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ABSTRACT

Learning sets programs were administered to preschool deaf children from a variety of representative educational programs throughout the southwest to improve their visual perception skills. The concept of learning sets was described as progression from trial-and-error learning to immediate problem solving by insight. The project consisted of six 1-year phases. Documentation of deficits in visual perception of preschool deaf children occurred during the initial phase. Phases II through V comprised the development of a treatment program for strengthening visual perception by problem solving and free play. Problem solving involved the child's discriminating commonalities and differences within stimulus sets to earn reinforcement. Free play included the child's exposure to eye-hand coordination toys in a free play setting. Phase VI featured identification of variables, compilation of descriptive data, statistical and test consultation, and data analysis. Main independent measures were five subtests of the Frostig Developmental Test of Visual Perception and the four subtests from the Illinois Test of Psycholinguistic Abilities. The study's important finding was the statistically significant increment in visual perception skills of the problem solving group relative to the control group as assessed by performance on the Frostig. (CB)

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STRENGTHENING THE VISUAL PERCEPTION OF DEAF CHILDREN

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U.S. DEPARTMENT OF
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Captioned Films for the Deaf

Abstract

The present project was concerned with: 1) documenting the deficits of preschool deaf children in visual perception; and, 2) developing a program which would reduce these deficits. The project consisted of 6 one year phases. The initial phase consisted of documenting the aforementioned deficits. Phases II through V consisted of the development of a treatment program for strengthening visual perception called Problem Solving and a treatment program called Free Play. The results of these programs were compared to a non-treatment control group.

Problem Solving consisted of the child's discriminating commonalities and differences within stimulus sets to earn reinforcement. Free Play procedures involved the child's exposure to eye-hand coordination toys in a free play setting. The children in the collective study consisted of preschool deaf children from a variety of representative educational programs throughout the Southwest. The important dependent measures within the test-retest design used were the five subtests of the Frostig Developmental Test of Visual Perception and four subtests from the Illinois Test of Psycholinguistic Abilities.

Statistical analysis indicated significantly greater gains in visual perception skills as measured by the Frostig for the Problem Solving group.

Table of Contents

List of Tables

List of Figures

Introduction

In order to facilitate the reading of this report, the writers have integrated the procedure and results sections so that the reader may follow the chronological development of the project from the time of its inception. Thus, following the literature review, each Phase of the study will be reviewed. The major compilation, analysis and interpretation of the data collected during this study is presented under Phase VI. Following the presentation of the data in Phase VI, the authors present their conclusions regarding the meaningfulness of this data relative to the purpose of the project and their recommendations.

Review of Literature:

The literature review shall be divided into two major sections. The initial section will consist of the literature review presented by Dr. Marshall in her Phase II proposal. Following this review will be a supplementary review on recent applicable literature which has been published since the initiation of the contract.

Initial Review of the Literature:

The initial review of the literature was subdivided according to the variables selected for the study.

Independent variables. The problem solving learning sets training was evolved to use prior research on children's problem solving, and to provide a condition under the control of the teacher.

"Learning sets" is a concept developed by Harlow (1949) to describe "progress from trial-and-error learning to the ability to solve a problem immediately by insight" (p. 116). His research used discrimination learning problems with both monkeys and children. Subjects were confronted with a board on which were placed two objects differing in color, size, shape, etc. When the object to be rewarded was picked up, the subject got the raisins or peanuts in the food cup beneath the object. When the nonrewarded object was picked up, there was no food in the cup. Learning was slow on the first problem. As the problem was repeated with several hundred pairs of objects, each new problem was solved in fewer trials. Eventually, the problem was solved in one trial. One year later, with no intervening practice, the subjects could still solve the problem in one trial.

The extensive research literature on development of learning sets in normal children is well covered in a review by Hayne Reese (1963). The literature on development of learning sets in the mentally retarded is reviewed by House & Zeaman (1963). Generally, the findings are that children can progress quite rapidly from simple to complex problems. The number of trials, rather than the number of problems is the basic determinant of the development of a learning set. The younger the child, the greater is the need to use objects as stimuli rather than pictures. Learning sets are established more rapidly when multidimensional stimuli (differing in many characteristics) are used initially. When normal children are given more trials on similar problems after they have developed a learning set, there is no longer retention of the one-trial problem solving ability. Extremely retarded children can develop learning sets, but are unable to retain them.

Free Play:

The program for free play with constantly changing eye-hand coordination toys is a "best guess" derived from the author's experience as director of university nursery school. When normal children have had months of this experience, they earn high scores on reading readiness tests. At the last school she directed, she purchased enough toys to schedule a daily change in an eye-hand coordination toy. As in the learning sets research, use of each toy led to more skill in solving the next, even if the child failed to master the first. At the end of a semester, the children could solve extremely difficult part fittings.

The only research found to corroborate this idea is briefly described in a summary of Russian research (Zaporozhets, 1965). Sokhina found that children of three to seven years could not discriminate purely visual elements of a complex form until they were given experience in constructing real structures from elements of different forms and sizes. Boguslavskaya found that molding the forms of perceived objects in clay was followed by more precise drawing of the objects by three- to seven-year-old children. L. P. Shchadrovitsky is reported to have demonstrated that the "transition from object-like models to models that resemble real objects less and less, will prepare the child to replace perceived objects with symbols" (p. 96). This type of transition occurs naturally when many eye-hand coordination toys are offered to children.

Nursery school free play is child-directed use of materials in a group situation. Children in American pre-schools spend most of their school day in this type of play. It is generally believed that this program encourages independence, curiosity, and imagination, in addition to easy acquisition of perceptual-motor skills and knowledge. This is another of the many ideas of educators that has not been tested by research.

However, there has been a considerable amount of research comparing "discovery or exploring" types of learning with several levels of teacher-directed learning in classrooms at older ages. The findings of such studies in the teaching of mathematics resulted in great use of this method in the "new math" programs. Cronbach (1963) summarizes this research by describing the following as "well established statements."

"A discovered response is readily discriminated from alternative responses. Pupils who apply a generalization given by the teacher may learn the mechanics of application without understanding and retaining the principle. If the generalization is given ready-made, the pupil may think he understands it when he does not, hence he may misapply it. When one detail fades from memory his knowledge tends to 'fall apart.' But if he has constructed the principle for himself, he can reconstruct it fairly rapidly by recalling the underlying experiences.

Pupils are challenged when asked to discover a solution. This motivates them to pay closer attention and to think about the material outside of class. The solution, when achieved, contributes to a sense of competence and to interest in further learning.

When one group has applied a principle given by the teacher, and another has constructed it from experience, the second group is more successful in discovering the principle for solving a further problem. The ability - or the confidence - that enables one to discover generalizations of a particular type is learned.

....The great value of discovery is in two transfer effects: in attitude toward a field of knowledge, and in improved ability to discover principles." (p. 379-380)

Comparable research with pre-school and older children trained and tested individually is called "curiosity" research. It is based, in most instances, on the ideas of Berlyne (1960). His theory states that certain stimulus characteristics, such as complexity, unfamiliarity, or incongruity, result in exploratory behavior in animals and children. Research on other factors affecting curiosity is only in its initial stages, as is described in an excellent review by Cantor (1963). Penney (1965) reported that less anxious fourth, fifth, and sixth grade children are more curious than those with high anxiety. Penney & McCann (1964) reported curiosity to be positively correlated with originality scores. Smock & Holt (1962) reported perceptual rigidity to relate negatively to the curiosity of first grade children.

Dependent Variables:

The Marianne Frostig Developmental Test of Visual Perception was published in 1964. It was standardized in 1963 on 2100 unselected nursery school and public school children between the ages of three and nine years (Frostig, Maslow, Lefever, & Whittlesey, 1964). The five subtests assess directly the five functions mentioned in Purpose 5. The Maurer adaptation of the test for deaf children is followed in the test administration.

The Illinois Test of Psycholinguistic Abilities (ITPA) was recommended by Dr. Phyllis Maslow of the Marianne Frostig Center of Educational Therapy. Because she and Dr. Frostig think it tests different abilities than the Frostig, their Center always gives both tests.

The ITPA was standardized on 700 linguistically normal children between the ages of two and nine years in 1959 and 1960 (McCarthy & Kirk, 1963). These were randomly selected from a pool of 1100 children who ranged in IQ from 80 to 120, were white, had parents occupationally representing the occupational distribution of Illinois, and were tested within two months of their full or half year birthday.

The four subtests possible to use with deaf children had very small intercorrelations (1.4 to .28) in the standardization group.

Supplementary Review of the Literature:

Covert assumptions of the present project are 1) that visual perception skills are measured by the ITPA and Frostig Test of Perceptual Development and 2) that the skills measured by these instruments are related to reading skills. The following literature review will report the results of studies which have attempted to examine this assumption.

ITPA:

Several studies have attempted to isolate the "factors" which the ITPA evaluation Center (1963) and Loeffler (1963) have reported that the Visual-Motor Sequencing subtest of the ITPA contains a significant "Memory" factor. Kass (1962) has reported that this subtest tends to correlate with reading disabilities.

Cripe (1966) compared two experimental groups of normal 1st grade children on selected aspects of the ITPA. The experimental groups were differentiated on the basis of auditory and visual linguistic vs non-linguistic learning tasks. The author concluded that "(1) differences being measured by the ITPA, if these exist, are extremely subtle, or

(2) that discrepancies in a child's ability to learn auditory and visual stimuli are not measured by this test."

Rachael Burkholder, in a 1968 doctoral dissertation, used the ITPA and other instruments (Gray Oral, Stanford Achievement, WISC) to select second and third grade children who were deficient in reading development.

Burkholder reported, "Practice exercises, primarily in the areas of perception, memory, closure, and classification, were developed along a continuum of complexity, from familiar to less familiar, from pictures and forms to letters and words, from concrete to abstract, from percept to concept. These were taught to ten experimental subjects over a regular schedule over a period of three months."

After three months of training, the children on the experimental group showed a significantly greater gains, relative to the control group, for the following skills: 1) oral reading 2) study skills 3) word meaning 4) auditory and visual memory skills 5) psycholinguistic skills of closure and automatic language, and 6) classification skills. A six month follow-up for 5 matched pairs indicated the experimental group retained its superiority in all of the above areas with the exceptions of word meaning and automatic language.

Slobodzian (1968) examined the relationship between reading achievement and specified reading readiness measures for 115 children in grades 1-4. Among her conclusions was that successful readers as a group score higher on the ITPA subtest of Visual Decoding and Auditory-Vocal Association.

FROSTIG:

Developmental Test of Visual Perception

The Frostig was proposed as a testing device for the visual perception skills of 1) eye-motor coordination, 2) figure-ground, 3) form constancy, 4) position in space, and 5) spatial relations (Frostig, et al, 1964).

Various factor analysis have been made of the five subtests of the Frostig, all of which have narrowed the factors involved in all the subtests to one or two, instead of five, factors. Olson (1968) stated that the five subtests of the Frostig appear through factor analysis to test a single common factor rather than five different factors. Ward (1970) agreed that a general factor accounts for most of variance and that factor is "perceptual maturity."

Hueftle (1967) suggested that two factors were found in an analysis of the Frostig: 1) combination of eye-hand motor coordination and personality characteristics with ability to understand and remember test directions; and 2) the recognition and recall of geometric figures, eye-hand skills, and understanding and remembering directions.

In a summary of research on the factor analysis of the Frostig, Olson stated, "All the studies cited...are consistent in finding that the five subtests of the Frostig DTVP possess a common perceptual function, which strongly suggests that the individual tests are not sufficiently different to assume that the measure separate abilities (1968)." It is suggested that the interpretation of the Frostig DTVP be restricted to the results as a whole and inferences made cautiously from subtest data.

The relationship of the Frostig to reading ability is an area of study which has received sufficient attention to warrant at least tentative conclusions. Olson (1968) states that "there seems to be a consensus that visual perception does play a part in the earliest stages of reading development." Several studies (Barrett, 1965; Frostig, et al, 1964; and Stuart, 1967) have presented strong evidence of the relationship between reading achievement and visual perception.

Three studies dealing with the effects of presentation of a perceptual training program found that scores on the Frostig DTVP did correlate with different phases of reading (Arciszewski, 1969; Brown, 1967; and Alley et al. 1968), but found also that there was a discrepancy in the findings as to the value of the visual perception program in improving reading readiness.

Arciszewski found that normal children receiving the visual perception training did not make significant gains in reading (1969). Brown (1967) found that perceptual training had no effect on reading skills of class for educationally handicapped. Alley et al. (1968) indicated, however, that perceptual training was of value to reading readiness score gains for culturally deprived children. There is not a clear trend present, however, it is suggested that visual perceptual skill training cannot be accepted readily as a means of improving reading potential.

In a study of the relationship of visual perceptual skills with reading in deaf children, it was found that deaf children possessed less proficiency in their ability to handle the alphabetic code, but that both deaf and hearing groups had similar per cent correct scores on the Greek trigrams so there appeared to be no difference in the visual perceptual skill itself (Hartung, 1968). In view of the populations tested and the limited findings, there is not enough existing evidence to determine the relationship between deafness and visual perception, and the effect of visual perceptual training on the reading skills of deaf children. There does seem to be a widespread opinion that perceptual skills are related to reading readiness in hearing children, but it is not known whether or not this relationship can be generalized to deaf children.

Phase I

Method

In July, 1965, Dr. Helen Marshall submitted a proposal to the Office of Education entitled "Pilot Study with Deaf Children." Dr. Marshall's stated rationale underlying this proposal were:

1. "To explore functional testing instruments in visual acuity and visual perception with deaf children."

2. "To suggest program structure and tactile and visual materials needed in a play therapy home or dormitory situation."

3. "To interrelate this program to a reading readiness classroom program."

4. "To suggest visual and tactile materials that should be produced for a more extensive study later."

5. "To develop exercises designed to strengthen visual perceptual abilities as defined by Frostig and Horne, viz., (1) perception of position in space, (2) perception of spatial relationships, (3) perceptual constancy, (4) visual-motor coordination, and (5) figure-ground perception." (Marshall, 1965, pg. 1, proposal number 66-308).

In the course of the pilot study, 51 children in pre-school classes for the deaf in Texas and New Mexico were given the five subtests of the Frostig (Eye-Motor Co-ordination, Figure-Ground, Constancy of Shape, Position in Space and, Spatial Relationships) and four subtests of the Illinois Test of Psycholinguistic Abilities (ITPA); Visual Decoding, Motor Encoding, Visual-Motor Sequencing, Visual-Motor Association). The age range of this sample is presented in Table 1.

