M.A. THESIS

# RELATIONSHIP BETWEEN ACADEMIC ACHIEVEMENT AND AUDITORY PERCEPTUAL SKILLS IN A BILINGUAL PROGRAM

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ABSTRACT

The purpose of this study was to examine the relationship between auditory perceptual abilities of Grade 4 children and achievement in English Language Arts, French Language Arts, and Mathematics. In addition, the auditory perceptual abilities of children in the same program whose first language is not English were compared with those of English speaking children.

The construct, auditory perception, has limited theoretical frameworks to explain it. Conflicting results are reported in recent studies of relationships between school subjects such as reading and auditory perceptual abilities, and considerable controversy exists regarding the usefulness of the perceptual approach to understanding underachievement. Few researchers have studied the auditory perceptual abilities of children in bilingual programs and none have discussed the auditory perceptual abilities of non-English speaking children in these programs. Two processes identified more frequently than others as important to school achievement were studied in this research. These are auditory discrimination and auditory memory.

Four groups of twenty children, with ten males and ten females in each group, were administered an Auditory Skills Battery (ASB) of six auditory perceptual tests. The groups were compared by language (English and non-English) and achievement (high and low). The subjects

were matched by age, sex, and home school. Two tests of cognitive abilities, the verbal and non-verbal subtests of the Canadian Cognitive Abilities Test (CCAT), were included in the research as co-variates. The Auditory Skills Battery contained two tests of auditory discrimination and four tests of short term auditory memory. All but one test of auditory memory, which was specially constructed for the study were taken from well-known educational aptitude batteries. The tests were administered by trained speech pathologists and the researcher either to individuals or to small groups.

Significant differences were found for high and low achievers on all six tests in the ASB. When the effects of intellectual abilities on the scores were removed, differences were observed in the scores of only three tests, one of auditory discrimination and two of auditory memory. The three remaining tests measured abilities related closely to intellectual abilities making it difficult to determine whether cognitive abilities or auditory perceptual abilities contributed to the effects observed. No differences were found in the scores of English and non-English subjects for the six tests of auditory abilities, although a difference was observed for verbal cognitive abilities.

It may be concluded that a relationship exists between achievement and auditory perceptual abilities for the Grade 4 children in this study as the low achievers had significantly lower scores than high achievers on tests of auditory discrimination and auditory memory.

Further research is needed to determine the extent of the relationship and the degree to which delayed auditory perceptual abilities affect school achievement. As illustrated in this study, the conflicting results reported in the literature may be due to whether or not researchers include variables such as intelligence and language abilities when considering children's performance in auditory perceptual skills.

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INTRODUCTION

In this study the relationship between auditory perceptual skills and school achievement for children in Grade 4 is examined. The specific objective of the research was to determine if children rated by their teachers as achievers or non-achievers in English Language Arts, French Language Arts, and Mathematics perform differently on tests of auditory perception. An additional objective was to determine if children whose first language is English have different auditory perceptual abilities than those whose first language is neither English nor French. This objective was included in the research to further investigate the results of Warnock (1980) who found that Grade 4 and 5 children whose first language was neither English nor French performed significantly below grade level and their native English speaking peers on a battery of standardized achievement tests.

A unique feature of this study is the program in which these children are enrolled. It is the only French Immersion program reported in the literature that is taken by all children in Kindergarten to Grade 6. In addition, while most French Immersion programs immerse the child totally in the French language, the child in this program receives a half day in English and a half day in French throughout the elementary grades. In any French Immersion program the auditory channel plays an important part in learning, as the child is required to recognise, recall, and use the vocabulary and structures of two languages in a situation where most of the instruction is, of necessity, oral. In this particular program there is an increased demand on auditory discrimination and memory as formal reading instruction is introduced in both French and English at the beginning of Grade 1. This means the child must master the fine discriminations of two distinct phonetic systems at the same time. Because of the increased demands placed on auditory skills in this type of bilingual program, the auditory channel was selected as the area of investigation for this research

The thesis is organised into three chapters. The first chapter begins with a discussion of Wepman's (1968) conceptual model of the central nervous system and research based on these concepts. This is followed by a review of other relevant research in the area of auditory perception. Research that explores, auditory discrimination and auditory memory abilities is considered separately. Also considered separately are studies in which the perceptual approach to the learning process is criticised and studies in which the topic of auditory perception in bilingual French/English programs is discussed. A statement of the research problem and the research hypothesis completes the chapter.

In the second chapter the experimental design used in the investigation is described and details of the characteristics of the subjects, the method of subject selection, the measuring instruments, the method of data collection, and data analysis are given. In the third chapter the results of the investigation are presented and discussed. The thesis ends with a summary and statement of conclusions, a bibliography, and appendices.

# CHAPTER I

## REVIEW OF THE LITERATURE

In this chapter Wepman's (1968) model of the central nervous system, particularly its application to auditory perception is presented in some detail. Research based on this model, as well as the work of other researchers who examine the relationship between school achievement and auditory perceptual skills, are then discussed. Following, several studies of auditory discrimination and auditory memory are examined as well as the criticisms of authors who object to the perceptual approach to the assessment and remediation of learning difficulties. Finally research which relates specifically to the topic of auditory perception in the context of French Immersion programs is discussed. The chapter concludes with a summary and a statement of the research hypothesis.

### RESEARCH STUDIES BASED ON WEPMAN'S MODEL OF THE CENTRAL NERVOUS SYSTEM

One theoretical model for the development of auditory perceptual skills in children is offered by Wepman (1968). He developed this model in an attempt to explain why some children with normal intellectual potential were underachieving in academic areas, particularly reading skills. He believed that while a large body of

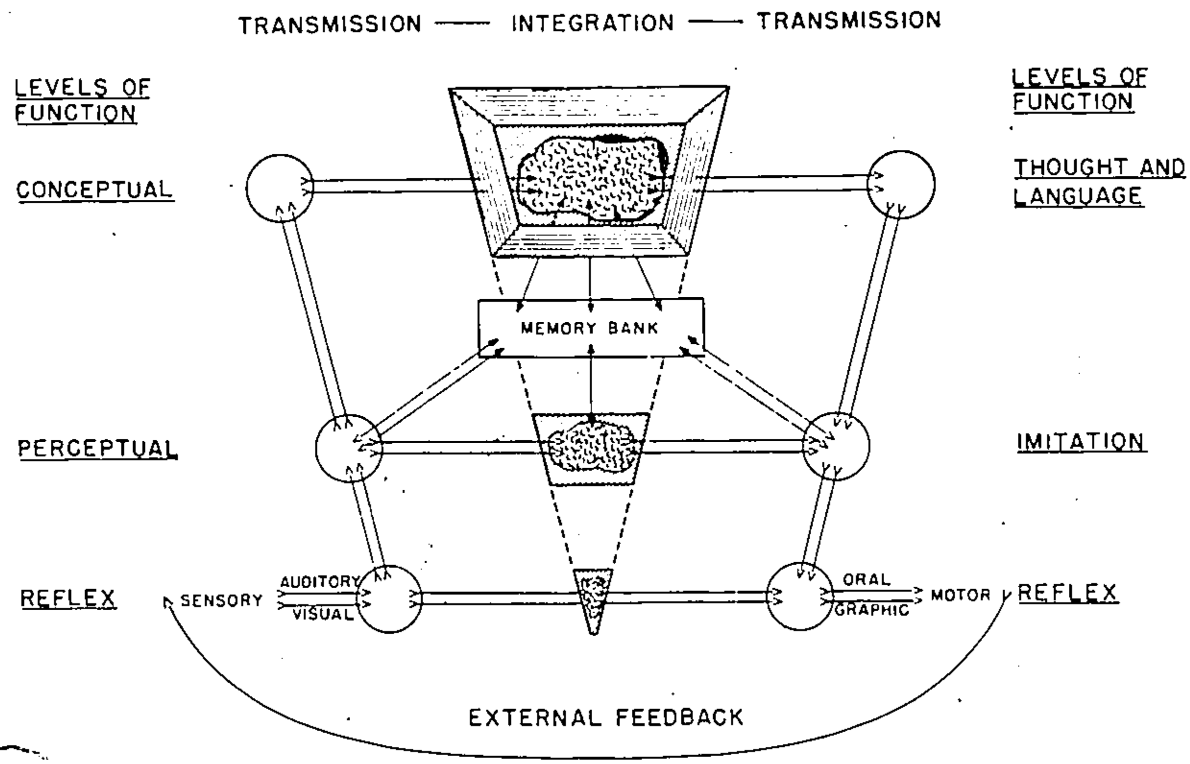


Figure 1: Wepman's model of the central nervous system.

research had provided insight into the process of learning, very little effort had been made to study the actual characteristics of underachievers.

Figure 1 shows Wepman's (1968) model of the central nervous system. He proposes a structural base underlying the learning process having two main features. First, all sensory input and motor output are modality bound - that is they are either visual, auditory, motor, or a combination of these in nature. Second, a child's neural system develops in a hierarchical yet inter-related way from a simple reflex level, present at birth, through a perceptual level in which the child learns to imitate, discriminate, and differentiate the sounds of the language and between the forms seen and heard, to a more advanced level. At this level the child is ready to associate input signals from different modalities with previous learning in memory and formulate an output signal with the intent to communicate. Input from the environment is therefore taken in through the appropriate modality, integrated, and then transmitted out.

In developing the first feature of his model, the modality concept, Wepman (1968) studied two major modalities, the visual and the auditory pathways. He points out that two other pathways, the visuo-motor and moto-kinaesthetic, are equally important and have been studied by other researchers. In looking closely at clinical data from the handicapped learner or underachiever, he noticed that many children with learning problems appeared to have a greater facility in using one input modality than others and that some had considerably less facility with one or other of the two major modalities . While these effects were seen most easily in children with known neurological impairments, such as brain tumors or accident trauma, the effects could also be observed in children with no demonstrable neurological impairments. This modality preference appeared to be related to the innate capacity of the child rather than to any environmental factors. In addition, he noticed that children developed at different rates in the two major modalities with some children exhibiting a developmental delay in one modality and not the other.

Wepman's (1968) main purpose in exploring the effects of modality preference and delay in children was to understand and assist the underachiever. He argued that if a child who is underachieving can be identified as having some real modality delay, any method of remedial instruction should be adapted to suit the child's learning style. An example of inappropriate instruction is teaching reading to a child experiencing a delay in the visual modality, using a method that involves memorizing words presented through the visual modality.

An important distinction made by Wepman (1968), overlooked frequently in subsequent work by other researchers, is that attempts to actually predict reading problems from results on perceptual tests have been less than successful. However, when poor achievement is identified, the identification of poor visual or auditory perception may help in selecting an appropiate method of remediation. In his opinion the two major modalities have developed fully in most children by age nine. He suggests that any delays in auditory or visual perceptual processes have been overcome by this time.

With the concept that development in the major modalities progresses from a lower simple reflex level through a perceptual level to a higher conceptual level, Wepman (1968) supposes that each level is dependent on intact learning at the level below it. He believes that if insufficient stress were placed on the initial reflex and perceptual stages of learning, later learning at the conceptual level could be faulty and without a basic structure upon which linguistic skills could be built. For this reason most of Wepman's work (1964, 1968, 1973) was focused on learning at the perceptual level, a level he considered critical to academic achievement and under-represented in the research. In Wepman's view (1968) a child having difficulty learning to read may well be started at too high a level if comprehension is required before the child has mastered perceptual tasks such as discrimination, retention and recall of sounds and letters, sequential order of phonemes and graphemes, and the ability to inter-relate one to the other.

A number of studies in which Wepman's model was used as a basis for investigation of the relationship between auditory perceptual skills and underachievement in children are described below. In a discussion of the auditory modality and reading, Morency (1968) argues that the processes of auditory discrimination and auditory memory are important contributing factors to the success or failure of children in any classroom. She defines auditory discrimination as the ability to differentiate between closely related speech sounds and auditory memory as the ability to recall and retain these sounds. She notes that, since the early 1930's, auditory discrimination and auditory memory ability have been the subject of much study in the area of speech development and reading. She identifies four major findings from earlier studies (Mykelbust, 1954; Wepman, 1964; DeHirsch, 1966) that are relevant to the present discussion. These may be summarized as follows: 1) There is a consistent increase in a child's ability to discriminate sounds as the child gets older; 2) children vary in the rate of development of both auditory discrimination and auditory memory; 3) some children do not develop completely in auditory discrimination and auditory memory until age nine or beyond; and 4) auditory measures are not predictors of success or failure in reading. It seems worth noting that although the processes involving auditory perception were studied quite extensively before 1968, research in recent years has added very little to the above conclusions.

Morency (1968) also describes a three year research study designed to investigate the effects of auditory discrimination and auditory memory on achievement. One hundred and seventy nine children from a pool of two hundred and fifty were present for the complete study. The children were tested on entering Grade 1, at the end of Grade 2, and on completion of Grade 3. The four tests used for each grade level were the Wepman Auditory Discrimination Test, the Lorge-Thorndike Group Intelligence Test, the Metropolitan Achievement Test, and an experimental test of auditory memory.

The results showed that perceptual abilities develop significantly in the first three years of school and that these abilities progress at differing rates in the visual and auditory modality in the same individual. Of particular interest was the relationship between auditory discrimination and memory ability at the beginning of Grade 1, and school achievement at the end of Grade 3. Children identified as having a delay in auditory discrimination and memory at the end of Grade 1 were found to be significantly below grade level on every sub-test of the achievement battery at the end of Grade 3. This study provided support for Wepman's (1968) earlier suggestion that an early delay in auditory perceptual abilities may contribute to the low level of school achievement for as long as three years.

