THE RELATIONSHIP BETWEEN AUDITORY FIGURE-GROUND PERCEPTION AND ACADEMIC ACHIEVEMENT IN OPEN AREA AND SELF-CONTAINED CLASSROOMS

by

CHERYL ANN BROWN

B.A., Sir George Williams University, 1966

Dip. Child Study, University of Toronto, 1967

A thesis submitted in partial fulfilment of

the requirements for the degree of

Master of Arts

in the Faculty

of

Education

We accept this thesis as conforming to the
required standard

THE UNIVERSITY OF BRITISH COLUMBIA

MARCH, 1975

ABSTRACT

This study was designed to investigate the effects of two different learning environments on the achievement of children who were suspected of having auditory figure-ground perception problems. Comparison of the noise levels in the three open area and three self-contained classrooms used in the study revealed that the open areas were consistently louder than the self-contained classes but the differences were only statistically significant in the mornings. Because of these expected differences in noise level, it was hypothesized that the more difficulty grade one children in open areas had with auditory figure-ground perception as measured by the noise subtest of the Goldman-Fristoe-Woodcock Test of Auditory Discrimination, the lower their achievement scores would be on the Cooperative Primary Tests. This relationship was not expected to be found in grade one children who received their first year of formal instruction in self-contained classrooms.

A stepwise multiple regression analysis was used to test this hypothesis with Wide Range Achievement Test scores (administered in the Fall) as covariates and three subtests of the Cooperative Primary Test scores (administered in the Spring) as dependent variables. Although a trend in the expected direction was found, the results were not statistically significant (α = .05). Therefore, it could not be concluded that children with auditory figure-ground perception problems were more appropriately placed in self-contained classrooms.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The assistance and patience of the members of my thesis committee, Drs. D. Thomas, J. Conry, and R. Conry are gratefully acknowledged. The cooperation of Mr. Lincoln Chew and Dr. H. E. McLean of the Vancouver Metropolitan Health Department was sincerely appreciated for gathering the data to compare the noise levels in the classrooms involved in my study while conducting their own investigation into sound levels in various classroom situations. I would also like to recognize the interest and support of Dr. E. N. Ellis and Mr. A. Moody of the Vancouver School Board's Department of Planning and Evaluation for making it possible for me to conduct my research in the Vancouver schools. Finally, I would like to express my gratitude to the principals, teachers, parents and children without whose cooperation this study would not have been possible.

CHAPTER 1

THE PROBLEM AND RELATED RESEARCH

Overview of the Problem

Children are bombarded constantly by competing auditory stimuli but in order to function effectively in the school situation, they must be able to attend and respond specifically to relevant stimuli. Academic success and behaviour may be seriously affected by impaired ability to separate foreground auditory stimuli from irrelevant background stimuli (Siegenthaler and Barr, 1967; Marsh, 1973).

When it is suspected that a child has a difficulty with auditory figure-ground perception, it is usually recommended that he be taught in a "calm" atmosphere (Magdol, 1973). Criticism based on teachers' opinions is frequently directed towards open area classes because of excessive noise conditions (Allen, 1972; Pritchard and Moodie, 1971; Metropolitan Toronto School Board, 1971 and 1973). Therefore, it is unlikely that this type of classroom would be appropriate for a child who has difficulty distinguishing between relevant and irrelevant auditory stimuli.

The following case study is an illustration of a child who was suspected of having an auditory figure-ground perception problem. Several years ago, a seven year old boy was referred to an observation class because of his disruptive behaviour and underachievement. His original placement had been in an open area situation which consisted of four classes in a large room. Individual psychological testing indicated that he had high average intelligence (Wechsler Intelligence Scale for Children: Verbal IQ - 116; Performance IQ - 115; Full Scale IQ - 117) with no apparent learning disabilities except great difficulty in listening situations with competing auditory stimuliaas measured by the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFWT). Consultation with his teacher and parents elicited many examples of his lack of attention in situations where there was background noise and speech. His parents noted that he frequently did not respond when spoken to if the television set was turned on or his father was playing the guitar. His teacher observed that he functioned in many ways like a deaf child because of his failure to attend to her directions or conversation when there was quite a bit of auditory activity in the classroom. His medical history included two mastoid operations during his preschool years and the hearing impairment prior to the operations could have impeded the development of his auditory processes even though his hearing was apparently normal at the time of referral. Because of his difficulty functioning in situations with competing auditory stimuli, it was suspected that he may have an auditory figure-ground perception problem. It was recommended that he not be returned to the open area because of this suspected problem, and subsequent placement in a quiet self contained classroom may have been partially responsible for eventual improvement in his behaviour and achievement.

The Problem

It is possible that other children who have difficulty focussing on relevant aspects of the auditory field and "tuning out" irrelevant background stimuli are inappropriately placed in open area classrooms which are believed to have more auditory distractions than self-contained classrooms. There does not appear to be any empirical evidence to support this statement, although a review of the literature lends credence to its validity.

The areas of research to be explored include specific studies related to auditory figure ground perception as well as the controversy over whether or not open areas are noisier than self contained classes. If some learning environments are noisier than others, there is a need to investigate whether this noise has a detrimental effect on all or some children such as the case described previously. Specific learning difficulties may result from poor auditory figure-ground perception; and, therefore, a review of studies related to the diagnosis and remediation of this type of problem is also presented.

Studies Related to Auditory Figure Ground Perception

As early as 1947, Strauss and Lehtinen expressed concern about children who had difficulty focussing on relevant aspects of the auditory field and 'tuning out' irrelevant background stimuli. Some studies of selective attention in children suggest that auditory figure-ground perception develops with age. In Junker's (1972) observations of infants, he noticed that the average twelve week old infant becomes silent in the presence of speech or music. By fourteen weeks, a child will turn his head and visually search for the source of sound stimuli. Junker devised an attention test for infants and found that children who had difficulty with auditory selective attention in infancy had a strong tendency to develop defective speech and/or communication skills as indicated from follow-up assessments two years later.

Maccoby and Konrad (1966) studied age trends in selective attention in respect to the selection of one auditory stimulus when two were presented simultaneously. Their subjects included thirty-two children in each of three grades: Kindergarten, second and fourth. Each subject listened twice to twenty-three pairs of words spoken simultaneously by two speakers, a man and a woman. On one occasion, the words were presented binaurally with both words in both ears at the same time, and on the second occasion, the words were presented dichotically with two different words in each ear at the same time. The subject was instructed to repeat the words said by the woman or man depending on the condition. Maccoby and Konrad found that the number of correct responses increased with age and the number of intrusive errors (i.e. reports of words spoken by the other voice) decreased with age.

Doyle (1973) investigated the effects of distraction on auditory selective attention with 108 children aged eight, eleven, and fourteen. She presented subjects with lists of target words which they had to repeat word by word and remember. While two-third of the subjects at each age level listened and repeated the target words, they were distracted by another voice speaking simultaneously. The rest of the subjects were not distracted while they listened and repeated the target list. Retention of the target words was tested by presenting each subject with a four alternative, forced choice recognition task. A similar task was used to test for retention of distracting words. It was found that the retention of the target words was more seriously affected among younger children, and that intrusive errors decreased with age. Doyle suggested that these results demonstrated an ability of older children to inhibit the intrusion of distractions during selective attention rather than an ability to filter out distracting material in the initial stages of processing.

Neither Doyle nor Maccoby and Konrad made any reference to the possibility of a sex difference in selective attention which was found to be a significant factor in a study by Siegenthaler and Barr (1967). They studied auditory figure-ground perception in five groups of children, aged four, five, seven, nine, and eleven. Each of these groups was composed of ten children of each sex. Using the Picture Identification Test on which a child is instructed to point to specific pictures, they determined each child's speech reception threshold under quiet and noise conditions. A tape recording of a man reading a story was re-recorded seven times to produce a babbling of voices effect and then played backward as the noise condition. A significant amount of variation was not found in girls between the ages of four and nine although there was a significant improvement in auditory figure perception in eleven year old girls. Boys tended to improve steadily from age six to eleven. At ages four and five, the auditory figure-ground perception of both sexes was equal but as age increased, boys tended to perform better than girls.

These findings conflict with the results of a recent study by Marsh (1973) who explored developmental trends in auditory figure-ground perception with 210 children from Kindergarten to grade three. Auditory figure-ground perception was tested by having the subject repeat spondee words presented in varying levels of white noise after each word had been successfully repeated under quiet conditions. Marsh found that errors decreased as age increased ($\alpha = .01$) but sex was not a significant factor. She also discovered a significant ($\alpha = .01$) relationship between the results of this test of auditory figure-ground perception and scores on the Wide Range Achievement Test (WRAT). Both tests were administered within two weeks of each other. With age held constant, children who made more errors on the auditory perception test had lower scores on the reading, spelling and arithmetic subtests of the WRAT.

