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PATTERNS OF COGNITIVE ABILITIES OF HIGH AND LOW ACHIEVING SCHOOL CHILDREN

by

© LARRY WILLIAM KRYWANIUK

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Patterns of Cognitive Abilities of High and Low Achieving School Children" submitted by Larry William Krywaniuk in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

The present study is concerned with the relationship of achievment and cognitive abilities. The purpose of this study was to examine the appropriateness of the Successive-Simultaneous processing model in analysing cognitive strategies, and to design a remedial program based on this model. Specifically, low and high achieving grade 3 children from Edmonton and low achieving native children from the Ermineskin School, Hobbema at the grade 3 level were chosen.

A battery of tests including cognitive measures and standardized intelligence tests was administered. Scores from standardized achievement tests were obtained from school records. These scores were compared by analysis of variance and by factor analysis. A remedial program was designed and presented to the Hobbema children.

The results show that low achieving children have lower Verbal than Performance IQ scores. This was taken to suggest poor verbal abilities in these children. High achieving children appear to have high abilities in a wide range of tasks. It appeared that low achievment was related not only to a lower intelligence but also to a different pattern of skills. This pattern could be successfully interpreted by means of the Successive-Simultaneous processing model. Low achieving children were shown to be deficient in verbal-successive strategies.

The comparisons between the low achieving Edmonton and Hobbema children demonstrated that the Hobbema children had a further deficiency in verbal abilities which was related to a difference in cultures. This was in addition to the verbal-successive difficulties both groups

shared. These two groups were shown to have some strengths in nonverbal abilities that were not taken advantage of by the academic process.

By means of the remedial program administered to the Hobbema children it was shown that the magnitude of the verbal-successive deficiencies could be reduced. The group of children receiving maximum teaching showed significant gains in visual and auditory memory and in word reading ability when compared to the group receiving minimum intervention. At posttest, the Hobbema children were shown to have more appropriate strategies, and were more similar to other low achieving children.

An analysis of the WISC profiles supported the interpretation that achievement was based on verbal abilities. Comparisons of factor structures for the groups in this study and another group of 10 year old children were made. They revealed that high achieving children were superior to an average group primarily in reasoning abilities and that low achieving children were inferior in understanding word meanings.

Investigating the relationship between achievement, intelligence and cognitive skills, it was found that low achieving Edmonton children were operating in terms of pre-reading and preconceptual skills. This was interpreted to mean that their poor verbal-successive skills limited their reading skills and conceptual abilities. High achieving children were shown to have successive and simultaneous strategies that are relatively independent of each other. For this reason they were able to match them more appropriately to the demands of the task.

The question of teaching specific skills vs. teaching general cognitive strategies was discussed. The latter was chosen because it required less time and it fostered more independence in attitudes toward learning. The intervention program based on the teaching of cognitive strategies was shown to be easily adaptable to classroom use.

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CHAPTER I

INTRODUCTION

Cole and Bruner (1972) have offered some valuable insights into research, particularly that which is of a comparative nature. They analyze the distinction between capacity and performance, and conclude that erroneous conceptions of capacity often arise; a consequence of "culture-blind" inferences made from performance. In their model, cultural deprivation becomes a special case of cultural difference. This has two main implications for education. First the recognition that educational difficulties may result from a difference rather than an "intellectual disease" should raise the status of the student in the eyes of the teacher, and second that the teacher should focus on getting the child to transfer skills rather than on teaching new ones.

The theoretical position stated above by Cole and Bruner provide an orientation toward program development. However, this position does present problems of a practical and ultimately theoretical nature. Their assumption is that the (presumably) low achieving child in one cultural setting has equal abilities to others in a different setting, and that a knowledge of the relative strengths of the various children in these groups exists.

In addressing these points, Jensen (1968, 1969, 1970) argues that the abilities of various culturally deprived groups and cultural minorities are not necessarily equal to the abilities of the cultural mainstream. The two levels of ability, Level I which is associative learning and Level II which is reasoning are disparately distributed.

Level I abilities, he feels, are normally distributed throughout the total population but Level II abilities are differentially distributed with a bias toward the more advantaged groups. This results from the assortive mating within groups, which is the tendency for people to marry within their intellectual and socio-economic levels. The proposition put forth by Jensen must be seriously considered.

In investigating Jensen's model, Das (1972) failed to find the hypothesized ability levels. Instead using a principal factor analysis he isolated two components which he termed Successive and Simultaneous processing. In considering the nature of the task requirements, the simultaneous-successive distinction proposed by Luria (1966a, 1966b) seemed to be more appropriate in describing the processes. At a later point, Das (1973a, 1973b) isolated a factor which was named Speed.

The present study attempts to examine high and low achievement in terms of basic cognitive processes such as simultaneous and successive integration. Antecedents of low achievement are also considered in order to determine whether these are similar for Caucasian and Canadian native children. In addition to these, an intervention program which is based on the theoretical model of cognitive processes is designed and tried out on the native children. The efficacy of the intervention program is later tested.

CHAPTER II

REVIEW OF THE LITERATURE

Intelligence and the environment

Usually, it is assumed that cognitive, perceptual and motor skills are acquired through "normal" processes of maturation. One of the unfortunate conclusions from this is that age or maturation is considered to be more important to learning than experience. Even where early childhood learning has been explored, the largest number of studies have been cross-sectional rather than longitudinal. IQ, for example, correlates with multiplicity of environmental indices. However, "few studies of any kind in the IQ area have been designed with the precision necessary to illuminate these relationships" (Fowler, 1962, p. 125)." In addition, because most IQ tests are verbal, they tend to miss improvements in motor and non-verbal activities due to early stimulation. As a consequence, we know very little of the cognitive patterns of the preschool child (p. 127).

Undoubtedly, one of the most important variables in early school learning are the prevalent learning processes, as well as the underlying emotional and personal attitudes. Fowler believes that most nursery school programs have been broad and uncertain in meaning and have rarely concentrated on the verbal aspect, so important in most IQ measures. This, unfortunately, is true even in the studies with a definite cognitive orientation. The rationale for most IQ tests is an undefined entity, encompassing both verbal and non-verbal tasks "neither logically related, nor organized into <u>types</u> of abilities (p. 127)". Consequently th-re is little known about the patterns of ability of preschool children. The IQ and nature-nurture controversy have obscured the fact that environment plays an essential role in development, however important the genetic aspects may be. "This dispute has seriously retarded interest in experimental work on preschool cognitive learning (Fowler, p. 128)". It is now generally agreed that the environment plays some role in development and thus it is the job of the psychologist to discover how to best use the contributions of the environment.

McDonald and Soeffling (1971) recognize that learning problems are not necessarily the child's response to the stimulus of the academic world but, in fact, to many variables such as early linguistic and physical environments and even family dynamics. Thus, intellectual style, they feel, may be patterned by a child's exposure to the cognitive and linguistic styles of the parents. In addition, learning problems may not be associated with any single factor--birth history, nutrition, environment, school entrance or heredity--but with a combination of some or all of these factors.

Schooling, too, emerges as a factor, especially Western-type schooling with materials rich in symbolic representation (Price-Williams, 1961; Bruner, 1971). Even when cognitive development has been assessed, mainly through conservation and identity problems, the underlying cognitive processes have not been closely examined. Schooling and urbanization tend to foster abstraction and the perception of wholes. In addition, other environmental variables such as exposure to art, music, varied stimuli and perhaps symbolic or graphic representation affect the development of cognitive abilities.

The relationship of cognition to cultural variables is not easily seen. We must note that the variables are not easy to isolate (Goulet, 1968). Language, for instance, is closely tied to culture, and may be inseparable from thinking (Bruner et al., 1966; Bruner, 1971). The multiplicity of variables compounds the problem and makes in-depth research extremely complicated. Breaking down intelligence into major patterns of abilities is one way of tackling this complex problem.

Patterns of Ability

Lesser, Fifer and Clark (1965) studied patterns of cognitive functioning among Negro, Chinese, Jewish and Puerto Rican children in New York City. They found significant differences in patterns of ability across these groups. Chinese children were high in number, spatial reasoning, but were low on verbal scales while Puerto Rican children were highest on space and number, but were low on reasoning and verbal. Jewish children were highest on verbal and number abilities, but low on space and reasoning and Negro children were high on verbal and reasoning scales, but low on space and number. Lesser, Fifer, and Clark concluded: "There seems little doubt that different emphases among ethnic groups in specified intellectual functions that are stimulated and encouraged are reflected in their different organizations of mental abilities (p. 78)". Status effects occurred in all groups, but the patterns remained the same, with the middle class being high. Very often, however, ethnicity is confounded with status and thus the effects are not clear.

The study demonstrates differing patterns of abilities among subcultures and suggests that the environment is a major determiner of cognitive functioning, if not necessarily in ability, at least in organization.

Cultural differences are not always accepted as the major determinants of differences in abilities.

Jensen (1969) believes that the number of people who are considered as culturally disadvantaged is generally overestimated by researchers using the cultural difference model. Most of the individuals with below average IQ are simply where they belong on the normal distribution curve. There is, however, a restricted number of people who are genuinely depressed in cognitive functioning as a result of environmental inadequacy. In support, Jensen suggests that 80 percent of the variation in intelligence scores can be accounted for by heredity with only 20 percent attributed to the effects of the environment.

This is consistent with Bloom's (1964) conclusion that most of the variation in IQ scores is accounted for before the school years. Das (1973a) indicates, however, that the geneticist would concede that the IQ of a child is also predictable from the IQ of his parents, and that Bloom's findings simply reaffirm the course of normal development.

In his model, Jensen postulates two levels of intellectual functioning, Level I (memory) and Level II (reasoning). Level I abilities are evenly distributed between sub-groups within the culture, but Level II abilities are not. Abstract reasoning abilities are higher in more advantaged groups.

In considering only those who are genuinely "environmentally depressed" Jensen attributes the variation in performance to the environment rather than to the culture. As a result, Jensen feels that wholesale intervention programs are of little value as they will not help a majority of the people involved in them.

Jensen's arguments represent an alternative to the environmentalist position, and can be seen in the broader context of the nature-nurture issue. At this point, the only conclusion that can be drawn is that patterns of abilities do exist between different groups of people but that it is not possible at the moment to decide what proportion of this difference may be attributed to heredity and the environment.

Cultural Deprivation

What is the relative contribution of the cultural milieu to intellectual abilities? Investigations into cultural deprivation can be seen as a logical development of the "nature-nurture" considerations mentioned above. Its scope includes a broad range, from Jensen's (1969) differential distribution of Level II intelligence to Zigler's (Butterfield & Zigler, 1965) linking of social reinforcement and cultural deprivation in mental retardation studies. The concept of cultural deprivation is too broad to be treated here in its entirety, but there are significant elements that should be noted, particularly in its relationship to early childhood education. The precise issue can take the form of several questions: Does cultural deprivation exist and, if so, what forms does it take? What are the effects, if any? and can the effects be removed.

Seen in the broader scope of socio-cultural variation, cultural deprivation is part of three basic issues: the heredity-environment controversy, the characterization and nature of development and the question of the structure of the intellect (Uzgiris, 1970, p. 8).

Presumably all these issues are involved in an analysis of cultural deprivation, but not always have they had the benefit of investigation guided by theory. Theoretical assumptions have been made but have not always been made explicit, and the results remain unco-ordinated and unintegrated.

Cultural deprivation can be defined as the reduction of opportunity for learning, experience a expression as a result of inadequacies or interferences stemming from the attitudes, modes of behaving and thinking and/or the physical and cultural surroundings. The variables assumed to be associated with cultural deprivation or disadvantage have been well documented.

Cole and Bruner (1971) suggest that the "deficit" hypothesis associated with ethnic and social class differences is based on the assumption that the community of the poor is disorganized and that this disorganization expresses itself as a deficit. The main source of this deficit as presented in the literature has been the inadequacy of child rearing practices followed by the mothers. It has also been associated with the absence of fathers and the resulting lack of a father model. Some other associated factors are the lack of guidance in goal seeking and lower positive and higher negative reinforcement. Specifically these factors have been held to be important for the symbolic and linguistic environments of the child. The lower class child has a restricted code in his linguistic expression, shows stereotyped interactions and plays strategy-less games. His home provides less figure-ground differentiation because of high noise levels and also provides uncertainty surrounding delayed and verbal reinforcement.

Cole and Bruner (1971) and Baratz and Baratz (1970) both reject the deficit hypothesis and argue for the acceptance of the cultural difference model. Baratz and Baratz feel the acceptance of the defect model has led to an institutionalized form of racism, as the remedial programs are designed to provide differential treatment to ameliorate deficits that do not exist. Head Start, in particular, falls into this category as it provides a blanket form of "cultural improvement" program, when in reality the culture is perfectly adequate and is only seen deficient in comparison to middle-class norms. The fundamental operating principle has been that the disadvantaged or "poor" (Das, 1973a; Jensen, 1970) suffer from a linguistic deficit (Hunt, 1970). Labov (1970) eloquently denies this conception on the principles of naturally developing language.

Baratz and Baratz (1970) believe that linguistic styles are only inferior when compared to middle-class norms in specific situations such as the school system. The failure to learn, then, results from the teacher's inability to adapt to the different cognitive styles of the sub-population. The differences are seen to arise in response to different but adequate cultural patterns and beliefs. Only when differences, and not defects, are found can accurate intervention occur. To illustrate this point, Cheney (1967) suggests that the so-called "culturally deprived" children have positive skills that others do not have. Lack of sports equipment, for instance, forces children to invent many variations on the same game. While watching a group of disadvantaged children at play, he counted as many as seventeen different games being played with a ball and bat. This ability to extemporize, among others, is seen as a positive skill not necessarily possessed by more advantaged children.

These strengths, however do not necessarily compensate for inadequate intellectual performance. Gray and Klaus (1965) find that the disadvantaged children have comparatively inferior performance on standardized tests of intelligence. The differences in intellectual performance often become "functional deficits" (Das, 1973a; Cole & Bruner, 1972) irrespective of cultural or linguistic adequacy. Disadvantaged children receive verbal commands to control their behavior less frequently at home than other children (Gray & Klaus, 1965) and thus act more impulsively and without regard to consequences (Hess & Shipman, 1965).

Luria (1961, 1963) has shown that speech plays an increasingly important role in the regulation of behavior as the child gets older. Verbal mediation is aquired through the socialization process and is therefore dependent upon the child's experience.

Most of the conclusions about the effects of cultural deprivation have been based on the study of American blacks, particularily in the urban ghetto. They do, however, apply equally well to the North American Indians.

North American Indians

Much of the concern with the education of native people in Canada has been devoted to the social and linguistic aspects of the schooling process. The recently completed Report of the Task Force on Intercultural Education (1972) summarized much of the literature in Canada on these topics, and divided the concerns with native education into five general areas: curriculum, parental involvement, culture, language competency and teacher training. The categories also reflect the opinions of parental groups, teachers and others concerned with the education of native people.

The Report, however, does not focus on the learning needs of the child. Instead it makes recommendations primarily in the area of curricular development and community involvement. There still exist a general lack of information regarding practical teaching approaches based on a sound theoretical framework.

In a monumental study guided by Havighurst (1970), the U.S. Bureau of Indian Affairs sought to investigate the education of the Indian people in the United States of America. It examines the multiplicity of variables found in learning and delineates some of the issues common to all aspects of societal living.

Do the Indians suffer the same cognitive defects as do children in urban slums? Cazden and John (1968) state that Indian children from 1 to 4 years show normal development, but show consistently lower gains in language achievement and because of this, "language remains an aspect of behavior burdened with cultural conflict (p. 2)". Although their findings support the general picture of better non-verbal than verbal abilities, they suggest that standardized tests do not necessarily have the same meaning for all groups. The scores from intercultural comparisons have meaning only when contrasted with the idealized standard of American behavior (Baratz & Baratz, 1970). This is a result of the misapplication of the principles of egalitarianism: sameness becomes equated with equality.

Lenneberg and Roberts (1956), Carroll and Casagrande (1958) and Suci (1960) indicate that differences in languages do affect cognitive behavior in limited ways but this does not necessarily imply a cognitive liability. However, as Cazden and John (1968) indicate, there are more subtle variables at play;

> Although there is no evidence to support the assumption that one language is superior to another as a tool of cognition, if the Indian child has not had the chance to develop his mother tongue before he is taught English, he may find himself in the position of the compound bilingual . . . who rely on both languages and show the poorest performance. The psychological effects of compound bilingualism may be particularly critical in the period of 5-7 years when the role of language in cognition is just being established (pp. 7-8).

Language is not the only source of variation in cognitive performance. Brophy and Aberle (1966) suggest three sources of conflict in values: the concept of time, the disposition to conform to nature rather than dominate it, and social withdrawal in school. The effects are that absenteeism is high and scheduling difficult. Lack of conformism can be interpreted as lack of motivation, as can be the lack of a work ethic and the necessary gratification of delay. These variables have also been isolated in the Report of The Task Force mentioned earlier.

In much of the literature on Indians, it has been suggested that their style of learning is mainly visual--learning by looking rather than learning through language. These children typically do their poorest work in reading vocabulary:

> The children of Indian tribes which have kept close touch with the world of nature and with their indigenous cultures are specially stimulated to observe accurately, to organize their observations and express them aesthetically . . . White children, and urban white children especially, may have much less chance to form

> concepts from firsthand observation, but must rely upon books and words. (Havighurst, Gunther & Pratt, 1946, p. 61).

The dominance of imitation is a commonly accepted characteristic of education in non-literate societies. In primitive cultures a great deal more of the tot.. culture may be available directly through the sensory facility th n in the white society, where much less adult behavior is understandable through direct observation and therefore is less appropriate to the play needs of the child.

The contact of cultures may play an important role in determining the direction children's growth may take. In the schools, the Native children learn "the ways of the white man", while at home they learn the ways of their people. This duality must have serious impact on the learning styles of these children (Cazden & John, 1968).

Rohner (1965) points this duality out very clearly:

> A fundamental difference lies in the method of learning. This difference creates an important discontinuity in the enculturation process of the children. Kwakuitl children typically learn by observation, manipulation and experimentation in their native setting, but they must learn by verbal instruction, reading and writing in the classroom (pp. 33-34).

Traditionally, Indians have not done as well as white children in schools, and this was shown to be related to the use of English in the home. Indians also fell farther and farther behind as they progressed through school. We now recognize this to be a phenomenon associated with the environmentally or socially disadvantaged child (Coombs, 1968). However, language may not be the only factor in achievement. Coleman (1966) suggests that beliefs about control over the environment and self-concept are also closely related to school performance.

This multiplicity of variables suggested does not simplify research in this area. Havighurst (1970), however, points out that there has been very little work done on the performance patterns among Indians, although this work is desparately needed and, in fact, has been done with other ethnic groups. "Also, learning theory so far has been mainly concerned with general theories of learning that are not culturally conditioned and has concentrated more on similarities than differences in individual and group behavior (p. 24)".

There is evidence to indicate that on non-verbal performance tests Indian children have the same average scores and range as white children (Havighurst, 1957); however, on other tests they fall progressively behind as they progress up the school ladder. Language alone is not responsible for this deficit. The deficit is more likely in the styles of learning employed (Havighurst, 1970, p. 25).

In conclusion the conference (Havighurst, 1970) ". . . recommends that a comprehensive research project be instituted to study the styles of learning employed by American Indian groups in their everyday lives; to investigate the effects of such styles on school achievement of Indian children; and to explore how education can be designed to take full advantage of these styles (p. 25 [their emphasis])."

Summary

In summary, we can note the plea made by Cazden and John (1968):

> We join those who seek a kind of education that will provide actual preparation for every Indian child in what we hope will be an increasingly pluralistic society. His education should equip the young Indian with the minimum of skills necessary for urban society, if he chooses to participate in it. And it must do this without neglecting

his growth within his traditional society, thus freeing him for the other choice of developing Indian life among Indians.

Variables in Cognition

In investigating the differences in achievement between individuals, one must first isolate the variables involved in learning. The contributions of heredity and environment have already been considered, but it is also necessary to investigate the specific intrapersonal abilities involved, as they are the means by which external events are translated into internal experience. Two of these basic units of cognition are the auditory and visual processes.

Auditory and visual processes are the individual's main methods of gathering information about the environment. The school setting with its emphasis on reading and language places a great deal of emphasis on gaining information through vision and hearing. Often, they become a source of difficulty in the learning processes of the child.

In investigating the relationship between auditory and visual perception to reading, Birch and Belmont (1965) found that initial reading ability reflects the developmental level of these skills while more general intellectual and cognitive factors influence the elaboration of reading skills. If the cognitive styles and needs for reading are not compatible, Birch and Belmont feel that an assisting of reading progress can be anticipated, perhaps at the grade 3 level.

The information from both modalities must be integrated at some point before reading can occur. Raab, Deutsch and Friedman (1960) and Birch and Belmont (1964, 1965) have used cross-modal coding, and found poor readers to be poor in auditory-visual integration. Reilly (1971) also found differences between grade levels, in auditory-visual integration and concluded that it is related to reading achievement but that it is more closely related to comprehension scores than to vocabulary scores.

Dornbush and Basow (1970) used digits in a bisensory memory task to study the relation between visual and auditory performance. They found little difference in the performance of good and poor readers; however, they do report difference in functioning of the two modalities--visual memory decreases with rate of presentation, while auditory memory increases. As an explanation, they offer several points: ". . . it is likely that Ss have to transpose information from the visual into an aurally based storage, which may serve to retard visual recall, particularly at the fast rate (pp. 1041-1042)". Also: ". . . the sequential nature of the present task may be modality specific. That is, the sequential or successive method of presentation is more practical for auditory stimuli than for visual which can be handled either sequentially or simultaneously (p. 1042)". Crowder (1966) was also found that visual recall is superior with a simultaneous method of stimulus processing.

Dornbush and Basow (1970) conclude that it is likely the tasks used tapped not just short-term memory capacity, but also the ability to grasp and to use effective coding strategies where necessary. Neufeld (1966) suggests these capacity increases with age.

Perhaps the younger children do not initially operate in terms of storage but simply deal with each stimulus as it arises. It is only later that they acquire the ability to store information for further processing. These children may not be prone to a high degree of spontaneous organization in free recall (Tulving, 1962) but may be able to organize information with prompting (Jensen & Rohwer, 1965).

In a study of language-delayed children, Holloway (1971) found a significantly poorer performance in understanding distorted (filtered) speech in these children as compared to matched normals, suggesting poorer auditory perception. He also found differences in auditory-visual integration. One conclusion is that auditory-visual integration is associated with a delay in language learning. The capacity of the individual to assimilate and organize multimodal information probably underlies man's ability to modify his behavior generally (Holloway 1971).

Jensen (1971) remarks that there has been little effort to compare visual and auditory memory, in spite of some current beliefs about the subject. In an experiment with undergraduates, he studied digits presented bisensorally. He expected this research to answer two important questions: "Do people in general learn or remember more effectively when the material is presented visually or aurally?" and "Do some individuals favor one sensory modality over another in learning and rembering? (p. 123)."

Interestingly, Jensen found that auditory memory was superior in immediate recall, but that visual was superior in the delayed condition (10 sec.). The first finding is consistent with other studies reported. To explain the second condition Jensen recalls Sperling's (1963) hypothesis that a primary function of verbal rehearsal in memory is to code visual material into auditory storage. Jensen feels this coding also strengthens the memory trace, and transforming the visual digits to auditory ones is less subject to retroactive interference than in the straight visual memory process.