In a continuation of this research, Morency & Wepman (1973) followed the same children to the end of Grade 6. At the end of six years, 120 of the 250 children initially tested in Grade 1 remained in the study. Each year each child was administered a battery of tests which included the Metropolitan Achievement Test and a perceptual test battery. Tests of auditory discrimination and auditory memory were part of this battery. Again auditory discrimination and auditory memory scores at the early Grade 1 level were found to be significantly related to underachievement on every sub-test of the achievement battery in Grades 4, 5 and 6. The authors conclude that the findings of these studies show the strong and pervasive influence of early perceptual readiness on later school achievement.

In summary, Wepman (1968) suggests that auditory discrimination and auditory memory develop at different rates in different children, with some children experiencing significant delays in both processes in the early grades. Morency & Wepman (1973) suggest that while early perceptual delays have been overcome by age 9, the effect of these delays, underachievement in academic skills, persists up to and well beyond the point where the delays themselves are no longer observable.

## OTHER RELEVANT RESEARCH IN AUDITORY PERCEPTION

Although there seems to be consensus among authors on the importance of auditory perception to academic achievement (Lerner, 1981; Morency & Wepman, 1973; Ritchie & Aten, 1976; Heasley, 1974; Sabatino, 1973; and Lyon, 1977), research in this area has been relatively neglected. Wepman (1972) found that between 1960 and 1972 only 63 articles were published on auditory perception. Sabatino (1979) points out that in a study done by Wepman (1968) of the frequency of test administration, the auditory perceptual tests did not even rank among the top ten tests most frequently administered to school children. These results are despite the fact that almost all the predictive and correlational studies reported in the literature indicate that auditory perception relates more significantly than visual perception to success or failure in basic academic skills (Vernon, 1971; Dykstra, 1966; Sabatino & Hayden (1970a, 1970b)), to language development (Morency, Wepman & Hass, 1970; Parnell & Korzenowski, 1972; Van Atta, 1973) and to reading-spelling achievement (Lloyd, 1968; Tikofsky & McInish, 1968; Gibson, 1970).

In reviewing the state of the art, Wallace & Larsen (1978) point out that, in comparison with visual perception, little information exists concerning the perceptual processes of audition. Sabatino (1979) suggests this is because visual perception is regarded by many authors as the dominant perceptual characteristic. He also believes that it is less complex and easier to understand.

Lyon (1977), Sabatino (1979), and Teuber (1965) suggest that the lack of adequate theoretical models as well as the lack of adequate definitions have hindered attempts to produce an acceptable operational definition of the construct, auditory perception. Wallace & Larsen (1978) point out that while perceptual assessments and programs became the most widely used methods for the evaluation of low achieving children between 1936 and 1970, there was not accompanying research to validate their usefulness in school.

In an attempt to clarify the importance of central processing dysfunctions in children, Chalfont & Scheffelin (1969) were commissioned by the United States Department of Health, Education and Welfare to conduct a review of the research in this area. It was hoped that this review would provide guidelines and direction for researchers. The reviewers identify the auditory channel as one of the most important avenues through which children and adults receive information about their environment. In their view, a child having difficulty processing auditory stimuli may perform poorly in some of the following tasks: 1) identifying the source of sounds, 2) discriminating among sounds or words, 3) reproducing pitch, rhythm, and melody, 4) selecting significant from insignificant stimuli, 5) combining speech sounds into words, and 6) understanding the meaning of environmental sounds in general. The reviewers state that while clinical studies have reported such behaviour as being characteristic of children who have difficulty processing and responding to auditory stimuli, no comprehensive description of the conditions under which subjects were able to perform appropriately and inappropriately has been given. They found the term auditory perceptual disorder being used to describe many of the behaviours which are characterized by difficulty in perceiving auditory stimuli.

Chalfont & Scheffelin (1969) conclude that the state of knowledge had not gone much beyond the early work done by

Mykelbust (1954) who defined auditory perception as the ability to structure auditory stimuli and select appropriate sounds. They suggest several factors which may have contributed to the lack of empirical data on auditory stimulus processing in children. These are: lack of information on the nature of auditory stimuli, particularly speech sounds, the difficulty involved in measuring and studying responses to auditory stimuli, the fact that different people progress at different rates in developing auditory processing skills, and the confusion caused by overlapping terminology. They suggest a need to more clearly identify auditory processing tasks and to describe and categorize the observable behaviours associated with them. They recommend that research be undertaken to explore the behaviours of auditory processing disorders related to a) attention to auditory stimuli, b) differentiating sound from no sound, c) sound localization, d) discriminating sounds varying in one acoustic parameter, e) discriminating sounds varying in several parameters, f) auditory figure ground selection (the ability to select relevant sounds in a background of irrelevant sounds), and g) associating sounds with sound sources. In addition they suggest that unless basic research is undertaken in neurology and biochemistry, measurement and classification will continue to be substituted for diagnosis of the real causes of underachievement.

Another approach suggested by Flower (1968) and developed extensively by Heasley (1974) is one in which auditory perception is described as a collection of subskills. The relative importance of each subskill to school achievement is then examined. In trying to determine which auditory processes might be involved in learning to read, Flower (1968) identified six auditory processes which appear frequently in the research. These are: auditory sensitivity -- the ability to hear a variety of sounds at appropriate levels of loudness; auditory attending -- the ability to detect and attend to an auditory stimulus in a background of irrelevant auditory stimuli; auditory discrimination -- the ability to differentiate and select a specific sound among similar sounds; auditory memory -- the ability to retain sounds in the correct sequence; auditory integration -- the ability to synthesize sounds into words orally; and auditory-visual integration -- the ability to recognise graphic representations of the sound heard.

Flower (1968) questions the use of approaches to the identification and remediation of learning difficulties in which children are rehearsed in the perceptual activities in which they are deficient. The assumption underlying this approach is that there is a causal direct relationship between these activities and the actual tasks involved in reading. He suggests an approach, which he has developed, whereby deficits in specific auditory tasks that are known to be directly related to reading are identified. He describes these tasks in the context of a five level hierarchical structure. The achievements described at each level depend on the achievements at the lower levels.

Levels 1, 2, and 3 involve only the auditory modality. Levels 4 and 5 involve visual as well as auditory processes; therefore, failure at these levels could be due to failure in the auditory or visual modalities or both. The five levels in ascending order of difficulty are: immediate repetition of single phonemes, repetition of a series phonemes in the correct sequence, isolation of particular phonemes in words and the identification of acoustically similar phonemes, blending of phonemes into words including the ability to interchange commonly used phonemes and graphemes in syllables, and the translating of unfamiliar graphemes into phonemes to construct words.

The first three levels contain the auditory perceptual skills identified by Wepman (1964) as auditory discrimination and auditory memory. Like Wepman (1964), Flower (1968) believes that the word attack problems of many older children are due to confusions at the first three levels of this particular hierarchy, and these confusions are due to the children being confronted with Level 4 activities before they have mastered the skills on which these activities are built. In Flower's (1968) view many of the tasks that must be mastered before a child can read successfully are based on auditory processes developed at the earlier levels.

Flower (1968) suggests a more specific breakdown of the deficient processes than does Wepman (1964). He suggests a set of criteria which must be mastered at each level. These include the specific skills involved in the reading process such as decoding of words containing certain vowels, consonants, and blends. The objective of his approach is to allow the tester to identify not only the deficient process but the specific phonemes or phonetic combinations that cause failure. He suggests that evaluation begin at level 5, the translation of unfamiliar graphemes into phonemes to make words or syllables. If the child is successful at this level, it is assumed that all of the auditory skills necessary for learning are adequately developed and no further assessment of auditory abilities is required. If level 5 is failed, each lower level is considered in turn until the criteria for success are met. Using Flower's (1968) method the tester is able to identify the deficient process in the context of reading related activities, thus obtaining more specific information on which to build a program of remediation.

The concept of specific sub-skills was extended by Heasley (1974). She developed a taxonomy of what she considered the most important components of auditory processing. This taxonomy was examined critically by Taylor (1978) in an effort to determine which of the thirteen components related most closely to school achievement. In his opinion Heasley's (1974) taxonomy represents one of the most thorough and complete lists of the skills involved in auditory processing. From a review of the literature on each component he concluded that seven of the thirteen were closely related to school achievement and should be of most concern to educators. These are auditory attention, auditory attention span, auditory discrimination, auditory memory, auditory memory span, auditory separation, and auditory closure. In a discussion of the reasons for academic failure he refers to Wepman's (1968, 1973) work to make the point that academic failure appears early and becomes progressively more serious as years go by. He describes some of this as being related to perceptual development. He agrees with Wepman (1964, 1968, 1973) that unknown numbers of children enter Grade 1 with inadequately developed auditory perceptual skills. He goes further, however, to state that these skills may not be fully matured until Grade 4 or beyond. Like Wepman (1968), he notes the fact that, despite a possible developmental delay, most students are taught as if their perceptual skills are mature. In Taylor's (1978) view the consequence of a delay in the development of auditory perceptual skills is that some students are not able to learn as well or as fast as their peers and so fall further and further behind, particularly in language acquisition. He suggests that by the end of the Grade 5, poor self concept, rather than immature perceptual skills, may have become the principal contributing factor in academic failure.

Lyon (1977) raises some important issues regarding the understanding of what constitutes auditory perception, the diagnosis of auditory-perceptual deficits, the relationship of auditory-perceptual skills to reading ability, and the value of training children's auditory perceptual skills with the assumption that this will improve their reading ability. In his view the ideas of what critical factors are actually involved in the auditory-perceptual process are as speculative as they were two decades ago. In discussing definitions and models he found confusion, contradictions, and very little empirical evidence to support a comprehensive model of auditory perception. He feels these factors have hindered attempts to produce an operational definition of this construct.

Lyon (1977) makes the same point in discussing the commonly used tests of auditory perception. He identifies the Roswell-Chall Auditory Blending Test, the Digit Span Subtest of the Wechsler Intelligence Scale for Children, The Illinois Test of Psycholinguistic Abilities, the Wepman Auditory Discrimination Test, the Seashore Measures of Musical Talent, and the Goldman-Fristoe Woodcock Test of Auditory Discrimination as the tests most frequently used to assess children's auditory perceptual abilities. He states that studies assessing the reliability and validity of commonly used tests, especially those examining the construct validity of the frequently used tests of auditory perceptual abilities, are sparse. Even those limited number of investigators who report significant predictive validity co-efficients tend to contradict each other. To illustrate the confusion surrounding these tests, he refers to Finkenbinder (1971) who found that many of the tests measure the same ability, several are limited in their assessment of auditory problems, and that neither the Wepman Auditory Discrimination Test nor the Goldman-Fristoe Woodcock Test correlate well with reading. These comments seem surprising based on the extremely positive results obtained by Wepman and Morency (1973), using the Wepman Auditory Discrimination Test for predictive purposes.

In discussing research of the relationship between auditory skills and reading achievement, Lyon (1977) reached the following conclusion: In comparisons of the performance of good and poor readers, auditory perceptual abilities appear to be significantly related to achievement in reading. He cautions that the effect observed may be due to the influence of higher intelligence rather than auditory perception. He found only one study, Golden & Steiner (1969), where youngsters were matched on the basis of intelligence. In correlational studies the results seem to depend on whether good or poor readers were identified prior to the administration of the tests. Those researchers who did not differentiate good or poor readers prior to testing found no correlation between auditory perceptual abilities and reading while those who did found a correlation. These results may be due to the way the groups were structured in the two types of studies. In studies where groups of very good readers were compared to groups of very poor readers, differences would naturally appear. In studies where groups of mixed ability readers were compared, the differences would not be as extreme.

Lyon (1977) warns that correlational studies should be interpreted with caution as a correlation between deficits in auditory perception and deficits in reading ability may be the result of a causal effect in either direction, or may also be associated with other unknown factors. It is difficult to assess this conclusion as only two examples of correlation studies are given to support the statement.

Finally Lyon (1977) states that small positive correlations ranging from r=0.2 to r=0.4 exist between predictions of future success and measures of early auditory-perceptual abilities. In fact, he points out that intelligence has been reported to be a better predictor of reading success than auditory-perceptual abilities for Grade 1 students. In general Lyon does support the view that auditory-perceptual factors such as listening and attention are extremely important in the development and execution of cognitive skills but he feels that there is little empirical evidence to support a specific position.

In summary, research in the area of auditory perception does seem to suggest a relationship between auditory perceptual skills and underachievement in children. However, it is difficult to evaluate the nature and strength of the relationship as there are several contradictory views ranging from those that find no relationship to those that find a strong relationship. Several authors make the point that research in this area is sparse and that much of the evidence and many of the assumptions on which their studies are based were developed before 1968. The lack of adequate definitions, models, and theories to explain the processes underlying auditory perception seems to have led researchers in this field in a direction which is more practical than theoretical. In many of the studies involving school age children, the relationship between specific skills which are believed to be components of auditory perception and other related areas such as language, reading, and overall school achievement is explored.

In studies of the relationship between auditory perception and school achievement, two skills, auditory memory and auditory discrimination, appear more frequently than others. Wepman (1968), Morency (1968), DeHirsch (1966), Flower (1968), and Taylor (1978) identify both skills as factors which may contribute to underachievement in academic areas. As these are the processes to be investigated in this research, the following section will include a discussion of studies in which these skills are considered.

