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ABSTRACT

The investigation sought to prove that retarded conceptualization behavior of deaf children can be improved by specific compensatory experiences in the manipulation of objects. Twenty-six deaf children of normal intelligence but deficient in language as determined by reading achievement level, ages 10-13 years, were randomly assigned to experimental and control groups. Experimental treatment consisted of participation in 30 30-minute sessions of science inquiry, structured toward the development of classification skills and based on physical manipulation of objects to discover relationships. Pre and posttesting with the Goldstein-Sheerer Object Sorting Test measured categorization level. The experimental subjects demonstrated a significant change in the level of categorization used, indicating that sensory experience, rather than language attainment, was the critical factor in the development of categorization. (KW)

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Studies conducted over the past twenty years have yielded evidence that the abstract mental abilities of deaf children are significantly inferior to those of hearing children. (Templin, 1950; Oleron, 1950; Larr, 1956; Myklebust, 1964) Many psychologists and educators of the deaf consider this an irremedial consequence of language deficiency, and direct their efforts toward changing the level of linguistic competence. There is, however, a largely unexplored possibility that the failure of deaf children to attain normal abstraction skills is only indirectly related to language deficiency, and directly related to restrictive experiential stimulation in early life. (Furth, 1963, 1964)

Categorization is a basic cognitive process. Through the categorization process, equivalent qualities of diverse stimuli are perceived. Research has convincingly demonstrated that categorization skill admits a developmental progression that is related to age. (Thompson, 1941; Goldstein and Sheerer, 1941; Reichard, Schneider, and Rapaport, 1944; Goldman and Levine, 1963) Primary classification is perception oriented, while higher level categorization is conceptual. Research reveals that deaf children are notably retarded in attainment of abstract categorization. While extensive research has been done in assessing the correlation between language deficiency ahd deficient categorization behavior of the deaf, virtually no significant experimental work has been done on possible means of changing this behavior.

Education of the deaf gives almost exclusive emphasis to the teaching of language. (Rosenstein, 1967; Lenneberg, 1967; Kopp, 1968; Streng, 1968; Woodward, 1968) Regardless of the effort exerted in this direction, the great majority of the profoundly deaf population never achieve the minimum criterion of linguistic competence, defined as the ability to comprehend and construct grammatically structured sentences. (Furth, 1966) This combination of circumstances, the inability of a large segment of the deaf population to achieve language competence and the retardation in the development of abstract mental processes in the deaf, invites the investigation of a pedagogical approach to the education of the deaf that stresses sensory experience rather than language attainment.

The goal of science education, as the goal of the education of the deaf, is the development of formal thought. (Educational Policies Commission, 1966; National Science Teachers Association, 1964; Advisory Committee on the Education of the Deaf, 1965; Kirk, 1962; Leitman, 1967; O'Neill, 1968; Simmons, 1968) Many science educators consider the most effective means of achieving this goal to be through inquiry. Though inquiry may be defined in many ways, it is here defined as that mode of learning whereby one discovers relationships through his own activity. This activity may involve physical interaction with the things of the environment or mental manipulation of conceptual schemes, depending upon the intellectual maturity of the inquirer.

Piaget's cognitive theory posits the roots of intellectual development in the direct manipulation of the environment, not in the verbal symbol. (1955) He supports his theory that the basic cognitive structures are derived from actions with the observation that young children classify manually before they can classify linguistically. (1968) The difficulty deaf children experience in the attainment of abstract thought may be related to a dearth of experiences in the manipulation of objects, experiences familiar to hearing children because of the stimulation of verbal communication. The purpose of this experimental investigation was to demonstrate that retarded conceptual categorization behavior of deaf children can be changed by specific experiences in the manipulation of objects.