Jensen (1971) concludes: "The fact that there are no significant individual differences as a function of sensory modality would seem consistent with the hypothesis that the stimuli, regardless of sensory channel, are encoded in a single auditory short-term system . . . This can be thought of as a kind of mediation process (p. 130)". One should be careful in making a sweeping generalization, however, as the population used was college students and these may have been well selected for verbal encoding ability by the educational process. The auditory and visual processes provide a basis for information gathering and eventually for conceptual and abstract thinking. These processes may also be involved at a higher level in the form of imagery.

Ninety years ago, Francis Galton (1883) concluded that vivid mental imagery could interfere with the formation of abstract thinking, especially verbal thinking. Aldous Huxley, too, considered himself a "low imager" and accounted for his abstract thinking in this way (1967). Hollenberg (1970) investigated the possibility that vivid mental imagery facilitates labeling but interferes with concept formation because the person finds it difficult to shift away from the obvious perceptual attributes of the object. Conversely, low imagers do not suffer from this interference and often find it easier to concentrate on underlying functional relationships. These functional relationships are necessary in elaborating categories into concepts. Generalization cannot just be on the primary stimulus values: "The results of this investigation point clearly to a contrast in the style of learning between children with a strong tendency to think in visual images and children who are weak in imagery (Hollenberg, 1970, p. 1013)".

She found that low-imagery children apparently had difficulty in forming initial categories, but once the categories were grasped, they formed an efficient mechanism for recall. High-imagery children, although they learned verbal labels more easily, did not groups as efficiently, and thus showed lower recall performance and categorization.

Paivio (1969) uses imagery to explain the finding that concrete pairs are more easily learned than abstract pairs, in paired-associate learning. He suggests compound imaging, the super-positioning of two images, as being the operating mechanism. These results are not entirely consistent with Hollenberg's findings, in that she used nonsense syllables with known low-image evoking potential. Hollenberg also found the difference between high- and low-imagery children is most marked in the lower grades, with each group probably forming compensating strategies to cope with the inadequacies of either approach.

Memory Strategies

Belmont and Butterfield (1969) suggest that very little is known on how encoding, rehearsal and decoding strategies are used in short-term memory, how such strategies develop, and whether age-related differences in these strategies are qualitative or quantitative. However, Keppel (1964) has indicated that the same variables affect free recall in children as in adults.

Most tachistoscopically oriented studies of STM control for scanning, but evidence presented by Vurpillot (1968) and Zinchenko and Ruzskaya (1965) suggest scanning strategies change with age. Haith et al. (1970) suggest that 5-year-old children have a strikingly limited ability to report items under STM conditions. These were not attributable to scanning strategies, as exposure times were very small (150 msec.). Possibly the children were reporting from a visual memory, whereas adults recoded the information and were reporting from a verbal memory. This would suggest children had an inferior coding strategy to adults and thus were limited in the number of items coded. In support, Bernbach (1967) suggested that labeling enhanced memory and that adults automatically label, while children must be directed to do so.

Haith et al. (1970) did conclude that children had some means of encoding and organizing the data, but the conclusion was made mainly from anecdotal evidence. The inefficiency of the children's strategies was most often seen in the lack of consistent field scanning tendencies when a larger number of items were presented. It seemed the capacity was overloaded, destroying any stimulus-organizing effort. Children may not be able to circumvent these interfering stimuli by the use of mnemonic aides (Goulet, 1968).

Miller (Scientific American Offprint 419) discusses coding and its relationship to memory. He concludes that organization aids memory. The main process in organization is meaningfulness, although this seems to involve several levels. The lowest is reduction (substituting 1, 2, 3 for 001, 010 or 011) and next is ideation (substituting a label for a concept). This demonstrates the conscious effort a person must make to develop efficient memory strategies. Inefficient strategy limits memory and this in turn limits the productivity of intelligence. Miller suggests there is a limited number of factors a person can hold in his awareness at any one time, but he can increase his capacity by increasing the density of these factors using the above-mentioned memory devices. He calls this process "chunking".

Morin, Horning and Konick (1970) have investigated Miller's ideas in an experiment with young children. The focus of the study was a "keeping-trade" task; that is, remembering the states of several variables, e.g., that a dog was the last animal seen, or that a dress was the last clothing. They noticed that children tended to search the variable for state rather than referencing the exposure set itself (the set to be remembered) and adults tended to focus on the exposure set. A possible explanation was that adults were dependent on rehearsal for memory. They also found fewer errors when the sets were presented aurally rather than visually. This is in agreement with Jensen's (1971) finding for immediate as opposed to delayed recall.

Recent other studies (Kingsley & Hagen, 1969; Flavell, Beach & Chinsky, 1966) also have found that children use less spontaneous rehearsal. Rehearsal would tend to focus attention on the stimuli presented, whereas non-rehearsal does not tend to limit the alternatives and thus probably includes the state or class of the variables as well.

As Goulet (1968) documents, there has been very little research into the verbal learning processes, of children. The studies done have either dealt primarily with adults or have been of a descriptive nature. He cautions us that functionally it is practically impossible to separate maturational and experiental variables in verbal processes themselves depend both on maturation and the cultural surroundings. This can be circumvented somewhat by giving massed experience to children while holding age constant. The comparisons with age-controls can be used to estimate the effects of maturational processes and, of course, training effects.

It seems evident that verbal ability, especially verbal encoding and verbal memory, is a useful strategy--one demanded by our school system perhaps to the exclusion of others. It has been suggested that some relationship between auditory and visual memory exists. The main conclusion drawn has been that visual stimuli are coded into aural based storage. In this way, the visual stimuli are reinforced, or strengthened, and are less subject to decay.

Two possibilities exist for the nature of this coding. The first is that visual and auditory stimuli are integrated automatically through neural connections, and the second is that there is "mediation" involved.

Some physiological studies suggest the first alternative. Gordon (1972), in a study of cats' perception, demonstrated that certain cells in the superior colliculus of the brain can be triggered by visual, auditory <u>or</u> haptic stimuli. However, psychologically speaking, the system of mediation first suggested by Pavlov and continued by Luria seems the more useful, even though the two systems are not necessarily mutually exclusive. The results of studies suggesting verbal encoding are generally consistent with Luria's conceptualization.

An important point to note is the difference in the abilities of adults and children. It seems adults acquire the ability to use coding strategies alone with rehearsal in memory. This suggests that the cross-modal coding abilities are either learned or develop later than visual or auditory abilities. However, in either case, organization of stimuli seems to be the key concept. Calfee (1970, p. 150) suggests in his study with retardates and non-retardates that visual memory may involve more than just STM. He found that using colored animal pictures retardates performed as well as non-retardates on short-term memory, whereas on more abstract data they generally perform more poorly. He suggests poor organization or encoding as possible factors. Additional information suggested this was the case, as in an experiment in which data were organized a priori retardates were less able to benefit. Organization seems to play an increasingly important role in memory with age and this . . . "Suggests that the poor performance generally characteristic of retardates results not from reduced capacity in short-term or long-term memory, nor from a faster rate of loss of information in either system, but rather from an impaired ability to transfer information between these memory systems (p. 160)".

There has been a suggestion (Birch, 1962) that organisms differ in the hierarchical structure in which the senses are organized; different animals have different preferred senses. Bruner (Bruner, Olver & Greenfield, 1966) has extended this concept to humans and to individuals in his discussion of hierarchical thought structures. He considers the enactive, ikonic and symbolic modes of information processes to be hierarchically organized in response to maturational demands. The importance of this discussion is in the necessity to consider changes in the methods of information processing due to either maturation and/or learning. Individual inabilities or delays in switching strategies can lead to learning problems. Some supportive evidence is added by Bakker (1967) in his work with reading disabled children. Klausmeier and Meinke (1968), too, feel that individuals tend to process information according to some systematic plan and that performance is facilitated when a strategy is provided.

The main thrust of the evidence presented thus far has been to illuminate the relationship between auditory and visual abilities. The existence or non-existence of separate short-term memories has not been determined; however, certain trends do emerge. It seems clear that the encoding of visual memory into an auditory signal does improve memory and that encoding of auditory signals does also occur, but is not as efficient. Thus, it has been shown that auditory and visual STM are at least functionally related.

It has been demonstrated that young children do not spontaneously organize or encode the stimulus information as adults do and consequently have less efficient memories. This strongly suggests that these strategies are learned through a conscious effort and, further, that they can be manipulated as variables. This has a tremendous importance for studies involving remediation. Birch and Belmont (1964) conclude: "It is clear that we have but begun to explore the universe of conditions for learning and performance which will facilitate most effectively the expression of the potentialities for adaptation which exist in mentally subnormal children (p. 742)".

These comments set the stage for much of wh is to follow in future years. Although basic and descriptive research is still necessary, the second stage of research is manipulation. Not only should the variables be investigated in response to pressure or practice, but an increasing effort should be made to remediate both the conditions related to deficits and inefficiences, as well as the deficits or inefficiencies themselves.

Studies Involving Remediation

Before Head Start there were very few programs dealing with the disadvantaged or culturally different and even fewer curriculum models designed to remediate specific deficits. It was devastating to find that Head Start had done little to prevent scholastic failure in the early grades (Spicker, 1971, p. 629).

There have been at least three major models in recent years (Spicker, 1971, p. 629) dealing generally with remediation. The first attempts to improve aptitudes for, and attitudes towards scholastic learning by improving language, memory, problem solving, concept formation, comprehension and discrimination learning abilities. This type is typified by the approach of Klaus and Gray (1968). Secondly, the Montessori (1964) method exemplifies the perceptual-motor development model, which emphasizes visual discrimination and visual-motor integration. Thirdly, the Bereiter-Engelmann (1966) curriculum illustrates the academic skills development model. This approach emphasizes ineffective teaching as the key failure in dealing with the disadvantaged.

In his analysis, Spicker (1971) concludes curriculum models stressing cognitive or achievement skills produced the highest IQ gains, although other curricula can produce change under certain conditions. Further, he concludes that early programs for the culturally disadvantaged must improve fine motor, memory and general language abilities where they are inadequate if these children are to succeed in the academic setting. He finds, however, that most children have adequate motor and memory skills and, for this reason, programs emphasizing these areas are not effective as general procedures.

Several different issues are involved in the concept of remediation. Firstly, the belief that cognitive strategies and processes can be changed is implicit to the concept of remediation, as it results from the belief that cognitive processes are learned rather than inherited. Although this argument is not clearly resolved, the disagreement is not mainly one of extent of environmental influence rather than its actual existence (Hunt, 1970). One may assume, then, that cognitive strategies can be taught. It remains to be demonstrated under what circumstances and to what extent the changes will take place.

Closely associated with remediation is the issue involving possession of certain concepts and their availability for use. Many of the earlier studies were done using animals as subjects and many unfortunate and erroneous conclusions were drawn about the possession of abilities (Bortner & Birch, 1970). Capacity for behavior was equated with performance. It was later shown that the inferred capacity was actually a function of the elicitory nature of the experimental materials and that when the nature of the task was changed, a different and greater capacity was inferred (Bortner & Birch, 1970). The danger results not from the inference, but from the use to which the inference has been put. Similar findings as to capacity and performance in the study of children have been noted by Bortner and Birch.

Pathology and remediation

If one were to take a pathological approach to learning problems, one would be searching for possible correlates within the brain. This can only be done to a limited extent: those cases in which there is known brain damage and those cases in which animals are used. The latter has the problem of generalization in that findings derived from animal studies may not apply to humans. The former has been studied by Luria (1966a, 1966b), among others, who had described a general processing theory based on these findings. Generally, however, the analysis, synthesis, storage and manipulation of symbolic information take place in the brain in a form not accessible to direct observation (Chalfant & Scheffelin, 1969, p. 137). This limits us to the inference of internal processes.

Then, too, most educators would take the position that even knowledge of brain damage would not proscribe a differential treatment and may, in fact, stop any form of remediation (Chalfant & Scheffelin, 1969, p. 137). However, in reality there may be limitations that brain damage will set upon subsequent learning and remediation. When this is known, appropriate alterations to remediation can be devised.

The fact remains that, although the study of brain damage cannot be used as a blanket approach to learning problems, it can aid in removing some of the uncertainty from the trial-and-error philosophy. For the most part, though, educators must proceed with the inferential form of the study of learning processes, based in part, perhaps, on the theories derived from the physiological study of the brain.

Capacity and performance

Bortner and Birch (1970), as noted, distinguish between cognitive capacity and cognitive performance. Since psychology began as an organized effort, many people have taken the view that performance does not accurately reflect cognitive capacity: " . . . Changes in training procedures, task organization, social circumstances and motivations, as well as characteristics of the examiner, all significantly influence the level of performance (Bortner & Birch, 1970, p. 735)". In addition, Bortner and Birch call for a more fully expressed conceptualization to help in the guidance and development of remedial practices.

They find that children have strategies and concepts which are not available for use under certain conditions (free field). Younger children tended to use stimulus properties, while only older children used functional relationships. In cases where behavior was not dominated by stimulus properties, young children could see functional associations, but these were not available for use in categorizing. Birch has found this to be true generally for human problem solving (Birch & Rabinowitz, 1951) and specifically for brain-damaged children (Birch & Bortner, 1968).

The major strategy in remediation used by Bortner and Birch was the reduction of competitive stimuli: "The findings in these studies suggested the possibility that changes in problem solving and cognitive style as a function of age are based upon alterations in hierarchical selection set rather than simply on the acquisition of new concepts or new capacities (Bortner & Birch, 1970)".

The discussion of capacity and performance also is indirectly related to the idea of latent talents. It also relates to the maturationalist theories of the necessary environmental conditions at appropriate stages of behavior. Hollenberg's (1970) suggesting of compensatory learning is interesting, and again returning to Luria's model, Das (1973a) has suggested that there are strategies relating to the use of serial and simultaneous processes. These processes are specific to brain functions, but their use is determined by the person through his experience and interaction. Thus, a dominant mode or strategy may be passed on by the culture to each of its members, along with the life-style, customs, mores and socialization patterns. Evidence for the latter has been presented earlier in this paper.

Evidence for simultaneous and successive strategies

Through a factor analytic approach, Das finds evidence to substantiate the existence of two main modes of information processing. These are simultaneous and successive factors. A third one called "speed" or "personal tempo" has also been isolated. The factor loadings show that different groups of children may be using different strategies to solve the same problem. Retarded children for instance, tend to produce figure outlines from a total picture (simultaneous) while non-retarded children reproduce them from the memory of sequential movements (successive). In auditory to visual coding, the normal child uses a simultaneous process whereas the retarded child uses both successive and simultaneous processes (Das, 1972). In another study with Caucasian children and Orissa children from India, Das (1973a, 1973b) finds similar results: there are differences in factor loadings, thus suggesting different strategies in processing input information. The model of successive and simultaneous processing can be seen in contrast to models which postulate a hierarchical structure of abilities.

Burt (1972) and Vernon (1969) both advocate a hierarchical structure in abilities in which reasoning is given the top rank and memory given the lower. Although they advocate a general bond in all cognitive abilities, it is not given the prominence of Spearman's g in intelligence. Using a similar line of thought Jensen (1969) postulates two levels of ability which he calls Level I and Level II. Level I is primarily a measure of rote memory. Level II reflects abstract reasoning and is the ability usually measured by IQ tests. Jensen considers some memory ability to be necessary for abstract reasoning (Level II thought) generally, but beyond this threshold level it does not play a major role.

Jensen considers Level I abilities to be normally distributed in the population, but because of assortive mating in the sub-cultures, there is a disparate distribution of Level II abilities, with the high SES groups being favored. Highly skilled people tend to intermarry and thus the gene pool associated with Level II becomes depleted in the lower SES groups.

Jensen consistently finds high SES groups to have superior Level II abilities than low SES groups. Conversely, when matched on IQ, low SES groups do better on Level I tasks than high SES children. Orn and Das (1972) find general support for this conclusion, but they suggest that Level I abilities are bound to be higher for the low SES groups because matching an IQ means, essentially matching on Level II.

Das, however, does not consider the levels to be hierarchical. In a cross-cultural study (1973a), he finds evidence for parallel rather than hierarchical abilities. Using Luria's (1966a, 1966b) information processing model involving successive and simultaneous synthesis, a parsimonious explanation for memory and reasoning is given as follows:

> Rote memory or associative learning requires a sequential processing of information, whereas reasoning tasks . . . measure <u>parallel</u> processing. In simultaneous synthesis the subject is required to arrange input in a simultaneous array in order to arrive at a judgement whereas in successive the input must be arranged in sequence. The two modes of information integration have cortical

> locations as revealed by Luria's observations of brain lesions and their behavioral correlates. Simultaneous synthesis is located in the occipitoparietal area and successive in the fronto-temporal area (p. 1).

Accordingly, verbal tasks are usually done through successive operations whereas some spatial skills, such as watch repair, require simultaneous synthesis.

One is again forced to examine Jensen's interpretation. The very fact that factors emerge differently for different groups suggests that culture influences performance of these tests. If we can assume that these factors represent equivalent and task appropriate methods of processing, there is no particular reason for the assumption that they are determined genetically.

Simultaneous or Successive strategies can be used alternatively, Farnham-Diggory (1970) has taken this approach in an experiment in which she taught alternative map-reading strategies to children.

In a similar vein, Williams and Ackerman (1971) conclude from their findings that distinctive letters can be introduced simultaneously while highly similar letters should be introduced successively for best results. It seems that comparisons are most useful when there are no rotational or reversible transformations possible, while perhaps a different encoding system is necessary when there are possible transformations.

To conclude:

> . . . the two modes of information processing are proposed as alternatives for reasoning and memory. The two parallel modes are available to an individual and are used according to the nature of the task, as well as the bias of the individual, towards one or the other method of information integration. Cultural or individual preferences for the use of a specific mode may thus exist. But intelligence is not marked by the preference for one or the other mode. Perhaps

> it is a general ability characterized by the efficiency with which information is used for task solution (Das 1973a, p. 8)."

In designing a remedial program, one should consider who is likely to benefit from the enrichment experience. General and unspecific programs do not necessarily serve the needs of any particular group of children. Jensen (1969) has suggested that only a certain number of children are "environmentally depressed" and all those are below an IQ of 100. Das (1973a) has suggested that disadvantaged children between 1 and 2 standard deviations below the mean (IQ of 100) may gain substantially from an enrichment procedure.

It is likely these children will be characterized by academic failure and will be found near the bottom of the academic range for their class or grade.

The remedial program, and indeed the educational setting, must strike a balance between the traditional values of the culture and the constantly changing requirements of a progressive society. Without entering into a major sociological change, the most efficient way of achieving a balance is to help the disadvantaged child become more congruent in cognitive abilities to the major culture surrounding him.

MacArthur (1968), however, warns us about inferences based on cognitive abilities, as he finds that the patterns of ability vary from group to group. MacArthur (1968, 1970, 1972) and Vernon (1965, 1969) have both shown that many of the instruments currently in use for assessing intellectual potential are useful in predicting achievement or potential for achievement if one recognizes the extent to which they are affected by cultural influences. These instruments are potentially useful in providing information for educational innovations and in developing the theoretical rationale for these innovations.

The disadvantaged child typically falls further and further behind as he progresses up the educational ladder. One could either leave them alone, or fall behind, or intervene and try to remove the educational lag. Although neither of these are ideal solutions, intervention is seen as the lesser of two evils.

Intervention can be justified even if one agrees with Bruner and Baratz and Baratz in saying that the cultures are different and not deficient. However, interactions with the majority culture with which sub-groups are forced to compete, demonstrate that certain cognitive ability patterns and ways of thinking (cognitive strategies) are inefficient in developing the full potential of the individual. Thus, these differences become de facto deficiencies. The label has no bearing on the actual existence of a problem but it can influence the course of remediation. A label like "deficit" can contribute to the hopelessness of both the researcher and subjects, but it does serve to point out the importance of intervention. On the other hand a "difference" label may lead to passivity.

Summary

The chapter can be summarized as follows:

1. Heredity and environment both play important roles in the later intellectual functioning of the child, however, since inheritance cannot be manipulated as a variable, the focus of research should be primarily concerned with the environmental issues.
2. Two main points of view emerge in considering the relationship of the environment to later cognitive functioning. One viewpoint

considers cultural differences and the other considers deficits leading to deprivation. A possible synthesis is that certain cultural differences produce learning strategies which are inefficient and ineffective under certain environmental conditions.

3. One should, therefore, be concerned with the patterns of cognitive abilities associated with particular sub-groups and how they differ from each other.

4. It has been proposed that patterns of abilities result from the use of particular cognitive strategies which are at least partially determined by the cultural patterns of the sub-groups.

5. Patterns of abilities and cognitive strategies are generally derived from descriptive studies and, although these are not without value, an effort should be made to investigate the possibility of changing these patterns, particularly where they are deemed to be inappropriate.

6. It has been demonstrated that the cognitive organizations of young children can be changed and therefore that educational change taking advantage of research into cognitive strategies should logically be started at this age.

7. Cognitive operations ultimately depend on sensory processes for information and thus cognitive processes and strategies can influence the form and organization which new or additional information will take.

8. Evidence indicates that all sensory stimuli may be coded into a verbal store, through a process of mediation or integration; however this aspect is not yet clearly understood.

9. Schooling is very closely linked to the verbal cognitive processes of the adult and the child, although the development of these processes has not been sufficiently researched at this time. Inadequacies in verbal ability are almost always associated with educational failure and may be common to particular subgroups.

10. Little attention has been given to the educational problems of North American Indians in spite of a great need in this area. The research that has occurred has been of a local and informal nature and has typically lacked a consistent organizational structure.

11. It seems that the patterns associated with cognitive strategies and memory reflect those found in the surrounding environment. From this, it is fair to conclude that they are, at least in part, learned and thus changeable.

12. The mechanism of change must be based on a clearly expressed theoretical structure. The instructional program must be carefully evaluated to insure that the goals of the program are being adequately met.

CHAPTER III

EXPERIMENTAL PROCEDURES

A Description of the Sample and Testing Procedures

The Sample

Edmonton. The children originally considered for this research project represented the total grade 3 population of four schools in the Edmonton Public School System. On the basis of the previous year's work, and on the basis of the teachers' assessment, these 205 children were divided into three groups with school achievement as the criteria. These groups were labelled High Achievement (HEd), Middle Achievement (MEd) and Low Achievement (LEd).

For various reasons, including incomplete records, absenteeism, incomplete testing and transfers, the sample with complete resu was reduced to 155. At this point, the distribution was: HEd, 56; MEd, 43; and LEd, 56. The smaller middle group reflects the original decision to include slightly more than one-third of the population in the High and Low groups to compensate for possible sample attrition. This turned out to be a fortuitous decision as the attrition rate was somewhat higher than anticipated.

Table I shows the distribution by sex within the groups.

Although a socioeconomic rating was not done, the school population was apparently composed in the same proportion as the rest of Edmonton with regard to SES. Any biasing would probably be slightly toward the lower end of the socioeconomic spectrum as there were no exclusively "upper class" neighborhoods feeding these schools.

Table I

Distribution by Sex

	F	M	Total
HEd	30	26	56
MEd	21	22	43
LEd	26	30	56
	77	78	155

Conversations with the various principals and teachers confirmed these observations. The school personnel did feel, however, that the low achieving children tended to come from the lower socioeconomic levels more frequently than did the high achievers.