TABLE 1

Number of Children at Each Age Level

Chronological Age	Number
2-0 to 2-11	1
3-0 to 3-11	9
4-0 to 4-11	9
5-0 to 5-11	21
6-0 to 6-11	10
7-0 to 7-11	1

(from Marshall, 1966, pg. 4 Phase II Proposal)

Results

Dr. Marshall reported the results of the pilot study in terms of concordence between test scores and chronological age. This was the only type of information presented. She did state that "most of the data will be analyzed this (1966) summer, but a brief preliminary analysis is possible here (Marshall, June 1966, page 3). Table 2 presents the reported results.

TABLE 2

Number of Children Scoring Above, Below, or the Same as Their Chronological Age Norms on Subtests of the Frostig Developmental Test of Visual Perception and the Illinois Test of Psycho-linguistic Abilities (ITPA)

Subtest	Above	Below	Same
Frostig Test			
Eye-Motor Coordination	25	24	2
Figure Ground	11	38	2
Constancy of Shape	17	32	2
Position in Space	3	47	1
Spatial Relationships	30	19	2
ITPA			
Visual Decoding	15	35	1
Motor Encoding	19	30	2
Visual-Motor Sequencing	4	46	1
Visual-Motor Association	26	24	1

(from Marshall, June 1966, pg. 3 Phase II Proposal)

Inspection of subsequent reports submitted to "Captioned Films" failed to indicate evidence of further analysis of this pilot data.

The interpretation of the data presented in Table 2 was as follows.

"On five of the eight subtests, considerably more than half of the children were below their chronological age norms. On two subtests, almost half were below th[illegible]r chronological age norms. On the remaining subtest, two-fifths of the children scored below the norm. Clearly, most of the children performed poorly on almost all of the tests of perceptual abilities.

"The mean size of the deficit was 15 months on the Frostig subtests and 18 months on the ITPA subtests. These are sizeable proportions of the ages of the children, shown in Table 1." The perceptual deficits can be described as extremely large.

"All 51 children were below their age norm on at least one subtest. However, 47 were at or above their age norm on at least one other subtest. The size of the deficits or gains was extremely variable over the eight subtests.

"Forty-eight children were given complete tests of visual abilities. Only eight had any visual difficulty (20/40 or poorer acuity, nystagmus, or use of only one eye). For five of these eight, the difficulty had been diagnosed earlier and treated. None of the children were color blind. Hence, the perceptual deficiencies cannot be described as due to a large frequency of visual difficulties.

"It must be concluded that these children had not compensated for the auditory loss by greater development visually. Instead, these data suggest that these children had been deprived of opportunities to develop visual perception. All of the abilities tested are learned skills (Frostig, 1964). All are essential to learning to read, write, and spell. Perhaps, deprivation of opportunities to learn visual perception contributes to the difficulties of deaf children in learning to read." (Marshall, June, 1966, pg. 4-5).

A second part of Phase I was concerned with developing a program for providing opportunities for deaf children to develop visual perception skills. Two different types of visual training materials were developed during Phase I: (1) the problem solving learning sets training and (2) the free play with eye-hand coordination toys.

Phase II

Method

Phase II consisted of the initial exposure and evaluation of the effects of the two programs for developing visual perception skills which were developed during Phase I. The two programs were problem solving learning sets training (Problem Solving) and free play with constantly changing eye-hand coordination (Free Play). In addition to these groups a control group which received no visual perception training was included.

The procedures for the problem solving group were based on Harlow's (1949) discrimination training studies. These procedures require an organism to attend to differential stimulus characteristics among a set of stimuli and respond by selecting the stimulus with the atypical characteristic of the given set. Set may vary in terms of color, size, shape, position in space, etc. Reinforcement is obtained upon the occurrence of a correct response. Children in the Problem Solving group received forty 15-minute sessions over a 20 week period.

Procedures for the Free Play group consisted of having children in this group spend a period time commensurate to that of the Problem Solving group manipulating toys which, based on face validity, required eye-hand coordination. (The description and rationale of the Problem Solving, Free Play, and Control group procedures prepared by Dr. Marshall for the Phase II proposal are presented in Appendix A).

The dependent measures specified in Phase II were 1) the five subtests of the Frostig Developmental Tests of Visual Perception; 2) the four subtests of the ITPA related to visual perception; 3) tests of visual and tactile curiosity; 4) memory tests; and 5) the Suchman Test of Color Preference. (Dr. Marshall's descriptions of the dependent measures are presented in Appendix B).

Control variables were 1) visual acuity; 2) tests of color blindness; 3) the Kephart Perceptual Motor Survey tests of large muscle coordination 4) teacher estimates of vocabulary; and 5) child and family characteristics e.g. age, audiograms, age of first detection of hearing loss, father's occupation, number of siblings, and minority group status.

Results

During Phase II, data was presented for test-retest differences for 79 children, Dr. Marshall's presentation and interpretation of the data is presented below.

Frostig, ITPA, and IQ scores

Seventy-nine children were given all tests used in statistical analysis. On initial tests, their perceptual age was below their chronological age on seven of the nine subtests of the Frostig and ITPA. The size of the difference is shown in the table below.

TABLE 3

Comparison of Perceptual Age to Chronological Age for Frostig and ITPA Subtests

Subtest	Difference in months from CA initially	Difference in months from CA on retests	Months gain
Frostig:			
Eye-motor coordination	- 9	- 3	12
Figure Ground	- 3	- 1	7
Constancy of shape	+ 4	+ 11	14
Position in space	- 13	- 7	12
Spatial relationships	+ 1	+ 2	7
ITPA			
Visual decoding	- 6	0	12
Motor encoding	- 10	- 1	14
Visual-motor sequences	0	+ 17	22
Visual-motor association	- 7	+ 5	19

(from Marshall, 1967, Pg. 2 Progress Report No. 4)

They were at or beyond their age level on five tests by retest time. Most gains exceed the 5 to 7 calendar months that elapsed between tests.

The gains do not exceed the children's mental capabilities. As is shown in the table below (Table 4) more than half the children were above average in Leiter or Hiskey IQ, and only 23 per cent were below average. It was not a usual or "normal" sample mentally.

The highest IQ was in the 170's, two were in the 160's and several were in the 150's. The two lowest IQ's were 50 and 59.

TABLE 4

Number of Children in Each Training Group Scoring within Three Ranges of IQ

Training group	Below 90 IQ	Average, 90-110 IQ	Above 110 IQ	Mean IQ
Problem solving	6	8	12	110
Free Play with toys	8	12	19	110
Control - no training	5	4	5	99
Total	19	24	46 *(36)	108
Percent of total	23 *(24)	30	57 *(46)	

(from Marshall, 1967, Pg. 2, Progress Report No. 4)

The difference from most deaf populations probably is associated with the age of these children. Brighter parents probably discover deafness earlier and try to give their children more help than do average parents. In the total sample, IQ had a negative correlation with chronological age (-.30). This means either that the older deaf children are when they begin schooling, the more they have been deprived of stimulation essential to IQ, or that there has been less concern about the child's behavior and about helping the child.

IQ did not relate to the size of gain on any test. However, it is the one of all test scores that has the largest correlations with scores on all subtests initially, and at retest. This means that brighter children were less likely to be far from their age level on Frostig and ITPA tests initially, and that average and below average children were likely to be further from their age.

The only test scores that related to the size of the gain were the initial and retest scores on the particular subtest, and these relations were opposite in direction. Gain related negatively to initial test score. That is, children furthest below their age on the initial test gained more months than children who tested close to or above their age level initially. The positive relation between size of gain and the retest scores suggests that the position of many children was quite changed at this time.

*Note: The errors in addition and percentile computation were present in the original table. The corrected values appear in parenthesis.

The correlations between initial test and gain are large enough to account for 12 to 30 percent of the variation between children in size of gain, more than enough to offset any training program.

Statistically, differences between groups can be determined if one factor influencing scores is uncontrolled. There are two factors that relate to these retest scores: IQ and initial test score. In the 1967-1968 year, one factor needs to be controlled in assigning children to training groups. Initial test score is the easiest to control. Children will be assigned to equalize initial test scores of this years groups, and those of next year.

For the above reasons, we cannot determine by adequate test whether differences in our training groups were real. The groups were not well matched on initial test scores. Scores of the problem solving group were one to nine months higher than those of the other two groups on eight of the nine tests. Scores of the free play group were higher than those of the control group on five of the nine tests.

I hope the differences are real. On retests, the problem solving group was at least one month above its chronological age on all Frostig and ITPA subtests. On two subtests, they averaged 20 months above their age level. A primary objective of this project was to find a method of training that could quickly bring children up to their age level.

Retests of the free play group were at or above their chronological age on five subtests. On two of these, they averaged seven and 15 months beyond their age. These findings suggest this training is promising, also. It is easier to give this training to young children than to give problem solving.

The control group was still below their age level on seven of the nine tests. Unfortunately, the IQ difference can account for this. They were 13 months beyond their age level on one test.

The most important factor (a cluster of scores relating to each other) in the factor analysis included IQ and the Frostig and ITPA scores. The test to determine which scores influenced others cannot be run on the computer until fall.

Purdue Perceptual-Motor Survey

The test of large muscle coordination related to most Frostig scores (all involve crayoning), the motor encoding and visual motor sequences subtests of the ITPA, the memory test scores (alternation, etc.), and chronological age. All except the Frostig scores constitute the second main factor in the factor analysis.

Curiosity tests

The measure of curiosity used in analyses to date was the number of seconds the viewing of the most complex stimuli exceeded or was less than time viewing the average of the medium and simple stimuli. This, like last year's measure, correlates negatively with IQ, and obviously is not a measure of curiosity. Apparently brighter children percieve a picture or felt stimulus sooner than those less bright. A different score will be tried in analyses this fall.

A study last year found that deaf children spent more time exploring tactual materials and less time exploring visual materials than hearing children. On retests this year, children averaged three seconds less time on most complex tactual stimuli than at the initial test. They averaged six seconds more exploring the most complex visual stimuli at retest than initially. Such a reversal has been interpreted to mean greater maturity in research with hearing children.

Double alternation (memory) test

The proportion of children learning double alternation (that food is in the two boxes in front in this sequence - LLRRLLRR) was very small. A real difference in training groups appeared in the proportion solving this problem on retests of all the children solving it either test time (five solved it initially but not on retests). Initially, the proportion in all groups was about 1/3. On retests, the proportion in the free play and control groups was still 1/3. In the problem solving group, it was 7/9.

Scores based on a progress from inability to solve any task, to solving the spinning disk, to solving single alternation, and solving double alternation were given each performance. These are the scores that correlate with the ITPA memory test, the Purdue survey, IQ, and CA.

Color-form preference test

On retests, 28 children preferred form, 26 preferred color, and 25 either displayed no preference or could not do the test. Training groups did not differ in preference. Test-retest changes were numerous; only five children failed to change.

Twelve categories of change were needed to cover all types, and no category included more than 14 children.

I have recently worked out a score based on change categories. It will be analyzed on the computer this fall.
(from Marshall, 1967, Progress Report No. 4)

It is the opinion of the present authors that the data presented for Phase II is not amenable to meaningful interpretation in that there is no comparison of change scores within and between the three groups. Although there was a breakdown of IQ data, this was considered a control variable and no attempt was made to relate the performance on the dependent measures to exposure to the various procedures.

The present authors feel that analysis of the data from just Phase II at this time would be inefficient and inappropriate. Further data is available from later phases and to evaluate soley Phase II would be unnecessary. Analysis of change data from first and second year participation in the various programs using children tested during Phases II thru IV will be presented later in this report.

Phase III

Method

In Phase III it was proposed that the sample size be increased by at least one hundred subjects. For those children who received one year of training, a second year of training was proposed. "Materials for the second year of training will be the same as those of the first year, and new materials will be offered." (A copy of the instructions used during Phases II and III are presented in Appendix C).

In addition to the replication and extention of Phase II, Dr. Marshall's proposed to utilize the Coleman Pre-primers. Her rationale for this was follows:

Training with Coleman Pre-Primers

Dr. E. B. Coleman, Graduate Dean at the University of Texas at El Paso, has developed pre-primers that successfully taught Los Angeles kindergarten children to read this past year. He is willing to adapt these for use of deaf children, and to work with Dr. Marshall in designing preliminary training.

The pre-primers will be tried with those children who have a perceptual age of five or more years on most subtests of the Frostig and the ITPA, except those in the no training control group. The books will be mimeographed. Dr. Coleman has filmed some, but the films are designed for hearing children.

(from Marshall, 1967, Phase III Proposal)

Results

As of November 1967, 181 children, from 12 schools were tested, Table 5 presents the difference between test age and chronological age for the 181 children tests. No information was available indicating the test score-chronological age differences for each of the three groups.

The reported number of Ss in each group were: Problem Solving 64; Free Play 69; and Control 56. It was reported that children were assigned to training groups on the basis of their mean months difference in sub-test age from their chronological age on sub-tests on the Frostig Test of Perceptual Development and the Illinois Test of Psycholinguistic Abilities. Training groups were well balanced in all but the upper extremes of the ± 12 to ± 35 months.

(from Marshall, 1967, Pg. 2, Phase III Proposal)

No further criterion was given for group placement and the present author feels that this may account for the intra-sub-test variability between groups.

The following statistical analysis was presented:

Statistical Analyses

Analyses of covariance were programmed for the computer. When IQ was controlled in comparisons of retest scores and gains of last year's children, the problem solving group improved significantly more than the other two groups on the Frostig subtest on Constancy of Shape and on the double

TABLE 5

Test Age Difference in Months from Chronological Age of 181 Deaf Children During the First Months of Their School Attendance

Subtest	27 to 39 mos. N = 31	40 to 47 mos. N = 28	48 to 59 mos. N = 32	60 to 71 mos. N = 34	72 to 83 mos. N = 40	84 to 98 mos. N = 16	Total N = 181
Frostig Eye-motor Coordination	0	- 2	- 2	- 4	-13	-19	- 7
" Figure-Ground	- 6	- 7	- 6	+ 1	- 7	-16	- 6
" Constancy of Shape	- 4	+ 3	+ 2	+ 5	- 4	-26	- 2
" Position in Space	-10	-15	-18	-15	-17	-32	-16
" Spatial Relations	+ 1	+ 3	- 2	- 2	- 6	-17	- 2
ITPA Visual Decoding	- 5	- 5	- 7	- 5	-14	-27	- 9
" Motor Encoding	- 6	- 8	-13	-12	-14	-35	-13
" Visual-motor Sequencing	+ 1	0	- 2	+ 6	- 4	-17	- 1
" Visual-motor Association	- 5	- 6	- 8	-11	-14	-29	-11
Mean difference on all subtests	- 3	- 4	- 6	- 4	-10	-24	- 7

(from Marshall, 1967, Pg. 3 Phase III Proposal) alternation test of memory. When initial test score was controlled, the same differences were significant. Other significant differences should be found with experimental control of initial test scores and larger numbers of children.