## RESEARCH ON AUDITORY MEMORY AND AUDITORY DISCRIMINATION ABILITIES

Flynn & Byrne (1970) conducted a study of auditory abilities in a selected group of advanced and retarded readers in Grade 3. Advanced readers were defined as those who scored at Grade 4.2 level or higher on the reading tests of the Iowa Test of Basic Skills. Retarded readers scored at Grade 2.2 level or less. From a sample of children drawn from Grade 3 in four elementary schools, fifty two children were rated as advanced readers while forty-two were rated as retarded readers. Intelligence scores were obtained using the Lorge-Thorndike test. Children with scores below 85 were eliminated as were those with hearing impairments. The auditory abilities tested included discrimination, memory, blending, and articulation. The authors considered that the nine auditory perceptual tests selected represented the best available. The advanced readers scored significantly higher on six of the nine tests. These six included three tests involving discrimination between pairs of words and nonsense syllables with similar sounding initial and final consonants, one test of different pitch, and two blending tests. No significant results were obtained for memory of single short words, memory for digits, and articulation.

An additional component of the study, although not directly related to this research, is of interest. Advanced and retarded readers were assigned to a high or low socio-economic level and their scores examined accordingly. No differences were found for socio-economic level. Retarded readers in the low socio-economic environment performed like their counterparts in the high socio-economic group on the tests of auditory perception, and advanced readers in the two socio-economic levels could not be differentiated on tests of auditory perception. This observation agrees with Wepman's (1968) findings that in the populations who had been clinically studied, children with auditory deficits were found to come from all types of homes including the highly verbal university setting as well as the almost non-verbal disadvantaged environments. One factor that stood out in this study was that intelligence scores were highly related to reading. The advanced readers were more than one standard deviation above the retarded readers regardless of social class. This result may be partially due to the fact that the test used to measure intelligence, the Lorge-Thorndike Intelligence Test, requires the pupil to read either the questions in the verbal battery, or a series of directions for the use of shapes or figures in the non-verbal and quantitative battery. If the pupil's reading ability is low, the score will be reduced by his inability to read the question or follow instructions.

Sabatino & Hayden (1970)(a) explored the information processing behaviours associated with learning disability in elementary school children. The purpose of their study was to examine processing behaviours associated with learning and to identify specifically those related to failure. They wished to build a system of psychoeducational tests that would assess the information processing behaviours which theoretically contribute to academic learning. The data obtained from such tests could then be used for diagnostic prescriptive teaching purposes.

The subjects were 472 children failing in Grades 1 through 6 ranging in age from 6 years 3 months to 14 years 7 months. Their teachers were asked to estimate each child's academic rank in each subject by comparing the child with his classmates. Three indices from Burk's Behavioural Check List - distractibility, perceptual discrimination, and social personal skills - were also completed. An extensive individual assessment of cognitive development, perceptual development, and academic achievement was conducted on each child. Twenty-five sub-test variables which related specifically to these three areas were identified. A component analysis of the 25 variables produced five principal components. The data were treated by orthogonally rotating the variables so that the principal components extracted could be interpreted in a meaningful psychological sense. Component I was essentially a vocabulary component containing no perceptual behaviours. The authors feel this supports the hypothesis that perceptual skills are separate and distinct from cognitive skills. Component II was a teacher-description index. There was a high degree of overlap in the teacher's observations of perceptual, academic, and social-personal behaviours with minimal discrimination among these behaviours. Component III was a learning disability component and comprised auditory and visual-auditory integrative behavioural measures. The component was called a learning disability component and not a psycholinguistic component nor an auditory perceptual memory component because these test variables seemed to measure highly complex perceptual behaviours comprising many component parts. The loadings on this component were auditory-perceptual and auditory-visual integration. Component IV was a visual perceptual component. This component and component III represented the information processing behaviours related to learning disability. Component V was an academic achievement component. Chronological age and three academic achievement measures loaded on this component. The authors suggest that for children who were failing the isolation of academic achievement tests into a single component indicated that these measures are distinctly separate from the basic information-processing behaviours. They give only a level of achievement and not a diagnosis of the reasons for failure nor what can be done about it. The five principal components accounted for 40% of the total variance with component III alone accounting for 15% of the variance. This component retained test variables with the greatest commonality and yet contributed maximally to the total variance.

The authors concluded from these results that the children in this study who are experiencing failure in Grades 1 to 6 do have specific language and perceptual information processing problems. The language processing problems appear as difficulties in receptive, central, and expressive language. The perceptual processing problems appear as difficulties in auditory discrimination, auditory and visual memory, and auditory and visual-perceptual integration. Those children who are failing do not seem to have perceptual copying, motor, laterality, or directional difficulties. Neither teacher ratings nor academic achievement provided a basis for understanding why failure occurs. A suggestion is made that auditory perception contains many components which need to be isolated and which are extremely important to academic learning.

To further explore the nature of the information processing behaviours identified in their study, Sabatino & Hayden (1970)(b) re-analysed their data on an age basis. As the mean age of the sample was 9.6 years, the population was divided into two age groups, one older and one younger than 9.6 years. Significant differences were found between the children in the two age groups on perceptual and psycholinguistic behaviours. These differences were not accompanied by significant differences in language functions. In the younger group the component which accounted for the largest amount of the total variance was termed an auditory-perceptual component. In the older group the component which accounted for the largest amount of the variance represented vocabulary or central language skills. Unlike the younger group this component was not represented by any auditory perceptual test variable; verbal sub-tests loaded on this component. The authors suggest the results of this analysis support the hypothesis that age 6-9 is the maximum growth period for perceptual skills and that language over-rides perceptual behaviours as children develop intellectually.

They suggest their findings relate directly to classroom practices because their results indicate that more effort should be made to concentrate on perceptual behaviours of young children as non-language perceptual training seems to lose its effectiveness after age 10.

Ritchie & Aten (1976) investigated the ability of 10 year old children with and without reading disabilities to retain and recall serially presented verbal and non-verbal stimuli. They defined auditory retention as the ability to store and recall a selected number of serially presented auditory stimuli. They were primarily interested in the extent to which a delay or disorder in this skill affects reading. Six tests of auditory retention, two non-verbal and four verbal, were administered to two groups of twenty children. The mean reading level of the groups differed by approximately three years. As expected, a statistically significant difference was found between children with and children without reading disabilities on the four verbal measures which were reading related in that they tested phonemes, words, sentences, and syntax. What was not expected was that the reading disabled group differed significantly from the non-disabled group on the two non-verbal tests. These measured the retention of audible sounds which varied in duration and rhythm. The authors concluded that a deficiency in auditory retention of verbal and non-verbal sequential stimuli is related to reading disability. They suggest that a child's ability to perceive a sound may depend on the rate at which it is delivered.

Sounds which are delivered more quickly than others, such as consonants before or after a vowel, may be delivered too quickly for the child to discriminate and retain them. As the emphasis in words is on the vowel sound, the child may hear the similarity in vowel sounds but miss the differences in consonants as they are delivered too quickly. It seems logical to suggest that a child with such a disability would have difficulty in learning to read in situations where much of the instruction is oral.

Badien (1977) examined the performance of retarded readers on auditory-visual integration tests. He was interested in the role played by "underlying processes" in the process of auditory-visual integration. One of the major underlying processes he examined was short-term memory. He noted that there is considerable evidence that disabled readers are inferior on sequential memory tasks. However, little evidence exists to support the hypothesis that there could be significant underlying factors affecting auditory-visual integration. The purpose of his study was to test the performance of adequate and retarded readers not only on auditory-visual integration tests with increasing demands on memory, but also on the perceptual and memory processes upon which auditory-visual integration is based. He suggests that these processes include auditory discrimination and short-term auditory memory for the initial stimuli, as well as visual discrimination of the response stimuli. He suggested that it is only when the underlying perceptual and memory processes are intact that one can say failure on an auditory-visual integration test is due to a deficit in auditory-visual integration.

For the study Badien (1977) selected ten adequate and ten retarded readers in each of Grades 4, 5 and 6 in the same school. The retarded readers, 17 boys and 13 girls, had a mean intelligence score of 100, a mean chronological age of 119.3 months, and mean reading scores ranging from Grade 2.2 to 2.8 on various reading tests. The adequate readers, 16 boys and 14 girls, had a mean intelligence score of 102, a mean chronological age of 116.5 months and mean reading scores ranging from Grade 5.6 to Grade 6.4. Children with inadequate English, a significant loss in hearing or vision, frequent absences from school, significant emotional problems, and intelligence scores of less than 80 were excluded from the sample. The test battery included two tests of underlying processes (visual and auditory discrimination, auditory memory of non-verbal patterns), the Auditory Sequential Memory sub-test of the Illinois Test of Psycholinguistic abilities (ITPA), and seven tests of auditory-visual integration (4 non-verbal and 3 verbal) given under several timing conditions so that there were varying demands upon short-term auditory memory for the initial stimuli. In addition the subjects were rated by their teachers for inattentiveness and hyperactivity using the Connors Teacher's Rating Scale. The results indicated that retarded readers were significantly inferior on all seven auditory-visual integration tasks, on both non-verbal and verbal short-term auditory memory tasks and on teacher's ratings for inattention. There was no difference between groups on the auditory and visual discrimination tasks and on the rating for hyperactivity. The test that best differentiated the groups was the ITPA Auditory Sequential Memory sub-test. This was followed by tests of either short-term auditory memory or auditory-visual integration which required the most memorization. The retarded readers were found to be very inferior to the adequate readers on all tasks demanding short-term auditory memory. When memory demands were reduced, the actual task of integrating visual and auditory stimuli to reach a correct answer presented few difficulties. It was only when a memory component was added that the retarded readers began to experience difficulties.

Badien (1977) identifies four main findings from this study: 1. There is a relationship between auditory memory and performance on auditory-visual integration tests. 2. Retarded readers are inferior to adequate readers on both verbal and non-verbal tasks making demands on short-term auditory sequential memory. 3. Retarded readers have little difficulty with non-verbal auditory-visual integration when memory demands were minimal. 4. Retarded readers' auditory-visual integration performance deteriorated as memory demands increased. He concluded that inferior performance of retarded readers on auditory-visual integration tests is likely to be due neither to defective visual-auditory integration ability nor even to a difficulty with temporal-spatial transfer, but rather to an impairment in memory for short-term temporal sequences. This conclusion seems warranted given the results obtained.

In general, most of the research reviewed in the area of auditory discrimination and auditory memory leads one to conclude that these skills affect school performance. In several studies retarded readers were found to have delays in either one or both of these skills. In older children deficits in auditory memory seem to be more frequently studied than deficits in auditory discrimination. In addition there is some evidence that older children can use language abilities to compensate for auditory perceptual delays. This is an important point for the research as it could account for Wepman's (1973) findings that early auditory perceptual delays are not observable after 9 years although the child is still underachieving. The perceptual delays may no longer be observable as the child's language abilities have reached a stage of development where they can be used as a compensatory mechanism.

## CRITICISM OF THE PERCEPTUAL APPROACH TO ASSESSMENT AND TEACHING

While there is a great deal of research to support the hypothesis that auditory perceptual skills play an important role in school achievement, particularly in learning to read, there is also controversy regarding the usefulness of perceptual assessments and training programs for the non-achiever. Most of the objections have come from one group of authors. (Hammill & Larsen, 1974, Larsen & Hammill, 1975, Larsen, Rogers, & Sowell, 1976, Larsen, 1976, Wallace & Larsen, 1978). They question seriously the relationship between auditory or visual perceptual abilities and academic achievement. The final section of this review will present their concerns, their findings, and some reactions to the points they make.

Wallace & Larsen (1978) question the use of the perceptual approach to assessment and teaching with children exhibiting academic failure. In their view, most commonly used perceptual tests have been shown to lack the necessary power to differentiate between low and normal achieving children and are unreliable predictors of school achievement. They go as far as advising educators to avoid the use of either perceptual tests or training techniques in working with children experiencing school failure. They state that the perceptual approach to understanding learning problems is unsupported by available research. To support these statements they refer to Larsen, Rogers & Sowell (1976) who examined the use of five perceptual tests in differentiating between normal and learning disabled children. Three auditory tests were used - the Auditory Sequential Memory sub-test and the Sound Blending sub-test of the ITPA and the Wepman Test of Auditory Discrimination. Two visual perceptual tests were also used - the Bender Visual-Motor Gestalt Test and the Visual Sequential Memory sub-test of the ITPA. The subjects were 89 children ranging in ages from 8 years 5 months to 10 years 7 months. Fifty-nine of these children were underachieving academically and were considered learning disabled. A control group of thirty children who had no record of academic problems was randomly selected from the same public school classes. Both groups had average intellectual ability and were matched by age and sex. The learning disabled group were further subdivided into two groups, one of 35 who were reading one grade below their expected level and one of 24 who were reading 2 or more grades below. Reading expectancy was based on chronological age. Thus three groups were available for comparison purposes, one group with no academic problems and two learning disabled groups. The tests of intelligence and perception were administered individually by trained diagnosticians while classroom teachers administered the Stanford Reading Achievement Tests. No significant differences among the three groups were found on four of the five perceptual tests including the three auditory perceptual tests. In fact the learning disabled subjects as a group received somewhat higher scores than their normal counterparts. Only one test differentiated among the groups - the Bender Motor Gestalt Test, a test of visual-motor integration. The authors question the value of the four tests which they found to be non-discriminating, particularly as these tests are widely used for purposes of diagnosis in the area of learning disabilities. They go on to question the validity of the perceptual or psychological constructs on which these tests are based. In their view constructs such as auditory or visual processing are abstractions which exist in the minds of the users. They suggest these abstractions are open to wide interpretation; as an example they identify the variety of ways the construct of auditory discrimination is defined and measured. The major point they make is that to quantify a perceptual construct one must refer to the method of assessment used to measure it; thus the construct is defined in terms of the measuring instrument. A logical conclusion is that if one can demonstrate that the instrument has questionable usefulness for diagnostic purposes, one must question the validity of the construct it measures. They suggest that if the reader considers any of the four tests which did not differentiate between the two groups as adequate representatives of the underlying construct, then there is little evidence in this study to indicate that these abilities are necessary in learning to read. The authors conclude by indicating that the results of this single study cannot be taken as definitive and refer the reader to two reviews of pertinent correlational research - Larsen & Hammill (1975) and Hammill & Larsen(1974). These researchers investigated the relationship of measured auditory and visual perceptual skills to school achievement, in general, and reading in particular. Approximately 1000 correlation coefficients from more than 100 different investigations were analyzed. Their conclusion was that auditory discrimination, memory, sound blending, and auditory visual integration are not necessary for successful reading. They do not offer suggestions for variables that are related to school achievement other than a suggestion that, in searching for causes of failure, time would be better spent studying the situational variables operating within a class.