The average age of the HEd group was 8.92 years and .403 years standard deviation, and the LEd group was 8.96 years and .435 years standard deviation. It was decided to use the age at the time the Wechsler Intelligence Scale for Children (WISC) was given, as the age of the children, for reasons to be explained later. Consequently, the ages of the MEd group were not recorded.

On the main, the children were eager to participate and in no case did the child refuse to perform the tests. The teachers (two male, eight female) of the 10 classes from which the children were taken were extremely co-operative in giving their time and energy toward this research project.

<u>The testing</u>. The following tests were administered:

Tests	Presentation
1. Raven's Progressive Matrices (RPM)	group
2. Cross-modal Coding (CMC)	group
3. Figure-Copying Test (FCT)	group
4. Visual Short-term Memory (VSTM)	group
5. Serial Learning Test (SL)	individual
6. Memory for Designs (MFD)	individual
7. Stroop Test (STR)	individual
8. Schonell Graded Reading Vocabulary Test (SCH)	individual
9. Wechsler Intelligence Scale for Children (WISC)	individual

In addition the results from tests given at the end of grade 3 throughout the Edmonton Public School System on a group basis were made available for purposes of this research. The writer gratefully acknowledges the permission to use the data from the following tests:

10. Gates MacGinitie - Vocabulary (GMV)
    - Comprehension (GMC)
11. Stanford Achievement - Word Meaning (SAT WM)
    - Paragraph Meaning (SAT PM)
    - Word Study Skills (SAT WSS)
12. Spelling (SP)
13. Arithmetic (A)
14. Lorge-Thorndike Intelligence Test - Verbal (LT V)
    - Nonverbal (LT NV)

The first eight tests will be referred to in this paper as the Das Battery (Das, 1973a, 1973b). Tests 9 to 14 will be referred to as the "System" tests.

The testing of the Edmonton sample was accomplished during the period of April 15 to June 15, 1973. In total, four different people participated in the administration of the tests (not including the teachers). Approximately half of the WISCs were given by the writer and half by his wife. The group tests (RPM, CMC, FCT and VSTM) were all administered by the writer, with the remaining tests (SL, MFD, STR, SCH) administered by two persons (one male, one female) hired for that purpose. The writer is a qualified psychologist, his wife (at the time of testing) had completed the course work for a Master's degree in Educational Psychology, and the other two individuals were taking majors in Psychology.

Because of the extended period of time, and the number of people participating in the research, the children were selected for testing in an essentially randomized order. Each child performed the test in three sections: group tests (1 hour), individual tests (30 minutes) and WISC (1 hour). No child did more than one of these sections in any one day.

The group tests were administered to one class at one time and were completed within the first two weeks of the testing period. At this point, but not on the basis of test results, the final selections for the three achievement groups were made. This was done to preclude any further testing of a child who had missed the group tests, and to indicate those students who would be given the WISC. After the group testing was completed, the children were given the individual tests.

It should be noted that within each section the tests were given in a fixed order; the RPM, CMC, FCT and STM were presented in the given order as were the SL, STR, MFD and SCH.

The WISC testing took the longest time within the testing period, and because the time span was significantly long were thought to be the most meaningful. Consequently, the MEd group's ages were not recorded. These ages were used in calculating the mean ages.

The sample was originally partitioned into three groups to increase the distinction between high and low achievement. Individuals who were not clearly high or low achievers were placed in the MEd group. The data from the MEd sample were included in the analysis to provide checks on the continuity of the test means distributions along the achievement dimension.

Hobbema - the Setting. The town of Hobbema is situated 50 miles south of Edmonton on a paved secondary highway. The townsite contains a few small businesses, some family dwellings, the Band Council offices and the Ermineskin School.

The school is a modern, well-equipped school providing grades K to 9. The 900 students occupy three school buildings, one of which contained grades 1 to 4, including the grade 3 classes used in this study. The children are bussed to school, and all have free lunches at the residence cafeteria.

Teaching follows the standard Alberta curriculum, although teachers are employed through the Canadian civil service. The school is administered through a locally elected school board.

Hobbema - at Pretest. Approximately 40 low-achieving children from five classes at the Ermineskin School at Hobbema were selected on the basis of the previous year's work. These children represented slightly more than one-third of the grade 3 population at that school. Only one child was selected per family to prevent familial effects from influencing the results. A total of 38 children were given the battery of tests used with the Edmonton sample. This group was labelled Low Achievement (LHo) and contained 21 males and 17 females.

The number of children selected is perhaps smaller than a statistical optimal; however, three factors contributed to the choice of this as the appropriate sample. Firstly, no other native children were available at the time of research, and secondly, it was felt that selecting a larger proportion of the sample available would tend to obscure any results or conclusions. Thirdly, a rather extensive amount of time was to be spent with each child and time constraints were becoming apparent. This sample size represented the best possible compromise under the circumstances.

The average WISC age was 9.52 years, with a standard deviation of 1.05 years, even though the testing was done at the beginning of the third grade year. Apparently, some Indian children had been held back one or more years or had begun school later than Edmonton children. The "history of failure" appeared greater at Hobbema than in the Edmonton sample. In addition, the level of achievement seemed lower than in Edmonton. Discussion with teachers reinforced this notion.

<u>Testing</u>. The pretesting was accomplished during the period of November 15, 1971 to January 30, 1972. The tests reported in the previous description were also administered to all children in the Hobbema sample. All tests were given on an individual basis in three sessions for a total of approximately two-and-one-half hours per child. No standardized test results were available for these children.

A competent person was employed for the WISC testing, with all other testing being done by the writer. The children were selected for testing in a random order with no child taking more than one series of tests per day.

When the testing was complete, the children were divided into two groups for the differential remediation procedure. The distribution by sex is presented in Table II.

Table II

Pretest Distribution by Sex (Hobbema)

	F	M	Total
Group I (high remediation)	8	10	18
Group II (low remediation)	9	11	20
	17	21	38

At this point the remediation was begun. This procedure will be described at a later point.

Posttest. The posttesting was done during the period of April 20 to June 20, 1972. Conditions for the posttest were kept as similar to the pretest condition as possible. WISC retesting was performed by the same person and the writer did the remaining retesting with the order of tests being constant. Due to protracted illness, three children did not complete the remediation and thus were removed from the sample. The remaining 35 children were distributed in the manner shown in Table III.

Table III

Posttest Distribution by Sex (Hobbema)

	F	M	Total
Group I (high remediation)	7	8	15
Group II (low remediation)	9	11	20
	16	19	35

The Testing Instruments

The Tests

In the section to follow, the testing instruments used in both parts of the study are described. A list of stimulus items and administration procedures can be found in Appendix A.

Wechsler Intelligence Scale for Children (WISC). The WISC is one of the standard intelligence tests for children of this age level. A Verbal, Performance and Full Scale IQ can be calculated for each child. The Verbal scale is derived from a combination of six subscales, namely: Information (I), Comprehension (C), Arithmetic (A), Similarities (S), Vocabulary (V) and an optional test named Digit Span (DS). Six other subscales--Picture Completion (PC), Picture Arrangement (PA), Block Design (BD), Object Assembly (OA), Coding/Digit Symbol (C/DS) and, optionally, Mazes (M)--are used in the calculation of the Performance IQ. The Full Scale IQ is based on a separately standardized combination of the Verbal and Performance Scale scores, and is not simply an average of the two.

A profile using the 12 scale scores can be drawn for each child. Each scale score has a range of 0-20, with a mean of 10. The IQ scales have a mean of 100 and a standard deviation of 15.

The WISC is administered on an individual basis and is scored according to criteria provided in the manual.

Figure Copying Test (FCT). This test was developed at the Gesell Institute of Child Study at Yale University (Ilg & Ames, 1964) as a means for determining developmental readiness for the traditional school learning tasks of the primary grades. It consists of 10 geometric forms presented one to a page with half of the page left to accommodate the child's reproduction.

The items are ordered according to difficulty and are scored with reference to the accuracy with which a child is able to reproduce the design. Each item would receive a score of 0 if his reproduction bore essentially no resemblance to the stimulus item, 1 if it resembled the stimulus item or a 2 if it was essentially an adult reproduction. Memory is presumed not to be tested as the child may use the stimulus item as a reference at any time. The test is not timed. The total possible score is 20.

Visual Short-term Memory. The VSTM test consists of two practice and 10 test items presented individually on a wall screen by means of a slide projector (a Kodak Carousel 850). Each stimulus item is a five-cell matrix presented in the shape of a cross, with one number per cell. The experimental procedure was typical of short-term memory tasks in which a stimulus is presented followed by a neutral filler task to prevent rehearsal over the retention time, and then recalled by the subject. An example can be seen in Figure 1.

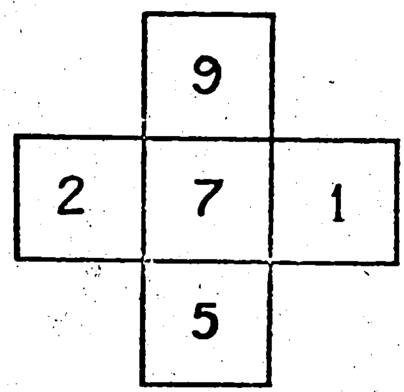

Fig. 1. A typical stimulus item on the VSTM

The neutral filler task was also presented on slides and consisted of bars of varying color projected on the same screen. Having viewed the stimulus digits for 5 seconds, the child was now expected to name as many of the colored bars as possible within a 2-second interval. Completion of this task was the signal for the child to write down the numbers he remembered. The screen was blank during this time.

The presentation cycles were controlled by an interval timer constructed for this purpose and wired directly to the slide projector. The timer was manually activated only once per sequence. Two seconds after the word "ready", the timer was engaged and, after the changing time, the stimulus grid appeared and remained for 5 seconds, at which point the timer automatically presented the neutral filler task for 2 seconds. The next change was the signal for recall. A graphic representation of the timing sequence can be seen in Figure 2.

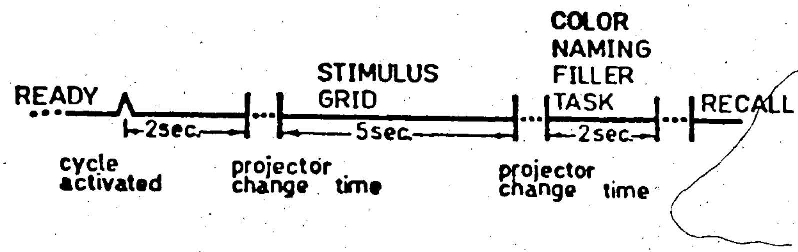

Fig. 2. Time cycle for Visual Short-term Memory Test

Scoring procedures involved only counting the numbers correctly placed within each grid, and summing these over the 10 test items. The maximum total was 50.

Memory for Designs (MFD). This test was originally developed by Graham and Kendall (1960) as a test of brain damage and organic impairment to be used both in clinics and as a research tool. It was intended to be employed in researching the connection between the inability to do certain tasks and organicity.

Fifteen cards, each five inches square with one drawing per card, make up the total test. Scoring criteria have been developed by Graham and Kendall focusing on the various distortions and errors present in the reproduced figures. Reversals are taken to be the best indicators of impairment and thus are scored the highest (3). Gross distortions and closure of open figures are rated next highly and given a score of 2. Figures with simple errors such as partial figure disorientations, missing elements and details receive a 1. Figures approximately the stimulus figure are scored 0. If a child has forgotten the figure, or is not satisfied with his reproduction, a score of 0 is also given.

Cross-modal Coding (CMC). Birch and Belmont (1964) developed this task as a measure of auditory-visual integration. They used a pencil tapping task in conjunction with visual recognition of patterns of sounds in their work with young children. It was felt this process was related to reading. Other studies (Das, 1973a, 1973b) have shown this test does not load specifically on the successive or simultaneous factors probably due to the ambiguous nature of the processes by which a solution is obtained.

The Birch and Belmont procedure was to tap a pencil and have the child visually recognize this pattern. However, this procedure was never entirely satisfactory, as it was not clear whether the child attended to the auditory or visual aspects of the task. Secondly, there may have been rather large time variations in the sequencing of the taps. In the present study, the patterns of sounds were presented as "beeps" by means of a tape recorder, which guarded against the possibility of visual-visual integration. Ten patterns of sound, originally prepared by Orn (1970) with tones of 1000 cycles per second and 0.15 seconds duration were carefully recorded on cassette tape. The patterns had short pauses of 0.35 seconds and long pauses of 1.35 seconds.

Each pattern was reproduced visually as a series of dots on 3" x 5" cards and was randomly assigned to a position with two alternatives on that card. The 10 auditory stimulus patterns were presented twice in the same order, but the order on the recognition card was altered for the second presentation.

A training series of 12 items in a simpler form was presented to each child before the test series to ensure that he understood the instructions and to reduce the practice effect in the test items. The test can be regarded as having an STM component, as the visual pattern is not presented until the auditory pattern is completed. A score of 20 was the highest possible.

Serial Learning (SL). The serial learning test was originally fashioned after Baddeley (1966) by Orn (1970). Baddeley developed a series of acoustically and semantically similar words which he presented in two separate lists along with an equal number of control words to housewives.

Orn used a similar procedure with children. He produced 12 four-word series of acoustically similar words and randomly interspersed them with a total of 12 control word series to form one test, and then formed another in which semantically similar words were substituted for the acoustically similar words. Thus, he had an acoustic scale and a semantic scale which he administered separately to different groups of children.

A procedure corresponding to the latter was used except that the tests were combined and presented to all children. The words were presented at a rate of one word per second, with a 7-second pause left for the child's oral response between each series of items.

The acoustically similar words were randomly selected from a pool consisting of the words man, mat, mad, pan, cab, cap, tap and cat. The semantically similar words were selected from among: big, large, tall, high, long, great, fat, wide and huge; while the control words were selected from: day, hot, cow, pen, book, few, key, bar and wall. A word appeared only once in any one group of four words.

A cassette tape recorder was used to present the complete list of 48 groups of words along with the instructions and three practice items. During the testing procedure, the test administrator had before him a sheet on which all items appeared in the presented order. As the child recalled the words, the serial position of each correct word was noted by means of a number written on top of each word. Each group of words was scored for words in the correct serial position (SP) and for the total number of words correctly recalled (FR). Some sample items and scorings can be seen in Table IV.

Table IV

Scoring Examples for the SL Test

Original Sequence	Child's Sequence	SP Score	FR Score
mat cat mad can	mat cat mad can	4	4
big fat large high	fat big large high	2	4
key pen day bar	day key bar few	0	3
can cat map man	can mat cat pan	1	2

Each child received two scores from this test: the total recalled in serial position (SLSP) and the total number correct in free recall (SLFR). The total possible was 192 for each scale.

The Stroop Test. Stroop (1935) developed a test having three parts named Word, Color and Color-Word. The total test is composed of three cards, each 18" x 25", having eight rows with five positions to a row. The Word test consists of the words red, blue green and yellow written in black ink, randomly assigned to one of the 40 positions. In the Color test, the words are replaced by bars of the appropriate color. Finally, in the Color-Word chart, the words are written in conflicting colors. For example, the word red may be written in blue ink and the word yellow in green or red.

In the Word test the subject is expected to read the words as quickly as possible; in the next, to name the colors as quickly as possible; and finally to name the color of the ink and not read the word.

For purposes of this research, although all tests were given, only the Word and Color tests were included in the analysis, mainly as tests of speed. A practice session was included in the test. The tests were timed to the nearest second.

The Schonell Graded Reading Vocabulary Test (SCH). Schonell (1942) developed this test to provide a quick, easy method of determining a child's reading level. It consists of 10 groups of 10 words presented in order of difficulty. The child is simply instructed to begin at the top of the page and to read the words slowly and as clearly as possible. The examiner listens to the pronunciation to determine whether the child knows the word and then records the number correct.

Schonell provides a method of determining reading grade level, but raw scores were used here, as they are related in a direct linear fashion.

Raven's Progressive Matrices (RPM). The RPM test has received considerable attention in recent years as a "culture-reduced" test of mental abilities (MacArthur, 1968). He feels that although much research is still required on this instrument, it performs more satisfactorily in a cross-cultural setting than other indicators of intellectual ability.

The RPM test used here has three separate series (A, A_B, B), each composed of 12 colored matrices. Each item is a matrix with a small section missing. The subject is expected to select the missing element from among six distracting elements and record his answer on the sheet provided. His answers are scored according to criteria provided in the manual.

Raven provides a standardized procedure for calculating age-percentile scores but raw scores were used here. The maximum possible was 36.

Gates MacGinitie Reading Test. At the grade 3 level, the Primary C form of the test is used. It has two parts: Vocabulary (GMV) and Comprehension (GMC).

The vocabulary test is designed to measure the child's ability to recognize or analyze isolated words, and contains a total of 52 items, each of which has a test word and four alternatives containing the correct synonym. The test is graded in terms of frequency of common usage of the test words.

The comprehension test is designed to measure the child's ability to read and understand whole sentences and paragraphs. This test contains 24 paragraphs of increasing length and difficulty, followed by two questions, each with four alternative answers. The child is to circle the best answer for each question and the answers are scored according to the criteria provided in the manual.

Spelling. This test is a locally standardized test of spelling ability. It, along with the other "systems" tests, it given to all grade 3 children in the Edmonton Public School System. The students listen to the words as they are dictated by the teacher and then write them down. The test contains 54 items.

Arithmetic. The arithmetic test is another locally standardized test of arithmetic skills. The items are presented visually and the child works them out individually. The total possible is 60 marks.

Stanford Achievement Test (SAT). At the grade 3 level, the SAT Primary II Battery containing nine subscales is appropriate. Only three of these subscales are used here: Word meaning (SAT WM), Paragraph meaning (SAT PM) and Word Study Skills (SAT WSS).

The Word Meaning Test consists of 36 multiple choice items, graded in difficulty, which measure the ability of a pupil to read a sentence and select a correct word to complete the sentence.

The Paragraph Meaning Test consists of a series of paragraphs, graded in difficulty, from which one or more words have been omitted. The pupil's task is to demonstrate his comprehension of the paragraph by selecting, from among four choices that are afforded him, the proper word for each omission. Reading and vocabulary levels have been controlled in this test.

At this grade level, the Word Study Skills Test includes 64 multiple choice items broken down into two sections: Beginning (15 items) and Ending (15 items) Sounds and Visual Phonics (34 items). In the first section, the teacher reads the words and the pupil chooses the word that has the same initial (or final) sound. In the second, he visually matches phonic elements between words.

Lorge-Thorndike (LT). The Lorge-Thorndike Intelligence Test has two levels: Verbal and Nonverbal. It is administered to groups of children in eight sections.

The Verbal scale has five sections, each with beginning and ending levels that are appropriate to the grade-age level of the group being tested. A standardized IQ may be calculated from the norms provided in the manual. The test items are multiple choice and are presented visually.

The Nonverbal scale has three subtests, each structured in the same fashion as the verbal sections. The items in this section are multiple choice and are presented visually in the test booklet. A separate IQ score may be calculated from the published norms.

CHAPTER IV

HYPOTHESES AND THE EXPERIMENTAL DESIGN

From the main conclusion presented earlier, certain hypotheses can be drawn. These will be described and an experimental procedure to test them will be outlined in this chapter.

Hypotheses

Four major hypotheses are stated and discussed below.

Hypothesis 1 (a) WISC Verbal scores will be lower than WISC Performance scores for the low achieving children.

Hypothesis 1 (b) The high achieving children will have equal WISC Verbal and Performance scores.

School success is closely related to verbal rather than to performance measures. If this is the case, a sample of low achieving children should contain a larger proportion of children who are low on their verbal scores than would otherwise be expected. Consequently, the WISC Verbal IQs of the low achievement group should be lower than their WISC Performance IQs. This statement includes the implicit assumption that the Verbal and Performance IQ scores are relatively independent of one another.

Confirmation of this hypothesis would be taken as a partial indication that the low achieving students have difficulties in using successive information processing strategies.

Hypothesis 2 The variance in performance on the cognitive tests will be parsimoniously explained by the Successive-Simultaneous processing model.

The theoretical structure presented earlier would predict the emergence of three factors, namely, Simultaneous, Successive and Speed, through principal factor analyses. Das (1973a, 1973b) has consistently isolated these factors, and used them in the study of cognitive processes.

The generality of the Theoretical model would be enhanced if the same three factors will be useful in describing the cognitive processes of three groups of children. This is not to say that the patterns of factor loadings will be identical, but that the Successive-Simultaneous Processing model provides a vehicle for the analysis and understanding of the learning strategies of children from different samples. It may well be that the separate groups have distinctive strategies within the model. Knowing these differences could provide valuable insights into the correlates and perhaps the cause of low achievement.

Hypothesis 3 (a) There will be no difference between the low achieving Edmonton children and the low achieving Hobbema children on test measures.

Hypothesis 3 (b) In the Edmonton sample, the high achieving children will perform at a superior level when compared to the low achieving children.

Hypothesis 3 (a) is essentially studied in null form. It is expected that no major differences will be found as both of these groups are low achievers in the school setting. There may be, however, some differences and these would be noted with interest as they may provide clues to the differential effects of varied environments. A model for this type of inference has been provided by Lesser, Fifer and Clark (1965).

In Hypothesis 3 (b) the specific correlates of low achievement can be found. It is expected that generally the low achievers will perform in a poorer fashion than the high achievers. Ability patterns, however, may show some differences.

Hypothesis 4 For the Hobbema children, performance on the tests after the intervention will show greater improvement for the maximum treatment group than for the minimum treatment group.

Confirmation of this hypothesis would be taken as a demonstration of the effectiveness of the intervention program. In addition, it would provide supporting evidence for the usefulness of the Theoretical structure in diagnosing learning problems and in designing appropriate remedial procedures.

Experimental Design

To test these hypotheses, an experimental procedure having two main aspects, has been elaborated. The first aspect is cross-sectional in nature and compares the high and low achieving white students in Edmonton and low achieving native students at Hobbema. The second is longitudinal in nature and involves an intervention procedure designed for the native children at Hobbema. Children at the grade 3 level were chosen, because they had been in school long enough to have become differentiated in achievement, and yet were young enough not to have unchangeable habits and patterns of behavior.

Design

Cross-sectional

Edmonton (White)			Hobbema (Native)
60 high achievers	60 low achievers	Original Sample	40 low achievers
Tests	Tests	Pretests	Tests
Test results		Analysis	Test results

(Hypotheses 1, 2, 3a, 3b)

Longitudinal

Hobbema (Native)	
40 low achievers	Sample
Tests	Tests (pretest)
Test results	Pretest analyses

Division into two arbitrary groups equal on WISC Verbal, Performance and Full Scale IQs

Maximum Treatment Group (I)	equated on WISC	Minimum Treatment Group (II)	Intervention based on the analyses of pretest results[1]
Test results			Posttests
Test scores	vs.	Test scores	Analyses of gain scores (Hypothesis 4)

[1]A list of intervention tasks for each group can be found in Appendix C.

CHAPTER V

ACADEMIC ACHIEVEMENT AND VERBAL DIFFICULTIES: A TEST OF HYPOTHESES 1 AND 3

Hypothesis 1(a) WISC Verbal scores will be lower than WISC Performance scores for the low achieving children.

Hypothesis 1(b) The high achieving children will have equal WISC Verbal and Performance scores.

Hypothesis 3(a) There will be no differences in the scores between low achieving Edmonton children and Hobbema children on test measures.

Hypothesis 3(b) In the Edmonton sample the high achieving children will perform at a superior level when compared to the low achieving sample.