These studies may have important educational implications. It is possible that some children, especially in the primary grades, have difficulty learning in certain environments such as open area classrooms because of some type of problem focussing on verbal instructions and directions while tuning out irrelevant background stimuli such as noise and speech (Palmieri, 1973).

Studies Related to Noise Levels in Classrooms

Kingsbury (1973), who is an architectural engineer, stressed that it is very difficult to adequately design open area schools in order to reduce ambient noise and increase speech intelligibility. Recent studies of open area classes in British Columbia schools indicated that one of the most common criticisms of open areas by teachers and principals was the presence of noise and distraction (Allen, 1972; Pritchard and Moodie, 1971). The Metropolitan Toronto School Board (1971) compared twelve open plan schools with twelve traditional plan schools and found that twenty-five percent of the open plan teachers reported noise as a problem whereas a similar complaint was made by only four percent of traditional plan teachers. In a booklet on open plan schools published by this school board, the advice given to new open plan teachers by experienced open plan teachers was "to be aware of the high noise level and to learn to ignore it, or withstand it, - "Take earplugs and plenty of tranquilizers" was one pointed suggestion (Metropolitan Toronto School Board, 1973, page 11)." Unfortunately, the booklet does not contain any advice for the children who have difficulty coping with the noise level.

Ambient noise and distraction may have been partially responsible for the results of a study by Bell and Switzer (1973). They found that at the end of the first grade, children in traditional classrooms performed significantly better on a battery of reading tests than children in open areas, even though the two groups did not differ significantly in terms of intelligence or perceptual skills at the beginning of the school year. In the discussion of their results, it was stated:

> A teacher must hold the attention of the class against considerable distraction, thus expending considerable energy unprofitably. Movements of classes through the area, and rival programmes, often with sound effects, make concentration difficult for the children, many of whom have a short attention span at the best of times.

> In addition, the teacher is placed in a tension-provoking situation which is probably not conducive to a state of harmony among staff members who must compete for a hearing, or between the teachers and the class (page 25-26).

Studies by Slater (1967), Carter and Diaz (1971), and Kassinove (1972) suggest that background noise does not affect children's learning and that schools should not waste their time and efforts attempting to eliminate such noise. Slater tested seventh grade children on the Reading Subtest of the Sequential Test of Educational Progress, under quiet (45-55 decibels), average (55-70 decibels), and noisy (75-90 decibels) conditions. Carter and Diaz tested sixth grade boys on the Reading Comprehension subtest of the Stanford Achievement Test under conditions of low background distraction (silence), medium background distraction (45-55 decibels), and high background distraction (55-65 decibels). Kassinove tested third and sixth grade children on written arithmetic tasks under conditions of no auditory stimulation, background stories, background music, music and stories presented simultaneously but difficult to discriminate, and music and stories presented simultaneously but easier to discriminate. In all of these studies, it was found that background noise did not affect childrens' performance.

Slater, who used seventh grade children in her study, and Kassinove, who used third and sixth grade children, both generalized their results to all grade levels without regard for developmental differences in attention. Carter and Diaz used sixth grade children but cautioned against generalizing their results to children in primary grades.

In these three studies, reading or arithmetic tasks were used as dependent variables. This suggests that the ability to make use of previously learned skills, in the presence of varying degrees of background noise was being measured. If the subjects had been required to learn some type of new skill under the various testing conditions, the background noise may have had a more detrimental effect on their performances. On the basis of the results of their studies, these researchers have implied that background noise does not interfere with children's learning even though they have made no attempt to measure the effects of this background noise on the speech intelligibility of teachers giving verbal instructions to students. In order to determine what effect background noise does have on speech communication in the classroom situation, it would be necessary to investigate the 'signal-to noise ratio' which is "the relationship between the intensity of the speech and the intensity of the noise" (Newby, 1972, page 275).

Specific Learning Difficulties Related to Auditory Figure-Ground Perception

In Kassinove's (1972) study, each child was observed through a one way mirror while he or she was being tested. These behavioural observations suggested that the effects of background noise seemed to be related to individual differences in children.

Dykman, Ackerman, Clements, and Peterss(1971) suggest that many learning disabilities are attentional deficits which result from defective inhibition in the cortex of the neurologically immature child. Kinsbourne (1973) said that some children are "stuck" being responsive to all stimuli because of a maturational lag in their ability to focus. Rabinovitch (1972) suggested that problems with auditory figure-ground perception may result from lack of sensory stimulation in early childhood.

Whether these attentional problems are physiologically and/or environmentally induced, there are children who appear to need remedial assistance because of their apparent inability to cope with excessive auditory and visual stimulation. In order to identify these children, diagnostic measures are necessary.

Diagnosis of Auditory Figure-Ground Perception Problems

Specific behaviours which may be observed in children who are suspected of having an auditory figure-ground perception problem are listed by Mann and Suiter (1974):

> 1. The student may exhibit forced attention to sound causing him to attend to extraneous noises in his environment.
>
> 2. He may find it difficult to attend to speech.
>
> 3. By comparison to other students, he may not be able to sit for long periods of time. He may appear to be distractable and hyperactive.
>
> 4. The teacher may find that the student obeys the commands of the teacher next door.
>
> 5. He may not be able to focus his attention on his own work and may tend to interfere when the teacher is working with another student. (page 70).

Nober (1973) administered the Wepman Auditory Discrimination Test to thirteen normal, thirteen speech defective, and thirteen reading retarded children (ages 5.1 - 7.11) under quiet and noise conditions. She found a statistically significant difference for the normal and reading retarded groups, (.01 level) between the number of errors made in a quiet test room as compared to the number of errors made in the same test room with taped classroom noise playing in the background. When the scores for each testing condition were compared using the adjusted Wepman pass-fail scores which take age into consideration, there was a statistically significant difference for the reading retarded group.

On the basis of these results, Nober questioned whether the Wepman test, which was standardized under quiet testing conditions, was a valid measure of a child's auditory discrimination ability under normal classroom conditions where formal learning is to take place. Although she makes no mention of auditory figure-ground perception, it would appear that this is the specific auditory perceptual skill which she believes should be measured.

One standardized test which can be used to assess an auditory figure-ground perception problem is the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFWT). This test was designed to "provide a measure of auditory discrimination under ideal listening conditions plus a comparative measure of auditory discrimination in the presence of controlled background noise (Goldman et al., 1970, page 4)."

Chalfant and Flathouse (1971; page 265) suggest that the following questions should be considered in an investigation of figure-ground perception:

1. Is hearing or visual acuity a factor?
2. Does the child understand what he is to do?
3. Has the figure stimulus been clearly identified?
4. Is the figure stimulus meaningful?
5. Are the background stimuli meaningful?
6. What is the strength (intensity) of the background stimuli? Of the figure stimuli?
7. How many stimuli are involved (complexity)?
8. How many times has a similar figure-ground condition been presented? Were the child's responses consistent?
9. Is fatigue a factor?
10. Are figure and/or background stimuli presented simultaneously or successively?
11. What happens if the child responds appropriately? Inappropriately?

In order to justify the use of the GFWT as a measure of auditory figure-ground perception, Chalfant and Flathouse's questions can be answered in the following manner.

1. Hearing and visual acuity should be within normal limits in order to make appropriate use of this test.
2. Directions are clearly presented on audio tape.
3. The figure stimuli are common English words.
4. All words used as figure stimuli are reviewed and/or taught to the child before formal testing begins.
5. The background stimuli are recorded environmental sounds from a school cafeteria.
6. The background stimuli are nine decibels less intense than the figure stimuli; the strength of the figure stimulus is 60 to 70 decibels.
7. One figure stimulus is presented at a time.
8. The figure ground condition is presented thirty times; Consistency of responses depends on the child.
9. The testing procedure only takes seven and one-half minutes so it is unlikely that fatigue would be a factor with most children.
10. Figure stimuli are presented simultaneously with the background stimuli.
11. The child does not receive feedback as to the appropriateness of his responses.

The only available data regarding reliability and validity for the GFWT is reported in the test manual. Test-retest reliabilities of .87 for the quiet subtest and .81 for the noise subtest and split-half reliabilities of .87 for the quiet subtest and .68 for the noise subtest are reported. To determine the validity of the test, GFWT scores were correlated with the judgments of expert clinicians for a group of eighteen subjects receiving speech therapy. The resulting coefficients of .68 for the quiet subtest and .72 for the noise subtest were used as evidence of validity by the test authors.

The GFWT was standardized on 745 subjects ranging in age from three to eighty-four. The developmental trend in auditory figure-ground perception noted in the studies of Marsh (1973), Doyle (1973), and Maccoby and Konrad (1966) was also observed in this standardization sample. The test authors also report sex differences but claim that they are "of small magnitude and thus, it is appropriate to use a single set of norms for both male and female subjects (page 16)."