The conclusions reached by Larsen, Rogers, & Sowell (1976) are questioned by McCarthy (1976), a co-author of the ITPA. He raises several issues regarding their research procedure and the tests they employed to measure components of perceptual ability. Two main concerns are raised: The first is that the subjects selected were either beyond the ITPA ceiling of 10 years 6 months or too close to it. This could mean the test was too easy for many normal and learning disabled children and so any differences between the two groups could have been masked by a ceiling effect. This is also true for the Wepman Auditory Discrimination test which has a ceiling level of 9 years. The second concern is that the tests selected were not true measures of perceptual ability. McCarthy (1976) states that the ITPA is a language test, not a test of perception. Therefore in his judgement the proposition that perceptual differences exist between normal and learning disabled children was not tested. He considers the Bender Visual-Motor Gestalt Test, the one test which did discriminate between the normal and the learning disabled pupils, to be the only perceptual test used in this study. McCarthy (1976) also points out that the literature review used by Hammill & Larsen (1974) to support their finding has been seriously questioned by Minskoff (1975). He notes that the support Hammill &

Larsen (1974) find regarding the questionable value of perceptual tests for diagnostic purposes is not accepted and is, in fact, contested by others (Minskoff 1975).

In a response to McCarthy (1976), Larsen (1976) points out that the two main arguments regarding the age of the subjects and the test selection do not offer a serious challenge to the research procedures or the results obtained. The raw data obtained on the three sub-tests of the ITPA are shown to demonstrate the fact that in none of the ITPA sub-tests did any of the subjects reach the ceiling. Larsen (1976) argues that, in fact, the ITPA sub-tests were not too easy for the subjects. No information is presented to support this statement for the Wepman Test of Auditory Discrimination. To refute the criticism that some of the tests are not truly perceptual in nature, Larsen (1976) argues that McCarthy's (1976) opinion represents one point of view and states that theoreticians, test constructors, researchers, and practitioners believe that these tests do measure perceptual abilities. He goes on to discuss research which has included memory as a part of perception by using visual or auditory recall tasks in studies of perceptual ability. He concludes that regardless of whether the tests are perceptual or not, the results of the study remain the same. Four of the five tests used did not discriminate between learning disabled retarded readers and children with average achievement levels. The question Larsen (1976) raises is whether these types of tests do yield data that are useful in educational practice. In his view they do not. Finally Larsen (1976) states that the point made by McCarthy (1976) regarding Hammill & Larsen (1974) is based on an error on his part as the article to which he refers was not used to support the conclusion nor even mentioned in the study. He refers McCarthy to the bibliographical section of Larsen, Rogers, & Sowell (1976) for a correct listing of references.

While not specifically relevant to this research, it is worth noting that even greater controversy surrounds the issue of perceptual training. In a review of 42 studies in which attempts were made to train children to use specific perceptual abilities, Hallahan & Cruickshank (1973) found that the better designed studies were more likely to produce results that showed no relationship between perceptual training and academic achievement than were poorly conducted studies. Wilson, Harris, & Harris (1974), focussing on the effects of an auditory perceptual remedial program, found that increased competency in auditory perception did not improve a student's proficiency in reading and spelling any more than instruction in traditional types of reading activities. Myers & Hammill (1976) reviewed 105 research studies of the effects of perceptual training programs and found little support for the continued use of these programs. Recent studies in this area tend to support their findings.

In discussing their objections to the use of assessments and programs based on a perceptual model of the learning process, the authors reviewed above present a convincing case for their point of view and there is evidence to support their position. Perceptual tests and programs have been used extensively for diagnosis and remediation with little concern for the underlying processes involved. While one may question tests and techniques, one cannot ignore the fact that there is a great deal of evidence that auditory perceptual abilities do affect school achievement and that children with deficits in these abilities are experiencing failure. More well designed studies that explore the relationship between auditory perceptual skills and underachievement are needed before one can accept the position taken by these authors.

## RESEARCH ON AUDITORY PERCEPTUAL ABILITIES IN BILINGUAL FRENCH/ENGLISH PROGRAMS

As the children in this study are registered in 50/50 French/English program, studies in which the relationship between auditory perception and school achievement in French Immersion programs are examined are considered separately. Most of the research in the area of French Immersion has reported extremely positive results. (Lambert & Tucker, 1972; Barik & Swain, 1974, 1975, 1976; Edward & Casserly, 1971, 1972; Morrison & Martin, 1978). As a result, few researchers, other than Trites (1976, 1980, 1981), have studied the characteristics of children who do not succeed in French Immersion. No studies were found in which the relationship between auditory perception and children's achievement in French Immersion programs were explored specifically. The relationship between auditory abilities and the ability to learn French as a second Language is discussed in the following section.

Pimsleur (1966) identifies a special factor beyond intelligence and industriousness which he believes accounts for how well an individual succeeds in a second language course. He calls it auditory ability and defines it as "the ability to receive and process information through the ear". In studying the performance of adults learning French in a group training program, Kinrade (1972) found that of a group whose performance was rated as unsatisfactory, 83% had low auditory ability.

In two years of study of learning disabilities found in early French Immersion students, Trites (1976) found a group of children who were bright, highly motivated, from advantaged homes, free from personality and neurological disorders, but unable to cope in French Immersion. They were able to progress normally however when transferred to an English-only program. At the time of the study the mean age of the children was 7.0 years. He suggests that a developmental delay in the temporal lobes may be the cause of this phenomenon. As the temporal lobes contain the auditory centre of the cerebral cortex, it seems reasonable that a developmental delay in this area could affect the auditory perceptual skills required for success in second language learning.

Thus although the auditory channel plays an important role in early French Immersion instruction, little research has been done to examine the relationship between auditory perceptual skills and underachievement in this area. Non-achievers are seldom mentioned in reports on French Immersion programs. This may be due to the fact that children who experience difficulty transfer quickly to English-only programs with little follow-up to examine the reasons for failure. These conditions produce limited opportunities for studying the characteristics of children who are not achieving well in French Immersion programs.

## SUMMARY AND RESEARCH HYPOTHESIS

In summary, the amount of research in the area of auditory perception seems to have reached a peak during the time of Wepman's earlier studies (1964, 1968) and declined since. More recent research has added very little to knowledge of the processes involved in auditory perception. Other than Wepman's model (1968), theoretical models of the constructs involved are almost non-existent.

Although the theoretical frameworks have not been developed, research involving the relationships between school achievement and auditory perceptual skills, tests and training programs has continued. There seems to be considerable controversy in these areas with some authors producing results which show a positive relationship between auditory perceptual skills and school achievement, and others contradicting their findings on methodological grounds or producing studies which have conflicting results. Very few researchers have evaluated the role of auditory perceptual skills in French immersion or Bilingual English/French programs. No studies were found in which the auditory perceptual skills of non-English children in bilingual programs were examined. This seems surprising as the auditory channel plays a major role in learning a second language.

In the studies reviewed, several researchers have examined the importance of the two auditory skills selected for this research, that is auditory discrimination and short-term auditory memory. There seems to be sufficient controversy to justify a study of the relationship of these skills to school achievement. The research indicates that auditory discrimination abilities are more likely to be fully matured by age 10, the approximate age of the children in this study, while auditory memory skills may not be fully matured until later. There is considerable evidence that children with delayed auditory perceptual abilities have difficulty with academic subjects, particularly reading.

On the basis of the research it seems reasonable to hypothesise a relationship between both of the above auditory skills and academic achievement. Because of the age of the children involved, differences between achievers and non-achievers may be greater in tests of auditory memory than in tests of auditory discrimination. As there is no evidence to suggest that children whose first language is not English have different auditory perceptual abilities than native English speaking children, no differences are predicted between the English speaking and non-English speaking subjects.

# CHAPTER II

# RESEARCH DESIGN

In this chapter the research design is presented. First the characteristics of the subjects and the methods used to select the research sample are described. This is followed by a discussion of the measuring instruments for the research; the six tests in the Auditory Skills Battery (ASB), and the two sub-tests from the Canadian Cognitive Abilities Test (CCAT) which are proposed as co-variates. Included in the discussion are, a brief description of the batteries from which the tests were chosen, a description of the tests themselves, a summary of relevant reliability and validity data, and the rationale for the selection of each test. The chapter concludes with a discussion of the methods used for data collection and data analysis.

## SUBJECTS

The research subjects were 80 children, 40 male and 40 female, attending elementary schools in an urban Roman Catholic school board in Ontario. All of the subjects were registered in a Grade 4 50/50 French/English Bilingual program. The ages ranged from 9.1 years to 10.6 years with the mean being 9.6.

The 80 subjects were selected from a pool of 300 pupils chosen at random from the 798 pupils registered in Grade 4 at the time of the study. Grade 4 pupils were selected for the study for two reasons. In the junior division (Grades 4 - 6) the instructional emphasis changes from the oral to the written mode, with the assumption that basic listening skills or auditory abilities are fully developed. The purpose of the study is to discover if this assumption is correct for all children. If children have not developed adequate auditory abilities by Grade 4, then timely identification of their problems gives the opportunity to teach them methods of learning that may compensate for their weaknesses. This should preferably be done before these children progress too far into the junior division. A second reason for the selection of grade 4 pupils is that the research includes the administration of group tests requiring a level of maturity and independence not present in younger children.

Classroom teachers (English and French) were asked to rate each of the 300 randomly selected pupils in English Language Arts, French Language Arts and Mathematics on a scale of 1 to 5. (1 - well above average, 2 - above average, 3 - average, 4 - below average, and 5 - well below average). Children rated 1 or 2 in all areas were assigned to a high-achieving group and children rated 4 or 5 in all areas were assigned to a low-achieving group. In a few cases for the subjects selected, the mathematical ability rating fell in the average range.

English and Mathematics Scores on the Canadian Test of Basic Skills (CTBS) administered at the end of Grade 3, correlated highly with teachers' ratings (r = 0.6 to 0.75), providing a validation of this procedure. In addition teachers were asked to indicate the first and second (if any) languages spoken in the home. On the basis of the data provided, 80 children were selected and assigned to one of 4 groups of 20 according to achievement (high or low) and first language spoken at home (English or a third language, neither English nor French). Each group contained 10 girls and 10 boys. To obtain 20 third language high-achievers, one girl and three boys rated as 3 in English, or French, or both were selected. To match the groups evenly, three similarly rated children were included with the English only high-achievers. The children in the 4 groups were matched as closely as possible by sex, age, and home school. Thus English high-achievers were matched with English low-achievers in the same school, and non-English high-achievers were matched with non-English low-achievers in the same school or type of school.

## MEASURING INSTRUMENTS

As the purpose of the research was to examine the performance of different groups of children on a battery of tests that measure auditory discrimination and auditory memory abilities, the tests selected were those that in the opinion of the researcher best evaluate different aspects of these skills. Also, it was considered important that tests relate as closely as possible to skills involved in the mastery of academic tasks, such as reading and mathematics. For these reasons, the tests selected are from auditory, reading, and aptitude batteries that are used to diagnose strengths and weaknesses in auditory discrimination and auditory memory. As it was also considered important to remove the effect intellectual abilities might have on auditory skills, scores from the Verbal and non-Verbal subtests from the Canadian Cognitive Abilities Test (CCAT) were included in the design as co-variates. These two group tests had been administered as part of a special project in November 1983 when the subjects were in Grade 4.

## THE AUDITORY SKILLS BATTERY

The Auditory Skills Battery (ASB) includes 6 tests. Five were selected from widely used achievement and aptitude batteries. One was specially constructed for the research. Two group tests were used to measure auditory discrimination as it was considered less likely to show differences than auditory memory. Four tests, two individual and two group, were used to measure short term auditory memory. The complete battery was expected to take approximately 60 minutes for group testing and 40 minutes for individual testing.

Each test of the ASB is discussed below in more detail. Where applicable, the battery from which the test was chosen is described. The items from each test are briefly described, the reasons for its selection are given, and relevant technical information is presented. This is followed by a similar discussion of CCAT sub-tests.

Test 1. Auditory Discrimination

The Auditory Discrimination Sub-test was selected from the Green Level of the Stanford Diagnostic Reading Test (SDRT). This battery is designed to provide accurate diagnostic assessment of the reading abilities of low-achieving pupils. It is available in three levels with each level providing for the measurement of various components of the reading process at different grade levels. The Green Level is intended for diagnosing the strengths and weaknesses of children in Grades 3 and 4.