Comparison of WISC Scores

A comparison of WISC Verbal and Performance scores for the LHo, LEd and HEd groups can be seen in Table V.

Table V

A Comparison of WISC Verbal and Performance Scores for the HEd, LEd and LHo Groups Using t-Tests for Correlated Samples

Group	WISC V		WISC P		Corr.	t-Test for Homogeneity of Variance		t-Test for Differences of Means	
	Mean	SD	Mean	SD		t	p	t	p
HEd	108.96	10.40	109.96	10.76	.245	.259	.797	.575	.567
LEd	93.88	10.51	98.96	11.78	.620	.148	.256	3.874	.001*
LHo	78.05	11.87	93.39	12.41	.567	.328	.745	8.364	.001*

For the low achieving groups, the results of the comparison are in the predicted direction, that is, the Verbal scores are significantly lower than the Performance scores. The difference of IQ point for the HEd group is nonsignificant. Hypothesis 1, therefore, can be confirmed.

This verbal performance difference is found particularly with culturally disadvantaged children (Cazden & John, 1968; Bernstein, 1961, 1965) and is taken to indicate verbal difficulties in school related areas. Here the divisions between high and low achievement were made on the basis of school performance. In terms of achievement, the LHo and LEd cannot be compared directly because no comparable achievement measures were used. However, a comparison on other measures can be performed to indicate other areas of similarity and difference. These results are shown in Table VI and will be examined in some detail.

<u>Means</u>

In considering only the means of the test scores, the groups are almost perfectly ordered by their performance in the order HEd, LEd and LHo. The general suggestion is that this order also represents the order of achievement in school tasks, although the position of the LHo group can only be inferred from test scores. Analyses of variance were performed to test the differences between means. The results of these analyses are shown in Table VII. All measures except the MFD showed differences between groups at the $p < .001$ level of significance. Tests for homogeneity of variance were performed and differences were found on the STR W, SCH, SL FR, MFD, RPM and CMC. Glass and Stanley (1970, p. 372), however, feel that with respect to type I errors, a violation of the assumption of homogeneity is of almost no consequence, and that the

Table VI

A Comparison of Mean Scores for All Groups

Tests	HEd (N = 56)		MEd (N = 43)		LEd (N = 56)		LHo (N = 38)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
WISC Verbal	108.96	10.40			93.88	10.51	78.05	11.87
WISC Performance	109.96	10.76			98.96	11.78	93.39	12.41
WISC Full Scale	110.52	9.12			96.00	11.06	84.18	12.36
Stroop Word	22.14	4.29			25.52	5.30	32.97	11.33
Stroop Color	72.73	19.72			79.54	19.13	97.29	26.17
Schonell	44.80	10.18			28.59	5.27	27.81	11.36
Serial Learning (Serial Position)	145.45	26.40			130.43	32.78	92.39	32.78
Serial Learning (Free Recall)	159.68	18.23			147.61	28.24	125.39	30.29
Memory for Designs	3.52	3.67			5.52	4.29	3.82	2.84
Progressive Matrices	29.98	3.97	27.30	4.49	23.84	6.43	23.08	4.11
Cross-modal Coding	18.14	2.60	17.05	2.97	15.32	4.41	10.70	4.15
Figure Copying	14.09	6.41	12.77	4.71	11.89	6.93	12.08	4.94
Visual STM	33.93	9.30	32.35	9.52	28.09	10.26	24.97	10.24

Table VII

Analysis of Variance (ANOVA) between Groups

Tests	df (groups)	df (error)	F-Ratio	Probability of F-Ratio
WISC Verbal	2	147	93.28	.001
WISC Performance	2	147	25.45	.001
WISC Full Scale	2	147	70.31	.001
Stroop Word	2	147	27.01	.001
Stroop Color	2	147	34.88	.001
Schonell	2	147	58.75	.001
Serial Learning (Serial Position)	2	147	34.30	.001
Serial Learning (Free Recall)	2	147	20.44	.001
Memory for Designs	2	147	4.61	.012
Raven's Progressive Matrices	3	189	20.97	.001
Cross-modal Coding	3	189	34.13	.001
Figure Copying	3	189	8.97	.001
Visual STM	3	189	7.82	.001

probability level remains almost exactly the same.

Paired Comparisons

To locate the significance of the differences, all possible paired comparisons were made using the Scheffe procedure (Winer, 19 2). The HEd and LEd groups were different on all measures at the $p < .05$ level of significance but only the three WISC scales, Schonell, Matrices, Cross-modal Coding and Figure Copying were different at the $p < .01$ level of significance. These comparisons are summarized in Table VIII.

The HEd and LHo groups were different at the $p < .01$ level for all

Table VIII

Paired Comparisons of Mean Scores
(Scheffe Procedure)

Tests	Pairs		
	HEd-LEd Probability	LEd-LHo Probability	HEd-LHo Probability
WISC Verbal	**	**	**
WISC Performance	**	.078	**
WISC Full Scale	**	**	**
Stroop Word	.040*	**	**
Stroop Color	.037*	**	**
Schonell	**	.920	**
Serial Learning (Serial Position)	.039*	**	**
Serial Learning (Free Recall)	.047*	**	**
Memory for Designs	.019*	.094	.930
Raven's Progressive Matrices	**	.917	**
Cross-modal Coding	**	**	**
Figure Copying	**	.990	**
Visual STM	.020*	.518	**

*p < .05
**p < .01

tests except the MFD. A perusal of the means for this test reveals that only the mean for the HEd group is different from the LEd group's mean at the p < .05 level.

In regard to the LEd-LHo comparisons, one notes several tests on which the null hypothesis cannot be rejected even at the p < .05 level of significance. These are the WISC P, Schonell, MFD, Matrices and

Visual STM tests. With the exception of Schonell, these are all nonverbal tests, suggesting that these two groups are similar in nonverbal abilities. The results of these comparisons can be assigned to two categories: all groups different or LEd-LHo groups the same and both different from the HEd group (Table IX). This classification scheme does not perfectly differentiate these tests, but again the

Table IX

Verbal and Nonverbal Classification of Tests

All Groups Different* (Verbal)	LEd-LHo the Same, Both Different from HEd* (Nonverbal)
WISC Verbal	WISC Performance
WISC Full Scale	Schonell
Stroop Word	Raven's Progressive Matrices
Serial Learning (Serial Position)	Figure Copying
Serial Learning (Free Recall)	Visual STM
Cross-modal Coding	

*$p < .05$ (Scheffe procedure)

suggestion that verbal tests differentiate achievement to a greater extent than nonverbal tests can be taken.

A hierarchy in terms of verbal skills can be established among the groups: HEd, LEd, LHo. This hierarchy is also associated with a hierarchy in school achievement between the HEd and LEd groups. On the basis of extrapolation, one would predict the LHo would be the lowest in school achievement, although no direct evidence to this fact exists. However, this hierarchy does not extend to the nonverbal tests, as the

LEd and LHo groups are not differentiated by these measures. This point will be considered more extensively in a later section.

Hypothesis 3(a), then, is only partially confirmed, as the null hypothesis could be rejected for several tests, particularly those relating to verbal skills. Hypothesis 3(b) is clearly confirmed as the high group was superior to the low groups on virtually all tests.

Summary

The results presented thus far suggest that the high group is superior not only on academically related tasks, but also on other cognitive measures. These results favor conceptualization of cognitive competence similar to that of general intelligence. The converse, however, is not necessarily true. Academic incompetence may not be due totally to a lower general intelligence, but in fact to lower verbal skills as well. Differences in performance on the WISC Verbal and Performance scales show this to be true. In addition, the nonverbal tests tend not to differentiate between the two low achieving groups, whereas the verbally oriented tests do.

CHAPTER VI

THE APPROPRIATENESS OF THE SIMULTANEOUS-SUCCESSIVE MODEL: A TEST OF HYPOTHESIS 2

Hypothesis 2 The variance in performance on the cognitive tests will be parsimoniously explained by the Successive-Simultaneous Processing model.

Simultaneous-successive processing

To fully test this hypothesis, the data in the present study must be presented against a background of already existing information. Das (1972, 1973a, 1973b) has proposed a model of successive and simultaneous processing based on the findings of Luria (1966a, 1966b). Luria concluded through his work with brain-injured individuals that information could be processed either in serial or simultaneous form, and that these two processes operate independently of one another but are related at a higher level through language.

In a study of the learning abilities of retarded and nonretarded children, Das (1972) noted that the memory-reasoning model proposed by Jensen (1969) did not apply. Using principal components analysis, Das found that the factor loadings did not produce the hypothesized memory-reasoning distinction proposed by Jensen. Das felt these results could be more clearly explained by a simultaneous-successive processing distinction. He also noted that the factor loadings were not consistent between retarded and nonretarded children, suggesting that the processes were used differently by the two groups.

Simultaneous-successive processes across cultures

In a later study with children from Orissa (India) and Edmonton (Canada), Das (1973a) extended this model to include a speed component. The data for these analyses are presented in Tables X and XI.

Table X

Rotated Factors (Varimax) for Cognitive Tests: Orissa Children (N = 90)

Variable	I Sim.	II Speed	III Succ.
Stroop Word	-011	830	032
RPM	624	253	433
Cross-modal Coding	206	-640	233
Figure Copying	800	-278	-112
Memory for Designs	-809	111	-037
Visual STM	-013	-175	918

From: Das, J. P. Structure of cognitive abilities: Evidence for simultaneous and successive processing. Journal of Educational Psychology, 1973, 65, 103-108.

Three common factors emerged in accordance with the predictions of the model and these were appropriately named. In the Edmonton analysis, a fourth factor similar to school achievement emerged as well. Because of their basic similarity, the factor structures suggest that the children in these two groups process information in much the same manner. Progressive Matrices, however, does not load consistently for these two groups. For the Orissa sample it loads on both the successive and simultaneous factor, while for the Edmonton children it loads on the simultaneous factor. Das feels this may be a result of differing cultural backgrounds, as the successive processing mode is more heavily

Table XI

Rotated Factors (Varimax) for Cognitive and Achievement Tests: Edmonton Sample (N = 60)

Variable	I Succ.	II	III Sim.	IV Speed
ST W	-130	-320	045	-879
SL SP	896	355	042	013
FR	898	340	004	019
RPM	181	384	740	200
CMC	457	059	433	423
FCT	162	157	674	004
MFD	178	-055	-830	-162
VSTM	760	034	124	462
IQ (from school records)	347	793	204	045
Reading Achievement	184	851	100	266
Math Achievement	161	844	281	152

From: Das, J. P. Structure of cognitive abilities: Evidence for successive and simultaneous processing. Journal of Educational Psychology, 1973, 65, 103-108. (Note that the order of tests has been rearranged to conform with the format used in the present study.)

emphasized in the social and school settings of the Orissa children. The conclusion drawn is that although children from differing backgrounds have basically similar information systems, these processes are somewhat affected by cultural differences.

Simultaneous-successive processes across SES

Molloy (1973), in extending this line of pursuit, studied high and low SES Edmonton children at the grades 1 and 4 level. He found few processing differences between high and low SES groups. At the grade 4 level the three factors, simultaneous, successive and speed, emerged for both groups. He found that Cross-modal Coding, which loaded on the simultaneous and successive factors for the high SES group, loaded on all three factors for the low SES group and that Visual STM, which loaded on the successive and speed factors for the high SES group, loaded primarily on the successive factor for the low group.

Molloy also noted that these factors were stable across the age groups. Data from an analysis of a combined high and low SES group at the grade 4 level are presented in Table XII. The three factors emerge clearly and are similar in construction to the ones presented earlier.

Table XII

Rotated Factors (Varimax) for Grade 4:
SES Combined (N = 60)

Variable	I Succ.	II Sim.	III Speed
ST W	-129	002	842
ST C	-005	070	833
SL SP	950	-054	013
FR	941	-008	012
RPM	-008	876	007
CMC			
FCT	005	797	067
MFD	091	-750	-016
VSTM	689	-043	-188

From: Molloy, G. N. Unpublished Doctoral dissertation. University of Alberta, 1973. (Note that the order of tests has been rearranged to conform with the format in the present study.

Simultaneous-successive processing and the present study

For the present study, principal components analyses with Varimax rotations for the LHo, LEd and HEd groups are presented in Tables XIII, XIV and XV. In all three cases three factors emerged and were labelled simultaneous, successive and speed. Factors with eigen values greater than 1 were accepted according to the Kaiser-Guttman rule.

In the analysis of the LHo data, the factors emerged as successive, speed and simultaneous, respectively. Factor I was marked by the loadings from the two Serial Learning tests and also contained Matrices, Cross-modal Coding and FCT loadings. Factor II contained the Stroop Reading tests and Visual STM. The Stroop test measures latency and thus the negative sign on the VSTM reflects the opposite to this loading. Factor III contained loadings from the Memory for Designs, FCT, VSTM and Matrices. The negative sign on MFD reflects the fact that it is an error score.

Table XIII

Rotated Factors (Varimax) for LHo Children (N = 38)

Variable	I Succ.	II Speed	III Sim.
ST W	-126	856	135
ST C	-243	739	-069
SL SP	863	-139	-004
FR	852	-184	-007
RPM	668	072	379
CMC	585	-126	125
FCT	341	036	711
MFD	-002	080	-831
VSTM	-067	-624	481
Variance	2.455	1.751	1.611

Table XIV

Rotated Factors (Varimax) for LEd Children (N = 56)

Variable	I Succ.	II Sim.	III Speed
ST W	004	128	893
ST C	-063	-239	855
SL SP	917	111	-107
FR	905	155	-069
RPM	189	792	097
CMC	521	429	008
FCT	070	685	-067
MFD	-140	-764	125
VSTM	601	077	055
Variance	2.357	1.981	1.577

The clusterings of tests correspond favorably to those cited previously. Interestingly, the Matrices test loads both on the successive and the simultaneous factor as it did in Das' (1973a) study

Table XV

Rotated Factors (Varimax) for HEd Children (N = 56)

Variable	I Succ.	II Sim.	III Speed
ST W	-571	058	532
ST C	-359	099	765
SL SP	913	244	-093
FR	892	193	-050
RPM	128	745	296
CMC	248	603	-261
FCT	-054	654	-083
MFD	-233	-583	041
VSTM	-244	407	-623
Variance	2.278	1.962	1.431

with Orissa children. The VSTM loads on both the speed and simultaneous factors, although it usually loads on the successive or speed factors. This point will be considered at a later time. Considering the small sample size, however, the factor structure is remarkably congruent with past findings.

For the LEd group, the factors were named successive, simultaneous and speed, respectively, as noted by the placement by the marker tests. Factor I has loadings from the Serial Learning tests, Cross-modal Coding and Visual STM, while factor II contains Matrices, MFD, FCT and CMC. Again the negative MFD loading reflects the fact that it is an error score. Factor III is purely a speed factor and contains only the loadings from the Stroop tests. For this group the CMC loads on the successive and simultaneous factors and VSTM loads purely on the successive factor. Again the structure of the factors is similar to those previously presented.

In the principal components analyses for the HEd group, the factors emerged in the order: successive, simultaneous and speed. Factor I was characterized by the Serial Learning tests and also contained loadings from the Stroop test. As the latter measure latency, they have opposite signs to the Serial Learning tests. Factor II contains the Matrices, CMC, FCT, MFD and VSTM loadings. The negative sign on the MFD reflects the error scoring procedure. Factor III contains loadings from the Stroop test and VSTM.

The most notable feature of this analysis is the split loadings of the Stroop tests. Their main loading is on the speed factor, but they also load with the Serial Learning tests on the successive factor.

A test of Hypothesis 2

The basic similarity of the analyses presented here to those reported by other researchers suggests that the successive-simultaneous model can be successfully applied to the data in the current study. Hypothesis 2 can now be accepted.

Although the factor structures show that these three groups process information in a similar fashion, there are indications of differences. These areas of similarity and difference will be examined in some detail in the next section. A more direct comparison of factor structures using Tucker coefficients of congruence can be found in Appendix B.

CHAPTER VII

SIMILARITIES AND DIFFERENCES BETWEEN THE LEd, HEd AND LHo GROUPS

In the last two sections it was noted that the differences between the groups centred more around verbal abilities than nonverbal abilities, and this was seen against a background of basically similar simultaneous and successive processing strategies.

Verbal-performance differences

Both of the low groups had significantly lower Verbal than Performance IQ scores on the WISC. The HEd group did not show this pattern. This can be taken as the first piece of evidence to indicate that the low groups do not achieve because of verbal difficulties. Although there is a general lowering of the IQ with achievement, the decrease is greater for the Verbal scale. There also tends to be greater differentiation on the verbal tests than on the nonverbal tests.

A further examination of Table V shows that the correlations between the Verbal and Performance scales for the HEd, LEd and LHo groups are .25, .62 and .57, respectively. Verbal and Performance abilities tend to be more independent of one another for the high group than for the low groups. Taken with the other evidence, this would indicate that the high achieving group is more able to apply the appropriate skill to the task than the low groups. The low groups tend not to be differentiated in these abilities, suggesting that they tend to intermix these strategies to a greater extent. On this basis a hierarchy of achievement could be established: HEd, LEd, LHo. The first two are known to be in that order, and the LHo would be placed there by extrapolation from the verbal tests. Indeed, conversations with teachers in Hobbema confirmed this speculation.

Nonverbal similarities

In terms of test results, the Hobbema group seemed to be similar to the LEd group on the nonverbal tests, suggesting equal potential on these tasks. If they can be considered as better estimates of inherited potential than the verbal tests, as can the Raven's Progressive Matrices (MacArthur, 1970), then the conclusion can be drawn that these two groups would be more similar in intellectual capacity than their Verbal IQs predict. Their means, and consequently their abilities, on the Matrices are almost the same. Nonverbal abilities seem much less affected by cultural factors than do verbal skills.

Culture and verbal abilities

In addition, it might be said that although low achieving children tend to be selected in terms of poor verbal abilities (lower Verbal than Performance WISC IQs), the Hobbema children are further disadvantaged through their cultural experiences, particularly those involved in using English as a second language. Even though their native language need not be inferior in its basic level of complexity (Cole & Bruner, 1972), cultural influences may add differing conceptualizing strategies (Das, 1973a; Dart & Pradhan, 1967) which when intermixed with a second language may produce verbal difficulties. Bruner (Bruner et al., 1966) argues that language is the internalization of conceptual tools and is influenced by schooling which, in fact, is contact with Western modes of thinking. Presumably the Edmonton children are more "Westernized" than the Hobbema children. The internalized tools may not be easily translatable from one language to another.

Bernstein (1961, 1965) finds that academic achievement may be related to socioeconomic status, as schooling for the high SES group is more continuous with home experience than for the low SES child. Again, conversations with teachers in Edmonton and Hobbema suggested that both groups that were low achieving were low in SES, with the Hobbema group being lower than even the LEd group. Bernstein also finds that the low SES child is more disadvantaged in verbal than nonverbal areas. Presumably, these effects are linear, that is, the greater the disadvantage, the greater the effects on verbal skills.

To this point the arguments presented suggest that low achieving children are lower in verbal than nonverbal skills. In terms of the present study, this means that the low achieving children have poorer verbal than nonverbal skills, while the high achieving children have equally high verbal and nonverbal skills.

Also, considering only the LEd and LHo children, indirect evidence has been presented to show that although the two groups are equal on nonverbal skills, the LHo group has reduced verbal skills due to lower SES, more restricted codes and less contact with Western (or middle class) modes of thinking.

Successive processing difficulties

The step from reduced verbal skills to reduced successive processing between low and high achieving groups is easily made. It has been noted that the verbal tests tend to load on the successive factors in the principal components analysis, and that they are, in fact, successive skills. The means for Serial Position and Free Recall on the Serial Learning test tend to be more widely separated for the low groups than the high group, suggesting that serial ordering is not as good in the low groups as in the high group relative to free recall. In addition, it was noticed that the LHo children did not seem to have well ordered search/recall patterns in the VSTM. Informal observation suggested that visual search and recall patterns had not been firmly established. These children did not have well established successive strategies for use in short-term memory tasks.

Principal components analyses

In examining the principal components analyses it was noted that Cross-modal Coding loaded differently for all three groups. For the LHo group it loaded on the successive factor, for the LEd group it loaded on the successive and simultaneous factors, and for the HEd group it loaded on the simultaneous factor. If the LHo and LEd are poor in successive skills, they will be stopped in the first stage of this test (auditory perception) and will not be able to proceed to the rest of the test. Indeed, poor performance on this test is associated with the amount of loading in the successive factor.

Speed seems also to have varied loadings between the three groups. In the LHo group it is associated with the VSTM. As mentioned, if this group has poor successive skills, the memory of the digits seen may tend to disappear if the children are unable to match the viewing and recall order very quickly. Thus speed of processing would differentiate the results in this test. This explanation is appropriate for a group that scored poorly on the VSTM. The loadings are similar for the HEd group. However, this group performed at a high level and in fact speed may have only been the final differentiating factor in their scores. Interestingly, for the LEd group the VSTM loads with the Serial Learning and CMC tests on the successive factor, suggesting that these abilities contribute to the ordering of scores on the VSTM test. For the HEd group the Stroop test is associated with both the Serial Learning test and the VSTM test. Perhaps at a high level of performance on these variables the only differentiating factor is speed.

Interestingly, for the low achieving students more tests tend to cluster on the successive factor, perhaps further confirming the notion that successive abilities (or lack of them) are closely associated with academic failure. The high achieving group processes these tasks in a different and also more successful fashion.

A caution is required at this point. Principal component analyses ideally should have sample sizes of over 100. However, the results are suggestive and tend to confirm the earlier beliefs of verbal-successive difficulties being associated with academic failure.

Summary

To reiterate, the main conclusion drawn has been that academic failure is based on a verbal-successive deficiency, and that the LHo group differs from the LEd group mainly in a culturally produced verbal decrement rather than in nonverbal skills.

An experimental remediation program emphasizing successive strategies was applied to the Hobbema children. It is described in the next section.

CHAPTER VIII

THE INTERVENTION PROGRAM: A TEST OF HYPOTHESIS 4

Hypothesis 4 For the Hobbema children, performance on the tests after the intervention will show greater improvement for the maximum treatment group than for the minimum treatment group.

Following the initial testing, and the interpretation of the data to suggest that the low achieving children had successive processing difficulties, a remedial program was designed and administered to the Hobbema children. This was accomplished in the spring of 1972.

Procedures

The sample was divided into two parts, Group I and Group II, receiving maximum training (14-15 hours) and minimum training (3 hours) per child, respectively. In making this division it was decided to keep class groupings intact and thus minimize transfer effects between groups. Group I children were selected from three classes and Group II from two others. Table XVI compares these two groups on the pretest measures. The equality of the groups was established on the basis of the WISC IQs.