On the GFWT, stimulus words on the quiet and noise subtests are presented on audio tape and the subject has to choose one of four pictures which corresponds to the word he hears. Each word has a new selection of four pictures presented on a separate plate. If a subject's performance is above the twentieth to thirtieth percentile on both subtests, according to the norms, it is concluded that his auditory discrimination skills are adequate. If he scores above this cut-off point on the quiet subtest, but below it on the noise subtest, then it is interpreted that he functions poorly on auditory discrimination in a difficult listening situation. Given the condition that there is no hearing loss, if he performs below the twentieth to thirtieth percentile on both subtests, then the test authors suggest that he has an auditory discrimination problem and may also have difficulty in a listening situation with competing auditory signals.

Remediation of Auditory Figure-Ground Perception Problems

Once difficulties with auditory figure-ground perception have been identified, attempts can be made to remediate them. Mann and Suiter (1974) make the following general recommendations for children suspected of having an auditory figure-ground perception problem:

> 1. The teacher should provide a place that is reasonably quiet where the student can get off by himself for parts of the day.
>
> 2. He should not seat the student by the window, door, or noisy air conditioner.
>
> 3. He can help him select relevant from irrelevant sounds in his environment with his eyes closed, then with his eyes open.
>
> 4. He can use tapes or records to help the student build in sound selectivity (ear phones can be used to screen out distraction).
>
> 5. Drugs under strict supervision may help.
>
> 6. The teacher should regulate the rate of input accordingly. Going slower makes a difference.
>
> 7. He can condition the student by introducing sound into the environment on a selective basis. (Page 70-71).

In addition, there are many other sources of specific suggestions to assist teachers in developing remedial programmes for these children (Chalfant and Flathouse, 1971). Developmental Learning Materials of Chicago has a commercially produced Auditory Perception Training Kit which includes audio tapes to remediate auditory figure-ground perception problems.

To investigate the effectiveness of remedial training of auditory figure-ground perception skills, Marascuilo and Penfield (1972) conducted an experiment using their own taped training materials. They believed that children who did not know how to filter out background noise were at a tremendous educational disadvantage because, "without doubt, the degree of success that a student has in learning new materials is directly related to his ability to receive and transmit messages by oral communication skills (page 5)."

In this study, second, fifth, eighth and eleventh grade students were exposed to audio tape recorded remedial material designed to improve their listening skills in the presence of background noise. They found that this remedial training was effective with the second grade children but not with the other groups.

Summary

All of this information raises many questions regarding the educational implications of auditory figure-ground perception. Before schools direct a great deal of effort towards the identification and remediation of these suspected problems, additional research is essential. Attempts must be made to determine what effects auditory figure-ground perception problems have on academic achievement and whether specific learning environments impede the learning process in children with this type of difficulty. The present study has been designed as an attempt to investigate these areas.

CHAPTER 2

HYPOTHESIS AND OPERATIONAL DEFINITIONS

In Chapter 1, a review of studies related to auditory figure-ground perception indicated that children do differ in their ability to discriminate between figure and background auditory stimuli. The possibility of differences in the amount of background noise in various classroom environments was also discussed. It was suggested the children with auditory figure-ground perception problems have difficulty functioning in learning situations which have an excessive amount of background auditory stimulation.

Hypothesis

Based on these studies, it is hypothesized that the more difficulty children have with auditory figure-ground perception, the less likely they are to achieve academic success in open area classrooms; whereas, in self contained classrooms, problems with auditory figure-ground perception will have less effect on academic success.

Assumptions

In order for this hypothesis to be tested, it is necessary to investigate the following assumptions:

1. The subjects (Ss) used in this study came from a population similar to the normative population of the GFWT, and

2. The grade one open area classrooms used in this study have a

higher noise level than the self contained classrooms.

Operational Definitions

Auditory figure-ground perception refers to the ability to focus on relevant aspects of the auditory field and "tune out" irrelevant background stimuli. The test used to measure this ability is the Goldman-Fristoe-Woodcock Test of Auditory Discrimination which has two subtests - one under noise conditions and one under quiet conditions.

Academic success is measured by three subtests of the Cooperative Primary Test - reading, listening and mathematics.

Self contained classroom refers to a conventional learning environment with approximately twenty-five students andoone teacher in a standard sized room.

Open area classroom refers to a large learning environment containing two, three, or four classes, each with approximately twenty-five students and a teacher.

Noise Level. The noise level data were collected by observing the readings on a decibel meter for approximately fifteen seconds in each of ten different areas of each classroom. During each fifteen second observation, the upper extreme noise level, the lower extreme noise level, and the mean noise level were recorded. The decibel readings were taken once in the morning and once in the afternoon on two consecutive days for each class (Chew and McLean, 1974).

Delimitation of the Study

This study was restricted to English speaking grade one children in either open area or self contained classes located within the Vancouver school district.

Justification of the Study

If the hypothesis is supported by the results of this study, possibly the GFWT might be useful as a screening instrument to determine whether grade one children who have difficulty with auditory figure-ground perception are more appropriately assigned to self contained or open area classrooms. Thereby, it may be possible to prevent the learning and/or behaviour problems which can result from exposing a child to a learning environment with which he has difficulty coping.

CHAPTER 3

METHOD

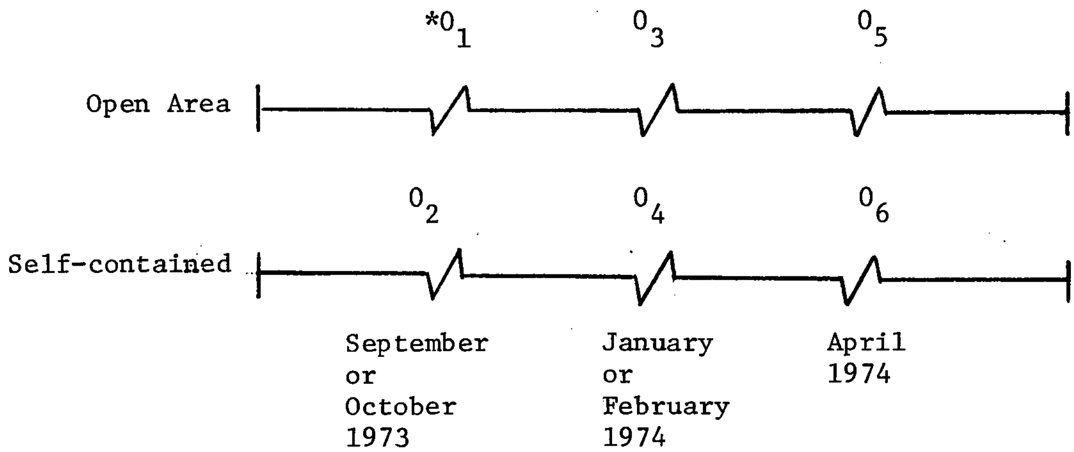
Design

In order to obtain data bearing on the hypothesis, a non-equivalent control group design was used (Campbell and Stanley, Design 10, 1963). (See Figure 1).

An experimental group of grade one subjects (Ss) was randomly selected from open area classes and a control group from self contained classes. To provide statistical control for possible beginning grade one achievement level in reading, arithmetic, and spelling, the Wide Range Achievement Test (WRAT) was administered individually to each S in September or October. In January or February, the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (GFWT) was administered to provide a measure of each S's ability to discriminate sounds in the presence of controlled background noise. In April, the Cooperative Primary Test (CPT) was administered to provide a measure of each S's academic progress in arithmetic, reading and listening skills.

Sampling Procedure

Originally, 12 Ss from each of four open areaand four self contained grade one classes were randomly selected from a pool of Ss whose parents gave their written permission for their participation in the study. A table of random numbers was used to make the random selection (Marascuilo, 1971). Shortly after this selection was made,



*$0_1 0_2$: WRAT

$0_3 0_4$: GFWT

$0_5 0_6$: CPT

Figure 1

Experimental Design

it was discovered that one of the open area classes was using the Initial Teaching Alphabet approach to reading which would have affected these S's performance on the standardized reading tests. This class and its control class were eliminated from the study and the number of Ss in each of the remaining classes was increased from twelve to sixteen per class.

From January to April, ten Ss had to be eliminated from the study because they had either moved to another school or had a lengthy illness during one of the follow-up test periods. Eighty-six Ss remained in the study.

Subjects

Ss were selected from open area and self contained first grade classes in Vancouver schools. In consultation with the Vancouver School Board's research department, three schools with primary open areas were nominated and control schools were chosen because of their physical proximity to the experimental schools. Included were schools which are located on both the east and west sides of the city and they represent a fairly wide range of socio-economic levels. The parents of all Ss gave their written consent for their participation in the study. According to teacher judgement and school medical cards which included whisper test results for all children and audiometer test results for some children, all Ss were able to speak English fluently and had no obvious hearing problems. Ages in September ranged from five years four months to six years ten months. The median age was six years two months.