PURPOSE

If categorization in the deaf is tied to language, its progressive development would be dependent on the development of language. No rapid change in categorization behavior could be expected, because the attainment of language is a slow and laborious achievement for the deaf. If experience is a critical factor in the development of categorization skills, a compensatory program of experiences, specifically structured toward the development of classificatory skills, could be expected to affect a rapid change in categorization behavior. This latter hypothesis formed the basis of the study. Science inquiry was selected as the appropriate method to achieve a change in categorization behavior of deaf children. A program of thirty sessions of science inquiry was developed to investigate the possibility of altering the abstract categorization abilities of deaf children.

METHOD

Subjects

Students of the Archbishop Ryan Memorial Institute for the Deaf in Philadelphia, between the ages of ten and thirteen, were the subjects of the study. The lower limit of the age range was set at ten because, even under normal conditions, abstract classification skill does not usually mature before that age.

The status of the children as language deficient was determined by the combined measurements of degree of hearing loss and reading achievement level. A loss of sixty to seventy-five decibels in the better ear indicates a hearing impairment severe enough to preclude acquisition of language through speech. (Newby, 1958) Three of the experimental children suffered such loss. The remainder of the children were profoundly deaf, with losses greater than eighty decibels in the better ear.

Reading comprehension level of less than 4.5 grade level was used as an index of language deficiency. Linguistic competence, the mastery of a finite set of rules that govern the construction and comprehension of grammatical sentences (Chomsky, 1965), is acquired by most hearing children by the age of four. Clearly, a reading comprehension test would be totally inadequate to measure the linguistic competence of a speaking person. The reading test is not generally accepted as a adequate measurement of linguistic competence of the deaf. Attempts have been made to develop a more valid measure (Cooper, 1967; Moores and Quigley, 1967; Myklebust, 1967; Rosenstein, 1967); but, to date, the reading test is as satisfactory a measure of linguistic competence of the deaf as is available (Furth, 1966; Cooper, 1967). Since the severely deaf and, especially, the profoundly deaf learn language graphically rather than phonetically (Lenneberg, 1967), the level of language attainment can be demonstrated through reading ability. It is more difficult for a deaf child to speak than it is to write; it is more difficult for a deaf child to write than it is to read.

The research of Fusfeld (1955) and Moores and Quigley (1967) indicate that the reading comprehension score of standardized tests yields an inflated estimate of the deaf child's mastery of language. The upper limit of the reading comprehension range established for this research was the attainment equivalent to the average reading ability of American children in the fifth month of the fourth grade (4.5). Below the fourth grade level, only fragmentary aspects of the spoken language are measured by the standardized tests used in this country. (Furth, 1966) A reading comprehension level less than 4.5, as measured by Stanford Reading Achievement Test, Intermediate I, Form W, was used as an index of deficiency in the mastery of language as a graphic system.

All the children in this investigation were of normal intelligence, as measured by the Kuhlman-Finch Scholastic Aptitude Test, and had incurred deafness by the second year of life. The twenty-six children who met the criteria for selection

TABLE 1

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS

Subject	Age (years)	Age (months)	IQ	Reading Level	Decibel Loss (better ear)	Age at Onset
Experimental Group						
A	13	165	73	2.8	103	birth
B	13	164	88	3.7	98	birth
C	13	161	87	2.8	83	birth
D	13	160	102	4.3	85	birth
E	13	159	71	2.3	83	birth
F	13	156	99	2.9	103	13 mos.
G	12	147	109	3.0	107	birth
H	11	140	75	3.4	103	birth
I	11	136	90	3.2	65	birth
J	11	134	91	3.4	98	24 mos.
K	10	127	100	3.0	63	birth
L	10	127	91	2.8	88	birth
M	10	124	116	4.2	108	birth
Mean	11.6	147	91.7	3.1	---	----
Median	12.0	147	91.0	3.0	---	----
Control Group						
A	13	164	103	4.0	62	birth
B	13	163	72	2.7	88	birth
C	13	162	96	3.9	85	birth
D	13	158	100	3.2	98	birth
E	12	148	118	4.0	102	birth
F	12	146	91	2.6	87	birth
G	12	144	85	3.8	110	birth
H	11	140	86	2.8	90	birth
I	10	131	101	3.1	92	birth
J	10	127	100	2.8	97	birth
K	10	125	100	2.6	92	birth
L	10	124	100	2.3	88	birth
M	10	123	100	2.2	100	birth
Mean	11.5	143	96.4	3.1	---	----
Median	12.0	144	100.0	2.8	---	----

were randomly assigned to an experimental and a control group.