Only in two cases, on the Schonell and CMC tests, did the groups differ significantly. In general, it was felt that the division was satisfactory as they were compared on 12 scales. This tended to increase the probability of finding a difference. In the analysis of the posttest data, the scores will be adjusted by covariance for

Table XVI

Comparison of Hobbema Groups on Pretest Measures

	Group I		Group II		ANOVA	
	Mean	SD[1]	Mean	SD[1]	F	p
WISC V	78.39	11.52	77.50	12.46	0.03	.870
P	94.33	11.08	92.55	13.73	0.19	.665
FS	84.55	11.01	83.95	13.75	0.01	.905
STR W	35.50	12.55	30.70	9.87	1.73	.196
SCH	24.06	11.67	31.20	10.20	4.06	.052*
SL SP	89.16	30.35	95.30	35.35	0.33	.572
FR	116.83	33.23	133.10	25.82	2.87	.099
RPM	22.17	3.85	23.90	4.25	1.72	.198
CMC	9.11	3.66	12.30	4.05	6.42	.016**
FCT	11.67	2.52	12.45	1.91	1.18	.284
MFD	3.72	2.89	3.90	2.86	0.04	.850
VSTM	26.05	11.95	24.00	8.63	0.37	.544

[1]A test for the homogeneity of variance (X^2) showed that the null hypothesis could not be rejected for any pair at the $p < .10$ level.

*significant difference at the $p = .05$ level
**significant difference at the $p < .02$ level

difference in initial tests.

Intervention: Individual

<u>Rationale</u>

Recently intervention programs have been critized for their failure to ameliorate the conditions producing low academic achievement. Baratz and Baratz (1970) stress that this is due to the inappropriate belief that the cultural conditions producing academic failure are fundamentally inferior to the mainstream culture. They argue that the intervention programs are remediating deficits that do not exist. They emphasize that the deficits are only superficial manifestations of a cultural or subcultural difference.

Cole and Bruner (1972) make a similar point. They believe that a deficit is only a special case of a difference in cultures. They do state, however, that in certain circumstances a difference can become a "functional deficit". Das (1973a) holds a similar opinion. He feels that when ethnic or minority groups are forced to compete with the majority culture, differences in intellectual processes often place these groups at a disadvantage.

Cole and Bruner suggest that teaching programs must be geared to a difference model. The teaching procedure would emphasize the child's intellectual strengths and transfer these skills to areas of weakness. Das (1973a, 1973b) has provided a model of cognitive processes that provides a basis for analyzing these strengths and weaknesses and, consequently, for building a remedial program. Das has shown that people from different backgrounds have varying simultaneous and successive processing strategies and that individuals have some choice as to how these strategies are employed.

In the preceding sections, it has been shown that low achieving children have inadequate verbal-successive processing skills. Accordingly, a program emphasizing successive strategies has been designed for the Hobbema children.

The children were divided into two groups, one to receive a maximum program, and the other to receive a minimum program. A minimum intervention program was chosen for one group in preference to a no treatment program for several reasons. First, it was felt that contact with the investigation was an important variable in test taking, particularly in a cross-cultural setting. A minimum intervention program would remove some of the differential contact effects. Second, it was decided to make the minimum intervention test relevant. Scores would show differential treatment effects with time spent in the remediation program. This would assure statistical continuity of the treatment effect.

The tasks used in the intervention program were selected according to the criteria presented below. First, they emphasized the use of successive strategies. Second, they were not specific to any subject area. Third, they were uncomplicated to produce or use. Fourth, they were easily available or adaptable for use in the classroom.

Sequence Story Boards

The sequence story boards consisted of three separate stories, each having 12 removable pictures that could be arranged to tell a story. They were entitled "A trip to the zoo", "Grocery store" and

"Building a house", each used on a separate day in the program.[1]

Generally, the procedure was simply to place the pictures in a random order in front of the child and instruct him to arrange them so they would tell a "good" story. When this was completed, the child was to tell the story, picture by picture, paying attention to the details in each picture.

The format of the board was three rows of four pictures each, so in effect the child proceeded in the same order as if he were reading a page.

As he told the story, the inconsistencies in his arrangement were pointed out, and he was given time to correct them.

If the child was having difficulty, the minimum amount of necessary help was given. For instance, he might be asked to point out the first picture in the story, and if he could not do so after a reasonable time, it was shown to him. If it was obvious the child was having considerable difficulty, the pictures were grouped into three piles, one for each row, with the correct pictures for that row in each pile, but in random order.

The purpose of this procedure was to give the child practice in ordering data into sequential forms by paying attention to visual details. Included in this was the necessity for the child to attempt at least some verbalization. The task was expected to augment verbal mediation in serialization and improve scores on the Picture Arrangement and Picture Connection subtests of the WISC and the Serial Learning test.

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[1]These story boards are commercially available from The Judy Company, 310 North Second Street, Minneapolis, Minnesota 55401.

Parquetry Designs

Task I. The parquetry designs kit consisted of a number of squares, rhombuses and triangles of various colors which could be arranged into patterns, the whole pattern usually forming a square. There were four color patterns (templates) available on sheets of paper. In the first few trials, the child built the pattern directly on the sheet simply by placing the colored block over the appropriate shape (and color) on the sheet. This was done mainly to familiarize the child with the various shapes and how they related to each other.

The child was then required to build these designs again, but not on the pattern sheet. He consulted the pattern but built the design directly on the table. This involved not only the perception of the pattern, but also construction of the pattern using the provided design as a reference but not as a template. The patterns contained sub-patterns which could easily be discerned by most students. The children were allowed to choose their own strategies for building the pattern, but if they had difficulty an approach was suggested, generally that of buildin subunits.

The purpose of this task was to teach the children search strategies and to give practice in the serialization of spatial designs. The simplest strategy was to choose a reference point and work from it in a consistent fashion. Generally, much help was not given or required, as the children usually developed an adequate strategy by the third pattern attempted.

Task II. Several series of outline forms were developed which could be filled with the blocks used in the previous task. A series would consist of three to five forms, each more difficult than the preceding one, and developed from it by the addition of more pieces, e.g.

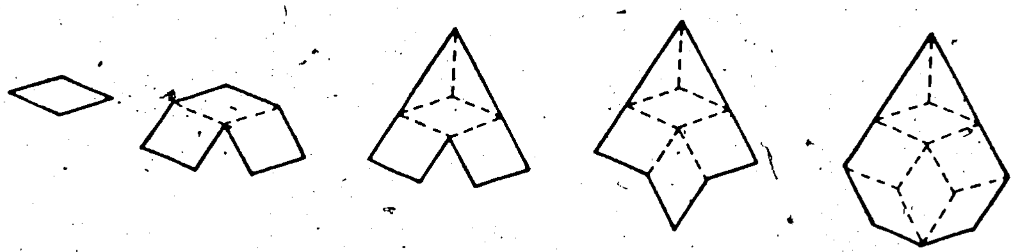

Fig. 3. A typical series of outline forms (dotted lines do not appear on the child's sheets).

Each outline was presented on a separate sheet and they were centred so the pages could be overlayed and the child could see how the easier form related to the more complex one. The outline forms were prepared by making fairly dark lines on ordinary paper.

As he filled in each form, the child was instructed to remember how he did it, and to do the next one in the same way, before adding the new pieces. Performance of this task involved a certain amount of spati memory and the recognition that spatial things are usually made up of serial events. In the beginning many children did not use this approach but simply attacked each form as a new problem. This was allowed, but it made solution much more difficult, as there were generally only one or two patterns that would fill these forms correctly, and the easiest was usually the sequence developed in the series. The forms were all symmetrical and ordered in a way to provide several clues. The child had a choice of colors, as most o the same shapes came in varied colors. Usually he constructed colorfully pleasing patterns.

For most children there was a gradual learning of the required strategy, that of remembering the preceding design and using it as the core of the next one. For some children the strategy worked only for the medium difficulty level and then broke down in the more difficult ones. Generally, the only help given was to show the child he could take the previous sheet with the simpler form and overlay it on the more complex form to try and re-derive some of the relationships. With most children this task seemed to serve the purpose intended, which was to develop consistency in spatial synthesis as well as add memory strategies for use in the solution of spatial problems.

Task III. This series of tasks was much like the preceding one, except that it was more difficult, that is, it contained more complex patterns.

Practice with parquetry blocks should improve the scores on the WISC Block Design and Progressive Matrices as well as scores on the FCT and MFD tests. All three tests are based somewhat on the use of forms and the ability to abstract forms from visual data. The basic blocks and designs are commercially available.

Serial Recall

This intervention task had two parts. In the first, 12 common objects were laid on the table and the child was instructed to name them. Any name the child gave was accepted. These were then placed in a box, and the child was asked to recall as many as he could. If he did not remember all 12, the omitted objects were all placed on the table, and the child studied them once more. He was again asked to recall them. This procedure was repeated until he could recall all 12 objects.

In the second part, 12 different objects were used. As before, they were laid on the table for the child to name, but now he was asked to put them into piles that were "the same" in some way. If he did not understand, some guidance was given. Usually the objects were grouped according to color, material, shape or functional association. This was done to encourage the child to use grouping strategies in recall. The task then continued as in the first part.

Short-term memory is thought to be one of the primary abilities needed for intelligent thought and reasoning (Jensen, [illegible]) and for this reason received a considerable amount of attention in the remedial program. This task should improve the scores on the WISC Digit Span and the other measures of short-term memory.

<u>Coding</u>

In this task the child first underwent a small training series of hand and knee "claps" in which he followed the administrator's movements. This was done to familiarize the child with the task and introduce the two necessary movements: clapping the hands together and slapping both hands on the knees. The movements were done in a rhythmic fashion, using patterns similar to those in the CMC test. When the child was able to copy the instructor's movements, he was introduced to the cards on which these movements were coded by dots and squares: a dot for a hand clap and a square for a "knee clap". The series began with simple patterns and proceeded to more complicated ones. Some patterns are shown below:

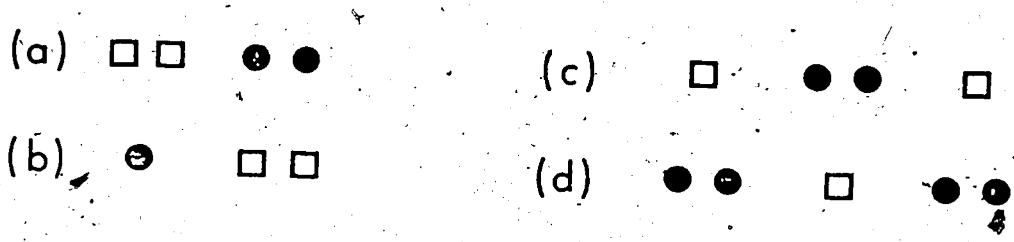

Fig. 4. Some typical "clapping" patterns.

The criterion for each task was completion in a rhythmic fashion. If he did it incorrectly, he was asked to do it again, up to a maximum of three trials. He then proceeded to a new card. Most children completed these tasks reasonably easily although some had considerable difficulty. When the series was complete, the cards were inverted, having the effect of reversing each card, and the series was done again.

The purpose of this task was two-fold. First, it provided practice in visual-auditory (kinesthetic) cross-modal coding. Second, it encouraged the use of symbolic mediation and rhythm which are thought to constitute processes necessary in reading. This intervention device was aimed primarily at the CMC test, but as rhythm is important to many processes, it may have more general implications.

Matrix Serialization

This training series had two parts, differing mainly in difficulty, and presented on different occasions.

Task I. In general the training tasks resembled items presented in the VSTM test. Because it was felt that the children at Hobbema did not have an established visual search pattern, the initial six training series were constructed in a way that they would establish a consistent pattern. Initially, a simple matrix was devised (Figure 5).

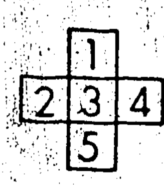

Fig. 5. A simple matrix

This matrix was broken down into its five component parts, each part being presented singly on a separate page as in Figure 6.

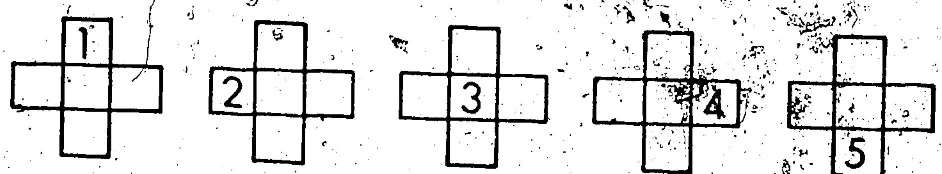

Fig. 6. Component matrices

Each matrix was presented separately in the order shown and the child was expected to read the numbers out loud as they appeared. When all five matrices were shown, he was expected to repeat the entire series of numbers. If he failed to do so, he was shown the complete matrix (Figure 5) and then asked to read it and then recall it. The latter part of the procedure was repeated a maximum of three times. When he could repeat it correctly, he was asked to write it down.

The first six training trials were presented in the fashion outlined. The next six were presented as single matrices, as by this time the order had been established. The task was graded in difficulty to allow for the development of memory strategies.

Task II. The second part was similar to the first except that it was more difficult and was presented during a different time in the remedial program. It consisted of 12 different matrices which were read, repeated and written down.

It was observed during the initial testing that the children did not have consistent search/recall patterns. Consequently, they made many mistakes in serial position recall. It was felt that this was one of the reasons these children were having difficulty reading and comprehending visual material. Consistent visual strategies are required by many perceptual tasks.

This remediation was aimed primarily at the VSTM test but it should also have some more general implications.

Auditory Discrimination and Digit Span

The auditory discrimination task consisted of three parts administered consecutively in one day and contained all of the different words used in the Serial Learning test. The first task series used the words cow, pen, few, day, book, bar, wall, hot, key. The words were read one at a time and the requirement was a simple repetition. If a mistake was made, the word was repeated.

The second part was structured to encourage the use of associations in memory. The words big, long, great, tall, fat, wide, huge, high, large were read one at a time and the child was required to think of a word (or object) that could be described by the stimulus word. When the list was completed, it was read again one word at a time and the child was asked to repeat the word (or object) he originally associated with it. This was done a maximum of two times. It was interesting to note that many children found it difficult to think of words that could be described by these adjectives. These particular children seemingly understood the words but could not apply the concept. Admittedly, the process is the reverse of the usual order for the adjective-noun process; however, it seemed unusually difficult.

The memory part was also poorly done. Time did not permit an expansion of this task even though it was suggestive of a problem area. These words were taken from the semantically similar section of the S[illegible]t.

The third part consisted of the words from the acoustically similar section of the test: man, mad, mat, cat, cab, cap, can, pan, map, tap. These words were read one at a time and the child was asked to write the word down and then to draw a picture representing the word. If the child did not write the word correctly, it was repeated. If the error persisted, his mistake was corrected and he was given some help by example. The purpose of this task was to encourage the use of visual symbolism in auditory tasks.

In general, the purpose of these tasks was to present alternative strategies for use in serial memory.

The digit span task consisted of series of random numbers from three to eight digits in length. The digits were read in such a way as to group them initially into groups of three. The child then repeated them, usually adopting the grouping strategy. As he progressed through each series, the grouping was faded out in the stimulus presentation. The child generally retained his grouping strategy. If he did not, the grouping was reintroduced. This proceeded from series of three numbers to as many as the child could remember. The task was continued until the grouping strategy was firmly established. The purpose of this task was to introduce the grouping strategy into memory. This grouping strategy was intended to improve auditory discrimination and short-term memory as measured by the WISC Digit Span and Serial Learning test.

Summary

These tasks were all done individually. In general, the children were encouraged to use verbal mediation and were encouraged to verbalize their thinking. At all times the writer attempted to encourage the use of appropriate strategies and to lead the learning tasks in such a way as to point out how these strategies were used in the solution of the problem.

Intervention: Group

Sesame Street

This group of children also watched at least eight hours of "Sesame Street" during the course of remediation. There has been considerable interest in educational television and the implications for research and teaching. Meichenbaum and Turk (1972) recently reviewed some of the literature involving "Sesame Street" and concluded it is a significant precedent in combining research and program development. It is especially important in that it can help reduce some of the preschool and continuing differences between the abilities of children.

<u>Filmstrips</u>[1]

In addition, both groups of children went through a series of five filmstrips. The filmstrips were presented to groups of three or four children and were entitled:

Visual discrimination and spatial orientiation

Visual-motor co-ordination

Visual memory

Figure and ground

Visualization

These filmstrips represented the total remedial program for the minimum intervention group (Group II), but only part of the program for the maximum intervention group (Group I).

<u>General description</u>. It is recognized that visual perception plays a major role in learning and cognitive growth. The filmstrips were designed in such a way as to develop perceptual skills and to remediate them for those having problems. Visual perception is not a single skill or ability, and for this reason a series of filmstrips was included to develop the various facets of visual perceptual skills.

Each filmstrip was composed of about 30 frames, each with a separate (visual) problem requiring a response from the children. The filmstrips were shown in groups of three or four children at one time. The children were asked to call out their answers or to respond by raising colored blocks as their response.

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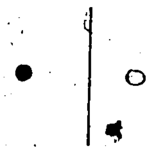
[1]The filmstrips were developed by the Classroom Materials Company, 310 North Second Street, Minneapolis, Minnesota 55401.

The social nature of the task was recognized and taken advantage of in teaching perceptual strategies, as the child had an opportunity to compare his response to that of the whole group. If it was different (wrong, in most cases) he was asked to look at the problem again to see if he was right or wrong and to change his answer if he desired. The others were also asked to examine their responses to see if they were correct. If there was a variety of responses, this was pointed out, and the children again checked their responses.

Because each filmstrip was graded in difficulty, the group as a whole had the opportunity to respond to more and more complex problems. At all times they were required to give correct responses. In the cases that they could not reason out the correct response, it was explained to them before the next problem was encountered. Although not all children could do the most difficult problems, they all seemed to enjoy the task and the associated interactions.

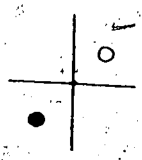
Extreme care was taken in the first few frames to ensure the children knew what was required of them. It was noted that there was often a series of errors before "insight" took place, and subsequently a nearly perfect series of responses. No records were kept of the responses as the children were very sensitive to academic failure. It was reasoned this should be an enjoyable learning experience free from the constraints, failures and frustrations these children usually found in their learning experience. For this reason, the tasks were left as general and unstructured as possible.

Visual discrimination and spatial orientiation. This series included the ability to discriminate directional differences such as right-left, up-down, forward-backward, and in-out in relation to objects in space. For example:



Which dot is to the left of the line? Which dot is to the right.

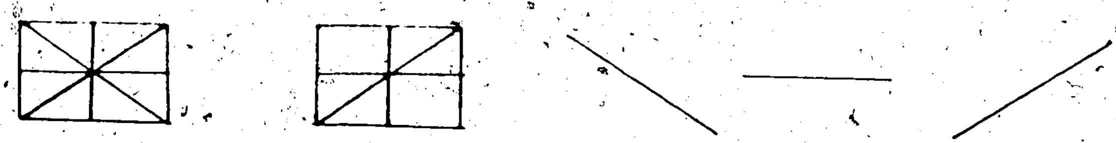
and



Which dot is to the right and above? Which dot is to the left and below? Which dot is to the left and above (none)?

Fig. 7. Two items in visual discrimination and spatial orientation.

Visual-motor co-ordination. This task requires the ability to discriminate and construct the integral components of basic forms. The children were required to decide which of several alternatives would complete one form (incomplete) and make it look like the completed form. For example:



criterion test alternatives

Fig. 8. A visual-motor co-ordination item

The child was required to mentally superimpose each alternative on the test and respond by saying which was the correct one--left, middle or right. It should be noted that this response method reinforces the concept learned in the previous filmstrip.

Visual memory. This task required the ability to remember visual stimuli. Each problem in this series required two frames. The first frame presented the problem in picture form. At the top was a card pictured face down and beneath there were three or more cards presented face up on which there were varied stimulus objects. The child was instructed to remember both the pictures and their positions. In the second frame, the top card was presented face up showing one of the stimulus objects, and the bottom row was presented face down. The child was required to name the position the stimulus object was in previously. For example:

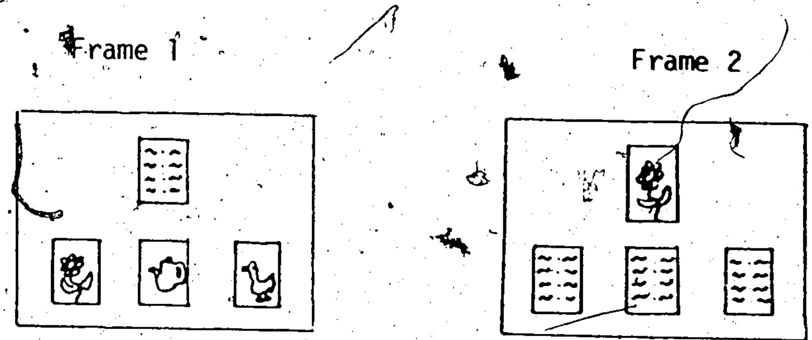


Fig. 9. A visual memory item

After frame 2, the child was required to say "left". If the wrong answers were given, the original was presented again and the child had the opportunity to see what the correct response should have been.

Figure and ground. This task requires the ability to select the appropriate visual stimulus in spite of visual distractions. The problems consist of a number of overlapping or non-overlapping geometrical figures in which colored dots are placed. The questions asked take advantage of the conjunctional forms "and", "but not in", and combinations of these. For example:

Which dot or dots are in the square and the circle but not in the triangle? Which dot is in the triangle but not in the circle or square? Which dot is in the square and triangle but not in the circle (none)?

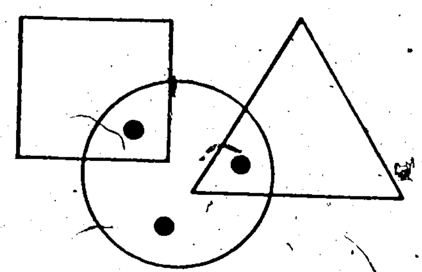


Fig. 10. A figure and ground item

Visualization. This task is based on the ability to integrate all the visual perceptual skills. Complex and overlapping visual stimuli are to be discriminated and the correct response given. In each frame the child is required to follow lines that originate from letters or numbers on the left side to numbers or letters at which they end on the right side. The children were urged to use only their eyes and not their fingers. For example:

Which number does A join up with?

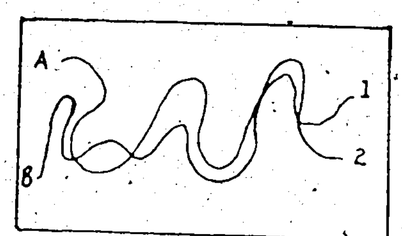


Fig. 11. A visualization item

Summary

The emphasis in the program was on the use of successive skills in both the auditory and visual modalities. For Group I verbal production was encouraged and strategies useful in short-term memory were taught. It was expected that the filmstrips would reinforce the strategies for Group I but yet would provide a general training procedure for Group II.

Group I (maximum intervention) did the total program described above involving approximately 14 hours per child. Group II (minimum intervention) participated only in the filmstrip section of the program. This involved approximately three hours per child.

Results

Having completed the remedial program, the Hobbema children were retested on all measures.

Gain scores

The scores were first checked for improvement within each group by using analysis of variance for repeated measures. The data for these analyses are presented in Table XVII. Group I (maximum treatment) improved on all measures except the WISC V, WISC FS and MFD, while Group II (minimum treatment) improved only on the WISC P, Matrices and CMC. At first glance, at least, the results indicate that the intervention was extremely successful in improving the scores of Group I and less successful in improving the scores of Group II. Differential gains between groups would be expected on the basis of time spent in remediation, and the results are in the predictable direction.

An examination of the correlations between pre- and posttest scores for each group (Table XVIII) indicates that the measures are generally reliable in preserving the rank ordering of individual results. Only in three cases are the correlations not significant, the reasons for which must remain as speculative. For the CMC in Group I the possibilities are either an unreliability in the test effect or differential treatment effects over individuals. The latter is preferred, as the low correlation is also accompanied by significant improvement in results.

