiated with 60 blind children (kindergarten through grade 2) in order to validate the order of a sequence of tactual discrimination tasks leading to the use of braille and the Optacon. Ss were tested with tasks designed for the readiness level (discrimination of large solid geometric shapes, flat puzzle pieces, embossed dot geometric figures, raised line geometric figures, embossed dot line figures, and raised line segments), culminating with the tactual discrimination of braille figures and of inkprint figures presented on the Optacon. Scalogram analysis of the data supported the hypothesized order of the tasks. Tactual discriminations on the Optacon, considered separately, were not beyond the capabilities of most of the second grade children in the study. (Author/IM)

The Validation of a Learning Hierarchy in Tactual Discrimination for Blind Children

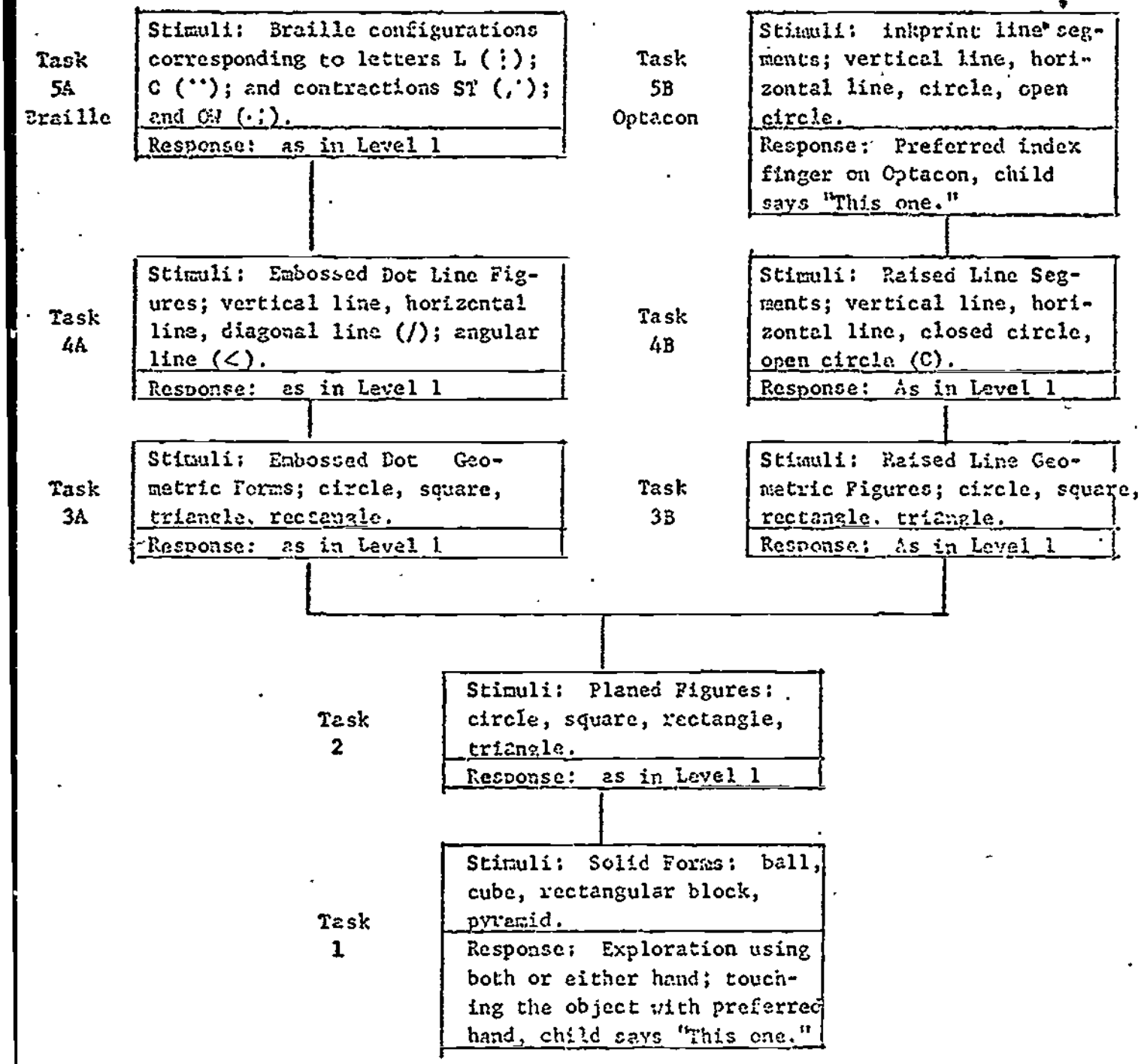
The general focus of this study was aimed at the so-called "readiness" level of tactual discrimination skills in visually handicapped children. Specifically, an attempt was made to validate a series of tactual discrimination skills designed to culminate in the discrimination of simple braille figures and simple print letters perceived through the Optacon.