The Auditory Discrimination Sub-test is a group administered test that measures the pupil's ability to determine whether the same sound occurs at the beginning, in the middle, or at the end of two dictated words. The test includes 36 items; eighteen consonant sounds (6 single consonant letters, 6 consonant clusters and 6 digraphs), and eighteen vowel sounds (6 short vowel sounds, 6 long vowel sounds, and 6 diphthong sounds or sounds controlled by certain consonant letters).

The examiner's manual provides extensive information on the initial construction and refinement of the SDRT. The information given suggests that the test is reliable and has high content validity. Kuder-Richardson 20 reliabilities range from 0.79 to 0.98 for the various sub-tests at different levels, with a majority of the coefficients exceeding 0.90. For the auditory discrimination sub-test the reliability coefficient at the Grade 4 level is 0.93. Correlations between sub-tests are lower than reliabilities (most fall in the 0.65 to 0.75 range), suggesting some degree of independence among the skills measured by the sub-tests. The discussion of the validity data places a high emphasis on content validity. Buros (1978) describes the methods used in constructing the specific sub-tests as "painstaking" and the technical character of the test as "highly satisfactory".

This test was chosen as it represents a reliable and valid measure of an auditory discrimination activity required for mastery of basic phonics.

Test 2: Auditory Discrimination and Orientation.

Test 3: Letter Memory

Tests 2 and 3 were taken from the Monroe-Sherman Group Diagnostic Reading and Aptitude Battery for pupils in Grades 3-9. The battery measures visual, auditory, and motor abilities related to academic tasks. The results provide a profile of each child's aptitudes and identify areas of weakness which may interfere with learning.

In the Auditory Discrimination and Orientation Sub-test the subject must identify a word given orally and then locate its position in a series of four similar sounding words which are also given orally. The 25 items become increasingly difficult and range from a series of simple three letter words to a series of polysyllabic and hyphenated words. This test was chosen as it represents a different type of auditory discrimination task from the first test. It requires the student to recognise and locate the position of whole words rather than single sounds within words.

The Letter Memory Sub-test evaluates the ability to retain and reproduce in writing a series of letters that have no meaning. This is a fairly difficult memory test, as the pupil must be able to retain the stimulus letters long enough to write them. However it does represent the type of activity expected from a student in the junior division where directions are given orally with the expectation that the student has the ability to remember and follow them. For the purpose of the research the test was scored in two ways.

1) As intended by the author: to test memory with sequencing, 16 items with 2 to 9 letters were each given orally. The subject was required to remember and reproduce the letters in writing in the given sequence. The subject receives credit only if the complete sequence of letters is correct. The possible score therefore is 16.

2) As modified for this research by the researcher: to test memory without sequencing, the 16 items were re-scored giving the subject credit for each letter retained regardless of sequence. The possible score for this modification is 88 (88 letters are presented).

Although this test battery is used widely as a measure of aptitude, surprisingly little technical information is provided regarding its construction and standardization. The examiner's manual gives two pages of directions for administration and twelve pages of norms. No reliability or validity data are provided and there is no description of the normative population. The only reference found to this test was a paragraph in Buros (1972) giving this same information. The strength of this aptitude battery lies in the detailed instruction for interpretation of the result. The information provided gives a great deal of insight into the constructs on which each sub-test was based and suggests possible causes for low achievement in each area, as well as possible ways to remedy the problem. This lack of technical information was not considered a serious threat to the validity of using the two sub-tests selected as these tests provide measures of aspects of auditory discrimination and auditory memory which are insufficiently covered in other tests but commonly required in classroom practice. For this reason the tests were considered valid and useful measures of performance in these skills.

Test 4: Memory for Digits.

To determine if the subjects' short term memory span changes when the stimulus items change from letters to numbers, the Warnock Test of Auditory Digit Span was administered. This test, identical in format and length to the previous test, was specially constructed for this study as available tests of digit span were either designed for younger children or too short and therefore unlikely to provide the level of discrimination required. The only difference between this test and the previous test of letter memory was that the memory task involved required the retention of items from a pool of ten digits instead of 26 letters. As in the Letter Memory Sub-test, the test was scored in two ways.

1) To test memory with sequencing, 16 items with 2 to 9 digits were each given orally. The subject was required to remember and reproduce the digits in writing in the given sequence. The subject receives credit only if the complete sequence of digits is correct. The possible score is 16.

2) To test memory without sequencing, the 16 items were re-scored giving the subject credit for each digit retained regardless of sequence. The possible score is 88.

The reason for including this test was to determine if the subjects' short-term retention is affected by the type of pool from which the stimulus items are drawn or by the actual number of stimulus items presented. If the type of pool does not affect performance, the results from the digit span test should be similar to the results from the letter span test.

Test 5: Recognition Memory.

Test 6: Memory for Content.

Tests 5 and 6 were taken from the Goldman-Fristoe-Woodcock Auditory Skills Test Battery (GFW). This very extensive battery was designed to identify and describe deficient auditory perceptual skills in persons aged 8 through 80. It is intended for clinical use to provide fine discriminations in the auditory skills of subjects whose performance is deficient for their ages. Selective attention, auditory discrimination, recognition memory, memory for content, memory for sequence, and sound-symbol relationships are measured.

The Recognition Memory Sub-test measures the ability to recognise an auditory event which has occurred in the immediate past. A series of tape-recorded words are presented to the subject who is required to remember if the stimulus item has been said before, and respond yes or no accordingly. As the test progresses more words are introduced between the stimulus word and its repetition creating more interference before the subject hears the word again. Thus the memory task becomes increasingly difficult. New stimulus words are given every 22 items. The test includes 110 items giving scores in the range 0 to 110.

The Memory for Content Sub-test measures the ability to recognise the elements in an auditory event without regard for the sequence of those elements. Before this test is given, subjects are trained to associate a set of words with pictures relating to those words, until the associations are completely familiar. The subject is then asked to listen to a sub-set of the words presented using a tape-recorder and then to point to two pictures whose corresponding words were not presented. The task becomes increasingly difficult, ranging from two words and an array of four pictures, to nine words and an array of eleven pictures. The task is always the same - to point to the two pictures whose associated words were not presented. The subject must always respond in the time allowed for each item. This test requires reasoning as well as memory as the subject must remember a series of words, switch to a visual display of these and then sort out which words are missing - all in a very limited time. Sixteen test items each containing two correct responses are provided giving a possible raw score of 32.

The technical manual provides details on the criteria used for developing the test battery, the standardization sample, and reliability and validity data. The major similarities between tests are summarized clearly as a means of examining the battery's validity. The construct validity is examined in three ways. (1) Inter-correlations among the tests range from 0.18 to 0.32 which suggests the tests measure different abilities. (2) Correlations between age and test scores are provided. These tend to be high and positive for the three to eight age range, low and positive for the nine to eighteen, and high and negative for ages 19 to 80. (3) A comparison of normal subjects and subjects with mild to severe dysfunctions suggests that the test does differentiate between those who are normal and those with dysfunctional abilities. The split-half reliabilities for the two tests used here are reported by age group: 3 to 8 years group -- 0.78 to 0.97 (median 0.87); 9 to 18 years group -- 0.46 to 0.96 (median 0.77); 19 to 80 years group -- 0.73 to 0.97 (median 0.90). Buros (1978) considers these reliabilities to be greatly inflated because of the correlations between GFW scores and age, however, he recommends the GFW battery as a diagnostic tool worth serious consideration for the assessment of 8- to 11-year old subjects with suspected auditory dysfunctions. Reservations are expressed regarding its usefulness with younger or older subjects. Additional research and development are suggested to ascertain the battery's reliability, to further explain its construct validity, and to give a better description of the standardization sample. These recommendations seem reasonable. The reliabilities reported are based on a wide-range age group rather than within-age groups and no test-retest reliabilities are provided. The norming data are reported in the same way, by age groups rather than by chronological ages; therefore one does not know the actual number of persons included in the sample at each chronological age. While the construct validity data do suggest the battery differentiates between persons with dysfunctional abilities and normals, the analyses do not control for any factors which could contribute to performance other than age.

These two memory sub-tests were chosen as they represent activities which are different from other memory tasks in the ASB. They test short term memory for whole words rather than memory for letters or digits. The selection was also based on Pressman (1982). In a study where patterns of auditory perception in 8- to 11-year old boys with learning disabilities were examined, she found that these two sub-tests were the only tests in the GFW battery which discriminated between learning-disabled and non-learning-disabled children.

## THE CO-VARIATES

The Verbal and Non-Verbal Sub-tests were taken from the multi-level edition of the CCAT. This edition provides a continuous set of appraisals for Grades 3-12. The battery has evolved from 15 years of research with the Canadian Lorge-Thorndike Test, a group intelligence test. It is based on the theory that there are three major types of symbols involved in cognitive reasoning. These are verbal symbols (Verbal Battery), quantitative or numerical symbols (Quantitative Battery), and spatial or geometrical symbols (Non-Verbal Battery). The test has been constructed to provide a variety of tasks using each of these three types of symbols. The tasks in the sub-tests have been kept simple, clear, and familiar with the hope that an individual's score will reflect primarily the ability to discover relationships and show flexibility in thinking.

The Verbal Battery includes 100 multiple choice items, takes 34 minutes working time and is made up of four sub-tests -- Vocabulary, Sentence Completion, Verbal Classification, and Verbal Analogies. The Vocabulary Sub-test evaluates the subject's knowledge of different words, and flexibility in identifying the specific meaning of the word being used. The Sentence Completion Sub-test measures the individual's sense of structure of the English language and the comprehension of the ideas expressed in a sentence. The Verbal Classification Sub-test requires the individual to abstract the common element among three or four verbal stimuli. The Verbal Analogies Sub-test requires the individual to discover the relationship between a pair of words and, when given a third word which is the first word of a second pair, complete the analogy.

The Verbal Battery was chosen as a co-variate as three of the tests in the ASB use meaningful words as stimuli, and it seems reasonable to predict that a subject's ability to manipulate verbal stimuli will contribute to the variance on these. In addition, the ability measured by the Verbal Classification sub-test is reported as being related to efficient verbal memory processes.

The Non-Verbal Battery includes 80 items, takes 32 minutes working time and consists of three sub-tests: Figure Classification, Figure Analogies, and Figure Synthesis. The items in the sub-tests involve neither words nor numbers. In the Figure Classification Sub-test the subject is required to identify common elements among stimuli. In the Figure Analogies Sub-test the subject is required to discover relationships among elements. In the Figure Synthesis Sub-test the subject must mentally organise separate pieces into a whole and show flexibility in mentally manipulating spatial configurations.

The Non-Verbal Battery contains no verbal stimuli in the items, therefore the scores on the test are not influenced by reading ability or language facility. This sub-test was chosen as a co-variate to determine if the types of abilities assessed by this battery contribute to the variance in the scores on the ASB. Since this is a non-verbal battery, the abilities measured may affect the three tests in which the stimulus items are non-verbal.

The scores from the Quantitative Battery were considered but not included in the research as they were found to be unrelated to scores on any of the ASB sub-tests.

The technical data described here were obtained from a preliminary manuscript that will be published in November 1985. An extensive Canadian sample of the population for whom the test was designed was used in the 1980 standardisation procedure. In discussing the content validity, the types of tasks called for in the tests are described as those dealing with abstract and general concepts requiring the interpretation and use of symbols, the ability to identify and deal with relationships among concepts and symbols, flexibility in organizing concepts and symbols, the ability to use experience in dealing with new patterns, and power in working with new ideas. Mechanical ability, social intelligence, and practical intelligence are not the kinds of abilities tested in the CCAT.

The relationship between the CCAT abilites and academic achievement seems substantial with correlations between the CCAT and the CTBS sub-tests ranging from 0.51 to 0.70 at the Grade 4 level. The Verbal Battery is identified as an indicator of general academic competence, the non-Verbal Battery as an indicator of ability less dependent on academic achievement, and the Quantitative Battery as an indicator of abilities important for arithmetic, mathematics, and work study skills involving graphs and tables. No reliability data is reported. Mean and standard deviations of item difficulty are expressed as a percentage of the correct answers for the three batteries. At the Grade 4 level, the mean is 58% for the Verbal Battery (SD 24%)., 62% for the Quantifative Battery (SD 23%) and 72% for the non-Verbal Battery (SD 20%). The authors conclude that for a multiple-choice test the CCAT is slightly difficult but close to the optimum and permits a given test level to function adequately for the range of ability in each grade. This conclusion seems warranted based on the data presented.

In summary, the six tests chosen for the ASB provide eight measures of auditory perceptual abilities. The two auditory discrimination tests measure different aspects of this skill, one with letters and one with words. The four auditory memory tests provide six measures of short term memory. Memory for Letters and Memory for Digits test the same ability with different stimulus items, that is, the ability to recall a series of letters and digits in sequence and out of sequence. Recognition Memory and Memory for Content represent two different memory tasks which use words as the stimulus items. The verbal and non-verbal sub-tests of the CCAT were included in the analysis as co-variates to determine if the subjects' scores on the ASB are significantly different when the effects of the cognitive abilities measured by these two tests are removed.

## METHOD OF DATA COLLECTION

The Auditory Skills Battery was administered during the months of January and February 1984 by the researcher and two speech pathologists. The complete battery took two testing sessions, a group session of 50 to 60 minutes, depending on the subjects' response times, during which tests 1 to 4 were administered and an individual session of 40 minutes during which tests 5 and 6 were given. In both group and individual sessions care was taken that the subjects completely understood the task required and, for each test, practice times were given until the testers were sure that all children in the group were able to follow the directions. Instructions were repeated where necessary.