Table XVII

Analysis of Variance on Gain Scores (Repeated Measures ANOVA)
for Groups I and II (Hobbema)

	Group I				Group II			
	Pre Mean	Post Mean	F-ratio	p	Pre Mean	Post Mean	F-ratio	p
WISC Verbal	80.27	77.08	1.58	.229	77.75	76.20	1.35	.259
Performance	93.93	100.20	16.46*	.001	92.55	97.55	6.02	.024
Full Scale	85.33	87.07	2.05	.174	82.95	85.10	3.02	.098
Stroop Word	36.13	30.93	5.71*	.031	30.70	28.55	3.31	.085
Stroop Color	49.47	40.07	5.94*	.029	44.05	43.15	.27	.611
Schonell	24.80	28.27	60.47*	.001	31.20	29.70	1.90	.185
Serial Learning SP	89.88	117.33	18.45*	.001	94.65	90.95	.65	.429
FR	120.20	152.80	36.81*	.001	133.10	131.00	.16	.691
Progressive Matrices	21.67	24.87	14.30*	.002	23.90	26.25	7.93*	.011
Cross-modal Coding	9.27	14.67	26.21*	.001	12.30	14.35	7.87*	.011
Figure Copying	11.27	13.27	16.80*	.001	12.45	12.60	0.07	.790
Memory for Designs	4.07	3.93	.02	.900	3.90	3.90	0.00	1.00
Visual STM	26.05	30.47	12.87*	.004	24.00	26.40	8.03	.099

*significant improvement

Table XVIII

Correlation between Pre- and Posttest Scores for Groups I and II

	Group I	p	Group II	p
WISC Verbal	.749	.001	.878	.001
Performance	.879	.001	.763	.001
Full Scale	.922	.001	.900	.001
Stroop Word	.791	.001	.849	.001
Schonell	.990	.001	.889	.001
Serial Learning SP	.754	.001	.840	.001
FR	.773	.001	.551	.012
Progressive Matrices	.602	.018	.561	.011
Cross-modal Coding	.380	NS	.654	.002
Figure Copying	.762	.006	.405	NS
Memory for Designs	.361	NS	.544	.013
Visual STM	.642	.010	.671	.001

The MFD is subjectively marked and this is probably reflected in the low correlation for Group I, although scores are accompanied by a small but statistically unreliable gain. For the FCT with Group II, the low correlation does not occur along with a change in mean scores and probably reflects unreliable subjective marking, although the test is highly reliable for Group I. One other possibility for the FCT is that the low correlation simply reflects a restricted standard deviation. The results from these tests must be interpreted with caution.

Considering the test-retest reliability generally, it is unlikely that the gain scores are spurious, and therefore they must be attributed to the remedial program.

Posttest comparisons on means

The group posttest means were also compared by analysis of variance procedures (Table XIX). Group I was clearly superior to Group II only on the Serial Learning tests. Recalling the pretest comparisons,

Table XIX

Posttest Comparisons between Groups
Using Analysis of Variance (Hobbema)

	Group I (N = 15)		Group II (N = 20)		ANOVA	
	Mean	SD[2]	Mean	SD[2]	F[1]	p
WISC Verbal	77.80	8.10	76.20	10.75	0.23	.633
Performance	100.20	12.23	97.55	12.54	0.39	.537
Full Score	87.07	9.63	85.10	12.10	0.27	.608
Stroop Word	30.93	11.94	28.55	9.16	0.45	.508
Schonell	28.27	12.54	29.70	10.47	0.14	.715
Serial Learning SP	119.47	36.62	90.90	37.54	5.07*	.031
FR	152.73	23.24	130.95	23.01	7.62**	.009
Progressive Matrices	25.20	3.14	26.25	3.63	0.80	.377
Cross-modal Coding	14.67	3.77	14.35	3.79	0.06	.808
Figure Copying	13.27	1.79	12.60	2.56	0.74	.396
Memory for Designs	3.93	4.04	3.90	3.37	0.00	.979
Visual STM	30.47	7.05	26.40	9.02	2.09	.158

[1]df between groups = 1, error = 33.

[2]Tests for homogeneity of variance (X^2) revealed that no variances were different at the $p < .10$ level of significance.

*significant at the $p < .05$ level
**significant at the $p < .01$ level

however, one can see that there are fewer significant differences than before, showing that the groups are more similar at this point than they were at pretest. Group I showed somewhat poorer performance on the pretest measures than Group II and real differences in gains may be obscured by differences in starting position.

Covariance analysis

The groups were again compared on posttest means, but the pretest means were adjusted for initial differences by a covariance technique. The resulting F-ratios and probabilities are shown in Table XX.

This procedure showed that Group I showed significant gains on the Schonell, Serial Learning and VSTM tests over Group II.

Table XX

Analysis of Variance with Covariance Adjustment between Groups I and II at Posttest (Hobbema)

	F-Ratio	p
WISC Verbal	0.002	NS
Performance	0.390	NS
Full Score	0.001	NS
Stroop Word		
Schonell	11.470*	.002
Serial Learning SP	15.83*	.001
FR	21.12*	.001
Progressive Matrices	0.09	NS
Cross-modal Coding	2.69	NS
Figure Copying	3.14	.085
Visual STM	6.00*	.020

*significant change

Test of Hypothesis 4

In order to test Hypothesis 4, three sets of analysis were performed. In the first, the posttest scores were compared to the pretest scores for both groups. This analysis indicated that Group I scores improved on practically all the test measures and that Group II gained on some of the test measures. The results were taken to suggest that the intervention program successfully changed test performance.

In the second analysis, the two groups were compared on posttest scores. Group I was superior to Group II only on the Serial Learning measures. It was noted, however, that Groups I and II were somewhat different on the pretest measures. Therefore, in step three these initial differences were removed by covariance and the adjusted posttest means were again compared. This analysis showed that Group I gained differentially over Group II in the Schonell, VSTM and Serial Learning tests. Hypothesis 4 can be confirmed for these measures.

Summary

The main conclusions must be that visual and auditory memory showed significant improvement and that these gains are attributable to the intervention program. The improvement in word recognition could also be attributed to the intervention program, although this improvement was unexpected. Possibly the training in successive skills transferred to word attack skills and resulted in improved word recognition.

Some Supplementary Analyses: The Hobbema Children at Posttest

In the following sections, some supplementary analyses are provided. It was felt that although Hypothesis 4 has already been tested, additional analysis would provide interesting information about the more specific nature of any changes. Accordingly, a posttest factor analysis was computed and compared to the pretest. In addition, the LHo group posttest scores were compared to the low achieving children.

Posttest principal components analysis

In the factor analysis based on post-intervention scores (Table XXI), the factors emerged in a different order. The serial factor continued

Table XXI

Principal Components Analysis
for the LHo Group at Posttest (N = 35)

	I Successive	II Simultaneous	III Speed
Stroop Word	01	065	906
Color	-237	-127	829
Serial Learning SP	890	254	-061
FR	890	240	-079
Progressive Matrices	495	289	031
Cross-modal Coding	743	-103	-256
Figure Copying	030	855	140
Memory for Designs	-242	-772	164
Visual STM	488	580	-114
Variance	2.735	1.898	1.644

to account for the most variation, but now the speed factor became less important than the simultaneous in accounting for the variance. The VSTM now loads more appropriately on the serial and simultaneous factors rather than on speed and simultaneous. It seems that the introduction of consistent search and recall strategies has eliminated speed as a limiting variable. The shift was accompanied by an improvement in performance in Visual Short-term Memory.

On the other hand, although scores for the serial and free recall tests showed highly significant improvement, the factor loadings did not shift. This also is expected; these have been found to be the marker tests for the successive factor.

The results of the factor analyses on post-intervention scores thus support the emergence of simultaneous, successive and speed as factors describing the performance of the Hobbema children in the present test battery. The effect of intervention was to increase the reliability of these children's performance, so that the factor structure is comparable to that obtained in previous studies on Caucasian school children.

Comparison of the LEd group to the LHo group at posttest

As was mentioned earlier, the LHo group gave some strong indications that it was an average group, at least in some respects. Although this specific point was not part of the hypothesis, it was decided to pursue this line of investigation further.

The total Hobbema samp[illegible]s again compared to the LEd group by means of an analysis of variance. A perusal of the means (Table XXII) will show that the two groups are now more similar than they were previously (Table VI, p. 60), although there still are WISC V, WISC FS, Stroop Word and Serial Learning SL differences favoring the LEd group. In some cases (FCT, RPM and Schonell), the scores now favor the Hobbema group, although not significantly.

Table XXII

A Comparison of the LHo (Posttest) and LEd Groups by Analysis of Variance

	LEd		LHo			
	Mean	SD	Mean	SD	F	p
WISC Verbal	93.88	10.51	76.89	9.60	60.09*	.001
Performance	98.96	11.87	98.40	12.46	0.05	.830
Full Scale	96.00	11.06	85.80	11.03	18.35*	.001
Stroop Word	25.52	5.32	29.51	10.28	5.94*	.017
Schonell	28.59	5.28	28.97	11.30	0.05	.828
Serial Learning SP	130.43	33.45	101.37	39.19	14.23*	.001
FR	147.61	28.24	139.26	25.58	2.02	.159
Progressive Matrices	23.84	6.43	25.63	3.55	2.27	.136
Figure Copying	11.89	2.63	12.80	3.30	2.80	.098
Memory for Designs	5.54	4.29	3.67	3.60	4.52*	.036
Visual STM	28.09	10.26	27.94	8.46	0.00	.945

*Significant difference

The differences in performance have been reduced, but not removed.

Indicators of intellectual strengths for the LHo group were best shown on two measures: the Raven's Progressive Matrices and the WISC Performance scale. The Matrices test has been considered a "culture reduced" test of intellectual abilities and has been used extensively in assessing this ability in non-Western groups of people (MacArthur, 1972). The scores, however, are converted into percentiles rather than standardized IQ points. A distribution of percentile scores was plotted for the combined group on the pre- and posttest situations (Table XXIII). As can be seen, in both cases more than one-half of the group scores above the fiftieth percentile.

Table XXIII

Percentile Scores on Raven's Progressive Matrices
on Pre- and Posttest for the Hobbema Sample

Pretest			Posttest		
Percentiles	Frequency	Totals	Percentiles	Frequency	Totals
90-100	4	21	90-100	8	24
80-89	4		80-89	2	
70-79	3		70-79	3	
60-69	2		60-69	4	
50-59	8		50-59	7	
40-49	5	17	40-49	2	11
30-39	0		30-39	0	
20-29	6		20-29	5	
10-19	2		10-19	1	
0-9	4		0-9	3	

It was also noted that the LHo as well as the LEd group scored within the average range on the WISC Performance scale. In these ways, at least, they seem to be a normal group. This has important implications in educational practice, as it seems these children have some potential that is not being used effectively by current school practices. The preceding analyses suggest that teaching could take advantage of the nonverbal skills the low achieving children already have.

CHAPTER IX

AN ANALYSIS OF THE WISC SCORES FOR THE LHo, LEd AND HEd GROUPS

It has already been shown that the WISC is a reliable predictor of achievement, and that low achieving children have lower Verbal than Performance IQs. It was decided to investigate the nature of the WISC scores by considering the subscale scores. These subscale scores readily lend themselves to factor analysis and profile comparisons. These supplementary analyses were performed for the LHo, LEd and HEd groups. A profile of subscale scores can be seen in Figure 12. Mazes were not included with the factor analyses.

WISC profiles

The most striking feature of the profile is the almost perfect ordering of the three groups. The order established by the WISC is the same as that established by the instruments used in the present study. It seems that the WISC is a reliable predictor of group means for cognitive tests and for achievement within the Edmonton sample. In all probability the achievement hierarchy would extend to include the Hobbema group. The greatest overall differences are seen on the Verbal scale and it is likely that academic achievement is related most closely to this scale.

On the Performance scale the differences between the LEd and LHo groups virtually disappear. This gives the impression that the groups are very similar on this scale.

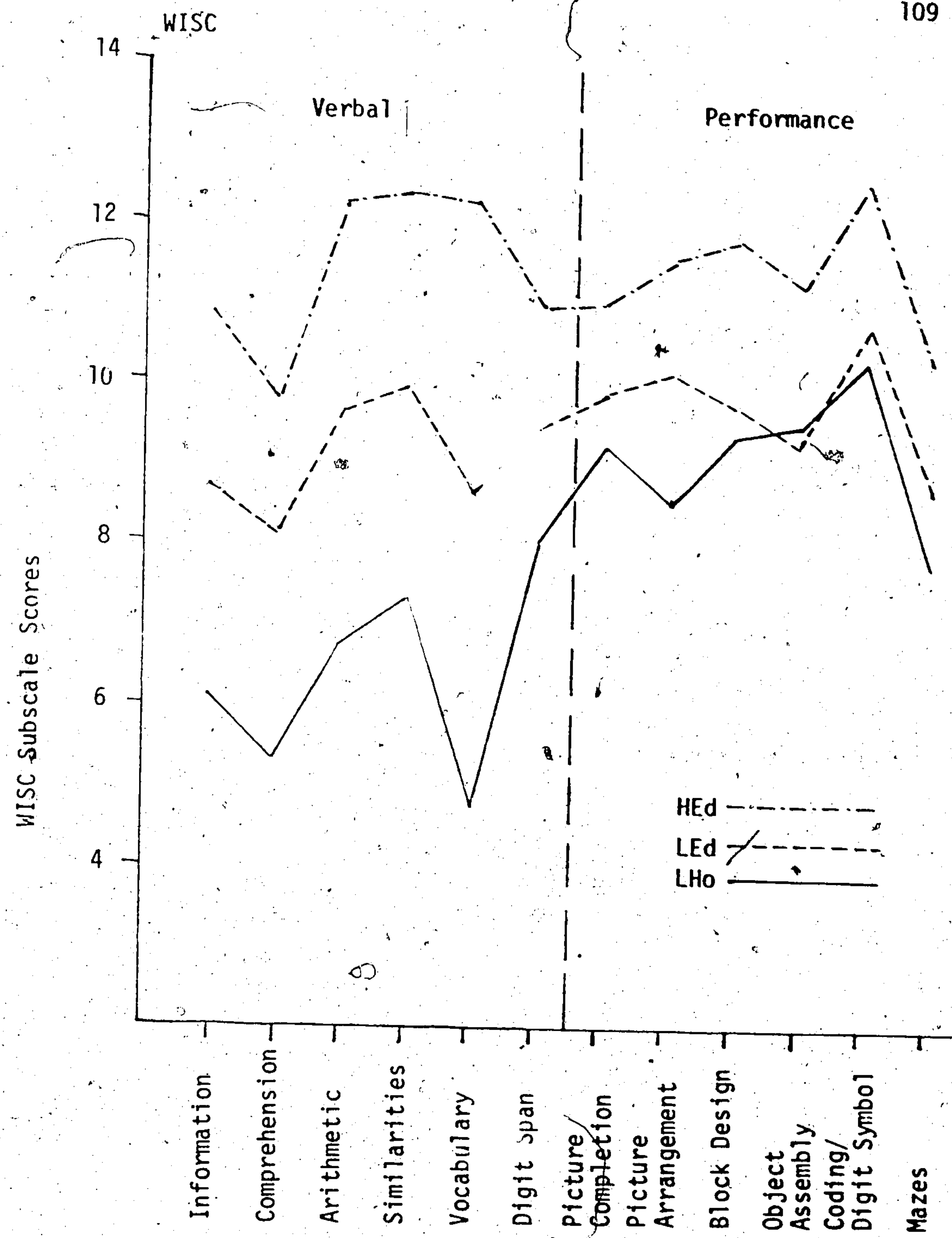


Fig. 12. WISC subscale profiles for the LHo, LEd and HEd groups

Intercorrelation of WISC scales

When the Verbal, Performance and Full Scale IQ scores were correlated to performance on the Progressive Matrices (Table XXIV), it was noted that the Matrices test correlates more with the Performance Scales than the Verbal scales. This could be expected, as the Matrices

Table XXIV

Correlations of the Matrices with the WISC IQ Scales for the LHo, LEd and HEd Groups

	RPM Verbal	RPM Performance	RPM Full Scale
LHo	.233	.554	.440
LEd	.501	.542	.605
HEd	.146	.604	.472

test is regarded as a nonverbal test of intelligence. For the LEd group the Matrices correlates with the Verbal and Performance scales to the same extent, suggesting that verbal and nonverbal tasks are processed in a similar fashion by these children. An examination of the WISC scale intercorrelations (Tables XXV, XXVI and XXVII) revealed

Table XXV

WISC IQ Scale Intercorrelations for the LHo Group

	Verbal	Performance	Full Scale
Verbal	1	.567	.803
Performance		1	.901
Full Scale			1

Table XXVI

WISC IQ Scale
Intercorrelations for the LEd Group

	Verbal	Performance	Full Scale
Verbal	1	.620	.903
Performance		1	.918
Full Scale			1

that the Full Scale IQ was highly correlated with both the Verbal and Performance scales for all groups.

Table XXVII

WISC IQ Scale
Intercorrelations for the HEd Group

	Verbal	Performance	Full Scale
Verbal	1	.245	.789
Performance		1	.779
Full Scale			1

It is also noted that the Verbal scale does not correlate with Full Scale IQ, but that Verbal and Performance scales do for the low achieving groups. These groups may be depending on one particular strategy, perhaps simultaneous, to solve intellectual problems, resulting in the interdependence between the two. The high achieving group, having well developed successive and simultaneous skills, uses them independently. Verbal and Performance IQs for this group appear to be relatively uncorrelated.

Principal components analyses

Quereshi (1972) presents results from a study in which he analyzed the WISC subscale scores (excluding Mazes) for 6, 10 and 14 year old children by the principle components procedure with a Varimax rotation. Table XXVIII reproduces these results for the 10 year old sample.

Table XXVIII

A Principal Components Analysis of WISC Subscales for 10 Year Old Children

	I	II	III	IV
Verbal				
Information	67	39	11	17
Comprehension	88	- 09	06	10
Arithmetic	31	41	19	60
Similarities	49	42	-24	16
Vocabulary	77	40	06	11
Digit Span	05	06	94	04
Performance				
Picture Completion	09	70	28	01
Picture Arrangement	40	45	05	03
Block Design	14	77	-07	34
Object Assembly	27	71	-05	23
Coding/Digit Symbol	08	13	-05	92

A similar procedure was used for the groups considered by this study. These analyses can be found in Tables XXIX, XXX and XXXI. For the Edmonton groups, four factors emerged naturally, but for the Hobbema group only three appeared. It was decided to accept the fourth factor for this group to faciliate comparison.

Quereshi named the four factors: Verbal Comprehension and Expression, Perceptual Organization, Perceptual Speed and Freedom from Distraction. In the Edmonton analyses, the factors were not named, but they appear to be similarly constructed. To test the similarity, a procedure designed by Tucker (Harman, 1967), in which coefficients of

Table XXIX

Principal Components Analysis (Varimax) on WISC Subscales for the LHo Group

	I	II	III	IV
Verbal				
Information	803	124	310	-003
Comprehension	794	-006	194	-073
Arithmetic	513	-046	554	438
Similarities	842	180	141	-013
Vocabulary	915	121	-047	181
Digit Span	559	154	544	253
Performance				
Picture Completion	-051	204	-001	928
Picture Arrangement	516	427	269	453
Block Design	197	897	044	093
Object Assembly	017	770	334	197
Coding/Digit Symbol	145	359	835	-086
Variance	3.726	1.839	1.641	1.415

Table XXX

Principal Components Analysis (Varimax) on WISC Subscales for the LEd Group

	I	II	III	IV
Verbal				
Information	232	612	444	153
Comprehension	009	767	-112	024
Arithmetic	238	403	662	046
Similarities	449	450	080	407
Vocabulary	236	767	263	045
Digit Span	046	041	066	962
Performance				
Picture Completion	774	143	041	-027
Picture Arrangement	446	354	141	-097
Block Design	733	262	253	178
Object Assembly	760	-055	240	120
Coding/Digit Symbol	103	-042	888	047
Variance	2.297	2.137	1.660	1.178

Table XXXI

Principal Components Analysis (Varimax) on WISC Subscales for the LEd Group

	I	II	III	IV
Verbal				
Information	839	124	088	016
Comprehension	604	009	-063	-645
Arithmetic	141	524	103	092
Similarities	826	034	-158	136
Vocabulary	612	461	-095	057
Digit Span	239	-038	-036	843
Performance				
Picture Completion	136	776	-265	024
Picture Arrangement	444	105	540	311
Block Design	-035	617	449	-133
Object Assembly	035	689	242	-126
Coding/Digit Symbol	-185	094	803	-060
Variance	2.456	1.983	1.324	1.292

congruence are generated was employed. Tucker does not provide levels of significance except to say that coefficients of .93 are "high" and ".46" are low. The procedure produces two sets of comparisons; one for a direct comparison and another set for a comparison in which one matrix is rotated (Varimax) against the other to arrive at the best possible fit. Results from the rotated comparison will be presented here, and only those for the relevant factor pairs (Table XXXII).

The comparisons show that the factors have rather remarkable congruence considering the rather large numbers of differences between groups. This attests to the robustness of WISC scores under a wide range of conditions. A large source of difference was thought to be the restricted IQ ranges for the groups in the present study compared to the normal range reported in the Quereshi study. However, Kebbon (1965) found that, generally, factor structures remained constant even

Table XXXII

Tucker Coefficients of Congruence for Factor Comparisons (Rotated) of the LHo, LEd and HEd Groups to the Quereshi 10 Year Old Sample

	I	II	III	IV
HEd to Quereshi	.9287	.9220	.6603	.7398
LEd to Quereshi	.8438	.9863	.7137	.9400
LHo to Quereshi	.9124	.8959	.6122	.8597

if restricted samples were taken. Here the factor structures appear to remain stable even for small sample sizes and groups of different ages.

For the HEd, LEd and LHo groups, Factors I and II appeared to make Verbal-Performance distinctions; however, these were not exceptionally clear except for the LHo sample.

An analysis of the differences between the compared factor matrices through the use of error matrices (not presented here) revealed that the HEd group differed from the average group mainly in the way Similarities and Picture Arrangement were performed, while the LHo and LEd groups differed mainly in Vocabulary. The high achieving group seems to differ in abstract reasoning while the low group differs in knowledge of word meanings.

CHAPTER X

RELATIONSHIPS BETWEEN ACHIEVEMENT, INTELLIGENCE AND COGNITIVE TESTS FOR THE HEd AND LEd GROUPS

The purpose of this section of the report is to explore the relationship between achievement, intelligence and cognitive scores for the HEd and LEd groups. It was expected that the differences in patterns of ability already found would be revealed more specifically in these relationships. The MEd group will be included in these analyses where possible.

Mean scores and analyses of variance

Performance on the achievement test measures ("system tests") is summarized for all three groups in Table XXXIII, with the subsequent analyses of variance and paired comparisons in Tables XXXIV and XXXV. The mean scores perfectly differentiate the groups into the three categories derived from school performance (high, medium and low), suggesting that the original designations are viable. In the paired comparisons, only two differences were not significant. For the HEd-MEd comparison, differences in the Stanford Achievement test (Word Study Skills) and the Lorge-Thorndike Nonverbal scales were not significant. As a general conclusion, the premise that these three groups are statistically different in performance can be accepted.