Materials

Wide Range Achievement Test. The WRAT was administered to provide a general measure of achievement in reading, spelling, and arithmetic. A test covering all grade levels was chosen because it was expected that beginning grade one children would be functioning at many different levels depending upon factors such as the flexibility of their Kindergarten programme and parental tutoring. The reading subtest includes a measure of alphabet naming which has been found to be one of the best single predictors of reading readiness in many studies (Lowell, 1971).

Available reliability and validity data support the use of the WRAT as a general measure of achievement. A United States national health survey correlated the WRAT reading and arithmetic scores for 2,500 children at all grade levels with the Stanford and Metropolitan Achievement Tests and concluded that the WRAT was a "satisfactory brief estimate of school achievement (Nat. Cent. for Health Stat., 1967)." Reger (1962) reported a correlation of .76 between the WRAT reading and arithmetic scores and the Metropolitan Achievement Test. A correlation coefficient of .92 between the WRAT reading subtest and the Gray Oral Reading Test was reported by Lawson and Avila (1972). Hopkins, Dobson and Oldridge (1962) correlated WRAT scores with teacher ratings and reported concurrent validity coefficients from .74 to .86 for 502 children in grades one to five. They also reported correlation coefficients of .86 and .71 between the WRAT and the California Reading Vocabulary and Comprehension tests. Split-half reliability coefficients for the reading, spelling, and arithmetic subtests were .98 to .99, .96 to .98, and .94 to .97 respectively, according to Jastak and Jastak

(1965) and .98, .99, and .98 respectively in a study by Sundeau and Salopek (1971). Jastak and Jastak report alternate form reliabilities of .88 to .93, .88 to .93, and .79 to .89 for the reading, spelling and arithmetic subtests respectively.

Goldman-Fristoe-Woodcock Test of Auditory Discrimination. The GFWT was administered to measure auditory figure-ground perception. The justification for the use of this test and the reliability and validity data was presented with the related research on pages 13 to 15.

Cooperative Primary Tests. The reading, mathematics, and listening subtests of the CPT were administered to provide a follow-up measure of academic achievement. These tests were designed to "survey understanding and skills considered basic to future development" in reading, mathematics and listening (CPT Handbook, 1967, page 6). According to the test authors, one of the objectives in designing this test was to provide academic measures which would be relatively independent of different teaching techniques. This makes the CPT appropriate for the present study because of the number of different schools, classes, and teachers involved.

The CPT Handbook includes item analysis data for each subtest and the content validity has been described as "outstanding" by Hanna (1972) in his review of the test in the Seventh Mental Measurements Yearbook. The median internal consistency coefficients were .90 for reading, .83 for mathematics, and .81 for listening. The alternate form reliability coefficients were .85 for reading, .82 for mathematics and .76 for listening.

Apparatus

A Sony TC106 tape recorder with two sets of high fidelity Hosiden earphones were used for the GFWT.

A Bruel and Kjaer Sound Level Meter, Type 2205 fitted with a piezoelectric microphone, Type 4117 was used to measure the noise levels in each classroom.

Procedure

In September and October, the WRAT was administered individually to each S according to the directions in the test manual. The Ss were all tested by the same examiner in quiet rooms in their own schools.

In January and February, the GFWT was administered individually to each S according to the directions in the test manual, using the tape recorder and earphones. All Ss were tested by the same examiner in the rooms used for the WRAT testing.

In April, the CPT was administered as a group test according to the directions in the test manual. The testing was carried out in three separate sessions, with each group being tested in their own school by the same examiner.

In May and June, the ambient noise level in each class was compared using a sound level meter on a time sampling basis. The following procedural description has been extracted from the report of Chew and McLean (1974) who were responsible for collecting these data:

> Measurements were made during the school day at random times throughout the morning and the afternoon. Each classroom was surveyed four times, twice a day (once in the morning and once in the afternoon) for two consecutive days. ...Each room was visually divided into a grid, cutting up

> the floor surface area into ten squares of approximately equal area. The actual location positioning of the instrument varied from room to room and from visit to visit in a given room, due to movement of students and positioning of furniture. ...One set of readings was taken in the centre of each of the ten grids. Each set consisted of 30 readings of the noise level in dBA using the SLOW meter response. This was done by observing the sound level meter needle for no less than 15 seconds and visually estimating the mean value, together with both the upper and lower extremes and repeating the whole process 10 times for each grid. Since there were 10 such grids per room a total of 30 readings were taken. (Chew and McLean, 1974, page 6-8).

Statistical Analyses

Assumption 1: A chi-square test was used to determine whether a statistically significant difference existed between the distribution of scores on the subtests of the GFWT for the sample used in this study and the normative population. Since most of the ninety-one Ss who were given the GFWT were between 6-0 and 6-11 at the time of testing, only these Ss were used for comparison purposes. Forty-five Ss were compared to the test norms for children ranging in age from 6-0 to 6-5 and thirty-eight Ss were compared to the test norms for children ranging in age from 6-6 to 6-11.

Assumption 2: In order to test the assumption that open area classrooms have a higher noise level than the self-contained classrooms, t-tests were performed on the data from the decibel readings using the Statistical Package for the Social Sciences (Kita and Morley, 1973b). Separate analyses were performed for the mean, upper extreme, and lower extreme decibel readings in the afternoons.

Hypothesis: In order to test the hypothesis that the more difficulty children in open area classrooms had with auditory figure-ground perception as measured by the GFWT, the lower their achievement scores would be on the CPT, a stepwise multiple regression analysis procedure was used. The advantages of using this data analysis technique have been discussed extensively by authors such as Cohen, 1968; Overall and Spiegel, 1970; and Walberg, 1971. This approach was particularly appropriate for this study because it allows for the testing of the effects of continuous variables without the necessity of making arbitrary groups which is necessary in analysis of variance.

The stepwise analysis involves an _a priori_ ordering of the independent variables. Estimates of each independent variable are adjusted for the effects preceding terms in the ordering but not for the terms which follow it. Separate stepwise analyses were performed for each of the three dependent variables, using the data from the GFWT noise subtest as one of the independent variables and the WRAT scores as a covariate.

In order to determine whether there was any relationship between performance on the GFWT quiet subtest and the dependent variables, separate analyses were carried out, identical to the analyses described above except that the scores on the quiet subtest were substituted for the scores on the noise subtest.

The regression analyses were performed using the stepwise regression programme (Halm, 1972). The probability levels (p) for significance were calculated using the following formula:

$$F_{(dfs,\ dfe)} = \frac{\Delta R^2/\text{df source}}{\text{SS error/df error}}$$ (Overall and Spiegel, 1970).

Post Hoc Analyses: Some post hoc analysis of the data was carried out to further investigate significant interactions resulting from the multiple regression analyses.

The UBC FREQ computer programme (Kita and Morley, 1973a) was used to plot histograms of observed frequencies of raw scores on the noise subtest of the GFWT. This facilitated the division of the data into meaningful groups for comparison purposes.

Four groups for each class type were generated in this manner. The fourth level groups (critical) represented Ss who were functioning in the critical region of auditory figure ground perception according to the test norms. The CPT results for the first three groups of each classroom type (non-critical) were collapsed to allow for an analysis of covariance between the critical and non-critical groups, using the WRAT scores as a covariate. The General Linear Hypothesis programme (Bjerring, Greig, and Halm, 1973) was used for this analysis.

CHAPTER 4

RESULTS

Initially, the results related to the assumptions are presented, followed by a statistical description of the sample used in this study. The results of the multiple regression analyses used to test the hypothesis are presented next. Included in this section are the results of the quiet subtest data as well as the noise subtest data. Finally, the results of the *post hoc* analyses are presented.

Assumption 1: The results of the chi-square test used to compare the distribution of scores on the GFWT for the sample used in this study with the sample used in the development of the test norms are presented in Table 1. There was no significant difference between the groups at either age level on the quiet or the noise subtests. Therefore, it can be concluded that they represent similar populations.

Assumption 2: The results of the t-tests performed on the decibel reading data are presented in Table 2. The collection of the noise level data consisted of observing the readings on the decibel meter for approximately fifteen seconds in each of ten different areas of each classroom. During each fifteen second observation, the upper extreme noise level, the lower extreme noise level and the mean noise level were recorded. The mean upper extreme reported in the table refers to the mean of all the recorded upper extreme noise levels in the ten areas in two mornings or afternoons of observation. The mean lower extreme was calculated in a similar manner. The mean noise level as well as

Table 1

Comparisons between the GFWT Norming Sample anddthe Sample used in this study (Chi-Square Goodness of Fit)

Subtest	df	Age 6-0 to 6-5	Age 6-6 to 6-11
Quiet	5	8.50	2.90*
Noise	12	7.12	18.35**

*Critical value for chi-square (df=5) is 11.070.
**Critical value for chi-square (df=12) is 21.026.