The purpose of this investigation was two-fold: (1) to validate the hypothesized order of a series of tactual discrimination tasks; (2) to determine the grade level(s) at which most "normal blind" children successfully perform simple tactual discriminations presented on the Optacon. The author reviewed the literature on a wide variety of related issues including tactile sensitivity, tactile resolution and tactile image perception. Within the last of these three topical areas, there was a substantial number of research studies dealing with the tactual discrimination of mazes, solid forms, raised-line figures, embossed dot figures and braille figures as well as Optacon-related research. The largest number of these studies compared blind and sighted subjects' performances using only one type of materials. There was only very scant research however to suggest an order, from easy to difficult for the use of all of these various materials. For this reason, it was also necessary to review the literature on the early development of tactual skills in blind and sighted children. From these reviews, the following sequence of tasks in tactual discrimination was devised and proposed to be in hierarchical order, from easy to more difficult. Table 1 shows a schematic diagram of the tasks, with

Table 1

Schematic Diagram of the Hierarchy of Tasks

in the Development of Tactual Discrimination



Place Table 1 About Here

tasks 5A and 5B representing the terminal and most difficult tasks in the sequence. It was hypothesized that: given the same question form in each case ("Find the one that is not the same") and requiring the same response in each instance (touching the figure and saying "This one"), basic tactual discrimination skills using the following numbered materials are acquired in the order of 1, 2, 3A, 4A, 5A, or 1, 2, 3B, 4B, 5B:

1. Large solid geometric shapes;
2. Flat (puzzle pieces) figures smaller than (1) above;
3A. Embossed dot geometric figures smaller than (2) above;
3B. Raised line geometric figure smaller than (2) above;
4A. Embossed dot line figures;
4B. Raised line segments;
5A. Braille figures;
5B. Inkprint figures presented on the Optacon

Subjects

The subjects were 60 blind children, twenty in each grade level from kindergarten through grade two in public and residential schools in the northeast quadrant of the United States. Ten children in each grade level were drawn from day schools and ten from residential schools.

The following criteria were applied to all children:

(1) Only children with vision in the range between total blindness and light perception or light projection were included. Any child who "eyeballed" the materials was excluded from the study.

TABLE 2

Distribution of Subjects by Sex,

Grade Levels and School Placements

Grade Level	Day School		Residential School		
	Boys	Girls	Boys	Girls	Total
Kindergarten	6	4	7	3	20
Grade One	4	6	6	4	20
Grade Two	4	6	2	8	20
Total	14	16	15	15	60

(2) Only blind children with no other recorded sensory, physical or intellectual handicapping conditions were included.

(3) Only children with onset of visual impairments before the age of five years were included. According to Lowenfeld (1973), children who become blind before that age do not have a workable visual memory, that is, are primarily tactually-oriented.

In order to locate the required number of "normal blind" children meeting the above criteria, it was necessary to communicate with a total of 15 states and to travel to nine. The distribution of subjects by sex, grade level and school placement is summarized in Table 2.