The mean difference in months between the children's subtest ages and their chronological ages in the three training groups of last year on initial tests and on retests is shown in Tables 6 and 7. The differences between initial ages and retest ages are shown in Table 8.

A stepwise linear regression program has been run on each of the initial test scores of last year (it requires two hours computer time for each subtest). These show which other variables contribute most to the variance in scores. Other subtest scores on the two tests accounted for most of the variance of the Frostig and ITPA subtest scores, a finding that agrees with studies of these relations in children with other handicaps. (Marshall, 1967, Progress Report No. 1)

In a later report the following treatment of the data was made.

When testing ended in June, 195 children had complete data for the first year of training. Statistical analyses have been progressing since that time, but are still incomplete. In general, the findings support the predictions.

Analyses of covariance (controlling IQ) were done separately for three-year old, and for four- to six-year olds. In seven significant differences between three-year old training groups, the problem solving training group scored further beyond their chronological age than the other two groups, as is shown in Table 1 on the next page.

Mean differences have been determined for each age year for the four-to six-year olds, but not for the group of 112 subjects. The general trend for the age years is shown in Table 6.

Correlations for three-year olds differed markedly from those for four- to seven-year olds. For the latter, the initial Frostig and ITPA subtest scores had between 22 and 27 significant rs with other scores. Retest scores had 19 to 24 significant rs with other scores. Retest scores had 19 to 24 significant rs, excepting Eye-motor coordination, which had seven. The initial Suchman had four significant rs, while the retest Suchman had 14 significant rs. The retest alternation had 13 significant rs. The Purdue

TABLE 6

Initial Test Scores, 1966-67

Difference in months from chronological age

	No Training Control	Free Play with Changing Toys	Problem Solving Learning Sets
	N = 14	N = 39	N = 26
Frostig subtests:			
Eye-Motor Coordination	- 8.1	-10.9	- 7.6
Figure-Ground	- 4.0	- 3.6	- 1.4
Constancy of Shape	+ 0.7	+ 3.2	+ 7.4
Position in Space	-15.6	-15.0	- 9.7
Spatial Relationships	- 1.1	+ 0.9	+ 2.1
ITPA subtests:			
Visual Decoding	- 7.5	- 8.3	- 0.5
Motor Encoding	- 1.2	- 4.5	- 8.3 *.01 Cov IQ
Visual-Motor Sequencing	+ 0.1	- 1.1	+ 2.1
Visual-Motor Association	-11.7	- 8.0	- 3.1
Scores on two tests:			
Double Alternation (Smaller score better)	78.1	70.8	75.0
Suchman Color-Form Preference	20.0	25.7	26.3

(from Marshall, 1967, Pg. 5, Progress Report No. 1)

TABLE 7

Retest Scores, 1966-67

Difference in months from chronological age

	No Training Control	Free Play with Changing Toys	Problem Solving Learning Sets
	N = 14	N = 39	N = 26
Frostig subtests:			
Eye-Motor Coordination	- 5.3	- 5.5	+ 0.7
Figure-Ground	- 7.3	- 0.9	+ 1.2
Constancy of Shape	- 1.7	+ 7.9	+21.3 *.01, Cov. both IQ, IT
Position in Space	-11.6	-10.1	+ 0.7
Spatial Relationships	- 0.6	+ 2.8	+ 3.3
ITPA subtests:			
Visual Decoding	- 1.4	- 0.4	+ 2.3
Motor Encoding	+ 3.3	- 4.1	+ 0.9
Visual-Motor Sequencing	+12.8	+16.4	+19.0
Visual-Motor Association	+ 8.4	+ 2.6	+ 8.1
Scores on two tests:			
Double Alternation (Smaller score better)	71.9	66.6	60.7
Suchman Color-Form Preference (Larger score better)	35.0	39.7	40.6

(from Marshall, 1967, Pg. 6, Progress Report No. 1)

TABLE 8

Months Gain between Initial Test and Retest, 1966-1967

	No Training Control	Free Play with Changing Toys	Problem Solving Learning Sets
	N = 14	N = 39	N = 26
Frostig subtests:			
Eye-Motor Coordination	+ 8.8	+10.9	+13.9
Figure Ground	+ 2.3	+ 8.3	+ 8.5
Constancy of Shape	+ 3.1	+12.7	+20.7 *.01, Cov IQ
Position in Space	+ 9.9	+10.2	+16.0
Spatial Relationships	+ 5.8	+ 7.0	+ 6.6
ITPA subtests:			
Visual Decoding	+13.9	+13.5	+ 9.3
Motor Encoding	+ 9.6	+15.8	+14.9
Visual-Motor Sequencing	+18.5	+22.6	+23.5
Visual-Motor Association	+28.4	+16.2	+17.1
Point Gain:			
Double Alternation	- 6.2	- 5.3	-13.6 *.01, Cov IQ

Note: Calendar months between tests ranged from five to seven.

(from Marshall, 1967, Pg. 7, Progress Report No. 1)

Perceptual Motor Survey had 23 significant rs. A score based on the visual acuity test had low but significant rs with (1) initial ITPA Visual-motor sequences, (2) retest ITPA Visual decoding, (3) the Purdue Perceptual Motor Survey, and (4) socio-economic rank of the family. Hearing loss in db had only one significant r, and it was with a test-retest difference.

Fifty children completed the second year of training. In analyses of covariance (controlling this year's IQ), the problem solving group scored significantly higher on the retest WPPSI. Differences were not significant on the initial WPPSI or the retest ITPA. (Marshall, 1967, Progress Report No. 4)

The statistical analysis of the data available by completion of Phase III is not readily interpretable. There appears to have been a selective process in the data chosen for presentation, as evidenced by missing data on more than half of the sub-tests used.

Whereas Dr. Marshall continually refers to further data analysis as "being in progress," no information is available to indicate that these analysis have been completed and/or interpreted. This information was not presented in future reports and the pattern of citing analyses in progress and failing to include them in later reports has been present since Phase I.

Phase IV

Method and Results

Due to the narrative presentation of the proposal for Phase IV, it is difficult to determine specifically what experimental design was intended for this phase of the study. Approximately 25% of the body of the Phase IV proposal was devoted to a description of the rationale underlying Dr. Coleman's research in "learnability" of letters. In her proposal, Dr. Marshall states that "using a paired associate

TABLE 9

Significant Differences in Analyses of Covariance for Three-Year-Olds (N=68)

Scores	p	Mean Months difference from chronological age: Problem solving	Free Play	Control
Initial Frostig Constancy of shape	.05	8.7	2.4	-5.3
Retest Frostig Figure ground	.05	0.3	-3.5	-8.3
Retest Frostig Constancy of shape	.005	18.2	7.0	-3.2
Retest Frostig Position in space	.01	-.9	-12.4	-13.3
Retest ITPA Visual-motor sequences	.05	22.1	10.4	4.5
Test-retest difference, Frostig Position in space	.005	16.9	3.7	.7
Test-retest difference, ITPA Visual-motor sequences	.01	29.4	10.7	9.7

TABLE 10

Significant Differences in Analyses of Covariance for Four- to Six-Year-Olds (N=112)

Scores	p	How groups differed
Initial ITPA Visual decoding	.05	PS best in years 4 and 5, C best in year 6
Initial alternation	.025	C best in years 4 and 6, FP best in year 5
Retest Frostig Eye-motor coordination	.025	PS best in years 4 and 5, C best in year 6
Retest Frostig Position in Space	.05	PS best in years 5 and 6, FP best in year 4
Retest Frostig Spatial relations	.05	FP best year 4, PS best year 5. C best year 6
Retest ITPA Visual-motor association	.05	PS best years 4 and 5, C best year 6
Retest alternation	.05	C best years 4 and 6, PS best year 5
Purdue Perceptual Motor Survey	.05	PS best all years

paradigm, a deaf child is taught letter-sound associations."
(from Marshall, 1968, Phase IV Proposal)

This would be most difficult in view of the auditory impairment of the deaf child.

The present authors feel that the clearest way to communicate the Phase IV proposal is to reproduce the Phase IV proposal submitted and allow the reader to make his own judgement.

Following the Sample in 1968-1969

Some 211 children will have been given at least one year of training and tests by the end of June, 1968 (based on April 15 knowledge of dropouts). The number in each age and training group is shown in Table 1. When any two consecutive age years are combined, the training groups have well balanced numbers, excepting the seven years and older groups. These three groups also are the only age groups with marked differences in mean scores on initial tests. These will be omitted in the analyses of the effects of training. To improve number balance at another age, six of the three-year-old control children will not be included in statistical analyses.

Only 24 children from last year's sample were in first grade or its equivalent this year (two others had moved away from this region). The age distribution in Table II suggests that the majority of the sample will remain in preschool classes in 1968-69. They will be given their second or third year of training, according to their assignment during the first year. Many new training materials were devised or purchased during this year. It should be possible to plan a third year problem solving training that uses visual projectors as basic materials. New toys continue to be marketed, so the third year of free play can be planned without undue repetition of toys.

TABLE 11

Number of Children with Complete Data in Each Age Year* and Training Group

Age year	Free Play Training	Problem Solving Training	No Training Control	Age Total
3-0 to 3-11	24	17	33	74
4-0 to 4-11	13	15	12	40
5-0 to 5-11	14	14	12	40
6-0 to 6-11	16	10	15	41
7-0 to 8-11	3	6	7	16
Training Totals	70	62	79	211

* Age at the time of initial testing (from Marshall, 1968, Pg. 2, Phase IV Proposal)

This year, children in their second year of training were given the Wechsler Preschool and Primary Scale of Intellegence (WPPSI) as an initial test. and the Illinois Test of Psycholinguistic Abilities and WPPSI as retests (and another mental test as a control test). The WPPSI performance scores appear to have little relation to scores on the Leiter, Hiskey-Nebraska, or Merrill-Palmer mental tests, although the latter three are closely related. Another readiness test will be added to the initial and retest battery for the second year children in 1968-1969. Possibilities now under consideration are the Bender Gestalt test, the Anton Brenner Developmental Gestalt Test of School Readiness, and the Denver Developmental Screening Test. Another of these will be given to children in their third year of training as initial test and retest. These children will also be given the Frostig as a retest. The simplest subtests of elementary reading and achievement tests will be administered to third year children also as initial tests and retests.

The first grade children this year could do only a few of the reading and arithmetic tests standardized for normal first grade children. An adequate measure was obtained by combining subtests from five different achievement tests; Gates Reading Readiness Test, Gates-McGinitie Reading Test, Metropolitan Readiness Test, Stanford Achievement Test, and the Wide Range Achievement Test. These will be used also in testing second grade children in the spring of 1969.

Children will be added to the sample from two schools new to this project. Almost every supervisor in these three states has asked that Audrey Hick's preschool in Houston be included in this research. She is willing to participate in 1968-1969. The other will be the New Mexico School for the Deaf preschool scheduled to open at New Mexico State University in the fall of 1968.

Pre-primers and Research

A set of pre-primers developed at the University of Texas at El Paso are being used now at the Dallas and El Paso public school kindergartens, and at Gompers Center in Phoenix. Their reception was enthusiastic. Enough books for half the sample schools will be prepared this summer.

Coleman (in press) will soon complete the broad outlines of a data base that will help arrange the pre-primers in their most learnable sequence. The pre-primers are based on the assumption that a child will begin reading to himself and teaching himself at a younger age if his first materials are engineered to be as learnable as possible. To arrange materials in the most learnable sequence, quantitative data are needed about the relative learnability of English words and the relative learnability of language units within words.

To design reading materials for the deaf, Dr. Coleman would like to collect the same data using deaf subjects. He has designed small experiments that measure various aspects of learnability for various language units. For example, using a paired associate paradigm, a deaf child is taught letter-sound associations (or whatever is being studied). The measure of learnability for each letter-sound association is the average number of learning trials of many children. This measure is used to rank order letters according to the ease of learning their sounds, and this rank ordering is used in designing phonics lessons. There are great differences in learning the sounds of different letters for normal children, and casual observation suggests much greater differences for the deaf.

Coleman, E. B. Collecting a data base for an educational technology. Reading Research Quarterly, (in press).

The two research technicians will add this training to their test batteries at each school. They will train children attending the school, but not included in this sample, also. Dr. Coleman will train teachers to do this at schools not participating in this project, such as those of Colorado.

Communication of Research Findings

The primary concern of Dr. Marshall in 1968-1969 will be communicating research findings and implications to parents of deaf children and to people working with deaf children. She will write papers for both popular and research journals. She will try to carry out a suggested method of writing short paragraphs for insertion in school newspapers. She will try to arrange talks at parent meetings of the participating schools. She will accept invitations to speak at professional meetings, such as the Alexander Graham Bell Association this summer.

Time for these activities should be provided by three changes. First, a larger proportion of her working time will be allotted to this project than in the two preceding years. Second, the test schedule for 1968-1969 should give the testers more home time. They are capable of handling aspects of the project that Dr. Marshall has carried, such as recording test scores on summary sheets, dictating travel requests, checking the condition of returned toys and materials, purchasing the food rewards, seeing that outgoing projectors have extra lights and that new batteries are put in battery operated toys, etc. Third, descriptions of the tests and training should require less time at familiar schools.

Added Consultants

Dr. Marshall Hester, whose ideas initiated this research, will keep his advisory role as a consultant.

Miss Dianne Fisher, preschool teacher of the deaf in Dallas, served as a volunteer consultant this year. She tried out and evaluated many materials for Dr. Henry Ray and Dr. Marshall. Next year she will have official status as a consultant.

Consultant's Meetings

A two-day meeting of the planning consultants will be held in the fall of 1968 at New Mexico State University. The participation of teachers and supervisors this past year was helpful to all. Travel expenses will be paid this year for a few invited teachers or supervisors.

Personnel Changes

> Mike Bergman has resigned as Research Technician as of May 31, 1968, in order to accept a position without travel. His replacement is not yet known. (from Marshall, 1968, Phase IV Proposal)

Results

In the first progress report for Phase IV, correlations between heavy loss (in dB), IQ, Chronological age (in months), socioeconomic studies and the subtests on the Frostig and ITPA, both initial test and retest were reported. No mention was made as to the type of correlation used. These correlations were obtained from the total sample and no data were presented based on the different groups. While of interest, the reported correlations communicate no information regarding the effects of training.

It was reported that data were being processed and "sent to the computer for analysis of variance" but no data was reported on this. In terms of dissemination Dr. Marshall reported preparing materials for talks to be given to teaching parents, a deaf association in Ft. Worth, Texas. It was reported that Dr. Marshall and Al Moger wrote a paper entitled "Adapting the Frostig DTVP for Deaf Children." It was not reported whether or not this paper was published.