Table 2

Summary of Sound Level Readings

Type	Mean dbA	tT Value	Significance*
Mean AM			
Open Area	62.50	2.26	Yes
Self-contained	55.20		
Mean PM			
Open Area	58.40	0.95	No
Self-contained	56.67		
Lower Limit Mean AM			
Open Area	58.83	2.28	Yes
Self-contained	51.60		
Lower Limit Mean PM			
Open Area	54.80	1.55	No
Self-contained	51.50		
Upper Limit Mean AM			
Open Area	66.00	2.30	Yes
Self-contained	58.80		
Upper Limit Mean PM			
Open Area	62.40	1.47	No
Self-contained	58.83		

*Critical value for t(df=9) for a one tail test is 1.833.

the mean upper and mean lower extremes of noise, were consistently higher in the open area classrooms than the self contained classrooms. However, in terms of statistical significance, only the noise levels in the mornings were significantly greater in the open areas than the self contained classrooms.

Description of the Sample: The means, standard deviations, and intercorrelations for the open area group are presented in Table 3 and for the self contained group in Table 4. T-test comparisons were made between the open area and self contained groups for each of the subtests of the WRAT and GFWT. The only significant initial difference between the two groups was found on the arithmetic subtest of the WRAT. The self contained group scored significantly higher on this subtest than the open area group.

The means, standard deviations, and intercorrelations between all of the variables used in this study are presented in Table 5. It is interesting to note that the correlations between WRAT reading and CPT reading, and WRAT arithmetic and CPT mathematics are not very high. This raises questions regarding the concurrent or differential content validity of these tests. They don't appear to measure the same facets of their respective domains.

Hypothesis: Stepwise multiple regression analysis was the statistical procedure used to analyze the data for this hypothesis. Two parallel sets of analyses were performed, one on the noise subtest data and one on the quiet subtest data. The purpose of the quiet subtest analyses was to ensure that an auditory discrimination problem was not responsible for the expected underachievement of the open area Ss who had difficulty with auditory figure-ground perception.

Table 3

Means, Standard Deviations, and Intercorrelations between the WRAT and GFWT Scores for the Open Area Group (N=43)**

Variable	$\bar{X}$	s	1	2	3	4	5
1. WRAT Reading	24.95	13.34	--				
2. WRAT Spelling	20.79	6.75	77*	--			
3. WRAT Arithmetic	16.84	2.94	75*	57*	--		
4. GFWT Quiet	1.35	1.27	-49*	-31*	-51*	--	
5. GFWT Noise	10.00	2.96	-12	-03	-31*	23	--

* Any correlation greater than .30 is significant where α =.05.

** Correlation entries are rounded to two figures and decimals are omitted. This sample does not include Ss who were eliminated from the study due to illness or changing schools prior to final CPT testing.

Table 4

Means, Standard Deviations, and Intercorrelations between the WRAT and GFWT Scores for the Self-Contained Group (N=43)**

Variables	$\bar{X}$	s	1	2	3	4	5
1. WRAT Reading	26.35	5.34	--				
2. WRAT Spelling	20.54	2.07	62*	--			
3. WRAT Arithmetic	18.16	1.77	34*	44*	--		
4. GFWT Quiet	1.54	1.20	-10	-15	-42*	--	
5. GFWT Noise	10.44	2.80	02	-12	-10	33*	--

* Any correlation greater than .30 is significant where α =.05.

** Correlation entries are rounded to two figures and decimals are omitted. This sample does not include Ss who were eliminated from the study due to illness or changing schools prior to final CPT testing.

Table 5

Means, Standard Deviations, and Intercorrelations between the Variables Used in the Study (N=86)**

Variable	$\bar{X}$	s	1	2	3	4	5	6	7	8	9	10
1. Class	0.50	.50	--									
2. Sex	1.51	.50	-05	--								
3. WRAT Reading	25.65	10.13	-07	14	--							
4. WRATling Spelling	20.66	4.97	02	02	74*	--						
5. WRAT Arithmetic	17.50	2.50	-27*	23*	66*	50*	--					
6. QFWT Quiet	1.44	1.23	-08	-26*	-35*	-25*	-43*	--				
7. GFWT Noise	10.22	2.87	-08	10	-07	-05	-20	29*	--			
8. CPT Reading	19.41	10.53	-23*	08	55*	52*	52*	-18	-07	--		
9. CPT Listening	30.04	6.42	-10	-01	56*	37*	52*	-40*	-41*	-48*	--	
10. CPT Math	30.72	8.48	-23*	16	47*	35*	64*	-30*	-15	54*	64*	--

* Any entry greater than .21 is significant where α =.05.

** Intercorrelation entries are rounded to two figures and decimals are omitted.

A rational ranking procedure was used for the ordering of the independent variables in the stepwise analysis. The first category of variables to be entered into the equation was the covariate. The combined reading, spelling and arithmetic scores of the WRAT were used as a covariate which effected the equivalent of an analysis of covariance. The second terms to be entered into the equation were organismic variables of little interest. The only variable which fell into this category was sex. The third category of variables to be entered was the scores on the noise subtest of the GFWT. The fourth category to be entered into the regression equation was the type of classroom - open area or self contained. The fifth term to be entered was the potential interaction between sex and noise subtest scores. The sixth term to be entered was the potential interaction between sex and type of class. The potential interaction which corresponds to the hypothesis was the seventh term to be entered. This was the expected interaction between type of class and scores on the noise subtest. The eighth category to be entered was a potential interaction between type of class, sex and scores on the noise subtest.

The regression model for each of the three dependent variables was asffollows:

$$Y = B_0X_0 + B_1X_1 + B_2X_2 + \ldots\ldots\ldots\ B_8X_8 + E,$$

where Y is the dependent variable,

X_1 is the combined effect of the covariates - WRAT Reading, Arithmetic and Spelling,

X_2 is Sex,

X_3 is scores on the Noise subtest of the GFWT,

X_4 is the Type of class,

X_5 is the combined effect of Sex and Noise scores,

X_6 is the combined effect of Sex and Type of class,

X_7 is the combined effect of Type of class and Noise scores,

X_8 is the combined effect of Type of class, Sex and Noise scores, and

E is experimental error.

This conceptual model for each regression analysis was built on six variables which were grouped into eight categories. Four of these six variables were considered to be interval scales, but sex and type of class were categorical variables which were represented in the analysis as dummy variables.

Separate stepwise regression analyses were performed on the noise and quiet data, for each of the three dependent variables. The results of the quiet subtest analyses are presented in Table 6.

The only significant source of variance (except for the covariates) in the three analyses of the quiet subtest data was the main effect of the quiet subtest on the listening measure. This corresponds to a significant source of variance found in the analysis of the noise subtest data (see Table 7) which was the effect of the noise factor on the scores of the listening measure. This suggests that the more difficulty children have with auditory discrimination under quiet as well as noise conditions on the GFWT, the poorer their listening skills will be on the CPT. There did not appear to be any relationship between poor auditory discrimination as measured by the quiet subtest and reading or mathematics achievement on the CPT regardless of classroom

Table 6

Results of the Regression Analyses for the Quiet Subtest Data

		Reading		Listening		Mathematics	
Source of Variation	df	ΔR^2	F_{obs}	ΔR^2	F_{obs}	ΔR^2	F_{obs}
Covariates	3	.3713	15.87*	.3551	15.58*	.4081	17.66*
Sex	1	.3716	.04	.3746	2.55	.4085	.05
Quiet	1	.3757	.53	.53	4.91*	.4092	.09
Type	1	.3964	2.65	.4129	.15	.4162	.91
Sex · Quiet	1	.3978	.18	.4243	1.50	.4195	.43
Type · Sex	1	.3985	.09	.4271	.36	.4196	.01
Type · Quiet	1	.4111	1.62	.4291	.26	.4209	.17
Type · Sex · Quiet	1	.4135	.31	.4304	.18	.4209	.00

Note - Error terms for Reading = .0078; Listening = .0076; and Mathematics = .0077.

*$p < .05$.

Table 7

Results of the Regression Analyses for the Noise Subtest Data

		Reading		Listening		Mathematics	
Source of Variation	df	ΔR^2	F_{obs}	ΔR^2	F_{obs}	ΔR^2	F_{obs}
Covariates	3	.3713	18.21*	.3551	17.41*	.4081	18.13*
Sex	1	.3716	.04	.3746	2.85	.4085	.05
Noise	1	.3717	.02	.4740	14.62*	.4094	.12
Type	1	.3956	3.53	.4758	.28	.4162	.10
Sex · Noise	1	.4092	1.99	.4852	1.37	.4205	.59
Type · Sex	1	.4096	.06	.4853	.02	.4206	.01
Type · Noise	1	.4163	.99	.4865	.18	.4210	.04
Type · Sex · Noise	1	.4914	11.04*	.4865	.02	.4379	2.27

Note - Error terms for Reading = .0068; Listening = .0068; and Mathematics = .0075.

*$p < .05$.

type.