Measurement Instrument

The Goldstein-Sheerer Object Sorting Test, as modified by Rapaport, Gill, and Schafer (1968), was selected for the measurement of categorization level. It was chosen in preference to other categorization tests because (1) it assesses overt categorization behavior by the manipulation of real, familiar objects, rather than pictures, geometric forms, or words; (2) it uses the clinical approach to identify the psychological bases underlying groupings of objects; and (3) it measures two distinct types of categorization behavior: free sorting behavior, initiated by the subject, and compliant categorization behavior, initiated by the examiner and identified by the subject.

The cognitive styles underlying free sorting and compliant classifications are indicated by the definitions the subject gives for the criteria used for grouping the objects. Three cognitive styles are identified by the test: (1) concretistic, a mode of categorizing that distinguishes relationships among environmental stimuli through external features, such as spatial and temporal contiquity or perceptual similarity; (2) functional, a mode of categorizing based on the external feature of use; and (3) conceptual, the abstract mode of categorization, based on intrinsic attributes and essences.

The material items of the test consist of thirty-three familiar things, such as silverware, pliers, cigars, sugar cubes, a toy ball, a pipe, and a bicycle bell. The two parts of the test are administered individually. In Part I, the child groups together all the objects that he considers related to a pre-selected sample. This section of the test consists of seven grouping tasks. After each group is completed, the child is asked to give the reason for the grouping.

Part II consists of twelve items. The examiner groups the objects by abstract categorizations of number, color, form, material, and class, and then asks the child to identify the categories used to form the groups. Twelve concepts are used in Part II: white, red, rectangular, round, paper, rubber, two, metal, silverware, smoking equipment, toys, and tools -- representing the five categorical systems of color, number, form, material, and class.

A valid assessment of conceptual categorization behavior, as measured in Part II of the test, requires a vocabulary competency that includes terms for these concepts. A vocabulary test was developed by the investigators (Boyd, 1970) for this purpose, consisting of twenty-eight multiple choice items. This test was given to all the children a week prior to the administration of the pretest.

The standard procedure for administering and scoring the Goldstein-Sheerer Object Sorting Test was formulated by Rapaport, Gill, and Schafer. (1968) The only modification of their procedure for use with the deaf children of this investigation was the addition of written instructions to accompany the oral instructions. The child was allowed to respond orally, in writing, or in sign language.

Procedure

The pretest-posttest control group design was used. Dual forms of the Goldstein-Sheerer Object Sorting Test were used to minimize pretest influence on posttest performance. An interval of ten weeks spaced the administering of the pretest (Form II) and the Posttest (Form I). The vocabulary test was given prior to the pretest to establish that the vocabulary achievement of the children equipped them with the verbal terms required for the conceptual definitions elicited by the Goldstein-Sheerer Object Sorting Test.

Experimental treatment consisted by participation in thirty thirty-minute sessions of science inquiry, structured toward the development of classification skills, and based on the physical manipulation of objects. The lessons were planned with the underlying assumption that the deaf child is different only to the extent that insufficient environmental stimulation has made him so. He knows his environment mainly through sight, smell, taste, and touch. Unaided by the categorical patterns imbedded in verbal language, he orders environmental input by developing his own unique system of categories. The thirty sessions developed and taught by one of the investigators, presented a structured, experiential introduction to elementary classification schemes.