Phase V

Method and Results

The major thrust of the Phase V proposal was the establishment of a new group called "Directed Play with Toys", to be compared with a control group. In addition, Phase V called for a teachers workshop, which was conducted.

Because of the incompleteness of the Phase V proposal and the progress reports, with respect to procedures and data, the original Phase V proposal and subsequent progress reports are reproduced below.

Following the Sample in 1969-1970

Children will continue problem solving or free play training at nine preschools in 1969-1970. They are few in number at most schools. A large number of grade school children will be tested in the spring of 1970. Many of these are mature enough for group tests. It appears feasible to plan on only one full time tester.

Tests for children in the fourth year of preschool will include the Bender Gestalt and the Frostig. Tests for third grade children will be more advanced forms of the reading and arithmetic achievement tests used in 1968-1969. A new mental test will be used, probably the Columbia Mental Maturity.

Directed Play with Toys Training

We will try to obtain a sample of 25 three-year-olds and 25 four-year-olds for the directed play with toys training. Both the Dallas and Fort Worth schools want to participate in training, but will lack children in our present sample. Probably this training can be added to the continued training at Albuquerque, Houston, Phoenix, Roswell, San Antonio, and Waco.

Coleman Pre-primers

The teachers like the Coleman pre-primer series so much that we have been unable to persuade them to return the slides and carousel used with the books. San Antonio begins use of these materials in the fall. We lack materials to begin another school. If Dr. Coleman's movies become available, we can begin use of the materials elsewhere. Additional books will be added to those now available in 1969-1970.

Consultant's Conference

A two-day meeting of the planning consultants will be held in the fall of 1969 at New Mexico State University. The participation of teachers and supervisors last year was a success in all respects. Travel expenses will be paid this year for six teachers or supervisors who have not attended before.

Summer Workshop for Teachers

A four-day workshop on the training developed in this project will be held for 15 teachers of the deaf in July, 1970. Teachers will be selected on a national basis. The equipment budget was enlarged to allow for purchase or construction of more training materials.

Personnel

Ara Lee Stevens will serve a third year as tester in the schools.

A research assistant (graduate student) will work half time on plans for the consultant's conference and for the summer workshop.

The consultants will remain the same as in Phase IV: four planning consultants, Dr. Coleman, and Dianne Fisher.

(from Marshall, 1969, Phase V Proposal)

FIRST PROGRESS REPORT
on
STRENGTHENING THE VISUAL PERCEPTION OF DEAF CHILDREN (Phase V)
by
Helen R. Marshall

Data Collection

At least 99 three- and four-year-olds were given initial tests. At each school, they were split into a Directed Play with Toys and a No Training Control group, and began their 20 weeks of training. About 30 children from earlier training groups were tested because they are still in preschool.

Speeches

Dr. Marshall reported project findings in November at the meeting of project directors in Washington, and at the Biennial Conference of the National Association for the Education of Young Children in Salt Lake City.

Consultant's Conference

The annual Consultant's Conference was held at New Mexico State University on November 20-21. Seven teachers and supervisors from participation schools attended the meeting.

SECOND PROGRESS REPORT
on
STRENGTHENING THE VISUAL PERCEPTION OF DEAF CHILDREN (Phase V)
by
Helen R. Marshall

Data Collection

Initial testing was completed with tests at the new preschool in Clovis. Midyear control tests (mental and visual acuity) were given at most schools. This is the first year we have used the Columbia Test of Mental Maturity; the IQ's from this test are much lower than those from other mental tests.

Supplying Toys

Shipment of toys to all but five schools has been completed. Moving the toys to the barracks where I have my office has made packing and shipping easier. This year we have enough toys to permit delays in returning the toys here; this has eliminated many trips.

Manuscript

I completed the manuscript title "Effect of Training on Visual Perception Skills and Reading Achievement of Deaf Children," and submitted it to Developmental Psychology.

Site Visit

I conferred with a site visit team, chaired by Don Perrin, on February 19. They made several constructive suggestions on plans for next year.

Supplies for Summer Workshop

Visual Aids made 14 copies of each of 10 transparencies, and has begun copying another set of about the same number. Two undergraduate assistants, replacing last semester's graduate assistant, began copying the formal instruction blocks and materials so that we will have 15 complete sets by summer.

(from Marshall, 1969, Progress Report No. 2)

Phase VI

Method

During the first five phases of the study, no major criticism was raised regarding the design, statistical analysis, or quality of information reported to captioned films from either federal officials or site evaluation teams and review committees responsible for research evaluation. At the completion of Phase V, major criticisms were directed at the "Strengthening Visual Perception of Deaf Children" project. The basis of the criticisms were: 1) the absence of sufficient data analysis to justify the continuation of the project and 2) the absence of clearly define procedures for dissemination of the findings of the first five phases should they warrant dissemination.

It was at this time that the present authors became involved with the project. Because of personal problems which, in the opinion of New Mexico State University, resulted in a loss of job efficiency and necessitated time for possible recovery, Dr. Marshall was granted a leave of absence. Due to the commitment of the University to see the project completed, the present authors, on the basis of their collective background in psychology, human research, and deaf education, were asked if they would be interested in trying to bring the project to fruition. After an examination of existing information, the authors felt that the project appeared sufficiently worthwhile to warrant their efforts towards completion. In resummitting the Phase VI proposal, the present authors specified the following three objectives. 1) Analysis of existing data to determine the efficiency of the learning sets program; 2) Preparation of learning sets manuals for parents and teachers; and 3) Dissemination of learning sets, materials and manuals.

The latter two objectives were contingent upon obtaining evidence which indicated the superiority of the learning sets procedure relative to the free play and control.

The purpose of Phase VI of the project was to organize and place the collected data in a form amenable to computer manipulation. Statistical treatment was coordinated with the Statistics Department of New Mexico State University. Test score interpretation and further statistical counsel was provided by Dr. Phillip Himmelstein, University of Texas at El Paso, whose report is included.

The projected date of completion of this phase was delayed mainly because of the change in project personnel. Before any analysis could be made, the directors had to familiarize themselves with the history and present status of the study. As there existed a plethora of data, it was not readily apparent how much of the data would be appropriate for statistical treatment, and, further, how much of the data was actually pertinent to interpretation.

After examining the data, the authors met first with a representative of the Statistics Department of New Mexico State University, then with the consultant, Dr. Himmelstein, to determine what type of statistical treatment would be pertinent. It is not suggested that the statistical treatment used is entirely appropriate. There were several problems in trying to determine valid relationships, and because of these problems the reasons for selecting final method of statistical treatment will be fully explained.

An examination of the data indicated that there were relatively few subjects in many of the test conditions, and there was inconsistent availability of some test scores. It was determined that there were enough subjects pre-tested and retested during the first year of the learning sets program that these results could be statistically treated due to an adequate sample size. It should be noted that the number of the subjects on whom test information was available for all conditions decreased from 277 in the first year to 60 in the second year. Thus, the results of the pre-test and retest comparisons for the second year are more suspect.

The tests chosen for analysis are the subtests of the Frostig: eye-motor coordination, figure-ground, constancy of shape, position in space, and spatial relations; and the subtests of the Illinois Test of Psycholinguistic Ability: visual decoding, motor encoding, visual-motor sequencing, and visual-motor association. It was felt that these scores would most appropriately reflect the gains made in visual perception.

The gains made in reading could only be assessed for 89 children in the third year in the program. Because of the age of the children starting in the program, reading tests were not given before the third year. Results of the reading tests will be presented.

After selecting tests to be treated, the problem arose as to how to present the results most meaningfully. It was suggested that because of obvious differences in group scores, comparison be made of differences between group means. By doing so the reader can see the relationship of the groups for the different tests studied. Thus, in the presentation of data in tabular form, t-tests for mean differences of the following groups are compared: control, problem solving, and free play. The reader can compare the pre-test relationship of the group's scores with the retest relationship to determine change, if any.

It is realized that there are several other methods by which the data could have been presented. The present project directors would like to suggest a more coordinated data collection system could have been implemented prior to the study. They were not a part of the project at the time and have had to react to data as it existed; not as they would have chosen for it to exist.

The data analysis was conducted in three phases: 1) identification of variables; 2) compilation of descriptive data; 3) statistical and test consultation and data analysis.

1) Identification of Variables:

Drs. Sachs and Fitch met with Dr. Marshall and Mr. Stevens to review the various tests used and type of data collected. The following variables were identified:

a) sex: males, females, <u>all</u>.

b) year in program: 1, 2, <u>all</u>.

c) treatment condition

    1) problem solving

    2) free play

    3) control

d) school

e) age at beginning of program

    1) 00-36 months

    2) 37-42 months

    3) 43-54 months

    4) 55-60 months

    5) 61-99 months

f) Race

g) IQ scores

h) auditory loss

i) visual acuity

j) test scores

The test scores included the following tests:

1) Purdue Perceptual Motor Test - 12 measures

2) Frostig - 5 measures

3) ITPA - 4 measures

4) Suchman Color Form Test - 4 measures

5) Single and Double Alternation and Delayed Reaction Time

6) Gates MacGinitie Reading - 2 measures

7) Curiosity - 6 measures

8) Anton Bremer

9) WPPSI

10) Metropolitan Reading

11) Bender Visual Motor

12) Stanford Achievement Test - 2 measures

Compilation of Descriptive Data

Descriptive data was computed in terms of number of subjects, means and standard deviations for each of the measures for each of the 12 tests. Data was computed in terms of months, trials, seconds or percentiles as was required. The raw data in all instances was converted to the appropriate measurement available, as suggested by the test consultant.

Descriptive data was computed for pre-test, retest, and change (retest-pre-test) on the basis of condition comparisons (Free Play - Control, Problem Solving - Control). The pre-test measure refers to test results obtained at the beginning of the school year. Retest measures refer to test results obtained during the latter part of the school year. The original experimental design did not call for matching subjects in a pre-test/retest design. The change score refers to differences scores for those Ss for whom pre-test and retest s ores were available. The major data of value was for males and females during the first and second years of the program. Most of the variables had few subjects and, therefore, were not amenable to suitable statistical analysis. The following variables had sufficient subjects for statistical analysis.

1) sex

2) year in program for first and second years

3) treatment condition (Problem Solving, Free Play, Control)

Data Analysis

As with descriptive variables, analysis of test scores was limited by those tests for which sufficient data was available. An additional constraint on data analysis was that some of the tests used, such as the Suchman Color Form Test, are not directly related to the hypothesis that experience with the problem solving program should benefit reading readiness.

Following compilation of the descriptive data, copies of the data and test manuals were made available to Dr. Phillip Himmelstein, who served as test consultant. After examining the materials, Dr. Himmelstein sent the following analysis, which is included in Appendix D.

The data analysis consisted of comparisons between the three treatment conditions (Problem Solving, Free Play, Control) for the five Frostig measures and the four ITPA measures, as these measures were judged to be most highly related to skills of reading readiness and, in addition, generally had suitable numbers of subjects for statistical analysis. The statistical procedure used was t-test between group mean change scores.

Results

First Year of Study

Frostig Subtests:

The initial hypothesis underlying the learning sets program was that experience with the problem solving materials would enhance the visual-perception skills of deaf children. The clearest test of this hypothesis, within the restrictions of the tests used, was a comparison of the different treatment groups with the control group on performance change on the Frostig materials. The five Frostig subtests were eye-motor, figure-ground, shape-constancy, position, and spatial relations.

Table 12 presents the first year mean changes, standard deviations, and mean difference for the Problem Solving and Control Groups for the Frostig subtests. The means and standard deviations from which these data were derived are presented in Appendix E. As presented in Table 12 the Problem Solving group showed statistically significant gains on all five subtests. (Obtained t-values are presented in Appendix H). Of special importance to the original hypotheses was that the subtests showing the most statistically significant gain ($p < .01$ or greater) were the subtests of

TABLE 12

Mean Changes of Frostig for Problem Solving and Control Groups

from Pre-test to Retest:

First Year (In months)

Group	Number of Subjects	Eye-Motor Mean	Eye-Motor SD	Figure-Ground Mean	Figure-Ground SD	Shape Constancy Mean	Shape Constancy SD	Position Mean	Position SD	Spatial Relation Mean	Spatial Relation SD
Control	113	6.3	15.9	8.1	11.9	8.6	16.1	7.0	15.4	7.7	13.2
Problem Solving	58	10.4	18.8	14.3	15.3	14.8	22.3	15.2	21.3	13.2	16.3
Diff.		4.1*		6.2****		6.2**		8.2****		5.5***	

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .005$

figure-ground, position, and spatial relation, all of which are logically related to the task requirements of the problem solving program.

Comparison of the Control group with the Free Play group failed to show any statistically significant differences. The mean changes, standard deviations, and mean difference between Control and Free Play groups for the first year of participation for the Frostig subtests is presented in Table 13.

Figure 1 presents the mean scores for pre-test and retest for each of the three groups for the Frostig subtests. Steepness of slope is a graphic illustration of rate of change. Thus the steeper slope for the Problem Solving group indicates greater change from pre-test to retest relative to the other groups. It can be noted that the slope of the lines for the Problem Solving group is steepest for all of the subtests relative to the Free Play and Control Groups.

Figure 2 is a histogram which compares the first year change in means from pre-test to retest for each group for each of the Frostig subtests. It may be seen that the Problem Solving group showed the greatest mean change from pre-test to retest for all five Frostig subtests. This is a graphic illustration of the data presented in Table 12 and further illustrates the significant change of the Problem Solving group relative to the Free Play and Control groups.

ITPA:

Tables 14 and 15 show the mean changes in the ITPA from pre-test to retest for the first year for Problem Solving and Control groups, and Free Play and Control groups, respectively. The only statistically significant

TABLE 13

Mean Changes of Frostig for Control and Free Play Groups

From Pre-test to Retest

First Year (In months)

Group	Number of Subjects	Eye-Motor Mean	Eye-Motor SD	Figure-Ground Mean	Figure-Ground SD	Shape Constancy Mean	Shape Constancy SD	Position Mean	Position SD	Spatial Relation Mean	Spatial Relation SD
Control	113	6.3	15.9	8.1	11.9	8.6	16.1	7.0	15.4	7.7	13.2
Free Play	106	7.4	14.4	10.2	13.0	8.9	19.4	8.2	14.5	9.5	13.0
Diff.		1.1		2.1		.3		1.2		1.8	

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .005$

Figurc 1: First Year Pre-test and Retest Scores on the Frostig Subtest for Problem Solving, Free Play, and Control Groups.