The 80 subjects were from 24 schools which represented all but two of the elementary schools in the system. The number of students from each ranged from 2 to 8, the majority providing only 2.

## METHOD OF DATA ANALYSIS

Depending on intercorrelations between the 6 tests in the ASB it was planned to analyse the data using univariate analyses of variance and co-variance. The independent variables were language and achievement. Verbal and non-verbal scores on the CCAT were used as co-variates. Data were analysed using the BMDP statistical package (1981). The level of significance was set to 0.05. Further details of the procedures and results are described in the following chapter.

## CHAPTER III

## RESULTS AND DISCUSSION

In this chapter the results of the investigation are presented and discussed. First, the dependent and independent variables are identified. Then, the methods and rationale used to determine the types of data analyses conducted are discussed. The means and standard deviations obtained from the raw data are presented for the dependent variables and the co-variates. These are grouped in cells according to the independent variables. This is followed by a discussion of the results obtained from univariate analyses of the data. The chapter ends with a discussion of the relevance of the findings to the research question, and a comparison of the results obtained with those predicted from the review of the literature.

The two independent variables used in the final analyses are Language -- English and Non-English, and Achievement -- high and low. No differences were expected between males and females. An analysis of the data with sex as an independent variable is reported in Appendix F and it confirms this expectation. Thus sex was not included in the final analysis as an independent variable.

Initially the dependent variables for the Auditory Skills Battery (ASB) were two measures of auditory discrimination obtained from the two auditory discrimination tests, and six measures of auditory memory obtained from four tests of auditory memory. Two possible co-variates (verbal and non-verbal) were obtained from the Verbal and Non-Verbal sub-tests of the CCAT. These variables are identified by the following acronyms:

STAN (The Stanford Test of Auditory Discrimination)

MSDISC (Monroe-Sherman Discrimination)

MSLET (Monroe-Sherman Memory for Letters)

MSEQ (Monroe-Sherman Memory for Letters, re-scored for sequencing)

DIGITS (Warnock Memory for Digits)

DSEQ (Warnock Memory for Digits, re-scored for sequencing)

REC (Goldman-Fristoe-Woodcock Recognition Memory)

CONT (Goldman-Fristoe-Woodcock Memory for Content)

VERB (Verbal sub-test from CCAT)

NONV (Non-Verbal sub-test from CCAT)

The correlation matrix obtained from the subjects' scores for these eight variables and the two CCAT sub-tests is shown in Table 1.

TABLE 1: Matrix Showing Correlations among the Eight ASB Measures, the Transformed Variable, and the Two CCAT Sub-tests.

| | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | CONT | REC | VERB | NONV |
|---|---|---|---|---|---|---|---|---|---|---|
| MSDISC | .33 | | | | | | | | | |
| MSLET | .23 | .34 | | | | | | | | |
| MSEQ | .30 | .38 | .70 | | | | | | | |
| DIGITS | .19 | .28 | .76 | .59 | | | | | | |
| DSEQ | .17 | .30 | .68 | .77 | .77 | | | | | |
| CONT | .30 | .26 | .13 | .22 | .13 | .19 | | | | |
| REC | .19 | .27 | .47 | .24 | .33 | .30 | .21 | | | |
| VERB | .42 | .53 | .40 | .40 | .32 | .36 | .45 | .48 | | |
| NONV | .35 | .33 | .34 | .42 | .35 | .40 | .36 | .16 | .56 | |
| LDCOM | .25 | .37 | .88 | .87 | .88 | .91 | .19 | .38 | .42 | .43 |

Although coefficients greater than 0.22 are statistically significant at the .05 level, much larger values are necessary to account for practically significant proportions of the variance. Also, these correlation coefficients are likely to be inflated to some extent as average achievers were deliberately omitted from the sample. Inspection of the data suggests, however, that this is not a serious problem. The four dependent variables MSEQ, DIGITS, MSLET, and DSEQ are highly correlated. This suggests that the subjects' performance does not change a great deal for short term recall of letters or digits in or out of sequence. The scores for these four variables were therefore transformed to z-scores and combined to form one variable, named LDCOM, which measured short term memory for letters and digits with and without sequencing. The correlations between this combined variable and the other dependent variables are also shown in Table 1. It correlated highly with the four variables from which it was formed. A preliminary analysis showed that the covariates did not account significantly for the variance in this dependent variable, therefore a univariate analysis of variance was used for the analysis. The other two memory variables CONT and REC each measure distinctly different aspects of auditory memory from LDCOM. As they were not highly related to each other (r=0.21) or to LDCOM (r=0.19, 0.38), they were each analysed by a univariate analysis of co-variance with the two covariates VERB and NONV.

The abilities being measured by the two discrimination variables STAN and MSDISC overlap to some degree, however the two tests from which these variables were formed measure different aspects of the same ability -- one involving the discrimination of the position of the same sound in two words and the other involving the discrimination and location of a word in an array of similar sounding words. As STAN and MSDISC were not highly correlated (r = 0.33), they were analysed separately. STAN was analysed using a univariate analysis of variance rather than co-variance, as it was not significantly affected by VERB and NONV. MSDISC was analysed by a univariate analysis of co-variance using both VERB and NONV as co-variates.

In summary the data analyses were conducted as follows. The independent variables for the analyses were language and achievement. The dependent variables were STAN, MSDISC, CONT, REC, and LDCOM. The covariates were VERB and NONV. The scores from STAN and LDCOM were analysed using a univariate analysis of variance. The scores from MSDISC, CONT, and REC were analysed by a univariate analysis of co- variance with two covariates, VERB and NONV.

The cell means and standard deviations obtained from the data for the five dependent variables and the two co-variates are shown in Tables 2 and 3 respectively. The subjects are grouped by Language (English and non-English) and Achievement (High and Low). A preliminary inspection of the means suggests the subjects scored as predicted. High achievers scored better than low achievers for the five dependent variables and the two co-variates whereas the scores of English and non-English subjects differ only slightly with one exception, VERB.

In an analysis of variance which used VERB and NONV as dependent variables, subjects rated as high achievers scored significantly better than low achievers in both verbal and non-verbal cognitive abilities. This suggests that the skills measured by these two tests are related to success or failure in academic subjects. A significant difference between the scores of English and

TABLE 2
Summary Statistics (ASB)

Cell and Marginal Means and Standard Deviations. Independent Variables are Language and Achievement (High and Low). Dependent Variables are STAN, MSDISC, REC, CONT, LDCOM.

STAN

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 34.4 | 1.88 | 28.9 | 6.04 | 31.6 |
| non-Eng. | 34.0 | 2.13 | 26.8 | 7.79 | 30.4 |
| Total | 34.2 | | 27.8 | | |

MSDISC

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 23.35 | 1.04 | 21.15 | 1.81 | 21.77 |
| non-Eng. | 22.9 | 1.33 | 21.35 | 2.21 | 22.12 |
| Total | 22.65 | | 21.35 | | |

REC

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 105.5 | 2.78 | 102.4 | 3.94 | 103.9 |
| non-Eng. | 104.3 | 3.91 | 100.3 | 4.30 | 102.3 |
| Total | 104.9 | | 101.4 | | |

CONT

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 23.7 | 2.74 | 22.2 | 3.19 | 22.95 |
| non-Eng. | 23.75 | 1.97 | 20.75 | 3.19 | 22.25 |
| Total | 23.72 | | 21.47 | | |

LDCOM

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 0.54 | 0.55 | -0.60 | 0.72 | -0.025 |
| non-Eng. | 0.64 | 0.85 | -0.59 | 0.47 | -0.026 |
| Total | 0.59 | | -0.59 | | |

TABLE 3
Summary Statistics (CCAT)

Cell and Marginal Means and Standard Deviations. Independent Variables are Language and Achievement (High and Low). Dependent Variables are VERB and NONV.

VERB

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 70.1 | 11.07 | 45.8 | 8.87 | 57.95 |
| non-Eng. | 59.8 | 12.03 | 45.6 | 10.56 | 52.7 |
| Total | 64.95 | | 45.7 | | |

NONV

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 63.4 | 9.08 | 50.85 | 13.06 | 57.12 |
| non-Eng. | 60.4 | 10.14 | 53.8 | 9.84 | 57.1 |
| Total | 61.9 | | 52.32 | | |

non-English subjects and an interaction between language and achievement was found for verbal cognitive abilities. These effects were due primarily to the fact that the high achieving English subjects scored significantly better than the high achieving non-English subjects on this variable. This difference did not appear in the Non-Verbal Sub-test nor in the scores of the English and non-English low achievers for either sub-test. One would expect differences between the verbal abilities of English and non-English speaking children; however, it seems surprising that effects are observed for high achievers and not for low achievers. It is possible that low-achieving English speaking children have the same type of language delays as non-English speaking children; therefore no differences in the verbal cognitive abilities of the two groups are apparent. Differences between the mean scores of the language and achievement groups for the dependent variables in the ASB are considered in the analyses which follow.

To examine the equality of group variances for the dependent variables, Levene's test for equal variances was used. Three variables STAN, MSDISC, and LDCOM were found to have different group variances. In a preliminary analysis of variance significant differences were found between high and low achievers for STAN, MSDISC, and LDCOM. To test the appropriateness of using this F-statistic for the analysis, two additional statistics which do not assume equal group variances (Welch and Brown-Forsythe) were computed. The results obtained from these analyses supported the conclusions drawn from the results obtained from the analysis of variance. Significant differences were found between the scores of high and low subjects for the three variables.

The results of a univariate analysis of variance for the variable STAN are shown in Table 4 . (In this and subsequent tables an * next to a p value denotes a significant effect with an alpha of 0.05).

TABLE 4: Univariate Analysis of Variance. Independent Variables are Language and Achievement (High and Low). Dependent Variable is STAN.

| Effect | SS | MS | F | df | p |
|---|---|---|---|---|---|
| Language(L) | 31.3 | 31.3 | 1.19 | 1,76 | 0.28 |
| Achievement(A) | 806.5 | 806.5 | 30.65 | 1,76 | <0.001* |
| LA | 14.5 | 14.5 | 0.55 | 1,76 | 0.46 |
| Error | 1999.8 | 26.3 | | | |

No significant effects were found for language. Significant differences were found in the scores of the high and low achievers in favour of the high achievers. The auditory discrimination abilities measured by the test corresponding to this variable are therefore different for high and low achievers and do not appear to depend on intellectual abilities as VERB and NONV were found not to be significantly related to STAN when used as covariates. It seems surprising that STAN is not affected by the verbal co-variate as the correlation between VERB and STAN is relatively high (r=0.42). This effect can be explained when one inspects the data. There appears to be a ceiling effect for the high achievers on STAN. If the test had been longer, or more difficult, it might have produced more of a spread in the scores of the high achievers, and allowed the effects of the co-variates to appear.

The results of a univariate analysis of variance for LDCOM are shown in Table 5.

TABLE 5: Univariate Analysis of Variance. Independent Variables are Language and Achievement (High and Low). Dependent Variable is LDCOM.

| Effect | SS | MS | F | df | p |
|---|---|---|---|---|---|
| Language(L) | 0.052 | 0.052 | 0.12 | 1,76 | 0.73 |
| Achievement(A) | 28.1 | 28.1 | 63.5 | 1,76 | <0.001* |
| LA | 0.043 | 0.043 | 0.10 | 1,76 | 0.76 |
| Error | 33.7 | 0.44 | | | |

The scores of the high achievers were significantly better than those of the low achievers in the memory abilities measured by this variable. No significant differences were found for language or interaction. As VERB and NONV were not significantly related to LDCOM when used as co-variates, the differences between the scores of high and low achievers for this variable are not due to intellectual differences.

The results of univariate analyses of co-variance for the variables MSDISC, CONT, and REC are shown in Tables 6,7, and 8 respectively.

TABLE 6: Univariate Analysis of Covariance. Independent Variables are Language and Achievement (High and Low) Dependent Variable is MSDISC. Co-variates are VERB and NONV.

| Effect | SS | MS | F | df | p |
|---|---|---|---|---|---|
| Co-variates. | 19.44 | 9.7 | 3.75 | 2,74 | 0.03* |
| Language(L) | 0.25 | 0.25 | 0.1 | 1,74 | 0.76 |
| Achievement(A) | 9.92 | 9.92 | 3.83 | 1,74 | 0.06 |
| LA | 0.13 | 0.13 | 0.05 | 1,74 | 0.82 |
| Error | 192.0 | 2.59 | | | |

TABLE 7: Univariate Analysis of Covariance. Independent Variables are Language and Achievement (High and Low) Dependent Variable is CONT. Co-variates are VERB and NONV.

| Effect | SS | MS | F | df | p |
|---|---|---|---|---|---|
| Co-variates. | 72.4 | 36.2 | 5.05 | 2,74 | 0.01* |
| Language(L) | 2.55 | 2.55 | 0.36 | 1,74 | 0.56 |
| Achievement(A) | 3.98 | 3.98 | 0.56 | 1,74 | 0.46 |
| LA | 27.2 | 27.2 | 3.80 | 1,74 | 0.06 |
| Error | 530.5 | 7.2 | | | |

TABLE 8: Univariate Analysis of Covariance. Independent Variables are Language and Achievement (High and Low) Dependent Variable is REC. Co-variates are VERB and NONV.

| Effect | SS | MS | F | df | p |
|---|---|---|---|---|---|
| Co-variates. | 107.5 | 53.8 | 4.08 | 2,74 | 0.02* |
| Language(L) | 18.0 | 18.0 | 1.37 | 1,74 | 0.25 |
| Achievement(A) | 30.7 | 30.7 | 2.33 | 1,74 | 0.13 |
| LA | 14.6 | 14.6 | 1.11 | 1,74 | 0.29 |
| Error | 975.0 | 13.2 | | | |

These analyses indicate that there is an overlap between the skills represented by the co-variates, VERB and NON-VERB, and the skills measured by the tests of auditory discrimination and memory, represented by MSDISC, CONT, and REC. No significant differences were observed between the scores of either the English and non-English subjects or the high and low achieving subjects when the effects of these co-variates were removed. To determine if one or both co-variates affected these variables, the data were analysed using each co-variate individually. MSDISC and CONT were affected by both VERB and NONV while REC was affected by VERB only. This result is not surprising for the verbal covariate since the three tests use words as stimulus items and could measure the types of language abilities tested by the verbal co-variate. In addition MSDISC and CONT require spatial orientation abilities which are related to those measured by the non-verbal co-variate.