Place Table 2 About Here

Materials

All materials were prepared specifically for use in this study. All materials for tasks 1 and 2 were made of hardwood and finished with varnish; all wooden shapes were oiled. All materials for tasks 3A, 4A, 5A, 3B and 4B were prepared on heavyweight braillon. Items for task 5A, the braille configurations were prepared on a standard Perkins Brailler. Materials for the Optacon (task 5B) were prepared on an Olivetti electric typewriter (Editor 2) with Elite Correspondence Gothic type. A complete and detailed description of the materials is available on request from the author.

For each level of the hierarchy, each stimulus figure (e.g., the wooden ball) was compared with 3 other models of only 2 other stimulus figures (e.g., 1 ball and 3 cubes; 1 ball and 3 rectangular blocks). Correct responses appeared once in position (1) and (4) and three times

In positions (2) and (3). In this way, more weight was given to those items where three identical figures did not appear in a row.

With eight items in each of the eight tasks of the hierarchy, each child was given 64 items in all.

Administration

All subjects in the study were tested in the latter half of the academic year 1974-1975. Each child was tested individually by the same female experimenter. The administration procedures were established in pretesting and were identical for all subjects thereafter.

Since it was not the purpose of this study to compare the 2 parts of the branching hierarchy for tasks 3, 4 and 5, half the subjects in each grade level were administered parts A first, then parts B. The other half did parts B first, then parts A. Using a Student t-test, mean total scores for those who were administered the braille sequence first were compared with mean total scores for those who performed the Optacon sequence first. This analyses ($t=1.207$, not significant) (not shown) indicated that the order of presentation had no effect on performance.

Data Analysis:

Scalogram analysis (Guttman, 1950) was used in analyzing the data in reference to the hypothesis, which is concerned with the order of tasks. Two separate analyses were done, each using tasks 1 and 2 followed by 3A, 4A and 5A or 3B, 4B and 5B. The usefulness of scalogram analysis for the purpose of evaluating hypothesized hierarchical relationships among specified behavioral objectives has been shown (Boozer and Lindvall, 1971).

Scalogram analysis provides a procedure for arranging the tasks

Table 3

Scalogram of Results

for Tasks 1, 2, 3A, 4A, 5A;

Criterion of Mastery: 6 or more

Subjects Number	Tasks					
	1	2	3A	4A	5A	Total
15	1	1	1	1	1	5
17	1	1	1	1	1	5
19	1	1	1	1	1	5
20	1	1	1	1	1	5
21	1	1	1	1	1	5
24	1	1	1	1	1	5
25	1	1	1	1	1	5
26	1	1	1	1	1	5
27	1	1	1	1	1	5
28	1	1	1	1	1	5
29	1	1	1	1	1	5
30	1	1	1	1	1	5
31	1	1	1	1	1	5
32	1	1	1	1	1	5
34	1	1	1	1	1	5
35	1	1	1	1	1	5
36	1	1	1	1	1	5
38	1	1	1	1	1	5
40	1	1	1	1	1	5
41	1	1	1	1	1	5
42	1	1	1	1	1	5
43	1	1	1	1	1	5
44	1	1	1	1	1	5
45	1	1	1	1	1	5
46	1	1	1	1	1	5
47	1	1	1	1	1	5
48	1	1	1	1	1	5
50	1	1	1	1	1	5
51	1	1	1	1	1	5
52	1	1	1	1	1	5
54	1	1	1	1	1	5
55	1	1	1	1	1	5
56	1	1	1	1	1	5
57	1	1	1	1	1	5
58	1	1	1	1	1	5
59	1	1	1	1	1	5
60	1	1	1	1	1	5
39	1	1	1	0	1	4
49	1	1	1	0	1	4
14	1	1	0	0	1	3
2	1	1	0	0	0	2
5	1	1	0	0	0	2
6	1	1	0	0	0	2
9	1	1	0	0	0	2
37	1	1	0	0	0	2
53	1	1	0	0	0	2
1	1	0	0	0	0	1
5	1	0	0	0	0	1
7	1	0	0	0	0	1
13	0	0	0	0	1	1
22	0	0	1	0	0	1
4	0	0	0	0	0	0
8	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
16	0	0	0	0	0	0
18	0	0	0	0	0	0
23	0	0	0	0	0	0
33	0	0	0	0	0	0

such that achieving a passing score in a behavioral objective higher in the sequence reliably predicts passage of all objectives lower in the sequence. The analysis requires that raw scores be converted into dichotomous (pass-fail) scores as designated by a criterion of mastery. Although it has been shown (LaPresta, 1975) that the alteration of the mastery criterion can have a significant effect on the scales produced. For the present purposes only one mastery criterion, 6 or more correct responses out of 8 in each level of the hierarchy is being used.