PRETEST AND RETEST MEANS
FROSTIG (FIRST YEAR)

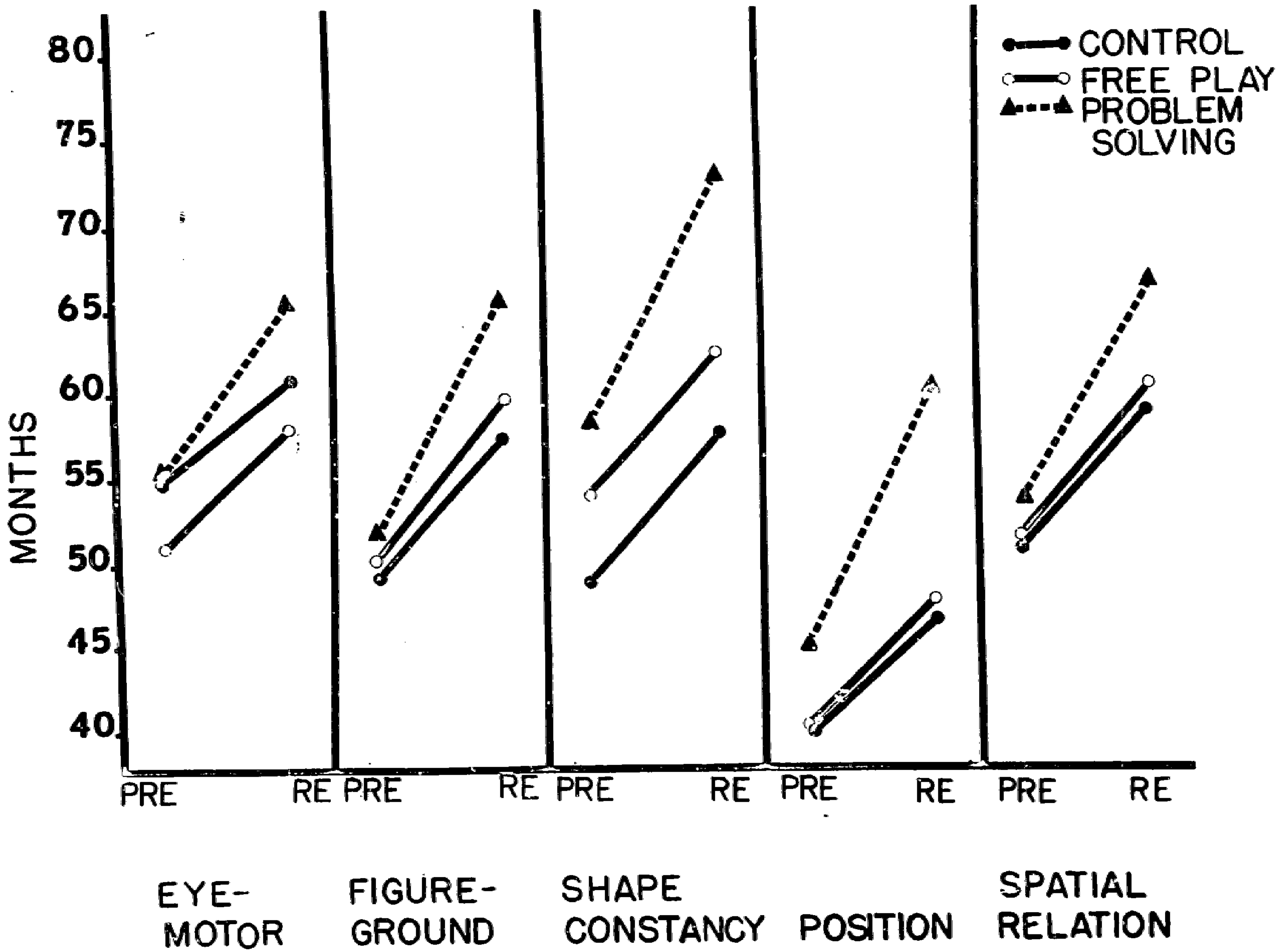
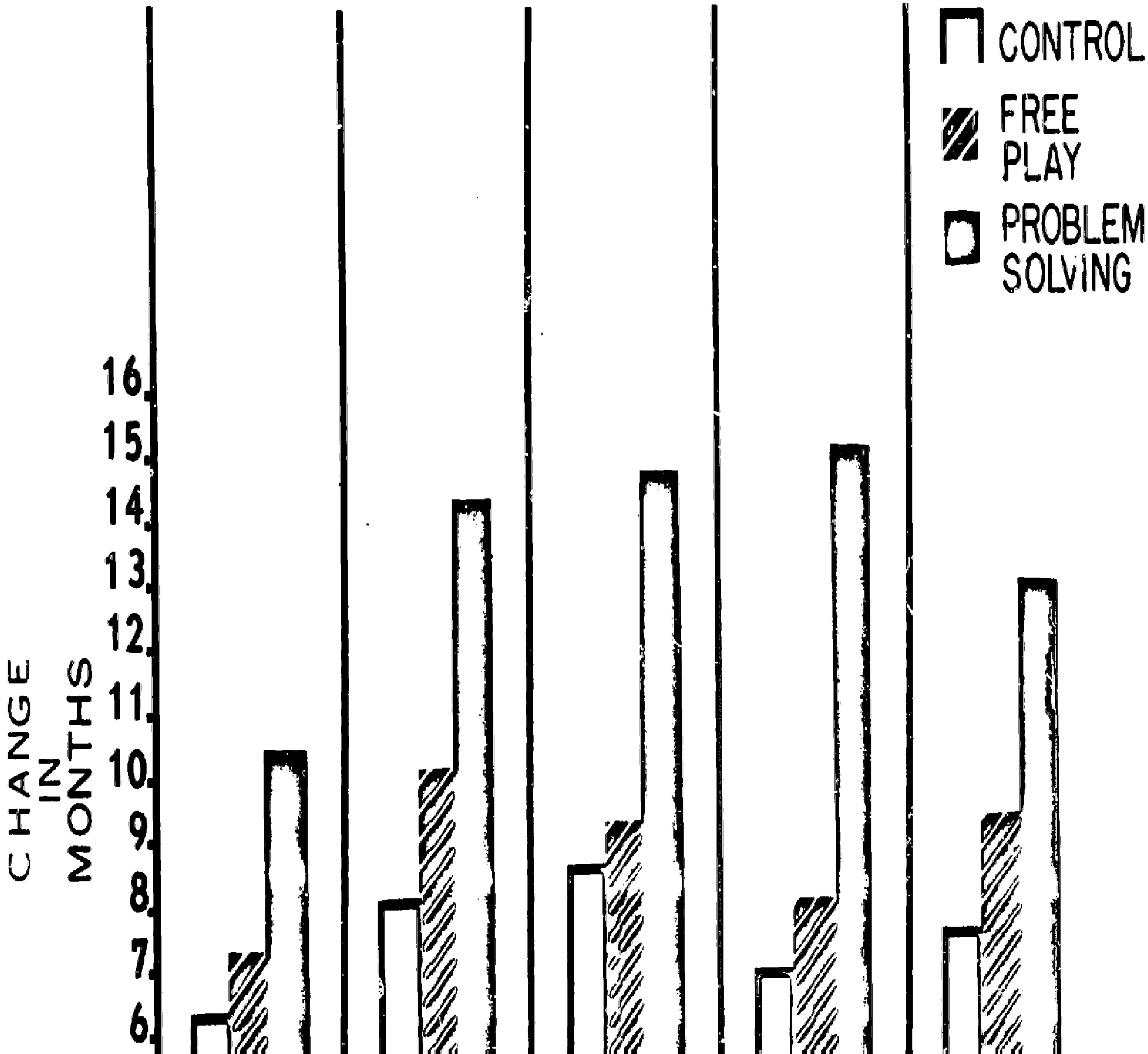


Figure 2: Histogram of First Year Mean Changes on Frostig Subtests for Problem Solving, Free Play, and Control Groups.

FROSTIG


CHANGE IN MONTHS
16
15
14
13
12
11
10
9
8
7
6
CONTROL
FREE PLAY
PROBLEM SOLVING

EYE-MOTOR	FIGURE-GROUND	SHAPE CONSTANCY	POSITION	SPATIAL RELATION

TABLE 14

Mean Changes of ITPA for Problem Solving and Control Groups

from Pre-test to Retest:

First Year (In months)

Group	Number of Subjects	Visual Decoding		Motor Encoding		Visual-Motor Sequencing		Visual-Motor Association	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	113	13.2	15.7	14.3	17.4	10.7	23.5	14.3	18.8
Problem Solving	58	13.2	20.1	16.4	16.5	21.4	26.6	17.4	20.7
Diff.		0.0		2.1		10.7****		3.1	

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .005$

TABLE 15

Mean Changes of ITPA for Control and Free Play Groups

from Pre-test to Retest:

First Year (In months)

Group	Number of Subjects	Visual Decoding		Motor Encoding		Visual-Motor Sequencing		Visual-Motor Association	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	113	13.2	15.7	14.3	17.4	10.7	23.5	14.3	18.8
Free Play	107	14.7	16.1	14.6	17.9	21.9	26.6	18.1	18.0
Diff.		1.5		.3		11.2****		3.8	

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .005$

change noted was on the Visual-Motor Sequencing subtest ($p < .005$). The mean ITPA scores for Problem Solving, Free Play, and Control groups for pre-test and retest for the first year are presented in Appendix F.

Figure 3 presents the pre-test and retest mean scores for each group on the four ITPA subtests. Figure 4 is a histogram which illustrates the mean changes from pre-test to retest for each group for each of the ITPA subtests. Both figures indicate the absence of a consistent superiority for any of the three groups across the four ITPA subtests. The only ITPA subtest on which a pattern change from pre-test to retest was noted was the Visual-Motor Sequencing subtest. On this subtest both Problem Solving and Free Play groups showed a significant increment to that shown by the Control group.

Second Year of Study

Frostig Subtests:

Tables 16 and 17 indicate the mean change in the Frostig subjects for Problem Solving and Control groups and Free Play and Control groups, respectively, from pre-test to retest. No significant differences were found in changes on any of the subtests (means and standard deviations of pre-test and retest data are presented in Appendix G). It should be noted the sample size for the second year is quite small and the population was not matched. (Analysis of similarity of the second year groups and a matched comparison of the second year population on a longitudinal basis will be presented in a subsequent report).

ITPA:

No second year data on the ITPA was obtained.

Figure 3: First Year Pre-test and Retest Scores on the ITPA Subtests for Problem Solving, Free Play and Control Groups.

PRETEST AND RETEST MEANS ITPA (FIRST YEAR)

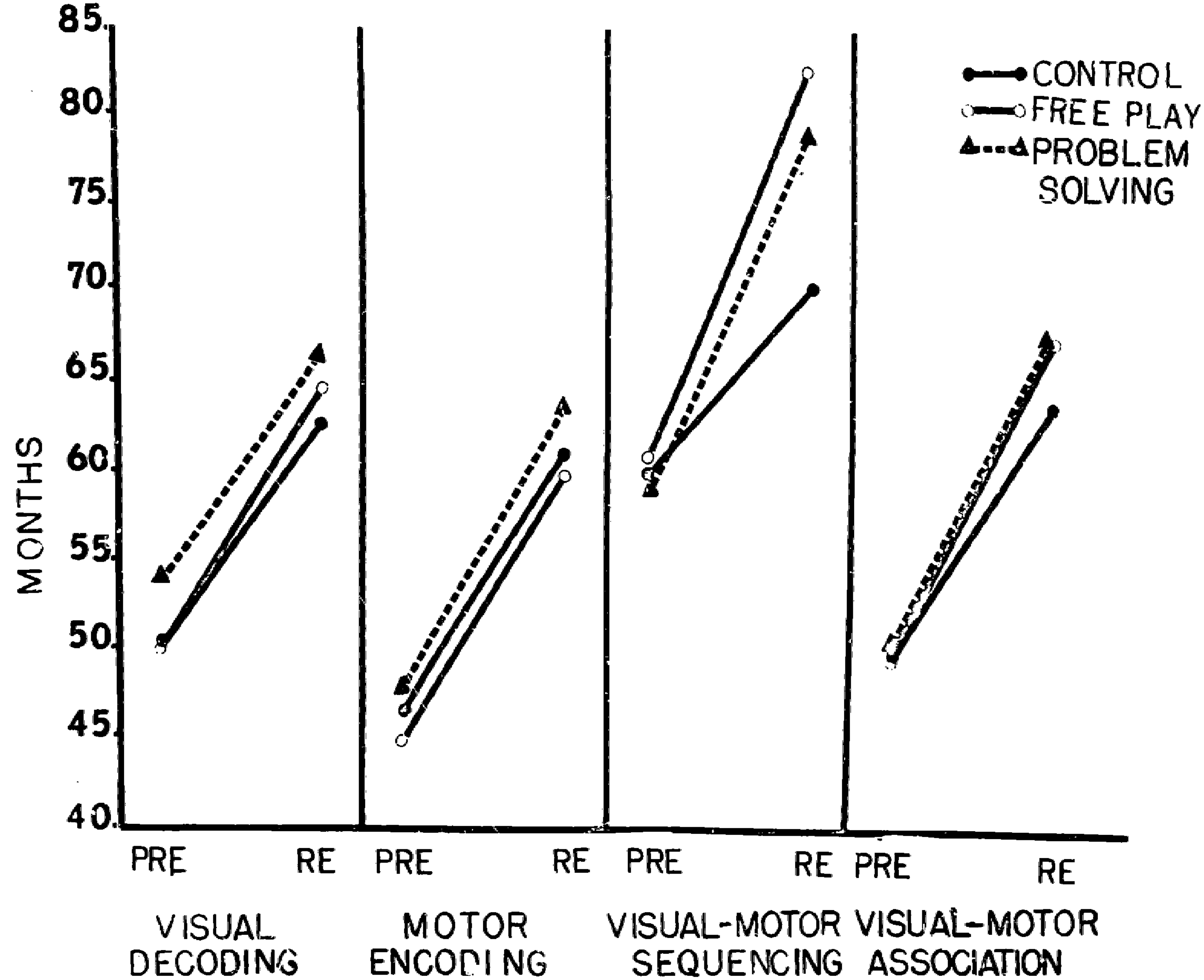


Figure 4: Histogram of First Year Mean Changes on ITPA Subtests for Problem Solving, Free Play, and Control Groups.