The above analyses show a significant difference between the mean scores of high and low achievers in favour of the high achievers on two of the dependent variables: STAN which represents the scores obtained from the Stanford Test of Auditory Discrimination, and LDCOM which represents the scores from the Monroe-Sherman Test of Letter Memory and the Warnock Test of Memory for Digits scored with and without sequencing. Although the high and low achievers differed in intellectual abilities, the between cell variance in auditory discrimination and auditory memory abilities found in these two analyses could not be attributed to intellectual differences. A ceiling effect for STAN may have prevented the effects of the co-variates from being observed. It appears the tests from which these variables were formed do measure auditory perceptual abilities which are distinct from intellectual abilities. This point is worth emphasising as many of the tests used to assess auditory perception are criticised for measuring intellectual abilities as well as those for which they were intended.

The analyses showed no significant difference between high and low achievers on three of the dependent variables: MSDISC which represents the scores from the Monroe-Sherman Test of Auditory Discrimination, and REC and CONT which represent scores from the Goldman-Fristoe-Woodcock Tests of Recognition Memory and Memory in Context. In preliminary analyses of variance a significant difference was found between the mean score of high and low achievers on each of these three variables. However, when the variables VERB and NONV were included in as co-variates, no significant difference was found between the two groups on each of these three variables. This suggests that the intellectual abilities measured by the CCAT tests and those abilities measured by these three ASB tests of auditory perception are related. It therefore becomes impossible to conclude that the differences obtained in the test scores are uniquely due to auditory perceptual abilities. One would expect that differences in verbal cognitive abilities would influence the scores of tests that incorporate meaningful words in test items while differences in non-verbal abilities would influence the scores of tests which have spatial components. Since the tests represented by these three variables do this, the above result is not remarkable.

No significant difference for language was found between the scores of the English and non-English groups on each of the five dependent variables used in the analyses. This finding supports the prediction that the auditory perceptual abilities of English and non-English speaking children are not significantly different. The only difference found between the scores of these two groups was the difference in verbal cognitive abilities noted previously.

The differences found in this study in the performance of high and low achievers on the different auditory perceptual tests could account for some of the conflicting results reported in studies of auditory perception. If tests of auditory perceptual abilities include skills that are affected by intellectual differences, these tests may be measuring cognitive abilities rather than perceptual abilities. As noted earlier, Lyon (1977) cautions that differences in perceptual skills may be due to the influence of intelligence rather than differences in auditory perception. Studies of auditory perception which do or do not control for intellectual differences would therefore produce different results. The conclusions drawn regarding the effect of intellectual abilities on the variables in this study are valid only for those abilities measured by the verbal and non-verbal subtests of the CCAT. These cognitive abilities were selected as they seemed more closely related to the research question than other intellectual abilities such as social intelligence, mechanical abilities, and practical intelligence. The conclusions may be different for other measures of intellectual abilities.

A finding of this study relates to the conclusion drawn by Sabatino and Hayden (1970) that children over 9 use language abilities to over-ride perceptual behaviours. The subjects in this study differed on six tests of auditory perception until the effects of the verbal and non-verbal co-variates were removed. They then differed only on the three tests which were non-language tests. These findings support the hypothesis that verbal cognitive abilities affect the scores obtained from language related tests; however, for two of the three variables, the differences could also be due to non-verbal cognitive abilities. If verbal cognitive abilities significantly affect the subjects' scores, researchers who use language based tests of auditory perception will report different results from researchers who use tests where these abilities can not be used.

In summary, the analyses of the data obtained from the ASB show that high achievers scored significantly better than low achievers in one measure of auditory discrimination and a combined measure of auditory memory abilities. Since verbal and non-verbal cognitive abilities were used as co-variates, the differences in auditory perceptual abilities seem not to be due to intellectual differences. One measure of auditory discrimination and two measures of auditory memory measured abilities related to verbal, or verbal and non-verbal cognitive abilities, making it impossible to determine which abilities, perceptual or intellectual, contributed to the differences found in the scores of the high and low groups. Conflicting results reported in studies of auditory perception may be due to the fact that intelligence and measures of auditory perception have common variance which is related to achievement. As predicted, differences were not found in the auditory perceptual abilities of English and non-English speaking children. The only difference found between these two groups of high and low achievers was in the verbal cognitive abilities of English and non-English speaking high achievers.

# CHAPTER IV
## SUMMARY AND CONCLUSIONS

In the preceding analyses the relationship between auditory perceptual abilities and school achievement was examined for English and non-English speaking children in Grade 4. It was found that high achievers performed significantly better than low achievers in one test of auditory discrimination and two tests of short term auditory memory. The differences found were due to differences in auditory perceptual abilities, not intelligence, as the cognitive abilities when used as co- variates did not affect the results. No differences were found in the auditory perceptual abilities of English and non-English speaking children although English high achievers had significantly better verbal cognitive abilities than non-English high achievers. Thus, from the results of this study one can conclude that there is a relationship between low achievement and poor auditory perceptual abilities. The results have limited generalizability as the sample was taken from one grade level. However, they do provide some empirical data in the area of underachievement which can be used to initiate follow-up research.

The consensus on factors which affect school achievement is that intellectual abilities are good predictors of success or failure. However experience has shown that some children with specific learning disabilities in perceptual processes do not progress in school in spite of average to superior intellectual abilities. While the low-achieving children in this study are not identified as having auditory perceptual learning disabilities, they have delays in two processes which are considered key components of auditory perception. These results suggest that when screening children for factors likely to affect school achievement, both intellectual and auditory perceptual abilities should be considered.

From the present study it is difficult to determine the extent to which achievement is affected by auditory perceptual abilities. It seems reasonable, however, to suggest that children with delays in auditory discrimination and auditory memory would have difficulty with the recognition and recall of information presented through the auditory channel. In a bilingual French/English program where the instruction is mainly oral, such a child may be unduly handicapped. To determine the extent of the relationship between auditory abilities and achievement, the type of study conducted in this research should be implemented at earlier grade levels and followed by intervention programs. It is possible that children can learn to compensate for delays in auditory perceptual abilities by using other input channels or by developing coping strategies. Classroom teachers could be trained to modify their methods of presenting material to suit the learning style of the child with an auditory deficit. The child could be trained to use alternative ways of receiving and recalling information. A teacher could help develop coping strategies by cueing the child to attend when auditory information is presented, training the child to watch the teacher's lips, teaching and reinforcing all new concepts through visual and kinaesthetic channels as well as the auditory channel, having the child repeat simple short instructions, showing the child a way of recording information to be remembered, and working with the child's parents to have these methods reinforced at home.

Compensatory strategies could include training the child to use stronger channels to compensate for the areas of weakness. The sight word method could be used to develop fluency in reading. Configuration clues could be taught to aid recall of sight words. Visual cues such as pictures containing certain sounds could accompany all phonetic sounds to be learned. Kinaesthetic reinforcers such as sandpaper letters, clapping out numbers and syllables, tracing numbers and words could accompany all new concepts and material to be remembered. "Buddies" in the classroom could be used to help with memory activities and in developing routines. The child could be actively encouraged to understand how he or she learns best and taught to develop personal strategies which become automatic.

The underachievers in this study require immediate specialized instruction which will help them in their day-to-day work. The majority of researchers suggest that, at 10 years, remedial instruction should not take the form of auditory perceptual training but should be practical, direct, curriculum-based activities which will aid and reinforce learning. In addition, classroom teachers must be made aware of the needs of these children and trained to use alternative teaching methods, such as those just discussed, to aid discrimination and recall when the instruction is auditory.

A further finding which should be examined is the difference found in the verbal abilities of English and non-English speaking children particularly as it relates to the high-achieving non-English subjects. At the present time, they seem to be able to compensate for the deficit in verbal abilities as they are achieving well. However, if a verbal delay persists into the later grades, they may not be able to compensate when the curriculum becomes more specific and contains subjects in which language plays a major role. A language stimulation program may be necessary to bring their verbal cognitive abilities to the same level as their English speaking peers.

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APPENDIX A
TEACHER'S RATING FORM

GRADE 4 - 1983

Biographical Information ID No.____

Name of Pupil:______________________________ DoB:______ Sex:____

School:______________________________ Grade:____ Grades Repeated:_____

First Language spoken at home: English_____ French_____ Other_____ (state which)

Other language(s) spoken at home:______________________________

| Teacher's rating of performance: | Eng.L.Arts | Math. | Fr.L.Arts |
|---|---|---|---|
| Scale | | | |
| 1. Well above average (top 10%) | ______ | ______ | ______ |
| 2. Above average | ______ | ______ | ______ |
| 3. Average | ______ | ______ | ______ |
| 4. Below average | ______ | ______ | ______ |
| 5. Well below average (bottom 10%) | ______ | ______ | ______ |
| Resource help | ______ | ______ | ______ |
| | (Indicate how much time daily) | | |

Teacher's Signature______________________________ Date __________

## APPENDIX B
## LETTER TO PARENTS OF CHILDREN SELECTED FOR THE STUDY.

To Grade 4 Parents:

Your child will be part of a group of Grade 4 students selected to take a short battery of simple tests related to listening skills. This battery will take approximately 1-1.5 hours of class time and will be done during January 1984.

The results will be used in a general way to study children's ability to hear and remember letters, figures, and simple facts.

The results will be kept confidential and will be made available to you if you wish to have them.

If you require further information or clarification, please contact me at 123-4567.

Thank you for your co-operation.

Sincerely,

Mairi Warnock,
Coordinator,
Student Services Department.

APPENDIX C
WARNOCK AUDITORY DIGIT SPAN TEST (WADS)

INSTRUCTIONS TO TESTER

1. Provide each student with a lined sheet of paper.

2. Have the students write the numbers 1-16 down the left hand side of the page.

3. Say, "This is a test to see how well you can remember and write numbers."

4. Give some examples of sets of digits orally. Ask the students to repeat them orally, then write them on the blackboard as the students respond.

5. Dictate the digits in each test item clearly, leaving one second between digits.

6. Do one item at a time.

7. Administer the test following the "Instructions for Students" exactly as written.

8. You may repeat a sequence once if the students seem to have difficulty remembering the first 2-3 digits. Be sure they put their pencils down before you dictate the digits for the second time.

INSTRUCTION FOR STUDENTS.

1. Write the numbers 1-16 down the side of your page.

2. Pencils down

3. Listen: I will say some numbers, when I have finished, pick up your pencil and write the numbers I say in the same order I say them, If you forget the order, write the numbers you remember anyway as you get points for remembering the numbers in any order.

4. Item number 1 - 3, 5. Write them. Pencils down when finished.

5. Item number 2 - 7, 6. Write them. Pencils down when finished.

6. Listen: (for a repetition) I will say the numbers again. Pencils down. 6, 7, 8 ... Write them.

TEST ITEMS.

1. 3, 5
2. 7, 6
3. 6, 4, 5
4. 1, 7, 4
5. 2, 6, 7, 4
6. 3, 0, 1, 9
7. 5, 4, 7, 6, 2
8. 1, 3, 0, 7, 6
9. 2, 5, 8, 3, 7, 1
10. 6, 3, 0, 5, 6, 2
11. 7, 4, 1, 2, 8, 6, 6
12. 2, 5, 9, 4, 5, 0, 3
13. 3, 1, 7, 6, 1, 0, 4, 2
14. 9, 2, 3, 2, 4, 3, 6, 6, 5
15. 2, 9, 4, 1, 6, 3, 9, 3, 0
16. 7, 3, 8, 2, 1, 9, 1, 7, 5

INSTRUCTIONS FOR SCORING.

Score the test in two ways.

For recall with correct sequencing

1. Give one point for each item if the digits are reproduced in the correct sequence. Possible score is 16.

For recall of single digits in each item.