In the initial session the children examined twenty or more objects that represented living and non-living categories. They were asked to sort the objects into two groups of objects that belonged together. When a child demonstrated his understanding of the concept living and the concept non-living through the formation of these groups, he was presented with the written labels living objects and non-living objects. The same procedure was followed as the following sessions encouraged the development of concepts of size, shape, texture, state, material, weight, odor, taste, transparency, viscosity, solubility, buoyancy, and flammability.

The basic skills required for inquiry were gradually introduced as the program progressed. In the first five sessions, the skills of observation, comparison, and classification by a single property were practiced. In subsequent sessions, the recording of data, measurement, seriation, timing of the rate of activities, prediction, and verification were practiced. The final sessions of the program attempted to develop hierarchical classification skills. (Boyd, 1970)

The sessions were held in a laboratory-classroom that was well equipped for inquiry. An effort was made to sustain an atmosphere of freedom and informality. The children were free to move around the room, use the available equipment and resources, and test materials as they wished. A free flow of communication was maintained between student and student, and between teacher and student.

In deference to the oral policy of the Ryan Institute, all demonstrations of techniques were accompanied by verbal explanations. The lessons were structured so that minimal language was required. A new vocabulary was presented in the course of the sessions, but a concrete, experiential basis preceded the introduction of each label. Emphasis was on the production of new concepts, rather than new vocabulary.

Each of the inquiry sessions was thirty minutes in length. The entire program extended over a ten week period. The control group followed the regular science curriculum of the school for an amount of time equal to that used by the thirty inquiry sessions.

RESULTS

The vocabulary test, designed for the study, was administered to the experimental and control groups prior to the pretest. A slight deficiency, three percent of the total possible score, was demonstrated equally in the performance of both groups.

One null hypothesis was tested by the research:

> Participation in specific science inquiry will cause no significant change in the abstract categorization behavior of deaf children, as measured by the <u>Goldstein-Sheerer Object Sorting Test</u>.

The two-tailed test was used and the five percent level was selected as indicative of significance. Although the study was focused on changes in abstract (conceptual) categorization, analysis of functional and concretistic categorization was made for comparative purposes.

The analysis of variance for a two-factor experiment with repeated measures of one factor was made of the total experimental data. (Winer, 1962) The value of this analysis is that, in measuring the significance of the change attributed to the experimental treatment, it takes into account the initial difference that existed between the groups and the change that occurred in the test performance of the control group, uninfluenced by the experimental treatment.

The results of the factorial analysis (See Figure 1 and Tables 2 and 3) lead to the following conclusions:

(1) the initial difference between groups had no significant influence in the final difference between groups.

(2) The test itself was a significant factor (educative) in the posttest change demonstrated by the experimental group.

(3) The experimental treatment effected a significant influence on the pretest-posttest change in the conceptual categorization behavior of the experimental group (Part II) beyond the change effected by the educative influence of the pretest on the posttest performance.

The results of the factorial analysis of the experimental data justify the rejection of the null hypothesis that was tested. The results of the analysis demonstrate a significant change in the level of categorization used by the deaf children in the experimental group. This indicates that sensory experience, rather than language attainment, is the critical factor in the development of categorization.

It is interesting that the difference in pretest-posttest performance in conceptual categorization of the experimental group in Part I, which tested active categorization, approached significance beyond the effect of the educative factor of the test itself. The change in the quantity of conceptual definitions achieved by the experimental group in the posttest seems an indication that the conceptual systems available to them prior to participation in the experimental program allowed inadequate expression of their developmental capacity. In other words, deaf children do use abstract forms of categorizing, but, apparently, the extent of abstract categorizing is limited by a paucity of conceptual structures that deaf children develop autonomously.