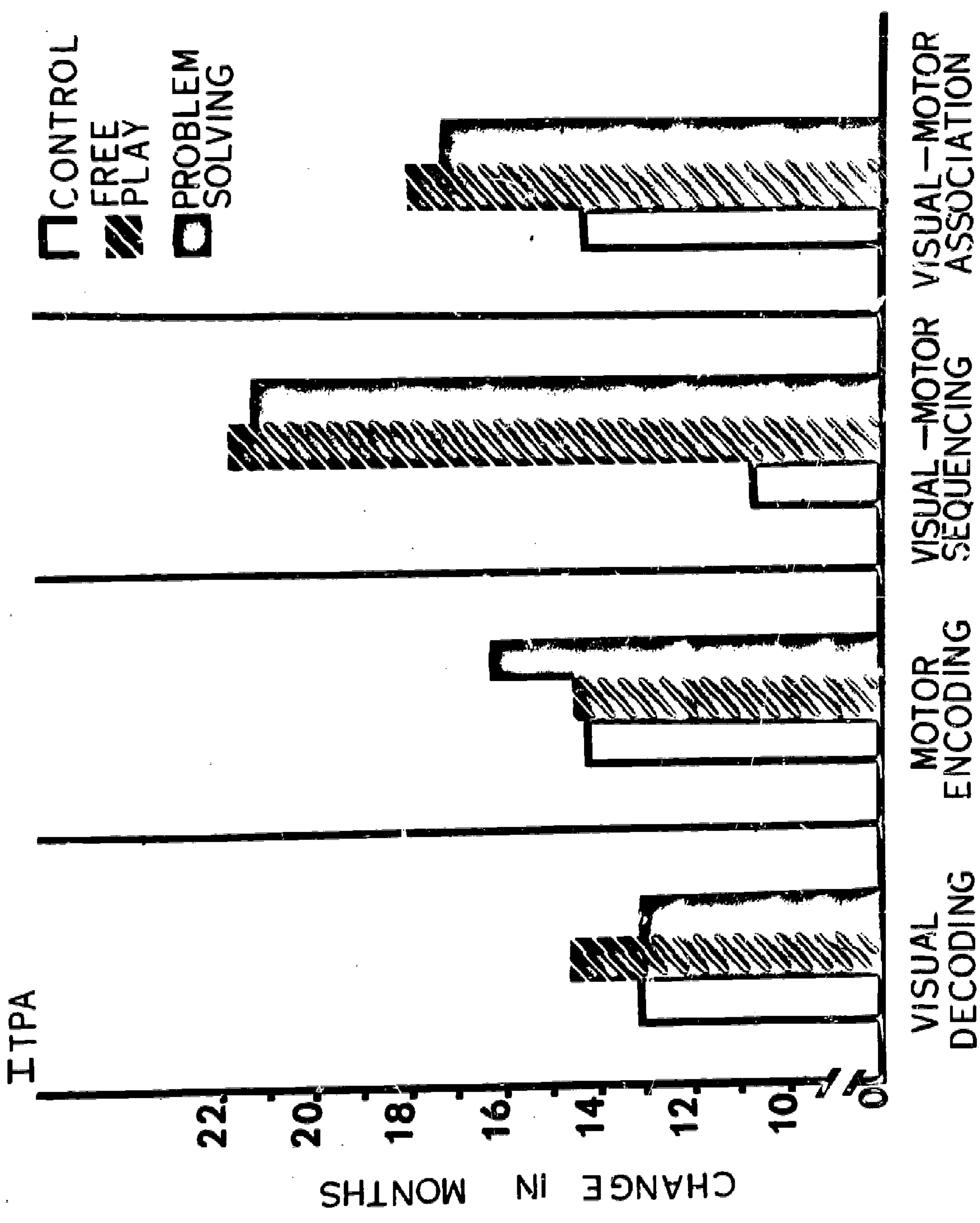

ITPA
CHANGE IN MONTHS
0
10
12
14
16
18
20
22
VISUAL DECODING
MOTOR ENCODING
VISUAL—MOTOR SEQUENCING
VISUAL—MOTOR ASSOCIATION
CONTROL
FREE PLAY
PROBLEM SOLVING

TABLE 16

Mean Changes of Frostig for Problem Solving and Control Groups

from Pre-test to Retest:

Second Year (In months)

Group	Number of Subjects	Eye-Motor		Figure-Ground		Shape Constancy		Position		Spatial Relation	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	26	7.3	18.7	6.5	13.7	6.8	16.7	8.4	17.2	14.0	14.0
Problem Solving	16	1.9	11.4	3.2	11.6	1.9	18.3	6.0	21.7	11.4	20.2
Diff.		5.4		3.3		4.9		2.4		2.6	

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .005$

TABLE 17

Mean Changes of Frostig for Problem Solving and Control Groups

from Pre-test to Retest:

Second Year (In months)

Group	Number of Subjects	Eye-Motor		Figure-Ground		Shape Constancy		Position		Spatial Relation	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	26	7.3	18.7	6.5	13.7	6.8	16.7	8.4	17.2	14.0	14.0
Free Play	15	5.1	16.9	10.1	12.8	7.8	15.2	14.8	19.4	15.8	12.9
Diff.		2.2		3.6		1.0		6.4		1.8	

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .005$

Reading

Table 18 indicates the results of tests of significance for means of the three groups for reading scores obtained during the third year after the child began the program. No significant relationships were found between the Contrcl group and either experimental group. Means and standard deviations for the reading scores can be found in Appendix I.

TABLE 18

Summary Table of Values of the t Statistic

for Mean Reading Scores at the End of Three Years of Program

Subtest	Problem Solving/Control			Problem Solving/Free Play		
	Diff.	t	Direction	Diff.	t	Direction
Gates-McGinitie Reading	15.8	1.6998	Problem Solving	9.8	1.3080	Free Play
Gates-McGinitie Vocabulary	8.0	.8790	Problem Solving	10.9	1.2680	Free Play
Stanford Word Meaning	6.2	1.248	Problem Solving	4.8	.5880	Free Play
Stanford Paragraph Meaning	3.0	.3948	Problem Solving	9.1	1.3580	Free Play

Conclusions

It is suggested that the results support the hypotheses from which the study was specifically designed; that is, that through administration of a learning sets program visual perception skills could be improved. Although all three groups showed an improvement in the Frostig subtests from pre-test to retest during the first year, this general improvement was anticipated since visual perception skills do improve with maturation in pre-school children. The important finding of the present study was that the Problem Solving group showed a statistically significant increment in visual perception skills relative to the Control group as assessed by performance on the Frostig. Thus all three groups improved, with the Problem Solving group showing the greatest improvement.

The results for the ITPA were not as clear as those obtained with the Frostig. The only ITPA sub-test on which significant improvement was noted was Visual-Motor Sequencing. Both Problem Solving and Free Play groups showed statistically significant increments relative to the Control group. The Visual-Motor Sequencing subtest has been found to have a significant factor loading on what has been described as a "Memory" factor (Center, 1963; Loeffler, 1963). This subtest has also been correlated with reading disabilities (Kass, 1962). The obtained superiority of the Problem Solving and Free Play groups might be attributable to increased experience on tasks requiring attention on behalf of the participants in the two experimental groups. Weaver (1963) reported a significant improvement on Visual-Motor Sequencing for one of two groups of young culturally deprived Negro children who "had been exposed to two 10-week summer training sessions plus home visitor contacts during the intervening winter" (pg. 36). The possibility that the Visual Motor Sequencing sub-test may be influence by a variety of subtle factors may be implied from the comment of Bateman (1965) in a review of Weaver's (1963) study. Bateman commented that "The Visual-motor Sequencing subtest continues its erratic behavior, noted in other investigations, and defies analysis at this state" (pg. 37). Thus the results of the Visual-Motor Sequencing test, cannot be fully explained and may be influenced by a variety of factors.

Although the Problem Solving group demonstrated a significant increment in visual perception skills, the suggested effect of these skills on reading was not demonstrated. By the time the child who had gone through the program was at an age when the reading readiness test could be administered, the results of the program were not obvious. The reason for this is not evident. It appears to be related to the need for consistent, methodical educational processes—a feature pointed to almost universally by persons involved in rehabilitation of the hearing handicapped. The original need for development of the learning sets program was predicated on the observation that the pre-school deaf evidenced poorer visual-perception skills. The data presented in the present report indicate that the Problem Solving group showed a consistent improvement in visual-perception skills during the first year of participation in the program. The loss of superiority and absence of transfer to reading achievement in succeeding years may be due to a failure to utilize the first year improvement as a basis for continuation and expansion of training.

The effect of "losing the edge" is not unknown in early pre-school programs for the hearing handicapped. Entire educational programs have been measured in longitudinal studies with results indicating that the effects pf pre-school training were no longer evident after the second year of school (Craig, 1964; Phillips, 1963]. Again, the reasons for this are not clear. It should be remembered, however, in evaluating this study that the learning sets program developed consists of 40 periods of 15 minutes each, or a total of 10 hours of training; a very minor part of the all-over program. That any significant differences were found is strong support for the effectiveness of the program.

It is the opinion of the directors that the learning sets program does have a demonstrated positive influence on visual perception skills in pre-school children during the first year and that this influence is sufficient to warrant preparation and dissemination of the program. It is also suggested that future consideration be given to the construction of learning sets to be added to the present program which would help maintain the gains achieved during the first year of the program. It would appear that if the gains achieved during the first year could be maintained, a strong positive effect would be noted on reading skills.

Recommendations

The authors suggestions for the steps necessary for successful termination of the project are:

I. Preparation of manual of instructions and procedures using a programmed format. The steps to be followed are:

1. Preparation of a manual using a programmed format to be written at a 6th grade reading level. This manual will be prepared in consultation with a programming specialist.

2. Validation of the manual by frame by frame analysis of 10 parents of pre-school deaf children to be randomly selected from the Las Cruces-El Paso area.

3. Modification of programmed manual based on frame by frame analysis.

4. Preparation of manual in final form.

II. Preparation of 50 kits

1. Contract to be bid by plastics manufacturers with a clause included in the contract for future kits which may be ordered singly by interested individuals.

2. Dissemination of prepared bits to representative sample of pre-school deaf educators across the country.

III Dissemination of Information

1. Preparation of journal articles and professional papers based on the data presented in the report submitted to Dr. Delgado and the final report, the latter to be completed and submitted by September 31, 1971.

2. Preparation of exhibits for professional meetings to include an automated slide-narrative presentation describing a) program materials, b) administration of program, c) and current data on program usage.

3. Preparation of brochures to be sent to all pre-school programs in the United States

References

Alley, G., Snider, W., Spencer, J. & Angell, R. Reading readiness and the Frostig training program. Exceptional Children, 1968, 35, 68-69.

Arciszewski, R. The effects of visual perception training on the perception ability and reading achievement of first grade students. Unpublished doctoral dissertation, Rutgers, 1968.

Barrett, T. Visual discrimination tasks as predictors of first grade reading achievement. Reading Teacher, 1965, 18, 276-282.

Bateman, F. The Illinois Test of Psycholinguistic Abilities in current research. Summary of studies, Institute for Research on Exceptional Children, University of Illinois, June, 1965.

Berlyne, D. Conflict, arousal, and curiosity. New York: McGraw-Hill, 1960.

Brown, J. The Frostig program for the development of visual perception in relation to visual perception ability and reading ability. Unpublished doctoral dissertation, University of Southern California, 1969.

Burkholder, R. B. "The improvement in reading ability through the development of specific underlying or associated mental abilities. Dissertation Abstracts, 1968, 29 (4-A), 1157-1158.

Cantor, G. Responses of infants and children to complex and novel stimulation. Advances in Child Development and Behavior. 1963, 1, 1-30.

Cantor, G., Cantor, J. & Ditrichs, M. Observing behavior in preschool children as a function of stimulus complexity. Child Development, 1963, 34, 683-689.

Center, W. R. A factor analysis of three language and communication batteries. Unpublished doctoral dissertation. University of Georgia, 1963.

Craig, W. N. Effects of preschool training on the development of reading and lipreading skills of deaf children. American Annals of the Deaf, 1964, 109, 280-296.

Cripe, A. Auditory and visual learning related to ITPA sensory channels. Dissertation Abstracts, 1966, 27 (2-B) 635.

Cronbach, L. Educational Psychology. 2nd ed., New York: Harcourt, Brace, and World, 1963.

Frostig, M. & Horne, D. The Frostig test for the development of visual perception. Teacher's Guide. Chicago: Follett, 1964.

Frostig, M., Maslow P., LeFever, D. & Whittlesey, J. The Marianne Frostig developmental test of visual perception. 1963 standardization. Southern Universities Press, 1964.

Gibson, E. J., Gibson, J. J., Pick, A. D. & Osser, H. A developmental study of the discrimination of letter-like forms. Journal of Comparative and Physiological Psychology, 1962, 55, 897-906.

Harlow, H., & Harlow, M. Learning to think. Scientific American, 1949.

Hartung, J. Visual perceptual, reading ability and the young deaf child. Unpublished doctoral dissertation, Washington University, 1968.

Hill, S. D. The performance of young children on three discrimination learning tasks. Child Development, 1965, 36, 425-435.

House, B. J., and Zeaman, D. Miniature experiments in discrimination learning of retardates. Advances in Child Development and Behavior, 1963, 1, 313-374.

Hueftle, M. A factor analytic study of the Frostig developmental test of visual perception and the ITPA and the WISC. Dissertation Abstracts. 1967, 28, 2139-2140.

Hunter, W. S. *The delayed reaction in animals and men.* William Wilkin Co., 1914.

Hunter, W. S. and Bartlett, S. C. Double Alternation behavior in young children. *Journal of Experimental Psychology*, 1948, *38*, 558-567.

Kagan, J., Rosman, B. L., Day, D., Albert, J., & Phillips. W. Information processing in the child: Significance of analytic and reflective attitudes. *Psychological Monographs*, 1964, *78*, 1.

Kass, C. E. *Some psychological correlates of severe reading disability.* Unpublished doctoral dissertation, University of Illinois, 1962.

Kephart, N. C. *The slow learner in the classroom.* Columbus, Merrill, 1960.

Loeffler, F. J. An extension and partial replication of Meyers, et. al.'s Primary abilities at mental age six. Paper presented to Council for Exceptional Children Convention, Philadelphia, Pa. 1963.

McCarthy, J. J., & Kirk, S. *The construction, standardization, and statistical characteristics of the Illinois Test of Psycholinguistic Abilities.* University of Illinois Press, 1963.

Marshall, H. R. *Pilot Study with Deaf Children*, 1965.

Marshall, H. R. *Strengthening the Visual Perception of Deaf Children.* Phase II, 1966.

Marshall, H. R. *Strengthening the Visual Perception of Deaf Children:* Phase II, Progress Report No. 4, 1967.

Marshall, H. R. *Strengthening the Visual Perception of Deaf Children:* Phase III, 1967.