These results demonstrate that high and low achieving groups can be reliably chosen in terms of the tests used by the Edmonton Public School Board. The tests sample reading/comprehension, intelligence, spelling and arithmetic skills, and these tend to predict general achievement as indicated by grade performance and teacher judgement.

The system tests tend to be verbally oriented, and probably best

Table XXXIII

A Comparison of Mean Scores for Edmonton Groups

Tests	HEd (N = 56)		MEd (N = 43)		LEd (N = 56)		Total Edmonton (N = 155)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Gates MacGinitie								
Vocabulary	40.93	5.03	36.65	5.09	30.46	5.67	35.68	6.87
Comprehension	36.29	9.61	28.70	7.81	24.02	6.09	29.75	9.49
Spelling	46.00	8.50	40.83	6.04	34.04	5.84	40.24	8.58
Arithmetic	48.45	7.14	43.33	7.55	38.89	10.28	43.57	9.36
Stanford AT								
Word Meaning	[illegible]5.36	4.59	24.44	4.88	21.09	5.16	24.65	5.84
Paragraph Meaning	[illegible].45	8.44	39.09	6.52	30.63	6.86	37.97	9.41
Word Study Skills	52.57	[illegible].39	50.67	7.38	41.96	9.82	48.21	9.81
Lorge Thorndike								
Verbal	110.64	13.55	99.72	12.37	86.98	10.29	99.06	15.67
Nonverbal	[illegible]0.09	16.08	103.51	13.42	88.20	15.24	100.35	17.70

Table XXXIV

Analysis of Variance (ANOVA)
between Groups (HEd, MEd, LEd)

Tests	df Groups	df Error	F-Ratio	p
Gates MacGinitie				
Vocabulary	2	152	54.80	.001
Comprehension	2	152	33.60	.001
Spelling	2	152	41.49	.001
Arithmetic	2	152	17.67	.001
Stanford AT				
Word Meaning	2	152	31.07	.001
Paragraph Meaning	2	152	49.69	.001
Word Study Skills	2	152	23.35	.001
Lorge-Thorndike				
Verbal	2	152	53.37	.001
Nonverbal	2	152	30.81	.001

Table XXXV

Paired Comparisons between Means
for the HEd, MEd and LEd Groups
(Scheffe Procedure)

Tests	HEd-MEd	MEd-LEd	HEd-LEd
Gates MacGinitie			
Vocabulary	**	**	**
Comprehension	**	017*	**
Spelling	**	**	**
Arithmetic	014*	040*	**
Stanford AT			
Word Meaning	**	**	**
Paragraph Meaning	**	**	**
Word Study Skills	560	**	**
Lorge-Thorndike			
Verbal	**	**	**
Nonverbal	102	**	**

*p < .05
**p < .01

illustrate that achievement is related to verbal abilities. Nonverbal tasks are not adequately represented and a judgement about the relationships between achievement and nonverbal skills cannot be made from these data.

Achievement and intelligence

The relationship between verbal and nonverbal skills, intelligence and achievement was explored for the HEd and LEd groups, by means of a series of factor analyses. In addition to the "system tests", the WISC Verbal and Performance, the Lorge-Thorndike Verbal and Nonverbal, the Schonell and the Raven's Progressive Matrices scores were used. For both groups four factors emerged.

The factors for the HEd group (Table XXXVI) were named Verbal-Intellectual, Nonverbal IQ, Study Skills and Verbal Comprehension. The line in the table divides the achievement tests from the others. Factor I is composed of the GM Vocabulary and Comprehension, Spelling and Stanford Achievement Word Study Skills, along with WISC Verbal, Lorge-Thorndike Verbal and Schonell. This factor shows very clearly the clustering of verbal skills and school achievement for the HEd group.

The second factor is clearly a nonverbal factor containing the WISC Performance, Lorge-Thorndike Nonverbal and Matrices loadings. Significantly, it has no corresponding loadings from the achievement tests, thus reinforcing, although negatively, the postulate of a high verbal component in achievement.

Factor III was termed Study Skills mainly because of the Stanford Achievement Word Study Skills and Arithmetic loadings. It seems that

Table XXXVI

Principal Component Analyses (Varimax) on Achievement and Intelligence for the HEd Group

	Verbal Intelligence	Performance IQ	Study Skills	Verbal Comprehension
Gates MacGinitie				
Vocabulary	651	208	300	488
Comprehension	669	177	438	265
Spelling	877	-053	226	-115
Arithmetic	097	272	801	-118
Stanford AT				
Word Meaning	126	058	069	884
Paragraph Meaning	521	139	562	432
Word Study Skills	200	-075	775	220
WISC				
Verbal	640	182	-010	339
Performance	228	822	182	-131
Lorge-Thorndike				
Verbal	608	290	172	486
Nonverbal	110	804	004	258
Schonell	874	025	084	059
Progressive Matrices	-036	837	072	099
Variance	3.585	2.321	1.972	1.800

achievement in Arithmetic for the high group is differentiated by the ability to carefully examine the problem. This factor is characterized by the lack of loadings from the predictive measures. Evidently, the IQ tests do not tap the differential study skills that determine achievement in the high group.

Factor IV was named Verbal Comprehension and was characterized mainly by the STA WM. It is significant to note the absence of word reading ability (Schonell) on this factor. The achievement measures have corresponding values from the WISC Verbal and Lorge-Thorndike Verbal.

A different picture emerged when the analysis for the LEd group was inspected. If one regards only the top half of the HEd and LEd analyses, one sees that the achievement tests load in a fairly similar, although not identical, fashion. However the lower portions seem extremely dissimilar. The obvious conclusion to be drawn is that group achievement tests for the two samples cluster with different abilities.

The factors were termed Verbal-Educational, Study Skills, Intelligence (g) and Verbal Comprehension, although the labels are not totally satisfactory. One of the more striking features of this analysis is the lack of verbal and nonverbal clustering. Reasons for this do not make themselves readily apparent, but they may be related to various limitations including, perhaps, successive skills.

Factor I for the LEd group is similar to that of the HEd group. The most notable feature of this factor is the high loading of the Schonell test and the lack of loading from the WISC Verbal, impelling the conclusion that achievement for the LEd group is most dependent on the ability to read, and that lack of reading ability obviously excludes the possibility of using other abilities in school work. Reading ability, in this case, acts as a threshold variable. Once he is able to read, he is also able to use other abilities in the classroom. This interpretation is supported by inspecting Factor III which appears to be a general intelligence factor and yet has no corresponding loadings in the achievement area. Apparently, there is a large fund of skills yet untapped in the low achiever.

Factor II, although labelled Study Skills, may involve simultaneous

Table XXXVII

Principal Component Analyses (Varimax) on Achievement and Intelligence for the LEd Group

	Verbal Intelligence	Performance IQ	Study Skills	Verbal Comprehension
Gates MacGinitie				
Vocabulary	770	007	074	269
Comprehension	830	199	-098	302
Spelling	799	-014	100	-165
Arithmetic	049	869	-064	089
Stanford AT				
Word Meaning	153	-039	164	886
Paragraph Meaning	690	239	022	297
Word Study Skills	715	257	201	-189
WISC				
Verbal	149	655	325	-427
Performance	-020	548	686	-130
Lorge-Thorndike				
Verbal	380	007	751	141
Nonverbal	-042	079	851	086
Schonell	701	-330	076	-049
Progressive Matrices	063	815	187	001
Variance	3.596	2.429	2.002	1.336

abilities and may represent a conceptualization ability. One is drawn to the negative loading from the Schonell test on this factor. It appears that word reading ability interferes with the ability to do arithmetic or vice versa. Poor successive skills may reveal themselves in the form of interference from simultaneous skills. This group is possibly using simultaneous skills to compensate for poor successive skills. An interpretation of this nature would also explain the lack of verbal and nonverbal clustering, as there would be no clear-cut strategies for the use of simultaneous or successive skills.

Factor IV has its highest loading in the form of Word Meaning with the addition of GM Comprehension. It is interesting to consider the significance of the negative WISC V loading. Again this suggests the operation of an interference factor. There may be a competition between understanding and a rote factor, either memory or speed. Knowledge of word meanings would thus be related to memory rather than to verbal abilities. Children must know the meanings of words before they can use them to gain understanding.

To summarize, the LEd group is most clearly seen in terms of its limitations rather than its skills. In the first instance there was the threshold effect of reading ability in achievement. Secondly, the competition between successive and simultaneous skills was seen in arithmetic and in general intellectual functioning. Thirdly, there appeared to be a conflict between memory and comprehension.

The HEd group, on the other hand, is able to utilize verbal and nonverbal (successive-simultaneous) skills appropriately. This is demonstrated by the relatively clear loadings of these tests on the factors.

Achievement and Das battery

In this analysis achievement measures are used again, this time in conjunction with the cognitive measures. This analysis is intended to investigate the relationship between cognitive skills and achievement. As in the previous analyses, only the HEd and LEd groups are represented.

For both groups five factors emerged; however, it was felt that naming them would not serve any purpose as the comparisons would be performed on a selective rather than a total basis. The achievement tests cluster in much the same fashion as in the previous analyses, indicating the robustness of these groupings and inviting comparisons between these and the previous analyses.

For the HEd group (Table XXXVIII), Factor I again contains loadings from most of the achievement tests and the suggestion of a verbal-intellectual factor is supported. The Schonell test figures prominently in this factor; however, it is evident that short-term auditory and visual memory also play a small role in this factor. Word reading speed seems to be more important, perhaps in the amount of material covered, or in the ease with which words and phrases are conceptualized.

In the analysis of the LEd data, the achievement cluster is similar except that STA WM is not included in Factor I (Table XXXIX). The Schonell test has a high loading on this factor; however, the lower emphasis on speed combined with the loadings on the FCT and CMC suggest that reading and pre-reading skills are, in fact, the main components of achievement. For the HEd group, achievement is governed by speed and memory in material that is read, while in the LEd group achievement is related to the ability to decode words.

Achievement in arithmetic can also be differentiated between the two groups. For the HEd arithmetic loads on Factor IV along with STA PM, STA WSS and CMC. Comparing this to the previous analysis, one notices the absence of GM V and GM C which now load with auditory memory. Arithmetic scores seem to be more closely related to ability to decode information and to pay attention to detail in understanding the problem

Table XXXVIII

Principal Components Analysis (Varimax) on Achievement and Cognitive Tests for the HEd Group

	I	II	III	IV	V
Gates MacGinitie					
Vocabulary	650	405	279	140	307
Comprehension	727	320	183	192	209
Spelling	846	139	-110	106	181
Arithmetic	123	249	097	814	048
Stanford AT					
Word Meaning	328	-001	279	003	676
Paragraph Meaning	602	346	128	377	355
Word Study Skills	462	-064	008	652	184
Stroop Word	-527	-201	-023	-275	-146
Schonell	843	147	096	010	-071
Serial Learning SP	318	909	150	134	-004
FR	271	915	064	139	-040
Progressive Matrices	-055	033	862	130	080
Cross-modal Coding	036	267	525	437	-187
Figure Copying	-093	092	418	201	-573
Memory for Designs	-351	-101	-638	150	082
Visual STM	343	-049	184	-227	-604
Variance	3.780	2.296	1.897	1.733	1.559

than to remembering the input information.

For the LEd group, arithmetic is split between Factors IV and II. Factor IV appears to be a memory or successive processing factor, while Factor II seems to be a simultaneous processing factor. Possibly

Table XXXIX

Principal Components Analysis (Varimax) on Achievement and Cognitive Tests for the LEd Group

	I	II	III	IV	V
Gates MacGinitie					
Vocabulary	767	166	-052	-063	315
Comprehension	735	007	116	272	393
Spelling	768	-066	181	121	-026
Arithmetic	036	480	019	708	-072
Stanford AT					
Word Meaning	097	148	-209	057	768
Paragraph Meaning	654	087	-009	221	373
Word Study Skills	772	248	257	093	-209
Stroop Word	-247	162	-140	146	-778
Schonell	639	-462	143	-068	229
Serial Learning SP	160	132	942	169	-034
FR	178	183	908	202	-046
Progressive Matrices	130	716	094	298	-080
Cross-modal Coding	334	311	177	614	-165
Figure Copying	457	597	130	-204	-010
Memory for Designs	132	-801	-187	-124	-177
Visual STM	054	-091	267	768	103
Variance	3.638	2.259	2.074	1.861	1.769

achievement in arithmetic for the LEd students is determined by the ability to attend to and retain numerical information in store for manipulation rather than by the ability to conceptualize the problem. Attention, decoding and memory are preconceptual skills and their association with arithmetic reinforces the idea that the LEd children are limited by their lack of prerequisite skills.

Factor V for the HEd group contains STA WM along with GM V and STA PM, suggesting that word meaning is tied to having a large vocabulary and that this influences meaning derived from sections of written work. These tests load negatively with VSTM and FCT, suggesting that visual sequential memory and visual figure drawing are processed in the opposite fashion to word meaning. The interpretation is that word meaning is poorest for those using rote skills. It seems that successive skills are necessary to gather information, but that meaning is based on simultaneous abilities. Children that depend on simultaneous abilities to gather information do not fare as well as children who use a successive approach.

For the LEd group the achievement context for STA WM is similar to that of the HEd group, but it loads with the STR W (word reading speed). This may reflect a test taking factor and argues against including speed in tasks for time limits for low achieving students.

Summary

Within the Edmonton population the tests used by the Edmonton Public School System differentiate high, medium and low achieving groups very clearly. They provide statistically reliable estimates of relative classroom performance for these groups of children.

For the HEd and LEd groups, exploratory principal component analyses indicate that the relationships between achievement, intelligence and cognitive measures are not identical for both groups, suggesting that these groups process information in different ways. For the high achieving group, the achievement tests cluster with verbally oriented skills which are separate from the nonverbal skills. The interpretation is that these children have adequate successive and simultaneous skills, and are able to use them appropriately. The achievement tests for the low achieving group cluster mainly with reading and pre-reading skills, suggesting that the ordering of children on achievement for this group is dependent primarily on reading ability and not on comprehension.

The high achieving group also appears to have strategies dealing with attention and the extraction of meaning from printed material, while the low achieving group is seen to operate in terms of limited prerequisite skills.

CHAPTER XI

GENERAL DISCUSSION

The teacher in the classroom is faced with two somewhat discrete groups of children: those who achieve, and those who do not. Evidence presented in this study demonstrates that achievement cannot be simply described in terms of intelligence. Although there is a linear dependency of achievement on intelligence, it is not simply a function of "more of" or "less of". The groups have been shown to have different patterns of abilities involving the differential use of successive and simultaneous strategies as well.

The low achieving children not only have lower intelligence, they also have poorer verbal than nonverbal skills. This can be interpreted as indicating inadequate successive processing skills. These deficiencies become even more exaggerated in a cross cultural setting.

Birch and Belmont (1965) suggest that the third grade is a critical level for learning academic skills, particularly reading. It has been demonstrated here that whereas the high achieving children have adequate conceptual and reading skills, the low achieving children lack prerequisite skills and are thus functioning at the pre-reading and pre-conceptual level.

The implications are clear: high and low achieving children have different academic needs, and therefore require different school experiences. The question is "what should these children be taught?"

Basically there are two approaches to the teaching of low achieving children: the teaching of academic skills, and the teaching of conceptual skills. Bereiter and Engelmann (1966) choose the first approach. In their program they emphasize the teaching of rote academic skills through repetition in a carefully controlled teaching environment. They view failure as "mis-learning" and emphasize the learning of new and more precise rules in language usage and development, reading and arithmetic. Through pretesting, they find the level at which the child is functioning, and then proceed to teach him the skills he will require to perform the desired task. Bereiter and Engelmann make the important observation that the low achieving child is already behind and will have to be taught more, rather than less, if he is to catch up with his peers. This implies a faster rate of teaching. Bereiter and Engelmann achieve this through a rapid presentation style and the use of highly structured materials.

The second approach is emphasized by Cole and Bruner (1972). They suggest using cognitive skills that the child already has, and transferring these skills into situations where he is having difficulty. The most notable feature of this approach is that it is potentially efficient. No new skills need be taught directly. Teaching becomes showing these children how to transfer the skills they already have into new situations. This was the position taken in the present study. The teaching of conceptual skills was chosen for two basic reasons. First, conceptual skills are more relevant to requirements that the school situation will later make. Consequently possession of these skills will enable the student to function with more independence than he would with rote skills. This becomes increasingly important as the tasks increase in complexity. Secondly, teaching cognitive skills requires less time than the teaching of rote academic skills. This approach takes advantage of the abilities a child has and therefore does not require a reteaching of all skills.

Low achieving students were found to have poor successive processing skills which were also poorly differentiated from their simultaneous processing strategies. Consequently, the simultaneous strategies were often inappropriately used in their place. High achieving students were shown to have good successive strategies that were relatively independent of the simultaneous abilities. These children could therefore use the strategies which they had more appropriately.

Much of our information is received in a temporal (successive) order. Some of this information is later used in a simultaneous fashion. Map-reading, for example requires successive scanning in the data gathering stage but later requires an integration into a simultaneous (spatial) schema. A child using simultaneous strategies is unable to gather the information efficiently and thus will have a poorly conceptualized schema. Reading, too, requires successive scanning even though the concept being read is of a simultaneous nature. A child with poor successive skills will be unable to remember the information in its sequential order, and consequently will make errors in interpretation.

This child cannot be taught effectively if his skills remain at a low level. It has been shown that the lacking successive skills can be taught by the application of an appropriate remedial program.

The deficit in successive abilities can be seen more broadly in terms of a verbal deficit. This child is unable to read words easily and thus has a poor vocabulary. Without a large and accurate vocabulary he is unable to understand informations, or follow verbal instructions. The low achieving child does have good nonverbal skills, however. A teaching program should take advantage of these abilities.

A program involving the use of these skills would rely less on verbally presented concepts and more on nonverbal and visual materials. The teacher would pay particular attention to the processing demands of the task and would be prepared to teach the use of simultaneous or successive skills either directly, by a program similar to the one presented here, or indirectly by the appropriate structuring of the information and content materials. The program advocated here, perhaps, is much more of a teaching methodology than it is a set of materials. The materials are not content specific; their use can easily be adapted to a subject area.

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APPENDIX A

INSTRUCTIONS AND STIMULUS ITEMS FOR THE COGNITIVE TESTS

Instructions for Cross-Modal Coding

I am going to let you listen to some patterns of sounds. Listen carefully. (Examples 1, 2 and 3 without the visual stimulus cards were presented.) Each of the patterns you heard are just like the dots you see on this card. (Card shown) Let's take a look at each one. Here is what the first one sounded like. (Example 1 presented.) This is what the second one sounded like. (Card 2 shown and example 2 presented.) You see. It is just like the dots that are on this card. Let's take a look at the other one that we listened to. (Card 3 shown and example 3 presented.) Each pattern you hear is going to be like one of the dot patterns you see here. Let me show you. Listen! (Card 4 shown, example 1 presented. N.B. Card 4 and all subsequent cards contain three possible sound patterns of which one is correct. Cards 1 to 3 contain only the correct pattern.0 Which one did you hear? It was this one. (Examiner points to the correct pattern.) Listen again, then you show me which one you heard. Ready? (Card 5 shown and example 2 presented.) Which one is it? (Subject points.) Let's listen to a different one. Ready? (Card 6 shown, example 3 presented.) Which one is it this time? Let's try another one. You show me which one you heard. Ready? (Example 1 presented, followed immediately by card 7.) Listen again and then show me which one you have heard. (Example 2 presented, then card 8 shown.) Ready? (Example 3, then card 9.) Ready? (Example 1, then card 10.) Ready? (Example 2, then card 11.) Ready? (Example 3, then card 12.) If the subject did not correctly identify any of the last three stimuli, the instructions were repeated until he could.) Listen carefully and pick out the dots that look like the tones you hear. Ready? (Test item 1 presented, followed by the rest of the test.)

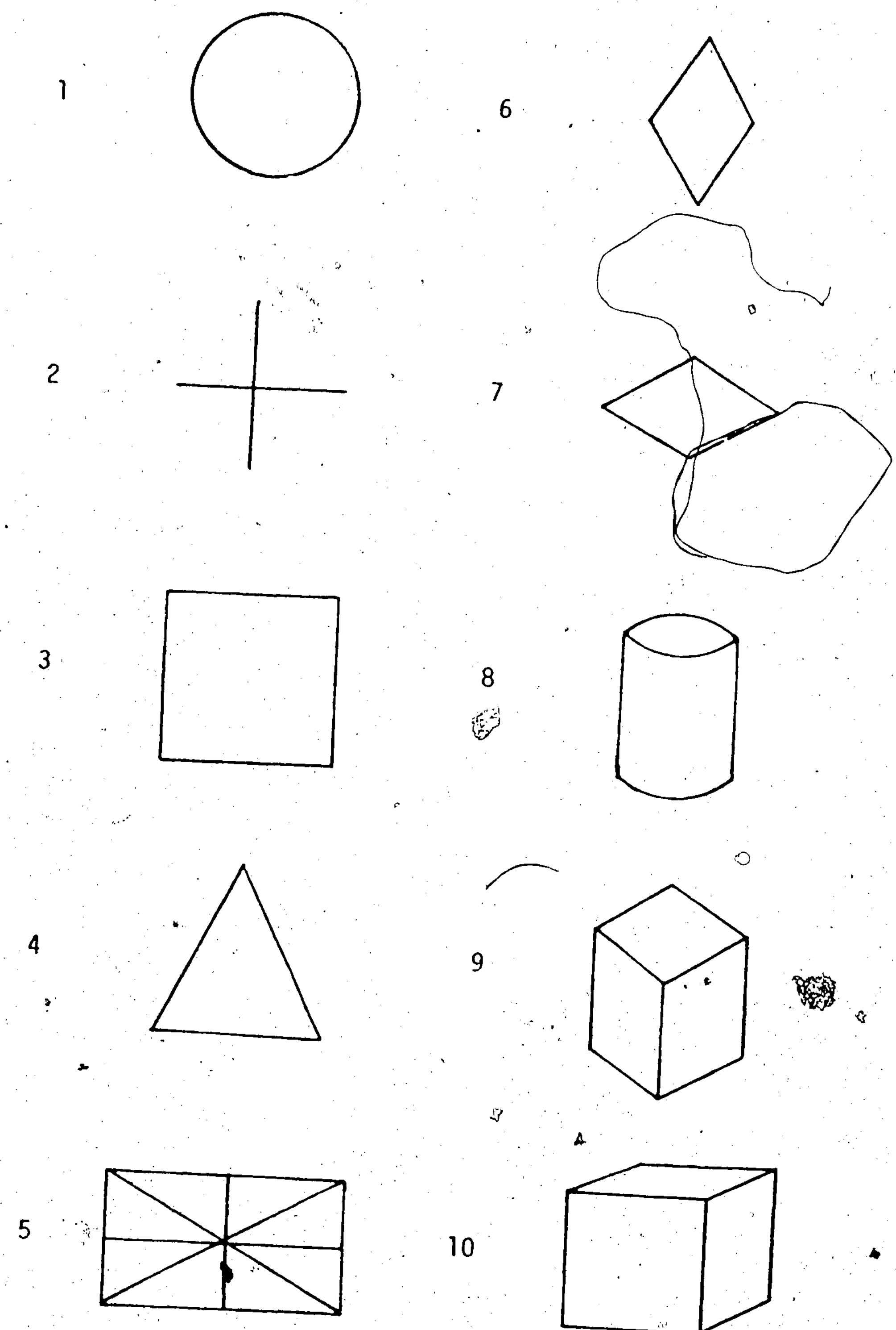
Cross-Modal Coding

Auditory and visual test stimuli for cross-modal coding are shown below. Large and small spaces represent approximate time intervals of 1.35 seconds and .35 seconds, respectively. The underlines were omitted from test cards when presented to the subjects.