The analysis of pretest and posttest data indicate a significant change in compliant categorization behavior of the experimental group. The developmental gain was achieved through a program of experiences in manipulating objects. Furth's

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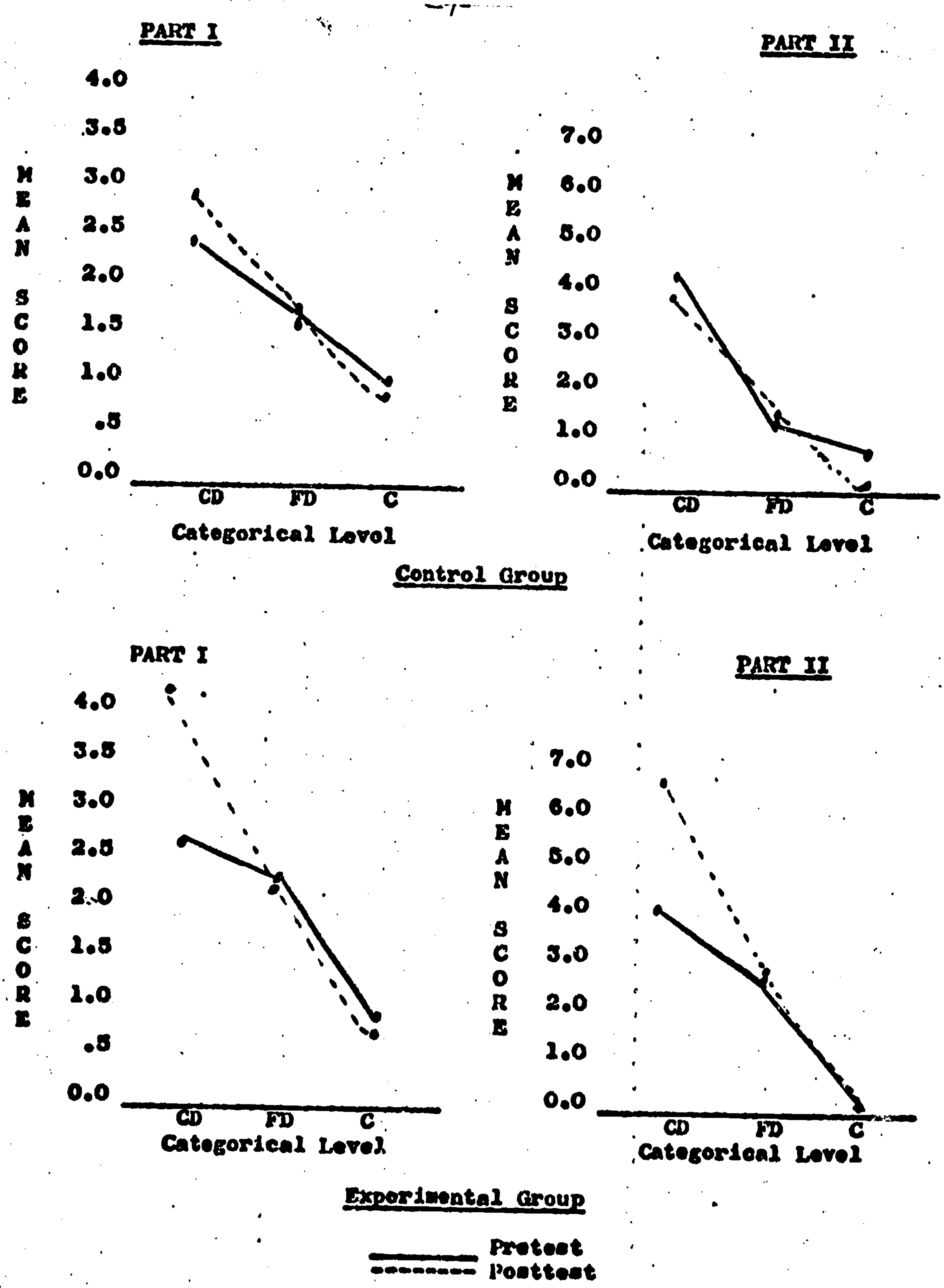

Categorical Levels:

C - Concretistic Definition
FD - Functional Definition
CD - Conceptual Definition