Marshall, H. R. Strengthening the Visual Perception of Deaf Children: Phase III, Progress Report No. 1, 1967.

Marshall, H. R. Strengthening the Visual Perception of Deaf Children: Phase III, Progress Report No. 4, 1968.

Marshall, H. R. Strengthening the Visual Perception of Deaf Children: Phase IV, 1968.

Marshall, H. R. Strengthening the Visual Perception of Deaf Children Phase V, 1969.

Marshall, H. R. Strengthening the Visual Perception of Deaf Children: Phase V, Progress Report No. 2, 1969.

Olson, A. Factor analytic studies of the Frostig development test of visual perception. Journal of Special Education. 1968, 2, 429-433.

Penny, R. K. Reactive curiosity and manifest anxiety in children. Child Development, 1965, 36, 697-702.

Penney, R. K., & McCann, B. The children reactive curiosity scale. Psychological Reports, 1964, 15, 323-334.

Phillips, W. D. The influence of preschool training on achievement in language arts, arithmetic concepts, and socialization of young deaf children in residential schools. Unpublished doctoral dissertation, Columbia University, New York, 1963.

Reese, H. Discrimination learning set in children. Advances in Child Development and Behavior, 1963, 1, 115-145.

Slobodzian, E. The relationship between certain readiness measures and reading achievement at level one. Dissertation Abstracts, 1968, 1053=1054.

Smock, C. P. & Holt, B. G. Children's reactions to novelty: An experimental study of curiosity motivation. Child Development, 1962, 33, 631-642.

Spiker, C. C. Stimulus pretraining and subsequent performance in the delayed reaction experiment. Journal of Experimental Psychology, 1956, 52, 107-111.

Stuart, I. Perceptual style and reading ability: Implications for an instructional approach. Perceptual Motor Skills, 1967, 23, 135-138.

Suchman, R. G., & Trabasso, T. Some relationships between dimension preference and learning rates in nursery school children. Paper presented at Society for Research in Child Development, March, 1965.

Sutton, D. The relationship of visualizing ability reading. Unpublished Master's Thesis, University of Illinois, 1963.

Ward, J. The factor structure of the Frostig developmental test of visual perception. British Journal of Educational Psychology, 1970, 40, 65-67.

Weaver, S. J. Psycholinguistic abilities of culturally deprived children. In Early Training Project, Murfreesboro, Tennessee City Schools and George Peabody College for Teachers, November, 1963.

Zaporzhets, A. V. The development of perception in the preschool child. Monographs of the Society for Research in Child Development, 1965, 30, 82-101.

Appendix A

Prescription and Rationale of Problem Solving/Free Play and Control Groups

Independent variables. The problem solving learning sets training was evolved to use prior research on children's problem solving, and to provide a condition under the control of the teacher.

"Learning sets" is a concept developed by Harlow (1949) to describe "progress from trial-and-error learning to the ability to solve a problem immediately by insight" (p. 116). His research used discrimination learning problems with both monkeys and children. Subjects were confronted with a board on which were placed two objects differing in color, size, shape, etc. When the object to be rewarded was picked up, the subject got the raisins or peanuts in the food cup beneath the object. When the nonrewarded object was picked up, there was no food in the cup. Learning was slow on the first problem. As the problem was repeated with several hundred pairs of objects, each new problem was solved in fewer trials. Eventually, the problem was solved in one trial. One year later, with no intervening practice, the subjects could still solve the problem in one trial.

The extensive research literature on development of learning sets in normal children is well covered in a review by Hayne Reese (1963). The literature on development of learning sets in the mentally retarded is reviewed by House & Zeaman (1963). Generally, the findings are that children can progress quite rapidly from simple to complex problems. The number of trials, rather than the number of problems, is the basic determinant of the development of a learning set. The younger the child, the greater is the need to use objects as stimuli rather than pictures.

Learning sets are established more rapidly when multidimensional stimuli (differing in many characteristics) are used initially. When normal children are given more trials on similar problems after they have developed a learning set, there is longer retention of the one-trial problem solving ability. Extremely retarded children can develop learning sets, but are unable to retain them.

The problem solving learning sets training will include most types of learning (discrimination, serial, paired associates, etc.) and a wide variety of stimuli. It will be given twice a week in 15 minute periods. Most of the training will be done individually, but some of the visual projector training will be given by the teacher to several children at the same time.

Approximately three months will be spent on discrimination learning problems using the standard Wisconsin (or Harlow) equipment. This consists of a three-sided gray box, on which is placed a tray. The tray contains food wells to be covered by objects. There are three wells, since Hill (1965) reported that a two-object problem is as easy for a one-year-old to learn as a three-object problem is to a four-year-old.

The multidimensional initial stimulus objects will be a family of dolls, another set of people, and two sets of small vinyl animals. Then, the stimulus objects will be taken from a set of blocks differing in color, size, and shape. The children will be given four problems of color discrimination, four of shape discrimination, and six of middle size discrimination. They will then do eight oddity problems, in which the odd one of the three stimuli is rewarded. A learning set for oddity problems developed more slowly in both normal and deaf children in the Phase I trial of training than for the preceding problems. A still more difficult problem for these children was the next problem, near and far position.

Using the same equipment, other discrimination training will be given with toys. This training requires the child to match a part placed on the top of a food well, and then fit it to parts previously used, or to the peg board.

Pictures will be the last stimulus objects used with the discrimination learning equipment. They will repeat, in pictures, the problems presented with dolls and blocks.

Serial learning sets will be developed with nested toys, Montessori seriation materials, and bead patterns. The child receives the food reward if he selects the next size or the next bead. This is the type of learning involved in the Visual Motor Sequencing problems of the ITPA.

Two types of training will be limited to children four years old and older. One is learning to solve the color and form oddity problems and matrices developed by Rosslyn Gaines Suchman. These are shapes and colors on sheets of typewriter size paper, and are smaller than the sizes recommended for younger children. Dr. Suchman is using these in her current research.

The other training for the older children uses the Gibson mock alphabet (Gibson, 1962). The child finds the one of 12 similar letters that is the best match to the stimulus card.

During this time, the children under four years of age will have more training with toy matching problems. Additionally, they will match changes in placement of arms and legs of dolls and stuffed animals. These are real object problems that parallel the Suchman and Gibson pictures.

Visual projector materials are still being developed. Three types of projectors will be used: slide, filmstrip, and overhead. Most of the materials for each type require the child to match cards, plaques, or puzzle parts to a projected picture. Materials that have been given trial include a flag filmstrip and card set developed by Dr. Henry Ray, Creative Playthings perception plaques of faces and clowns, and the Teaching Resouces, Inc. Visual-Motor Perception Materials. Children find the animal in the Holstein cow's spots in the overhead projection set designed by Dr. Henry Ray. A Matching Familiar Figures test developed by Kagan, Rosman, Day, Albert, and Phillips (1964) has been adapted to overhead projector training. The author expects to adapt other tests used in that research to visual projector training. She expects to do the same with simpler items of the Frostig training materials, if permission is received for such copying.

The order of presentation of learning sets training will not be the same at all schools. This is to counterbalance the effect of order, and to reduce the amount of required equipment.

The program for free play with constantly changing eye-hand coordination toys is a "best guess" derived from the author's experience as director of university nursery schools. When normal children have had months of this experience, they earn high scores on reading readiness tests. At the last school she directed, she purchased enough toys to schedule a daily change in an eye-hand coordination toy. As in the learning sets research, use of each toy led to more skill in solving the next, even if the child failed to master the first. At the end of a semester, the children could solve extremely difficult part fittings.

The only research found to corroborate this idea is briefly described in a summary of Russian research (Zaporozhets, 1965). Sokhins found that children of three to seven years could not discriminate purely visual elements of a complex form until they were given experience in constructing real structures from elements of different forms and sizes. Boguslavskays found that molding the forms of perceived objects in clay was followed by more precise drawing of the objects by three- to seven-year-old children. L. P. Shchedrovitsky is reported to have demonstrated that the "transition from object-like models to models that resemble real objects less and less, will prepare the child to replace perceived objects with symbols" (p. 96). This type of transition occurs naturally when many eye-hand coordination toys are offered to children.

Nursery school free play is child-directed use of materials in a group situation. Children in American preschools spend most of their school day in this type of play. It is generally believed that this program encourages independence, curiosity, and imagination, in addition to easy acquisition of perceptual-motor skills and knowledge. This is another of the many ideas of educators that has not been tested by research.

However, there has been a considerable amount of research comparing "discovery or exploring" types of learning with several levels of teacher-directed learning in classrooms at older ages. The findings of such studies in the teaching of mathematics resulted in great use of this method in the "new math" programs. Cronbach (1963) summarizes this research by describing the following as "well established statements."

"A discovered response is readily discriminated from alternative responses. Pupils who apply a generalization given by the teacher may learn the mechanics of application without understanding and retaining the principle. If the generalization is given ready-made, the pupil may think he understands it when he does not, hence he may misapply it. When one detail fades from memory his knowledge tends to 'fall apart.' But if he has constructed the principle for himself, he can reconstruct it fairly rapidly by recalling the underlying experiences.

Pupils are challenged when asked to discover a solution. This motivates them to pay closer attention and to think about the material outside of class. The solution, when achieved, contributes to a sense of competence and to interest in further learning.

When one group has applied a principle given by the teacher, and another has constructed it from experience, the second group is more successful in discovering the principle for solving a further problem. The ability - or the confidence - that enables one to discover generalizations of a particular type is learned.

....The great value of discovery is in two transfer effects: in attitude toward a field of knowledge, and in improved ability to discover principles." (pp.379-380)

Comparable research with preschool and older children trained and tested individually is called "curiosity" research. It is based, in most instances, on the ideas of Berlyne (1960). His theory states that certain stimulus characteristics, such as complexity, unfamiliarity, or incongruity, result in exploratory behavior in animals and children. Research on other factors affecting curiosity is only in its initial stages, as is described in an excellent review by Cantor (1963). Penney (1965) reported that less anxious fourth, fifth, and sixth grade children are more curious than those with high anxiety. Penney & McCann (1964) reported curiosity to be positively correlated with originality scores. Smock & Holt (1962) reported perceptual rigidity to relate negatively to the curiosity of first grade children.

Because of the general belief that free play promotes the development of curiosity, curiosity tests were given to the children in Phase I of this study. Only a few of the 51 children showed the curiosity responses characterizing university nursery school children's behavior in the same situation (Cantor, Cantor, & Ditrichs, 1963). They could not be described as willing to learn by exploring aspects of their environment. Perhaps free play training will add this method of learning to their repertoire.

The author has seen very few eye-hand coordination toys either in use or in storage at the schools for the deaf she has visited. The teachers participating in Phase I expressed much appreciation of the opportunity to learn about such toys and of the children's enjoyment of their use.

The program of training consists of three 15 minute periods each week of exposure to the toys in a group free play situation. At least one toy is changed each period. Children in Phase I were unable to use all the toys in two 15 minute periods a week, so the number of weekly periods was increased for Phase II.

It is difficult to classify the toys by the Frostig and ITPA categories for two reasons. Most overlap several categories, and children's use of many toys changes with age and greater sophistication. Most of the toys can be classified into the following types:

Fit-together toys, such as Tinkertoys and plastic blocks
Form boards
Peg boards
Puzzles
Lacing materials
Stacking toys, such as Bill Ding
Nesting toys (houses or bowls)
Matching toys (primarily pictures)

There are some that have to be labelled as miscellaneous, such as a Teleido-scope, or the new Play Doh molds.

The materials sent to the schools for free play use will include a cartridge projector and eight cartridges produced by Dr. Henry Ray, the light box originated by Dr. Ray, and the card form of his Holstein cows.

The order of presentation of toys will not be the same at all schools. This is to counterbalance the effect of order, and to reduce the number of toys to be purchased.

The no visual perception training will be handled in two ways. Either the children will not be given any training, or they will be trained in auditory perception. This decision will be made by the teacher or school. The auditory perception training was developed at the request of teachers in Phase I. Parents were present part or all of the day at these schools. All wanted their children to have special training.

The training is free play with auditory toys in a group situation. Teachers will decide on its frequency.

Appendix B

Description of Dependent Measures

The _Marianne Frostig Developmental Test of Visual Perception_ was published in 1964. It was standardized in 1963 on 2100 unselected nursery school and public school children between the ages of three and nine years (Frostig, Maslow, Lefever, & Wittlesay, 1964). The five subtests assess directly the five functions mentioned in Purpose 5. The Maurer adaptation of the test for deaf children is followed in the test administration.

The _Illinois Test of Psycholinguistic Abilities_ (ITPA) was recommended by Dr. Phyllis Maslow of the Marianne Frostig Center of Educational Therapy. Because she and Dr. Frostig think it tests different abilities than the Frostig, their Center always gives both tests.

The ITPA was standardized on 700 linguistically normal children between the ages of two and nine years in 1959 and 1960 (McCarthy & Kirk, 1963). These were randomly selected from a pool of 1100 children who ranged in IQ from 80 to 120, were white, had parents occupationally representing the occupational distribution of Illinois, and were tested within two months of their full or half year birthday.

The four subtests possible to use with deaf children had very small intercorrelations (.14 to .28) in the standardization group.

The _tests of visual and tactile curiosity_ all measure the length of time children look at or feel stimuli at three levels of complexity: low, medium, and high. The visual stimuli are abstract designs used by Berlyne (1960) and by Cantor, Cantor, and Ditrichs (1963). Another similar set of stimuli has been prepared by the artist assistant for retest purposes. In Phase I, more children showed visual curiosity (look at complex stimuli longer than at the simplar) when the visual stimuli were in color rather than black and white, and when they were presented by a Carousel projector rather than in the boxes used by Cantor, Cantor, and Ditrichs. Hence, in Phase II, the color sets will be presented by a Carousel projector. The child controls the length of time the pictures are shown.

The tactile curiosity tests are of shape and of texture. The stimuli are presented in three boxes designed by David Sullenberger, a research technician for this project. He also designed the stimuli. The child puts both hands in curtained holes, and the object is put into them. More children had tactile curiosity than visual curiosity in Phase I.

Curiosity tests were included because of the general belief that free play training encourages curiosity, while more formal training lacks this effect.

The memory tests were designed by Hunter (1914, 1948). The delayed reaction test has been used with children as young as 15 months. The score is the length of time the child remembers the one of two pictures a reward is placed under, when it is no longer possible to see the pictures. The equipment used for this test in Phase I was designed by Spiker (1956). Two boxes with a picture on the top of each are mounted on a disc. The disc can be spun at speeds preventing visual pursuit of the pictures. The pictures used by Spiker were tried in Phase I. They consisted of five and seven concentric circles. Very few Phase I children could remember these better than the 15 month memory of pictures of common objects.