This study was specifically designed to test the hypothesis that the more difficulty first grade children in open area classrooms had with auditory figure-ground perception as measured by the noise subtest of the GFWT, the lower their scores would be on the CPT achievement test. A similar relationship was not expected to be found in self-contained classrooms. The expected interaction between type of class and scores on the noise subtest was not found to be significant and therefore, the hypothesis had to be rejected. A trend in the expected direction was noted and this was explored further in post hoc analyses of the data.

Post Hoc Analyses: In order to visualize the relationships between interactions containing the noise variable and the dependent variables, it was necessary to group the raw scores on the noise subtest. Using the histogram presented in Figure 2, the following four groups were established: group 1, consisting of Ss with scores ranging from 0 to 6; group 2, consisting of Ss with scores ranging from 7 to 9; group 3, consisting of Ss with scores ranging from 10 to 12; and group 4, consisting of Ss with scores greater than 12.

Using these four groups to represent the levels of performance on the noise subtest, the type by noise interaction and the mean raw scores for each group of the three dependent variables are presented in Table 8. Even though these interactions were not found to be significant, it was noted that the self contained Ss in group 4 tended to score higher on all three dependent variables than the open area Ss in group 4. Since the fourth level group represented Ss who are suspected of functioning in the critical range of auditory figure-ground perception

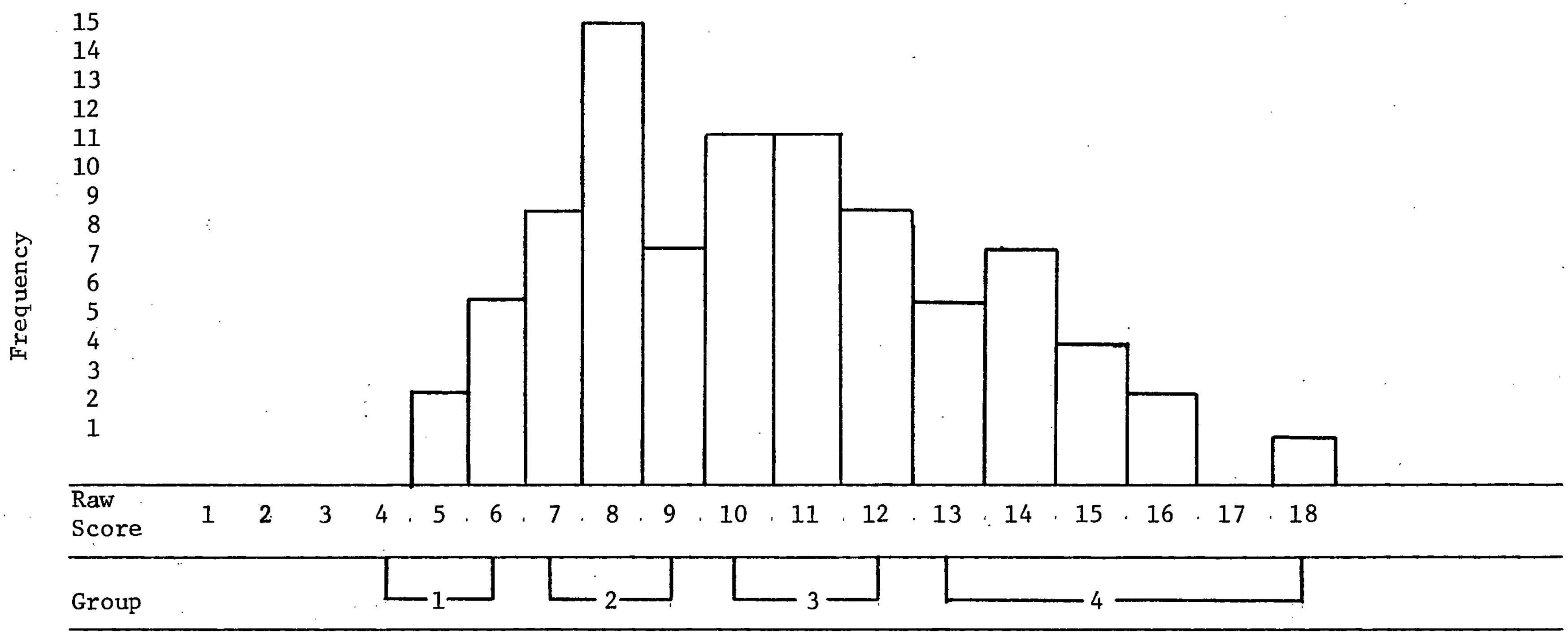


Figure 2

Histogram of the Observed Frequencies of the Noise Subtest Raw Scores

Table 8

Mean CPT Scores for the Type by Noise Interaction

		1	2	3	4
Reading	Open Area	14.84	15.80	23.19	9.43
	Self-contained	23.75	23.92	21.12	21.73
Mathematics	Open Area	34.75	27.40	32.13	21.63
	Self-contained	32.00	33.13	33.43	31.27
Listening	Open Area	35.00	30.27	30.50	22.63
	Self-contained	38.00	31.20	30.50	28.27

according to the GFWT norms for six year old children, the first three groups for each type of classroom were combined and compared with the fourth level groups by means of analysis of covariance. Table 9 presents the type by noise adjusted means for the reading, listening, and mathematics measures. None of these relationships were statistically significant which suggests that the academic achievement of children in group 4 who had extremely high scores on the noise subtest was not adversely affected by differences in their learning environments.

An unexpected statistically significant relationship between type of classroom, sex and noise subtest scores was found for the reading variables. This interaction (see Figure 3) suggests that the more difficulty boys have with auditory discrimination under noise conditions, the poorer their reading achievement will be in open area classes but not in self contained classes. A different relationship was found among girls, in that the more difficulty they had on the noise subtest, the poorer their reading achievement was in self-contained classes, but this was not true in open area classes.

Analysis of covariance was used to determine whether there was a statistically significant difference between the Ss in the critical and non-critical groups in this interaction. Graphical representation of the results of this analysis is presented in Figure 4. The resulting F ratio of 5.9142 was significant at the .05 level. This may be interpreted as meaning that boys with auditory figure-ground perception problems have more success learning to read in self contained classrooms than open areas but girls with a similar problem appear to have more reading success in open areas than self contained classrooms.

Table 9

Mean CPT Adjusted Scores for the Combined Groups
Of The Type By Noise Interaction

		1-3	4
Reading	Open Area	18.16	16.02
	Self-contained	21.56	19.51
Mathematics	Open Area	30.36	29.03
	Self-contained	31.56	30.68
Listening	Open Area	30.78	26.90
	Self-contained	30.84	27.62