Figure 1. COMPARISON OF MEAN PRETEST AND POSTTEST SCORES FOR THE CONTROL AND EXPERIMENTAL GROUPS

TABLE 2

FACTORIAL ANALYSIS OF VARIANCE FOR CONCEPTUAL DEFINITIONS OF PART I

Source of Variation	SS	df	MS	F
Between Subjects	162.308	25		
A (treatment)	11.077	1	11.077	1.758
Subjects within groups	151.231	24	6.301	
Within Subjects	59.000	26		
B (tests)	11.077	1	11.077	6.020+
AB	3.769	1	3.769	2.048
B x subjects within groups	44.154	24	1.840	

+Significant at the $p < .05$ level

TABLE 3

FACTORIAL ANALYSIS OF VARIANCE FOR CONCEPTUAL DEFINITIONS OF PART II

Source of Variation	SS	df	MS	F
Between Subjects	470.558	25		
A (treatment)	12.019	1	12.019	.629
Subjects within groups	458.539	24	19.106	
Within Subjects	91.500	26		
B (tests)	18.481	1	18.481	10.897+
AB	32.327	1	32.327	19.061++
B x subjects within groups	40.692	24	1.696	

+Significant at the $p < .005$ level.

++Significant at the $p < .001$ level.

postulate that the deficient classificatory behavior of the deaf is the result of experiential restriction in early life is clearly supported by the results of this study. (Furth, 1966)

The significant difference in conceptual categorizing behavior achieved by the experimental group is attributed to exposure to opportunities that encouraged the development of new conceptual categories. An examination of the inquiry program designed for the study (Boyd, 1970) reveals a strategy of continuing challenge of existing mental structures. This is a function of cognitive socialization that rarely reaches the deaf child in his daily life. A hearing child's emergence from egocentricity to socialized thought is stimulated by a gradually developed awareness that there are other ways of viewing the world than his own. (Piaget, 1966) The cognitive socialization of the deaf child is blocked by his inability to exchange viewpoints with the outside world. He can become locked into primitive coding techniques because their inadequacy remains unchallenged. The results of this study suggest that the diminished effectiveness of cognitive socialization in deaf children can be compensated, at least to a limited degree, by exposure to specifically structured experiential programs designed to challenge sub-logical cognitive structures.

IMPLICATIONS OF THE STUDY

The results of the study generate the following implications:

(1) Deficient categorization behavior in deaf children is not an irremedial consequence of lack of language.

(2) Conceptual systems of categorizing can be developed by deaf children through experiential enrichment, exclusive of language development.

(3) Deaf children can benefit from participation in inquiry based on physical manipulation of objects. The question raised regarding the possibility of inquiry without verbal discussion was resolved when it became evident that the children of the study, through several modes of expression (sign language, finger spelling, demonstration, facial expression, and lip reading), can communicate effectively with each other.

(4) The extreme difficulties evidenced by the deaf in the acquisition of language may be related, at least in part, to deficiency in the acquisition of the categorical systems that underlie language. If this is true, then an advance toward normal categorization behavior should favorably influence the acquisition of language by the deaf.

Suggestions for Future Research

(1) The play behavior of pre-school deaf children indicates a normal level of categorization, as describe by Inhelder and Piaget. (1964) In view of the deficient behavior demonstrated by older deaf children, it would seem that research on the categorization of deaf children from five to ten years of age might reveal a pattern of development that would provide a valuable base for the structuring of a compensatory program in the development of categorization skills.

(2) The change in categorization behavior demonstrated in this study was the result of a ten-week program. The positive results of the study should stimulate the development of a long-term study. Perhaps such a study would result in a qualitative change in the use of modes of conceptual categories.

(3) The permanence of the change in categorization behavior should be determined by a re-testing after the lapse of a year or so.

(4) It would be interesting to modify the research design and the science inquiry program for use with research on the categorization behavior of lanquage deficient populations other than the deaf.

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