Results from other tests suggested the children could not recognize these numbers as different. When the pictures were changed to a car and an airplane, all had a much longer visual memory span.

Equipment for the other two tests was a board facing the child, with two boxes at the base. All are painted a flat gray. In the single alternation test, the food reward is placed lrlrlr in the two boxes. Choice of the correct box on nine of 10 successive trials indicates the child can remember both the sequence and his choice on the preceding trial. Most of the children in Phase I had this memory ability.

In the double alternation test, reward placement is llrrllrr. Three sequences of eight correct choices indicates the child remembers both the sequence and his choice on the preceding trial. Many Phase I children did not learn this in the 80 trials of the test.

In Phase II, the single alternation test will be administered first to each child. Test performance will determine whether the simpler or more advanced test should be administered next.

The tests were included because both types of training are supposed to improve retention of learning. The training uses both action and visual stimuli. The ITPA visual-motor sequencing uses pictures of forms that deaf children may not recognize well enough for their memory span to be tested.

The <u>Suchman Test of Color Preference</u> (1965) is a series of slides that can be presented in two orders. Dr. Suchman is using it with normal children as a before and after test of the effect of training on color and form oddity problems and matrices. This training will be given to one group of older children in the project. If it seems feasible when schedules are developed, this test will be administered to this group immediately before and after the training.

It has been difficult to choose an intelligence test. The Leiter, Hiskey, and Ravens take a longer time to administer than is considered desirable in tests for normal children. The WISC does not extend below five years.

Intelligence tests have well standardized procedures and scoring. Hence, when the school has a psychologist, an attempt will be made to have him administer the intelligence tests. This was suggested as possible when arrangements were discussed with Gompers Clinic. This probably means that all tests would be used, to avoid much purchase of test materials. There is so little variation in scores obtained on the tests that this possibility is feasible.

The visual acuity and control tests were selected by William O. Edward, M.D., an opthalmologist consultant for this project. The acuity test uses the A-O Project-O-Chart with the children's slide. In pre-training, children are shown a capital E, and asked to make their fingers go the same way as the E, when it is in different positions. Teachers were asked to train in this in Phase I. Consequently, many more three-year-olds could be tested on the E chart than can be expected normally. When they cannot do the E chart, the slide has pictures of common objects for the children to name or demonstrat This part does not go below 20/30, while the E chart tests 20/25 and 20/20 acuity.

A tiny flashlight is used to check use of both eyes. If the light is centered in both pupils, the child uses both. If in one eye, the light is reflected from the iris, the child is not using that eye. This is the most common visual defect in children, according to Dr. Edward. Visual pursuit of the moving light checks nystagmus (jerks of the eye). The pupillary reflex is checked by suddenly increasing light.

The test of color blindness is the AO H-R-R Pseudoisochromatic plates (bound). The children trace the colored figures with their fingers.

The Kephart Perceptual Motor Survey tests large muscle coordination. It is described in his book, "The Slow Learner in the Classroom" (1960). Few scoring directions are given in this description. A score sheet with more adequate descriptions and point assignments was obtained from one of his former students. For this project, the visual control tests and pencil drawing tests are eliminated, because they are measured in other tests. Test scores discriminated between children, and seemed in line with observable muscle control during other tests. Control of larger muscles develops before finer control in children, and this is the basis for using this test.

Appendix C

Instructions for Problem Solving Training

This training is designed to build learning sets in visual discrimination. Most of the training is conducted with the folding gray discrimination box. This is placed on the table in front of the child, where the child can reach the food tray easily. Most problems require the child to select one of three stimulus objects; i.e., to lift it and the food well cover. Under that object is a piece of food, while there is nothing under the others. The child gets the food when he chooses correctly. Incorrect choices mean no food.

In training, the adult sits next to the child, and changes stimulus objects and food at the side of the box, out of the sight of the child. The reward should be placed in each food well equally of ten, and should never be twice in the same well. In the early problems, many children base choices on position. If a child appears to be developing a position preference, do not put food in that position for at least 15 trials.

The adult tries to avoid giving the child any verbal or visual cues about the correct and incorrect stimulus objects. The adult shows pleasure when a child chooses correctly, and smilingly shakes head on incorrect choices. If a child appears frustrated by failure, (this will occur only in early sessions) try to assure them they will figure it out, and give the child extra food when the session ends.

The child has solved the problem when he has nine of ten consecutive trials correct. The adult records each session for each child on a separate tally sheet. A sample is attached. Correct choices are marked +, and incorrect choices are marked either – or 0. The child's name and the date should be put on each sheet, in addition to the name of the problem or problems being solved. These records are to be given to Dr. Marshall.

The child may require many trials to solve the first problems. He should have about 25 trials a day, unless it looks as if he is on a nine of ten choices correct sequence. When he has had 100 trials on a problem, or has been successful, he is shifted to the next problem. The set is being formed whether he is successful or not. By the sixth to tenth problem he will be solving most problems in 10 to 15 trials. This means he has a learning set.

When the child solves successive problems in 10 to 15 trials, begin giving him two problems a day. The order of problems is given on a separate sheet, arranged so that you can keep track of problems solved by each child. The order is based on difficulty of the problem and repeats each type enough to ensure development of a learning set.

The child should have two training sessions a week, preferably not on successive days. Each will take about 15 minutes. If the child debates choices, however, it may take longer. Such debates occur usually in early sessions only.

The food well covers are topped with Velcro, the new nylon hooking material. Velcro has been placed on the bottom of the stimulus objects. When these are pressed on the covers, they will stay. They are removed by peeling the two Velcro pieces apart. If the Velcro comes off the stimulus object, it will need to be remounted with the Epoxy glue given you. A small amount should be mixed well, applied to object, and then the object is applied to the wrong side of the Velcro. Some pressure on

Velcro and object is needed during drying.

Second Year Problem Solving Training

A review of each type of block problem of Year 1 should begin the year. When the child does not have one or two trial learning on a particular type or problem give additional problems of that type until he has mastered it. When the child has one or two trial learning, proceed to the next type.

Two difficult problems with blocks have been added for the second year. They are on pages 36a and b.

Both the review and the new problems should have visual projector problems and problems with toys interspersed among them. For example, on the fourth training period, use projector problems. Use them or toy problems again on the sixth, eighth, tenth, etc. training periods.

Problems with toys. Any free play toys with two or more matching parts can be used in this training. If it is a peg board, put the empty board and a box with all of color pegs in front of the child. You have a peg of each color. Put a peg on one of the velcro blocks of the food tray. When the child picks a peg of the same color, and puts it in the board, he gets a food reward. Continue for all the colors of pegs.

If the toy is one like snap or peg blocks, the pats can be matched in shape, size, or color, whichever is least like the preceding problem Each part matched by the child should be fitted onto the ones he already has before the food reward is given.

Nested toys can be used with two food trays. Place either the largest or the smallest on the velcro block furthest left. The child is to put the next largest or smallest on the block to the right of yours. When he succeeds, he receives a food reward. He should end with all the blocks in the right sequence.

The record blank for this training is p. 45.

The University of Texas at El Paso
79999

Department of Psychology

April 6, 1971

Dr. David Sachs
Department of Psychology
New Mexico State University
Las Cruces, New Mexico 88001

Dear David:

After looking over the manuals and the test data, my comments are as follows:

1. The Frostig. It should be kept in mind that a raw score increment of one adds 3 months of perceptual age on all scales. With the exception of the Position in Space and Spatial Subtests, minus two standard deviations will bring you down to and sometimes just barely below the lowest possible score. Although there is some restriction of range, this appears to be amenable to statistical treatment. For the two named subtests, minus one S.D. produces the same effect, a rather inadequate spread.

2. ITPA. A raw score increment of one raw score unit produces 4-5 months of language age, depending on the subtest and age of subject. For some of the subtests such as visual encoding, and visual motor sequencing, have standard errors for the raw score of 2 or larger. A chance error, then, within the limits of the S.E. could produce an apparent change of eight or ten months. However, the distribution of scores appears to be adequate for statistical treatment. The spread of scores for those groups inspected is about the same as that of the Frostig : minus 2 S.D.'s is about as far as you can go before you run off the chart.

3. Stanford. Interpretation of change scores must be made with caution because of the unequal steps between converted percentile ranks. The most extreme example, for word meaning, shows that a raw score of 16 is at the 50th percentile, and 17 is at the 70th percentile. For many groups the S.D. is about as large as the mean. Minus one S.D. in almost all distributions inspected is at about the first percentile.

Let me know what other analyses and deep insights you might want real soon.

Sincerely,

Phil
Philip Himelstein
Chairman

Appendix E

Results of Frostig Eye Motor Subtest

Means and Standard Deviation for Control/Free Play/Problem Solving

(First Year)

Group	Pre-Test: Number of Subjects	Pre-Test: Mean	Pre-Test: S.D.	Retest: Number of Subjects	Retest: Mean	Retest: S.D.
Control	113	54.6	19.95	113	60.8	20.64
Free Play	106	51.0	13.60	106	57.8	16.77
Problem Solving	59	55.0	13.47	59	65.2	19.98

Appendix E

Results of Frostig Eye Motor Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

Group	Pre-Test			Retest		
	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	113	49.0	22.57	113	57.1	22.96
Free Play	106	50.0	19.90	106	59.6	20.34
Problem Solving	59	52.6	19.03	59	65.7	21.34

Appendix E

Results of Frostig Shape-Constancy Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

Group	Pre-test Number of Subjects	Mean	S.D.	Retest Number of Subjects	Mean	S.D.
Control	113	48.8	21.89	113	57.4	21.41
Free Play	106	53.9	21.58	106	62.1	21.50
Problem Solving	59	58.0	20.41	58	72.8	23.52

Appendix E

Results of Frostig Position Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

Group	Pre-test			Retest		
	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	113	39.8	17.90	111	46.8	21.64
Free Play	106	40.3	16.98	106	47.7	20.85
Problem Solving	59	44.8	20.32	58	60.1	23.81

Appendix E

Results of Frostig Spatial Relation Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

Group	Pre-test			Retest		
	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	113	50.9	19.54	113	58.6	21.44
Free Play	106	51.3	17.22	106	60.2	18.81
Problem Solving	59	53.6	17.19	58	66.2	19.62

Appendix F

Results of ITPA Visual Decoding Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

	Pre-test			Retest		
Group	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	113	50.3	20.22	111	62.9	20.77
Free Play	106	49.8	17.12	107	64.9	19.46
Problem Solving	59	53.6	19.43	59	66.8	17.12

Appendix F

Results of ITPA Motor Encoding Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

	Pre-test			Retest		
Group	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	113	46.6	18.14	111	61.1	22.13
Free Play	106	44.7	19.20	107	59.7	20.62
Problem Solving	59	48.0	17.30	58	64.2	18.19

Appendix F

Results of ITPA Visual-Motor Sequencing Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

	Pre-test			Retest		
Group	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	113	59.9	25.48	111	70.4	28.54
Free Play	106	60.7	25.72	107	82.6	25.49
Problem Solving	59	58.8	24.41	59	79.2	26.10

Appendix F

Results of ITPA Visual-Motor Association Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(First Year)

Group	Pre-test Number of Subjects	Pre-test Mean	Pre-test S.D.	Retest Number of Subjects	Retest Mean	Retest S.D.
Control	113	49.4	21.22	111	63.7	23.71
Free Play	106	49.5	19.27	107	67.3	19.92
Problem Solving	59	50.1	17.92	59	67.7	21.06

Appendix G

Results of Frostig Eye-Motor Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(Second Year)

	Pre-test			Retest		
Group	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	26	62.1	19.50	49	69.4	31.69
Free Play	17	64.6	22.28	29	69.9	22.81
Problem Solving	17	67.1	20.23	28	66.1	29.27

Appendix G

Results of Frostig Figure-Ground Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

Group	Pre-test Number of Subjects	Pre-test Mean	Pre-test S.D.	Retest Number of Subjects	Retest Mean	Retest S.D.
Control	26	52.5	18.20	49	62.3	29.53
Free Play	17	55.8	17.79	30	64.5	26.96
Problem Solving	17	61.8	12.05	28	59.5	26.21

Appendix G

Results of Frostig Shape Constancy Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(Second Year)

Group	Pre-test			Retest		
	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	26	52.7	17.76	49	61.9	20.65
Free Play	17	55.8	18.89	30	64.7	19.73
Problem Solving	17	60.0	22.22	28	61.0	14.07

Appendix G

Results of Frostig Position Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(Second Year)

Group	Pre-test			Retest		
	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	26	39.5	15.10	44	58.4	25.08
Free Play	17	44.8	20.44	27	64.9	17.57
Problem Solving	17	50.6	22.97	25	61.8	24.23

Appendix G

Results of Frostig Spatial Relation Subtest

Means and Standard Deviations for Control/Free Play/Problem Solving

(Second Year)

	Pre-test			Retest		
Group	Number of Subjects	Mean	S.D.	Number of Subjects	Mean	S.D.
Control	26	52.2	18.76	44	74.2	19.08
Free Play	17	57.5	15.70	27	79.1	17.03
Problem Solving	17	63.7	23.15	25	77.0	17.64

Appendix H

t-Scores for Frostig Subtests

		Eye-Motor	Figure Group	Shape Constancy	Position	Spatial Relation
1st year	Problem-Solving Control	1.4963*	2.9245****	2.1160**	2.8724****	2.4017***
	Free Play-Control	.5317	1.2426	.1250	.5911	1.0170
2nd year	Problem-Solving Control	1.0672	.7914	.8719	.3896	.4753
	Free Play-Control	.3957	.8314	.1919	1.0596	.4100

* $p < .10$

** $p < .05$

*** $p < .01$

**** $p < .005$

Appendix H

t-Scores for ITPA

	Visual Decoding	Motor Encoding	Visual-Motor Sequencing	Visual-Motor Association
Problem Solving-Control (1st year)	---	.7664	2.6952****	.9968
Free Play-Control	.7317	.1261	3.2276****	1.5200

* p < .10

** p < .05

*** p < .01

**** p < .005

Appendix I

Percentile Means and Standard Deviations of
Reading Test Scores - All Subjects in
Third Year After Beginning Program

	Gates-McGinitie Reading Test			Gates-McGinitie Vocabulary Test			Stanford Word Meaning Test			Stanford Paragraph Meaning Test		
Group	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Control	16	21.5	16.3	13	21.8	14.1	16	25.0	13.3	11	14.5	12.5
Free Play	18	31.3	25.5	18	32.7	28.5	14	20.2	23.4	10	23.6	17.8
Problem Solving	14	37.3	33.2	13	29.8	29.8	12	31.2	12.3	11	17.5	22.0