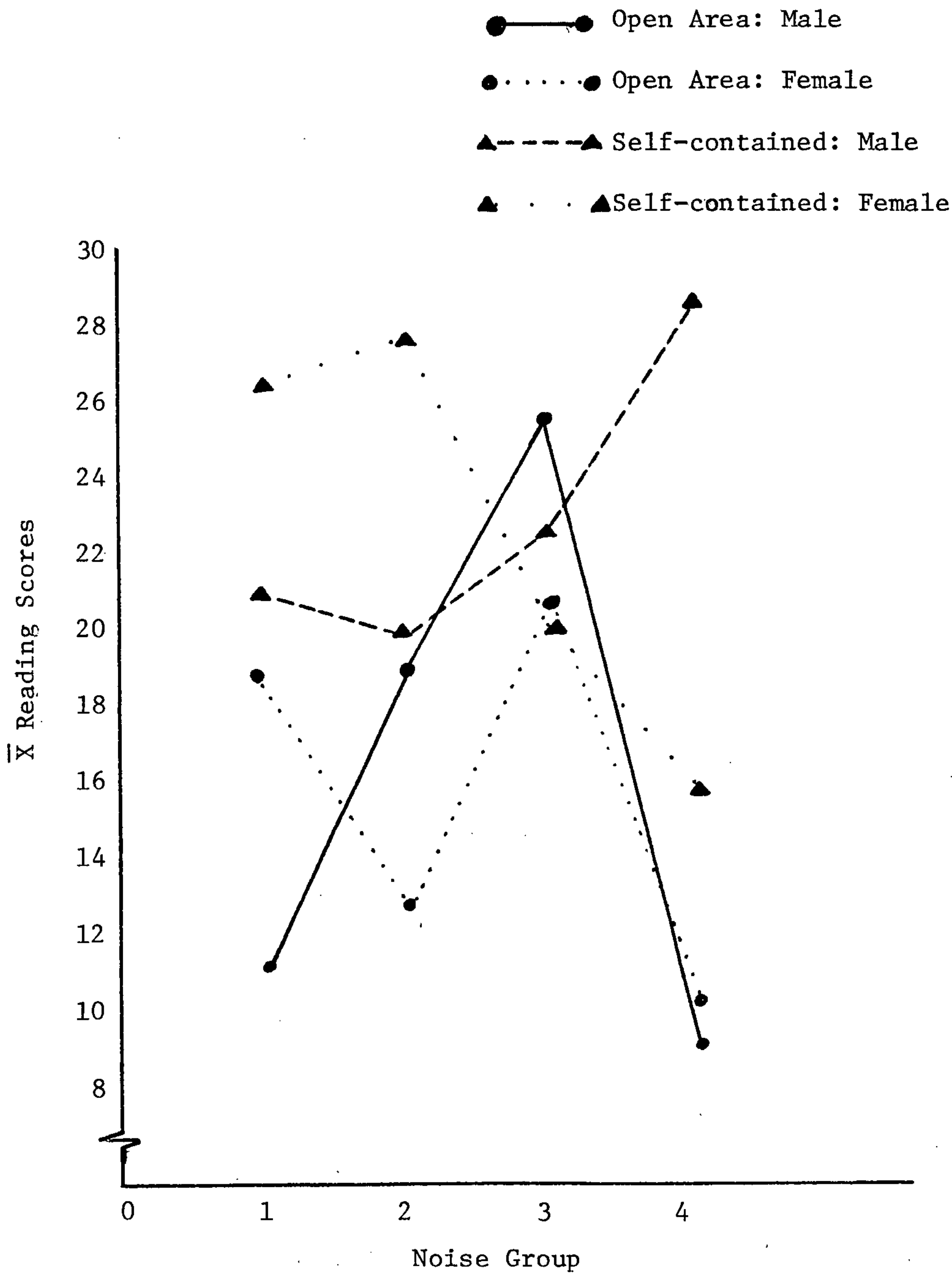


Figure 3

Type by Sex by Noise Interaction on the Reading Regression Analysis

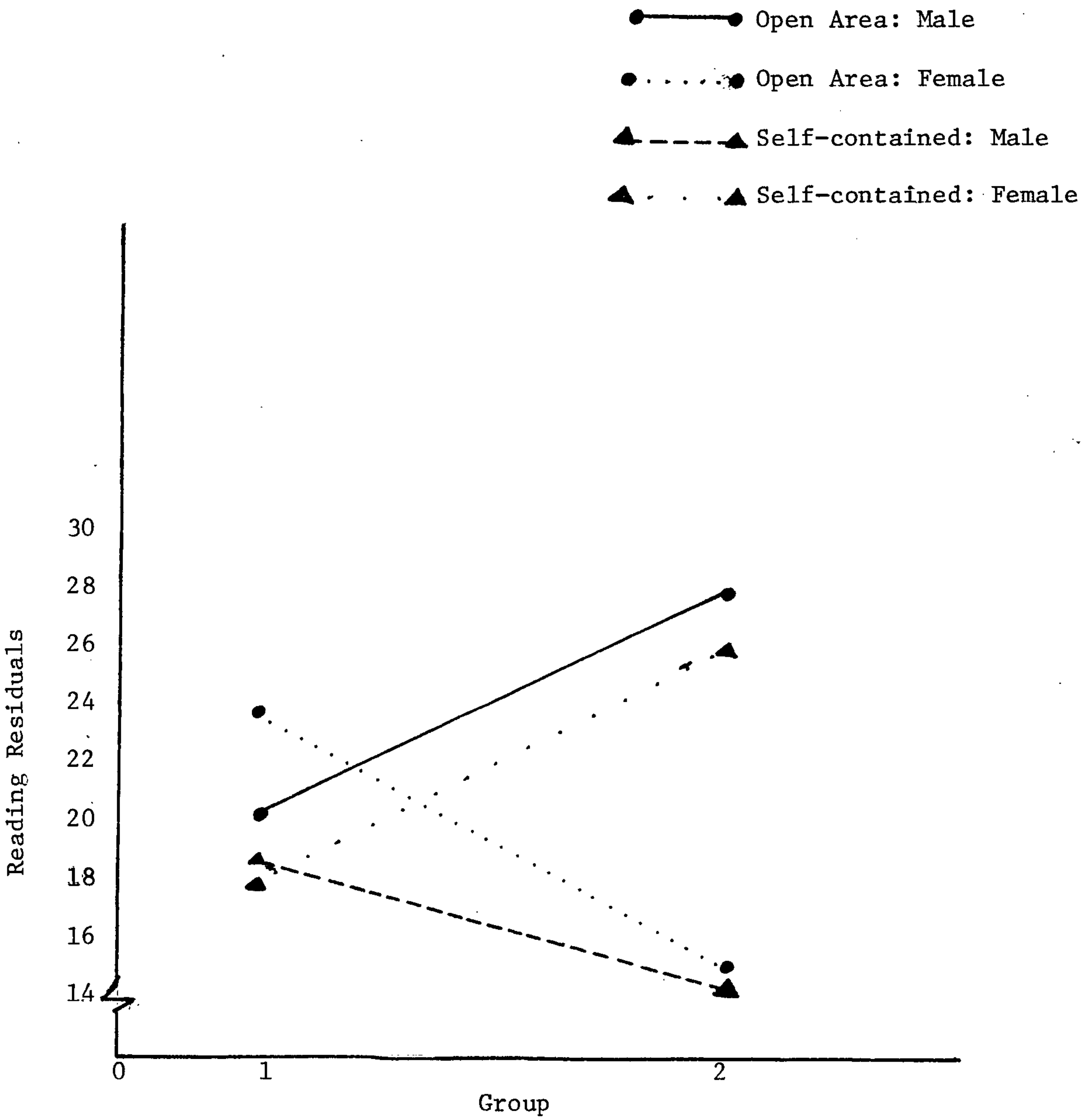


Figure 4

Type by Sex by Noise Interaction for the Critical and Non-Critical Groups on the Reading ANOVA

CHAPTER 4

DISCUSSION AND CONCLUSIONS

Discussion

The purpose of this study was to investigate the relationship between auditory figure-ground perception as measured by the GFWT and academic achievement as measured by the CPT, in open area and self contained classrooms. The noise level in open area grade one classrooms was expected to be higher than the noise level in self contained classrooms. This led to the hypothesis that the more difficulty children in open area classes had perceiving sounds in difficult listening situations as measured by the GFWT noise subtest, the lower their achievement scores would be. A similar relationship was not expected to be found amongst children in self contained classes.

Although the open area classrooms used in this study were generally found to be noisier than the self contained classrooms, the expected relationship between the GFWT noise subtest and performance on the CPT was not found to statistically significant. However, examination of the raw data indicated a trend in the expected direction. The Ss were grouped according to their noise subtest scores, and the Ss in the critical group were compared using the CPT grade norms. It was found that the average open area S in the critical group was functioning at the beginning grade 1.0 reading level in April whereas the average self contained S in the critical group was reading at the grade 1.8 level. There was also a tendency for the self contained critical group to perform slightly better than the open area critical group on the mathematics and listening subtests. Unfortunately, the covariates and variance due to other unknown factors masked possible statistically significant differences between these groups when they were compared by analysis of covariance. The difference between the two groups on the mathematics subtest of the CPT could be attributed to the significantly better performance of the self contained group on the initial WRAT arithmetic testing in the fall. There was no significant difference between the two groups in reading on the initial WRAT testing but there was a tendency for the majority of the open area subjects to function at a lower reading level on the CPT than the self contained group. This difference approached significance at $\alpha = .05$ and may be one of the reasons why the difference between the critical groups did not turn out to be statistically significant.

In the multiple regression analyses based on the noise subtest data, there were only two statistically significant sources of variance. Regarding the reading analysis, the interaction between type of class, sex, and noise subtest scores was highly significant, totally unexpected, and extremely difficult to explain. This interaction suggests that boys who have difficulty with auditory figure-ground perception learn to read more efficiently in self contained classes rather than open areas, whereas girls with a similar problem learn to read more efficiently in open areas rather than self contained classes. This relationship appears to be inexplicable within the framework of the present research and may be due to sampling error or some other procedural artifact.

The second significant source of variance on the noise analysis was the effect of noise scores on the listening subtest. A similar effect was found on the quiet analysis in which the quiet subtest scores of the GFWT were a statistically significant source of variance on the scores of the listening subtest. These findings indicate that the more difficulty children have perceiving sounds on the quiet and noise subtests of the GFWT, the poorer their scores will be on the listening subtest of the CPT. This information suggests that the GFWT could be used to identify children in need of remediation to improve their listening skills, if the development of listening skills is one of the objectives of a specific instructional programme.

The results of this study do not indicate a significant relationship between the GFWT scores and the reading and mathematics scores of the CPT amongst either the open area or self contained subjects. Conflicting results were found in Marsh's study in which a significant relationship was found between her measure of auditory figure-ground perception and the reading, spelling and arithmetic scores of the Wide Range Achievement Test.

This raises questions as to whether both tests are measuring the same auditory perception trait and whether the skills measured by the GFWT are essential for learning reading and arithmetic skills. It is possible that many of the children in this study who had difficulty on the GFWT were able to compensate for their auditory perceptual deficiencies by strengths in other perceptual areas.