2. Give one point for each individual digit remembered regardless of sequence. Possible score is 88.

## APPENDIX D

### TABLE D1: Raw Data - CCAT and ASB Scores

ENGLISH - MALE - LOW ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.3 | 32 | 34 | 66 | 33 | 22 | 49 | 7 | 65 | 7 | 95 | 18 |
| 10 | 29 | 12 | 44 | 33 | 21 | 60 | 6 | 67 | 7 | 103 | 22 |
| 9.3 | 40 | 38 | 63 | 24 | 19 | 65 | 8 | 75 | 8 | 105 | 24 |
| 9.7 | 57 | 37 | 53 | 24 | 24 | 69 | 8 | 74 | 9 | 108 | 22 |
| 9.6 | 51 | 41 | 65 | 36 | 21 | 64 | 9 | 64 | 7 | 105 | 21 |
| 9.5 | 62 | 44 | 64 | 33 | 20 | 63 | 6 | 70 | 7 | 101 | 24 |
| 9.3 | 41 | 31 | 54 | 12 | 22 | 68 | 7 | 71 | 10 | 105 | 21 |
| 10.1 | 49 | 34 | 53 | 34 | 21 | 54 | 7 | 60 | 6 | 102 | 28 |
| 9.2 | 48 | 20 | 46 | 26 | 18 | 39 | 4 | 69 | 7 | 95 | 29 |
| 9.5 | 43 | 20 | 15 | 34 | 22 | 54 | 4 | 50 | 4 | 106 | 21 |

ENGLISH - MALE - HIGH ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.7 | 64 | 42 | 72 | 35 | 22 | 82 | 10 | 74 | 10 | 106 | 25 |
| 9.8 | 65 | 47 | 69 | 36 | 22 | 62 | 5 | 74 | 10 | 102 | 25 |
| 9.6 | 51 | 37 | 54 | 36 | 23 | 83 | 11 | 81 | 12 | 104 | 24 |
| 9.4 | 77 | 44 | 69 | 34 | 23 | 60 | 7 | 68 | 7 | 105 | 27 |
| 9.7 | 50 | 44 | 66 | 36 | 21 | 68 | 9 | 74 | 11 | 106 | 24 |
| 9.3 | 75 | 41 | 68 | 34 | 23 | 76 | 8 | 73 | 9 | 105 | 21 |
| 10 | 72 | 42 | 60 | 33 | 24 | 73 | 10 | 79 | 12 | 108 | 24 |
| 9.3 | 74 | 35 | 60 | 36 | 24 | 74 | 8 | 80 | 9 | 105 | 19 |
| 9.6 | 66 | 54 | 61 | 36 | 23 | 73 | 9 | 67 | 7 | 109 | 27 |
| 9.9 | 65 | 44 | 68 | 32 | 25 | 76 | 9 | 80 | 10 | 108 | 22 |

NON-ENGLISH - MALE - LOW-ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.4 | 37 | 29 | 58 | 27 | 24 | 54 | 7 | 61 | 6 | 97 | 17 |
| 10.7 | 43 | 25 | 51 | 16 | 18 | 58 | 6 | 57 | 7 | 96 | 21 |
| 9.3 | 39 | 19 | 50 | 35 | 20 | 60 | 6 | 60 | 5 | 98 | 19 |
| 9.8 | 54 | 40 | 59 | 34 | 22 | 54 | 6 | 71 | 7 | 107 | 24 |
| 9.3 | 56 | 34 | 61 | 13 | 21 | 60 | 6 | 61 | 8 | 105 | 18 |
| 9.6 | 35 | 34 | 57 | 24 | 21 | 65 | 7 | 67 | 8 | 104 | 24 |
| 9.6 | 31 | 27 | 36 | 10 | 18 | 61 | 6 | 71 | 7 | 102 | 21 |
| 9.7 | 47 | 27 | 61 | 33 | 20 | 60 | 6 | 73 | 7 | 101 | 23 |
| 9.8 | 36 | 31 | 49 | 34 | 19 | 46 | 6 | 62 | 7 | 98 | 13 |
| 10.4 | 54 | 40 | 61 | 32 | 24 | 60 | 7 | 65 | 7 | 103 | 20 |

NON-ENGLISH - MALE - HIGH ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.8 | 60 | 33 | 67 | 35 | 22 | 63 | 7 | 78 | 7 | 106 | 24 |
| 9.5 | 62 | 32 | 47 | 35 | 23 | 64 | 7 | 71 | 8 | 109 | 22 |
| 9.3 | 57 | 36 | 61 | 35 | 21 | 78 | 8 | 70 | 7 | 106 | 22 |
| 9.9 | 61 | 20 | 45 | 35 | 21 | 62 | 7 | 77 | 7 | 99 | 20 |
| 9.3 | 31 | 41 | 45 | 33 | 23 | 63 | 7 | 71 | 8 | 95 | 24 |
| 9.7 | 59 | 38 | 68 | 36 | 22 | 62 | 6 | 65 | 8 | 105 | 25 |
| 9.6 | 66 | 31 | 69 | 36 | 24 | 67 | 8 | 69 | 8 | 107 | 25 |
| 9.7 | 48 | 45 | 62 | 30 | 24 | 82 | 13 | 88 | 16 | 106 | 22 |
| 9.2 | 59 | 52 | 72 | 33 | 22 | 78 | 10 | 79 | 11 | 108 | 23 |
| 10.3 | 67 | 32 | 60 | 35 | 24 | 78 | 10 | 79 | 11 | 106 | 26 |

ENGLISH - FEMALE - LOW ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.3 | 42 | 40 | 40 | 21 | 21 | 67 | 1 | 66 | 1 | 106 | 20 |
| 10.3 | 46 | 27 | 45 | 30 | 20 | 62 | 6 | 64 | 7 | 102 | 22 |
| 9.8 | 53 | 21 | 41 | 32 | 19 | 56 | 7 | 56 | 7 | 103 | 25 |
| 9.5 | 48 | 28 | 59 | 30 | 20 | 71 | 8 | 76 | 9 | 96 | 21 |
| 10.6 | 52 | 16 | 43 | 30 | 22 | 59 | 6 | 67 | 7 | 105 | 19 |
| 9.3 | 43 | 24 | 66 | 33 | 24 | 65 | 4 | 74 | 8 | 103 | 24 |
| 9.5 | 59 | 31 | 65 | 33 | 19 | 65 | 7 | 68 | 9 | 106 | 23 |
| 9.5 | 50 | 36 | 54 | 28 | 20 | 69 | 8 | 74 | 9 | 104 | 15 |
| 10 | 34 | 21 | 34 | 32 | 24 | 54 | 5 | 59 | 5 | 102 | 24 |
| 9.5 | 37 | 35 | 47 | 20 | 24 | 46 | 6 | 52 | 6 | 96 | 21 |

ENGLISH - FEMALE - HIGH ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.4 | 77 | 43 | 68 | 35 | 24 | 70 | 10 | 78 | 10 | 101 | 22 |
| 10 | 86 | 41 | 67 | 34 | 24 | 66 | 7 | 73 | 9 | 108 | 21 |
| 9.7 | 87 | 52 | 75 | 35 | 24 | 72 | 8 | 68 | 11 | 108 | 27 |
| 10.1 | 74 | 42 | 59 | 34 | 22 | 56 | 9 | 58 | 7 | 106 | 25 |
| 9.5 | 75 | 43 | 71 | 35 | 24 | 71 | 8 | 84 | 13 | 108 | 24 |
| 9.9 | 81 | 47 | 64 | 34 | 25 | 71 | 10 | 73 | 8 | 105 | 21 |
| 9.6 | 54 | 24 | 39 | 34 | 24 | 78 | 9 | 78 | 9 | 109 | 22 |
| 9.3 | 55 | 35 | 44 | 28 | 23 | 72 | 7 | 76 | 8 | 102 | 19 |
| 9.4 | 80 | 53 | 70 | 35 | 23 | 73 | 8 | 77 | 10 | 106 | 27 |
| 9.4 | 77 | 46 | 64 | 36 | 24 | 70 | 10 | 70 | 8 | 99 | 28 |

NON-ENGLISH - FEMALE - LOW ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.8 | 59 | 34 | 69 | 28 | 24 | 48 | 7 | 58 | 6 | 93 | 28 |
| 9.8 | 59 | 37 | 38 | 23 | 21 | 62 | 7 | 63 | 7 | 100 | 19 |
| 9.6 | 36 | 24 | 49 | 32 | 23 | 64 | 6 | 72 | 8 | 92 | 19 |
| 9.7 | 24 | 24 | 58 | 31 | 17 | 61 | 6 | 60 | 6 | 100 | 19 |
| 9.4 | 50 | 33 | 50 | 25 | 22 | 56 | 5 | 65 | 6 | 103 | 20 |
| 9.7 | 43 | 18 | 35 | 22 | 21 | 73 | 8 | 80 | 11 | 106 | 21 |
| 9.8 | 61 | 40 | 71 | 35 | 25 | 65 | 7 | 68 | 6 | 103 | 25 |
| 9.5 | 57 | 28 | 47 | 34 | 23 | 53 | 7 | 60 | 8 | 103 | 21 |
| 9.3 | 48 | 34 | 58 | 17 | 22 | 62 | 7 | 75 | 8 | 102 | 21 |
| 9.8 | 43 | 36 | 58 | 31 | 22 | 60 | 6 | 62 | 7 | 94 | 22 |

NON-ENGLISH - FEMALE - HIGH ACHIEVERS

| AGE | VERB | QUAN | NONV | STAN | MSDISC | MSLET | MSEQ | DIGITS | DSEQ | REC | CONT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.8 | 83 | 52 | 75 | 36 | 24 | 70 | 8 | 72 | 8 | 103 | 26 |
| 9.5 | 61 | 43 | 62 | 35 | 24 | 78 | 10 | 68 | 9 | 103 | 23 |
| 9.3 | 76 | 29 | 60 | 30 | 24 | 81 | 9 | 82 | 11 | 108 | 25 |
| 9.6 | 53 | 42 | 61 | 36 | 22 | 75 | 8 | 77 | 10 | 106 | 22 |
| 9.7 | 75 | 45 | 60 | 34 | 25 | 58 | 7 | 66 | 9 | 106 | 26 |
| 9.3 | 58 | 51 | 72 | 36 | 22 | 77 | 10 | 81 | 10 | 101 | 23 |
| 9.4 | 44 | 31 | 42 | 35 | 20 | 74 | 9 | 79 | 11 | 101 | 21 |
| 9.2 | 46 | 41 | 46 | 31 | 23 | 64 | 9 | 76 | 9 | 105 | 24 |
| 9.3 | 58 | 42 | 68 | 30 | 24 | 86 | 14 | 87 | 14 | 97 | 24 |
| 9.8 | 72 | 48 | 66 | 34 | 24 | 75 | 10 | 77 | 10 | 109 | 28 |

APPENDIX E

TABLE E1
Summary Statistics (ASB)

Cell and Marginal Means and Standard Deviations Independent Variables are Language and Achievement (High and Low). Dependent Variables are MSLETT, MSEQ, DIGITS, DSEQ.

MSLETT

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 71.3 | 6.68 | 59.95 | 8.53 | 65.62 |
| non-Eng. | 71.75 | 8.21 | 59.1 | 6.11 | 65.42 |
| Total | 71.52 | | 59.52 | | |

MSEQ

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 8.65 | 1.43 | 6.2 | 1.88 | 7.4 |
| non-Eng. | 8.85 | 2.03 | 6.4 | 0.69 | 7.65 |
| Total | 8.73 | | 6.33 | | |

DIGITS

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 74.25 | 6.00 | 66.05 | 7.52 | 70.15 |
| non-Eng. | 75.60 | 6.46 | 65.55 | 6.32 | 70.51 |
| Total | 74.92 | | 65.8 | | |

DSEQ

| | High | | Low | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Total |
| Eng. | 9.5 | 1.73 | 7.0 | 2.03 | 8.25 |
| non-Eng. | 9.6 | 2.33 | 7.1 | 1.25 | 8.35 |
| Total | 9.55 | | 7.05 | | |

## APPENDIX F

### TABLE F1
### Summary Statistics

Cell Means and Standard Deviations. Independent Variables are Language, Achievement (High and Low) and Sex. Dependent Variables are STAN, MSDISC, CONT, LDCOM, REC, VERB, NONV.

| | | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | English | | Non-English | | English | | Non-English | |
| | Variate | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Low | STAN | 28.9 | 7.4 | 25.8 | 9.6 | 28.9 | 4.7 | 27.8 | 5.9 |
| | MSDISC | 21.0 | 1.7 | 20.7 | 2.2 | 21.3 | 2.1 | 22.0 | 2.1 |
| | CONT | 23.0 | 3.4 | 20.0 | 3.4 | 21.4 | 2.9 | 21.5 | 2.9 |
| | LDCOM | -0.55 | 0.72 | -0.69 | 0.3 | -0.64 | 0.76 | -0.49 | 0.59 |
| | REC | 102.5 | 4.4 | 101.1 | 3.7 | 102.3 | 3.6 | 99.6 | 4.9 |
| | VERB | 45.2 | 10.3 | 43.2 | 9.0 | 46.4 | 7.6 | 48.0 | 11.8 |
| | NONV | 52.3 | 15.3 | 54.3 | 8.0 | 49.4 | 11.0 | 53.3 | 11.8 |
| High | STAN | 34.8 | 1.5 | 34.3 | 1.8 | 34.0 | 2.2 | 33.7 | 2.5 |
| | MSDISC | 23.0 | 1.2 | 22.6 | 1.2 | 21.8 | 6.3 | 23.2 | 1.5 |
| | CONT | 23.8 | 2.5 | 23.3 | 1.8 | 23.6 | 3.1 | 24.2 | 2.1 |
| | LDCOM | 0.63 | 0.63 | 0.43 | 0.94 | 0.46 | 0.48 | 0.85 | 0.24 |
| | REC | 105.8 | 2.1 | 104.7 | 4.8 | 105.2 | 3.4 | 103.9 | 3.6 |
| | VERB | 65.6 | 9.12 | 57.0 | 10.5 | 74.6 | 11.4 | 62.6 | 13.3 |
| | NONV | 64.7 | 5.6 | 59.6 | 10.3 | 62.1 | 11.8 | 61.2 | 10.4 |