In scalogram analysis, the number of errors in a set of data is used to calculate the coefficient of reproducibility, which is a measure of the degree to which the set of data approximates a perfect scale. Although there are several ways of counting the errors in a scalogram, only one method is used for the present purposes: All zeros that appear to the left of a one in a scalogram are counted as errors. A minimum reproducibility coefficient of .80 was used throughout this study as the criterion for the existence of an acceptable scale (Boozer and Lindvall, 1971).

Results

The data for each branch of the hierarchy were analyzed separately. Raw scores for the sequence of tasks 1, 2, 3A, 4A and 5A, the braille sequence were converted into dichotomous scores using a mastery criterion of 6 or more correct responses out of 8 for each task. The resulting scalogram is shown in Table 3. Observing this scalogram, it becomes

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Place Table 3 About Here

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apparent that the largest number of children passed all of the tasks in

TABLE 4

Scalogram of Results

for Tasks 1, 2, 3B, 4B, 5B;

Criterion of Mastery: 6 or more

Subject Number	Tasks					
	1	2	3B	4B	5B	Total
17	1	1	1	1	1	5
19	1	1	1	1	1	5
20	1	1	1	1	1	5
27	1	1	1	1	1	5
28	1	1	1	1	1	5
29	1	1	1	1	1	5
30	1	1	1	1	1	5
31	1	1	1	1	1	5
32	1	1	1	1	1	5
34	1	1	1	1	1	5
35	1	1	1	1	1	5
36	1	1	1	1	1	5
39	1	1	1	1	1	5
42	1	1	1	1	1	5
43	1	1	1	1	1	5
44	1	1	1	1	1	5
45	1	1	1	1	1	5
46	1	1	1	1	1	5
47	1	1	1	1	1	5
48	1	1	1	1	1	5
49	1	1	1	1	1	5
51	1	1	1	1	1	5
52	1	1	1	1	1	5
54	1	1	1	1	1	5
55	1	1	1	1	1	5
56	1	1	1	1	1	5
57	1	1	1	1	1	5
58	1	1	1	1	1	5
59	1	1	1	1	1	5
60	1	1	1	1	1	5
15	1	1	1	1	0	4
21	1	1	1	1	0	4
24	1	1	1	1	0	4
25	1	1	1	1	0	4
26	1	1	1	1	0	4
38	1	1	1	1	0	4
40	1	1	1	1	0	4
41	1	1	1	1	0	4
50	1	1	1	1	0	4
14	1	1	0	1	0	3
37	1	1	1	0	0	3
2	1	1	0	0	0	2
3	1	1	0	0	0	2
6	1	1	0	0	0	2
9	1	1	0	0	0	2
53	1	1	0	0	0	2
1	1	0	0	0	0	1
5	1	0	0	0	0	1
7	1	0	0	0	0	1
4	0	0	0	0	0	0
8	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
16	0	0	0	0	0	0
18	0	0	0	0	0	0
22	0	0	0	0	0	0
23	0	0	0	0	0	0
33	0	0	0	0	0	0

TABLE 5

Summary of Children in Each Grade Level

Passing Optacon Performance

Mastery Criteria:	Kindergarten		Grade One		Grade Two	
	Number	Percent	Number	Percent	Number	Percent
8	1	5	3	15	10	50
7+	1	5	5	25	15	75
6+	3	15	10	50	17	85
5+	3	15	11	55	18	90
4+	3	15	11	55	18	90

the hierarchy using this mastery criterion. When the total number of errors in this scalogram was used to determine the coefficient of reproducibility, this measure was .97, indicating that the data approximated a perfect scale and the hypothesis was supported.