Marascuilo and Penfield (1972) implied that children have to learn how to filter out background noise in order to successfully learn new material in the classroom situation. Although the results of their study suggest that this type of skill can be trained at the grade two level, they offer no evidence to link the usefulness of this skill with the learning of basic academic skills such as reading, and arithmetic. There is an obvious need for further research to clarify what effect auditory figure-ground perception has on children's learning and behaviour.

Conclusion

The results of this study have not provided statistical support for the suggestion that children with auditory figure-ground perception problems are more suitably placed in self contained classrooms rather than open area classrooms. However, many interesting questions have been raised regarding the educational implications of this ability to focus on relevant aspects of the auditory field and "tune out" irrelevant background stimuli. The answers to these questions await future research in order to ensure that children who are suspected of having an auditory figure-ground perception problem receive the best possible education.

Recommendations and Implications for Future Research

1. It could be argued that causative factors in the failure of the results of this study to support the hypothesis were lack of control for variables such as the variety of rooms used for test administration, lack of sound proofing in the test rooms, and use of a group achievement testing situation. If the study were to be repeated by a researcher who has access to a sound proof, mobile laboratory and

unlimited time in which to individually assess each child, it is possible but not probable that the hypothesis would be supported. A more realistic recommendation for future research would be to experiment with different measures of auditory figure-ground perception and/or achievement.

2. Examination of the results of the present and past studies indicates a need for an investigation of the construct validity of auditory figure-ground perception. For example, an attempt could be made to determine whether the noise subtest of the GFWT is measuring the same trait that is being measured by experimental measures of auditory figure-ground perception used in other studies.

3. Before a great deal of time and effort are spent attempting to remediate auditory figure-ground perception problems, studies are needed to further invesigate the effects of existing training procedures on the acquisition of skills such as reading and arithmetic. Possibly Marsh's test of auditory figure-ground perception could be used to identify grade two children with difficulties in listening under noisy conditions. One group of these children could be given remediation with Marascuilo and Penfield's training programme and another group could be given remediation in some unrelated area. At the end of the training period, the two groups could be compared on the WRAT to determine whether they was any difference in their reading, spelling, and arithmetic scores. If Marascuilo and Penfield's training programme is related to academic success, then the group receiving the training should score higher on the WRAT than the placebo group.

4. One otherpossibility for future research would be to repeat the

present study using Marsh's test as a measure of auditory figure-ground perception instead of the GFWT. Possibly Marsh's test would prove to be the predictive instrument which the present study unsuccessfully sought to help identify children who may be inappropriately placed in open area classrooms.

BIBLIOGRAPHY

Allen, D.I. Open areas in British Columbia. Vancouver, B.C.: Simon Fraser University, 1972.

Bell, A.E., and Switzer, F. Factors related to pre-school prediction of academic achievement: Beginning reading in open-area vs. traditional classroom systems. Manitoba Journal of Education, 1973, 8, (2), 21-27.

Bjerring, J., Gregg, M. and Halm, J. General linear hypothesis (U.B.C. BMDX64). The University of British Columbia, Vancouver, June, 1973.

Campbell, D.T., and Stanley, J.C. Experimental and quasi-experimental designs for research. Chicago: Rand McNally, 1966.

Carter, J.L., and Diaz, D. Effects of visual and auditory background on reading test performance. Exceptional Children, 1971, 38, 197-204.

Chalfant, J.C. and Flathouse, V.E. Auditory and visual learning. In H.R. Myklebust (Ed.), Progress in learning disabilities, Volume II. New York: Grune and Stratton, 1971.

Chew, G.L., and McLean, H.E. School sound level survey. Unpublished manuscript, Metropolitan Health Department, Vancouver, 1974.

Cohen, J. Multiple regression as a general data analytic system. Psychological Bulletin, 1968, LXX, 164-167.

Educational Testing Service. Cooperative Primary Tests: Handbook. New Jersey: Educational Testing Service, 1967.

Doyle, A.B. Listening to distraction: A developmental study of selective attention. Journal of Experimental Child Psychology, 1973, 15, 100-115.

Dykman, R.A., Ackerman, P.T., Clements, S.D. and Peters, J.E. Specific learning disabilities: An attentional deficit syndrome. In H.R. Myklebust (Ed.), Progress in learning disabilities, Volume II. New York: Grune and Stratton, 1971.

Goldman, R., Fristoe, M., and Woodcock, R.W. Test of Auditory Discrimination: Manual of Directions. Minnesota: American Guidance Service, 1970.

Halm, J. Stepwise regression (UBC BMD02R). The University of British Columbia, Vancouver, November, 1972.

Hanna, G.S. Review of Cooperative Primary Tests. In O. Buros, (Ed.), The seventh mental measurements year book. New Jersey: Gryphon Press, 1972.

Hopkins, K.D., Dobson, J.C. and Oldridge, O.A. Concurrent and congruent validities of the WRAT. Educational and Psychological Measurement, 1962, 22, 791-793.

Jastak, J.K. and Jastak, S.R. Wide Range Achievement Test: Manual. Wilmington, Del.: Guidance Associates, 1965.

Junker, K.S. Selective attention in infants and consecutive communication behavior. Acta Paediatrica Scandinavica, 1972, 231, 1-160.

Kassinove, H. Effects of meaningful auditory stimulation on children's scholastic performance. Journal of Educational Psychology, 1972, 63, (6), 526-530.

Kingsbury, H.F. Acoustics in the changing classroom. Educational Technology, 1973, 13, 62-64.

Kinsbourne, M. Developmental neuropsychology, childhood and old age. Paper presented at the Eighth Annual Neuropsychology Workshop, University of Victoria, March 1973.

Kita, S. and Morley, R. Goodness of fit tests (UBC FREQ). The University of British Columbia, Vancouver, November, 1973a.

Kita, S. and Morley, R. Statistical package for the social sciences (SPSS). The University of British Columbia, Vancouver 1973b.

Lawson, J.R. and Avila, D. Comparison of WRAT and Gray Oral Reading Paragraphs reading scores of mentally retarded adults. Perceptual and Motor Skills, 1962, 14, (3), 474.

Lowell, R.E. Reading readiness factors as predictors of success in first grade reading. Journal of Learning Disabilities, 1971, 4, (10), 563-567.

Maccoby, E.E. and Konrad, K.W. Age trends in selective listening. Journal of Experimental Child Psychology, 1966, 3, 113-122.

Magdol, M.S. Problems in attention: clearing up the terminology, Academic Therapy, 1972-73, 8, (2), 141-153.

Mann, P.H. and Suiter, P. Handbook in diagnostic teaching: A learning disabilities approach. Boston: Allyn and Bacon, 1974.

Marascuilo, L.A. Statistical methods for behavioral science research. New York: McGraw-Hill, 1971.

Marascuilo, L.A., and Penfield, D.A. Learning to listen: a study in auditory perception. California Journal of Educational Research, 1972, 23, (1), 4-16.

Marsh, D.H. Auditory figure-ground ability in children. American Journal of Occupational Therapy, 1973, 27, (5), 218-225.

Metropolitan Toronto School Board. Academic evaluation: an interim report. Study of educational Facilities,=1971.

Metropolitan Toronto School Board. Hints for survival in open plan schools. Study of Educational Facilities, 1973.

National Center for Health Statistics. Achievement tests used in the health examination surveys of persons aged 6-17 years. A Study of National Center for Health Statistics, 1967, 2, (Whole No. 24).

Newby, H.B. Audiology. New York: Appleton-Century-Crofts, 1972.

Nober, L.W. Auditory discrimination and classroom noise. Reading Teacher, 1973, 27, 288-291.

Overall, J., and Spiegal, D. Concerning least squares analysis of experimental data. Psychological Bulletin, 1969, LXXII, 311-322.

Palmerieri, J.C. Learning problem children in the open concept classroom. Academic Therapy, 1973, 9, (1), 91-97.

Pritchard, D.L., and Moodie, A.G. A Survey of teachers opinions regarding open areas. (Research Report 71-06), Vancouver, B.C.: Vancouver School Board, 1971.

Rabinovitch, S. Language development and associated disorders. Paper presented at the Seventh Annual Neuropsychology Workshop, University of Victoria, March 1972.

Reger, R. Brief tests of intelligence and academic achievement. Psychological Reports, 1962, 11, (1), 82.

Siegenthaler, B.M. and Barr, C.A. Auditory figure ground perception in normal children. Child Development, 1967, 1163-1167.

Slater, B.R. Effects of noise on pupil performance. Journal of Educational Psychology, 1967, 59, (4), 239-243.

Sundeau, D.A. and Salopek, T.F. Achievement and intelligence in primary and elementary classes for EMR. Journal of School Psychology, 1971, 9, (2), 239-256.

Strauss, A. and Lehtinen, L. Psychopathology and education of the brain-injured child. New York: Grune and Stratton, 1947.

Walberg, H. Generalized regression models in educational research. American Educational Research Journal, 1971, 8, 71-91.