Similarly, when the raw data of the optacon sequence (tasks 1, 2, 3B, 4B and 5B) were converted into dichotomous scores using a mastery criterion of 6 or more correct responses out of 8, the scalogram shown in Table 4 resulted. In this case 29 of the 60 children passed all of

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the tasks in the hierarchy using this mastery criterion. Ten children passed all but the highest task in the hierarchy. Of the two children who passed only three tasks, one child (Subject 14) shows a scalogram error. There are no other errors in the scalogram. The coefficient of reproducibility for this scalogram is .99, indicating that the data approximated a perfect scale and the hypothesis was supported.

In order to inspect performances on the Optacon alone, a variety of criteria of mastery were used. Scalograms (not shown here) were constructed using mastery criteria of 4 or more, 5 or more, 6 or more, 7 or more and 8 correct responses out of 8 items in each level of the hierarchy. As mentioned earlier, the alteration of the criteria of mastery can have significant effects on the scalograms produced. Table 5 summarizes the results of those children in each grade level who

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Place Table 5 About Here

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showed passing performance on the Optacon alone with various different criteria of mastery. Using the lower criteria of mastery (50%, 62.5% and 75% correct responses), half or more of the children in grade one and two were able to achieve passing scores on the Optacon. For all of the criteria of mastery (including perfect scores), half or more of the children in grade two achieved passing scores on the Optacon. This suggests that the simple tactual discriminations given on the Optacon were not beyond the capabilities of the first grade and were well within the capabilities of the second grade children tested in this study.

Discussion

The purpose of the present study was to validate the hypothesized hierarchical order of a series of tactual discrimination skills culminating with discriminations of braille figures and simple letters presented on the Optacon. The materials used in the proposed sequence of tactual discrimination tasks generally decreased in size and increased in complexity as the child moved through the levels of the branching hierarchy. Scalogram analysis was used to examine the results of the study and the analyses validated the hypothesized sequence of tasks.

Since the scalogram analyses and coefficients of reproducibility supported the hypothesis of the study, it may be concluded that the passage of the tactual discrimination tasks using braille figures and letters presented on the Optacon reliably predicted passage of all tasks lower in the scale.

For the teacher of the young visually handicapped child, this means that if a child can successfully accomplish the terminal tactual discriminations which appear high in the sequence, it is unlikely that he needs further experience with the tactual discrimination of large

three-dimensional geometric shapes, of flat (puzzle pieces) figures of smaller size, of raised line geometric figures or of raised line segments. If, however, the child is unable to accomplish the terminal tactual discriminations utilized in this study, the materials listed above are suggested as a sequence for teaching tactual discriminations which might culminate with those of braille figures and/or simple letters presented on the Optacon.

It should be noted that while this study attempted to validate the sequence of skills in the hierarchy, the relationship of these skills to the later reading of tactile materials was not investigated. Tactual discriminations were treated as a necessary, but not a sufficient condition for the later reading of tactile materials.

In the examination of performance on the Optacon alone, the data showed that given some familiarity with the task and a minimal period of familiarization with the Optacon, many of the first grade children and most of the children in second grade were successful in at least half of the simple tactual discriminations on the Optacon. This suggests that Optacon training need not be limited to older blind children because of the presumed limited tactual discrimination capabilities of young blind children.

Suggestions for further research included the exploration of other components of the task of reading tactile materials, the variations of materials within the present hierarchy and the application of the present hierarchy to different populations.

Summary

The purpose of the present study was to validate the order of a sequence of tactual discrimination tasks for young blind children. The tasks were designed for the readiness level, culminating with the

tactual discrimination of braille figures and of inkprint figures presented on the Optacon. Sixty young blind children in three grade levels were tested and scalogram analysis of the data supported the hypothesized order of the tasks. The tactual discriminations on the Optacon, considered separately, were not beyond the capabilities of most of the second grade children in the study. The implications of the study for instructional purposes were discussed and recommendations were made for further research in this area.

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