	AUDITORY STIMULI	VISUAL STIMULI		
		EXAMPLES		
	• ••	••	• ••	•••
	• ••	•••	• ••	•• •
	•• •	•••	• ••	•• •
		TEST ITEMS		
1	•• ••	• •••	• •• •	•• ••
2	• •••	••••	• •••	••• •
3	••• ••	•••••	•• •••	••• ••
4	• •• •	• •• •	•••••	•• ••
5	••• •• •	••• •• •	•• ••• •	• ••• ••
6	•• •••	••• ••	•• •••	•••• •
7	•• •• ••	•• •• ••	•••• ••	••• • ••
8	••• ••• •	•• ••• ••	••• •• ••	••• ••• •
9	•• • •••	•• •• ••	•• • •••	•• ••• •
10	• ••• ••	• •• •••	• ••• ••	•• • •••

Figure Copying

Ten examples of the designs used are given below.



Instructions for Visual Short-Term Memory

I am going to show you some numbers[1] and some colours. I want you to watch the screen and do as I tell you (project slide 1). Look at these numbers, try to remember each number (pause then project slide 2). Now name these colours starting at the top (pause then project blank slide 3). Now write the numbers you saw at first on this paper. Good. [If incorrect, repeat example 1.]

Now let's try another one (project slide 4). Look at these numbers and try to remember them (pause briefly then project slide 5). Name these colours starting at the top (project slide 6). Now write the numbers you have just seen.

[Repeat until subject understands the instructions and can successfully reproduce the digits.]

set timers

Now we are going to try again, but we will go a bit faster. Ready? (engage timers) [As the first sequence progresses say] look at the numbers . . . name the colours . . . Write . . . .

Let's try another set. Ready? (engage timers) Good. Remember to look at the numbers, name as many colours as you can, then write the numbers.

[Start test with each trial preceded by a ready signal.]

[1]When pictures of objects are used as stimuli, the method of recall consists of selecting matching objects (printed on discs) from an array of nine alternatives. The child manually places his choices on a grid board before him.

Stimuli numbers for visual short-term memory

*1.	9 8 4 5 1	7.	5 4 8 1 6
*2.	9 2 7 1 5	8.	9 7 5 3 1
3.	2 4 9 7 1	9.	3 5 6 1 8
4.	7 2 3 9 6	10.	7 3 9 8 4
5.	7 5 2 9 4	11.	3 8 6 9 4
6.	4 8 9 3 1	12.	5 3 6 1 9

*Series 1 and 2 were for practice purposes only and were not scored.

Instructions for the Serial Learning Test

Instructions

I am going to say some words. When I am finished I want you to say the words just the way I said them. There will be four words in each group. I'll repeat the instructions. I am going to say some groups of words. When I am finished I want you to say the words just the way I said them. Let's try a group of words. Ready? Big long great tall. (Pause) You should have said, big long great tall. Each time I say a group of four words, I want you to say the words in exactly the same order that I do. Let's try another group of words. Ready? Cow day key few. (Pause) You should have said, cow day ey few. Let's try one more list of words. Ready? Man mad map pan. (Pause) You should have said, man mad map pan. You see, when I say a group of words, I want you to say the same words just as I do. Now let's try some other groups of words. Ready (begin test).

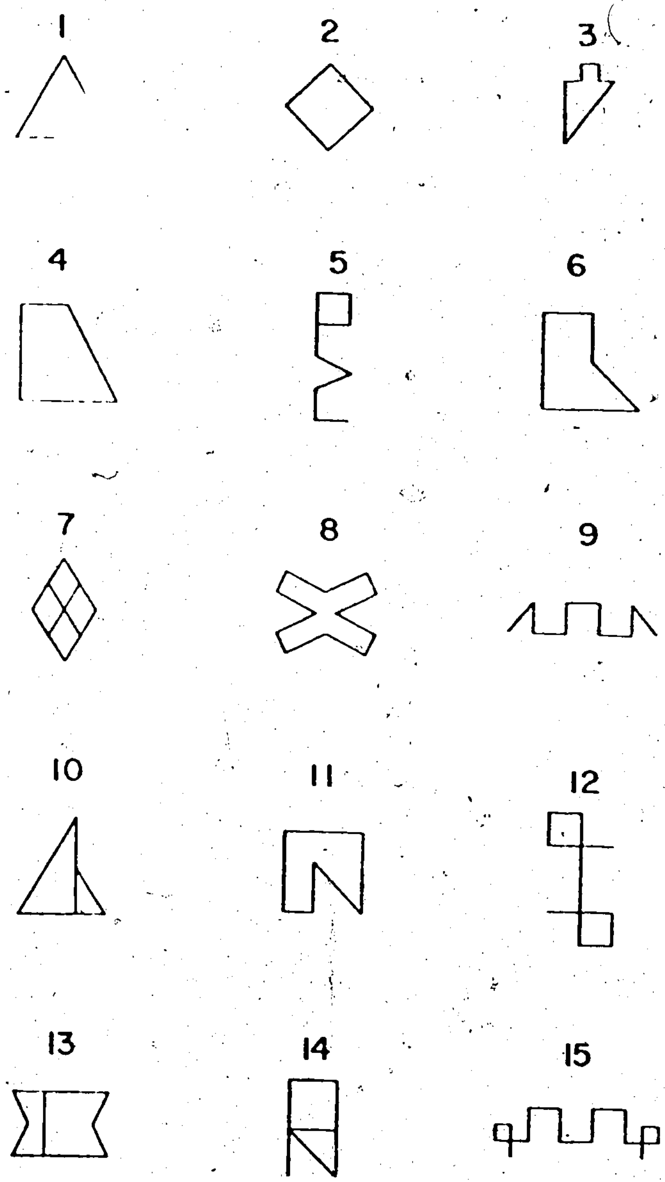
Word Lists Presented in the Serial Learning Test[1]

1.

	Acoustic	Semantic
1.	key hot cow pen	key hot cow pen
2.	cab cat mad can	wide large big high
3.	day cow wall bar	day cow wall bar
4.	man mad pan mat	long big fat great
5.	pen wall book key	pen wall book key
6.	book bar wall hot	book bar wall hot
7.	key few hot book	key few hot book
8.	can pan tap cab	high fat huge wide
9.	tap mat pan cat	huge great fat large
10.	key day cow bar	key day cow bar
11.	cab cap cat tap	wide tall large huge
12.	bar pen few day	bar pen few day
	45 second rest	45 second rest
13.	cab man mad map	wide long big great
14.	mat can cap man	great high tall long
15.	few pen hot wall	few pen hot wall
16.	day cow bar wall	day cow bar wall
17.	cap pan cat can	tall fat large high
18.	man mad mat pan	long big great fat
19.	few day cow book	few day cow book
20.	cap man mad tap	tall long big huge
21.	key book day hot	key book day hot
22.	cab tap man cat	wide huge long large
23.	can cap pan mad	high tall fat big
24.	pen few wall cow	pen few wall cow

Memory for Designs

Given below are the Memory for Designs test drawings. Numbers did not appear on the faces of the actual plates, but are given here for purposes of identification.



Memory for Designs

Administration

The subject was provided with a pencil, an eraser and a sheet of white paper. The following instructions were given: 'I am going to show you some cards with drawings on them. I will let you look at a card for five seconds; then I will take it away and let you draw from memory what you have seen. Be sure to look at the drawing carefully so that you can make yours just like it. Don't start to draw until I take the card away. Ready, here's the first one.' The examiner then showed the card for five seconds, holding it at right angles to the child's line of vision. As it was withdrawn, he was told, 'Now draw it just like the picture'. It was sometimes necessary to remind the subject several times not to draw until the card was taken away. No attempt was made to urge guessing or the completion of a partly remembered design.

Scoring

Each design was scored on a four-point scale with values from 0 to 3. The total score was the sume of the scores on the 15 individual designs; the higher the score, the poorer the performance. The general principles for scoring are elucidated below.

0 points:

a. This rating is given to a satisfactory reproduction or (with certain exceptions) to one that contains no more than two easily identifiable errors. (Symmetrical errors, which occur frequently on Designs 12 and 15, are counted as only one error.)

b. Omitted or incomplete drawings, if no error has been made up to the time subject indicates loss of the memory, are also given 0 ratings.

1 point:

a. More than two easily identifiable errors have been made, but the general configuration or gestalt is retained.

b. Reversal of a part only is rated 1.

2 points:

a. The general configuration has been lost. (These ratings are the most difficult to make, but the criteria have been objectified by the use of examples.)

b. The strict counting of errors has not been adhered to; certain errors, as omissions and additions of parts, are penalized more heavily than others because they may change the total configuration radically. Although, in general, the omission of a minor detail or a small addition is considered only one error, when the omission or addition changes the shape of the design (e.g., from a quadrangle to a pentagon), a rating of 2 is given.

3 points:

a. The design has been rotated (i.e., the axis turned 180°, 90° or, in the case of Designs 2 and 7, 45°) or reversed (mirrored either laterally or in such a way that the reproduction is upside down).

b. In general, orientation errors of 90° may be recognized and scored even when the figure is incomplete. However, those of 180° may not be scored as orientiation errors unless the figure otherwise meets the requirements of a rating of 0 to 1.

c. Exceptions:

   i. Reversals of parts only are not scored in this category, but are given a rating of 1.

   ii. Errors in the orientation of Design 4, since they do not clearly differentiate control from brain-damaged subjects, and since an incorrect slant of only one side occurs frequently and easily gives the impression of a rotation or reversal, are given a score of 1. this represents a change from the original scoring instructions.

SCHONELL GRADED WORD READING TEST

tree	little	milk	egg	book
school	sit	frog	playing	bun
flower	road	clock	train	light
picture	think	summer	people	something
dream	downstairs	biscuit	shepherd	thirsty
crowd	sandwich	beginning	postage	island
saucer	angel	ceiling	appeared	gnome
canary	attractive	imagine	nephew	gradually
smoulder	applaud	disposal	nourished	diseased
university	orchestra	knowledge	audience	situated
physics	campaign	choir	intercede	fascinate
forfeit	siege	recent	plausible	prophecy
colonel	soloist	systematic	slovenly	classification
genuine	institution	pivot	conscience	heroic
pneumonia	preliminary	antique	susceptible	enigma
oblivion	scintillate	satirical	sabre	beguile
terrestrial	belligerent	adamant	sepulchre	statistics
miscellaneous	procrastinate	tyrannical	evangelical	grotesque
ineradicable	judicature	preferential	homonym	fictitious
rescind	metamorphosis	somnambulist	bibliography	idiosyncrasy

[P.T.O.

APPENDIX B

A COMPARISON OF THE LHo, LEd AND HEd GROUPS USING PRINCIPLE COMPONENTS ANALYSES AND TUCKER PROCEDURES

This analysis contains an exploratory comparison of factor structures. It is included in the Appendices because it was felt that it was too technical and detailed to be of general interest.

Das battery

For the three groups in this study (LHo, LEd, HEd) three factors emerged in the principle components analyses for each group. The data for each group will be considered separately; however, in general the three factors isolated by Das (1973b) were also found here. They were named Successive, Simultaneous and Speed.

In the analysis of the Hobbema data (Table B1), Factor I (Successive) was composed mainly of the SL SP, SL FR and RPM with smaller loadings of the CMC. Factor II (Simultaneous) included major loadings from the FCT and MFD, with lesser loadings from the RPM and VSTM. The MFD loaded

Table B1

Principal Components Analyses (Varimax)
for the LHo Group

	I Serial	II. Simultaneous	III Speed
Stroop Word	-228	181	774
Serial Learning SP	874	013	-125
FR	869	006	-170
Progressive Matrices	636	440	197
Cross-modal Coding	594	149	-078
Figure Copying	299	747	093
Memory for Designs	026	-809	197
Visual STM	-011	400	-790
Variance	2.419	1.627	1.360

negatively on this factor because it is composed of error scores. Factor III (Speed) had loadings from the STR W and the VSTM. It should be noted that the Stroop test measures latency and thus the negative sign of the VSTM loading merely reflects the opposite to this effect.

The major difference between this analysis and others reported (Das, 1973a, 1973b; Molloy, 1973) is that RPM loads on the serial factor and that the VSTM loads on the speed factor and on the simultaneous factor. In addition, the CMC, which usually has a multiple loading, here loads only on the successive factor.

All three differences can be reconciled by postulating a deficiency in successive skills. The RPM is usually considered as requiring simultaneous abilities and indeed it does load on the simultaneous factor. Although the mean scores fall into the normal range for this test, the ordering of scores seems to be related to the (inappropriate) use of successive strategies. The VSTM loading on the speed and simultaneous factors could be explained in a similar fashion. If the seriation skills in searching the matrix and in recalling the numbers are poorly organized, then an inordinate amount of time will be required to match the memory pattern to the recording pattern. Those capable of processing information more quickly would receive higher scores. The preceding would constitute using simultaneous strategies to compensate for poor successive skills.

The low VSTM scores reflect these poor strategies. It was noted during the administration of this test that children wrote the numbers into the response matrices in an inconsistent fashion. This suggested that the children searched the original matrix in much the same manner as they would examine a photograph or a scene. This remains consistent with the interpretation provided.

In considering the CMC loading on the successive factor, it is noted that this test has a rather low commonality (.381). It appears that the other abilities contributed in a random fashion to success on this test. Perhaps the children are overwhelmed by the successive nature of this test which requires a conversion of a serial auditory pattern into the recognition of a visual display of that pattern. Poor successive skills would prevent the child to display his simultaneous or speed skills as he would be blocked on the first step of the test, which is remembering and decoding the auditorily presented sounds.

In the analysis of the LEd data, Factor I (successive) was composed mainly of SL SP, SL FR and VSTM with smaller loadings from the CMC. The simultaneous factor (II) had mainly RPM, FCT and MFD with the CMC also being included. The third factor, although labelled speed, could also be called cautiousness as it seems the VSTM and CMC loaded with slowness or latency (STR W) rather than with the negative value which would be speed.

Table B2

Principal Components Analyses (Varimax) for the LEd Group

	I Serial	II Simultaneous	III Speed
Stroop Word	-068	028	827
Serial Learning SP	906	166	-196
FR	890	208	-168
Progressive Matrices	181	775	202
Cross-modal Coding	543	346	355
Figure Copying	054	750	-184
Memory for Designs	-156	-747	078
Visual STM	622	011	364
Variance	2.359	1.912	1.090

Generally, the factor structure for the LEd group and the corresponding loadings seem more appropriate than those for the Hobbema children. This suggests only more appropriate use of these skills and does not reflect on the quality of these skills. The LEd group may still be regarded as having poor successive skills and that low achievement reflects these skills.

The data from the HEd group (Table B3) was rather more difficult to interpret using the three postulated processes as two tests usually loading on different factors loaded on the same factor (Factor I). The STR W and SL scales loaded together and in so doing made the decision whether to name this factor Speed or Successive difficult. Consequently, Factors I and III remain unnamed.

Table B3

Principal Components Analyses (Varimax) for the HEd Group

	I	II Simultaneous	III
Stroop Word	-650	-063	109
Serial Learning SP	935	159	133
FR	914	079	143
Progressive Matrices	004	897	025
Cross-modal Coding	324	414	467
Figure Copying	-029	416	557
Memory for Designs	-213	-678	-070
Visual STM	013	-106	859
Variance	2.284	1.656	1.321

Factor III had loadings from the VSTM, FCT and CMC, and may in fact reflect extremely good successive skills differentiated only by speed.

Factor II was named the simultaneous factor and was similar to that of the LEd group with the exception that the FCT had a somewhat lower loading. For the HEd group, the FCT loading on the successive factor suggested that a serial attempt, particularly on the more difficult items, produced better results. Perhaps for an adult the most efficient method would be to form a gestalt of the stimulus figure, say that of a cube seen in perspective, and then represent this on paper using the concept of parallel sides. However, for the child at the grade 3 level this "gestalting" process may not be completely developed. Although it ultimately is the best strategy, at this level complex figures are most efficiently drawn copying the figure line by line (successively) rather than by reproducing the imperfect gestalt. This also serves to indicate the importance of being able to choose the appropriate strategy and of being able to switch between them.

Generally, these results must be viewed with caution as the sample sizes are rather small. However, the apparent stability of the factors from group to group and in comparison with earlier findings encourage one to put more faith in the interpretation than would otherwise be warranted.

Comparison of factor structures

The factor structures were further compared by the use of the Tucker method of orthogonal comparisons (Harman, 1967), which produces a matrix of coefficients of congruence for factor comparisons. Tucker does not provide levels of significance for this approach except to say that a coefficient of .93 is "high" and a coefficient of .46 is "rather low".

This comparison proceeds on two levels. On the first level, the comparison matrix is simply compared to the target matrix, and on the second, the comparison matrix is rotated toward the target matrix by a Varimax procedure to obtain the best possible match, and then compared.

For the second level, an error matrix, which is the difference between the rotated matrix and the target matrix, is calculated. It provides a visual record of the largest sources of difference between the two matrices. This procedure has received some attention in spite of its limitations (Kebbon, 1965) and will be used here in comparing the factor structures of the three groups.

For the HEd and LEd unrotated comparisons (Table B4) the first two factors compare rather well (.83 and .95) in spite of the fact they were not named for the HEd group. The third factors do not compare

Table B4

Matrix of Tucker Coefficients
for HEd and LEd (Unrotated)

Factors	1	2	3
1	.8286	.2767	-.4627
2	.3381	.9549	.1261
3	.6080	.4380	.3554

very well (.36).

After rotation, the two factors compare more favorably with values of .94, .96 and .66. The third factors could be considered only marginally congruent. However, considering the rotated matrix for the HEd group (Table B6), one could notice that the first factor would now be named Successive and the last factor Speed. The STR W now loads on both factors and the loadings of the SL tests partially follow this pattern. We notice the "cautiousness" rather than speed on this factor.

A perusal of the error matrix reveals that the major areas of

Table B5

Matrix of Tucker Coefficients
for Rotated HEd and LEd

Factors	1	2	3
1	.9422	.3886	-.1879
2	.3828	.9609	.1032
3	-.2165	.1207	.6640

difference are on the STR W and on the FCT.

For the LEd-LHo, results for the unrotated and rotated comparisons for the LEd-LHo groups are presented in Tables B8 and B9. The error

Table B6

Rotated Factor Matrix (Varimax)
for the HEd Group (From the Tucker Comparison)

	I	II	III
Stroop Word	-.4455	-.0791	.4834
Serial Learning SP	.8128	.1966	.4668
FR	.8068	.1165	-.4445
Progressive Matrices	-.0329	.8968	-.0003
Cross-modal Coding	.5166	.4476	.1650
Figure Copying	.2913	.4423	.4512
Memory for Designs	-.1726	-.6874	.0875
Visual STM	.5377	-.0621	.6755

Table B7

Error Matrix for Rotated HEd and LEd Comparison

	1	2	3
Stroop Word	.3786	.1072	.3447
Serial Learning SP	.0778	-.0314	.2797
FR	.0822	.0912	.2745
Progressive Matrices	.2142	-.1217	.2025
Cross-modal Coding	.0269	.1018	.1888
Figure Copying	-.2360	.3075	-.6359
Memory for Designs	.0166	-.0596	-.1652
Visual STM	.0859	.0508	-.3128

matrix is presented in Table B10.

In the unrotated comparison, the first factors have a coefficient of congruence of .85, the second .89 and the third .32.

Table B8

Matrix of Tucker Coefficients for LHo and LEd Comparison (Unrotated)

Factors	1	2	3
1	.8472	.5686	-.1402
2	.2969	.8866	.2702
3	-.4695	.0140	.3164

Rotation did not seem to increase the degree of congruence significantly, producing coefficients of .88, .93 and .28, respectively.

Table B9

Matrix of Tucker Coefficients for Rotated LEd and LHo

Factors	1	2	3
1	.8759	.4439	-.2085
2	.4393	.9259	.1944
3	-.2285	.2153	.2762

In inspecting the error, one sees that the highest areas of difference are first the VSTM test and then the RPM test, as previously noted.

Table B10

Error Matrix for Rotated HEd and LEd Comparison

	1	2	3
Stroop Word	.3517	-.0842	.1233
Serial Learning SP	.0397	.0125	-.2709
FR	.0174	.0604	-.1978
Progressive Matrices	-.3167	.2499	-.1349
Cross-modal Coding	-.0218	.1036	.2988
Figure Copying	-.0933	-.0300	-.3451
Memory for Designs	-.2671	.0554	-.2723
Visual STM	-.5218	-.4359	.1345

Rotation did not reconcile the differences in Factor III as the two highest loadings for the Hobbema group have opposite signs and have similar signs for the Edmonton group. The major difference in Factor III seems to be the relationship between the VSTM and STR W. The Hobbema children have scores that are limited by lack of speed, while the LEd children have scores that improve when the children proceed more slowly.

As the last step in this series of comparisons, the HEd group was compared to the LHo group.

In the unrotated comparisons (Table B11), Factors I and II compare favorably, although with less congruence than for the LEd-LHo comparison (.83 and .77). Factors III have a negative coefficient

Table B11

Matrix of Tucker Coefficients for HEd and LHo Comparison (Unrotated)

Factors	1	2	3
1	.8256	.0550	-.4850
2	.5729	.7718	-.0341
3	.3715	.6279	-.4689

which represents a simple (arbitrary) sign difference (-.47). Rotation in this case removes the sign difference and generally improves the congruence level (Table B12).

The rotated comparison produces coefficients of .89, .90 and .65 for the three factors, making this the most satisfactory comparison overall. The main areas of difference (Table B13) seemed to be in the loadings of STR W and MFD, as evidenced by the high values in the error matrix.

It is, however, unwise to place much emphasis on the differences

Table B12

Matrix of Tucker Coefficients
for Rotated HEd and LHo

Factors	1	2	3
1	.8893	.3124	-.3829
2	.3053	.8966	-.0646
3	-.3563	-.0613	.6517

between factor structures found by this technique, as this procedure seems to overreact to differences. It is perhaps a better technique for finding areas of similarity. Another problem is the difficulty in assigning levels of significance to the coefficients.

Table B13

Error Matrix for Rotated HEd and LHo Comparison

	1	2	3
Stroop Word	.3782	-.0508	.6432
Serial Learning SP	-.0014	.1145	.2400
FR	.0517	.1588	.2460
Progressive Matrices	.2000	-.2067	-.2468
Cross-modal Coding	.1598	-.3356	.1887
Figure Copying	.1797	.0015	.2935
Memory for Designs	.3327	-.3547	.4135
Visual STM	.1174	-.0657	-.0717

Perhaps the main conclusion to be drawn is that the basic clusterings of scores for all groups are very similar for at least two factors. The third factors may represent the areas of greatest difference and may provide some clues to the differing strategies involved.

It seems that the greatest differences revolve around the relationship of the STR W and other visual test, particularly the VSTM. This test along with the RPM, FCT and MFD are open to both successive and simultaneous processes and thus may be most sensitive to differences in these processes. Performance may depend on selecting the best suited strategy for each case.

Summary

An analysis of the WISC profiles showed the three groups to be most different on the Verbal scales and the LHo and LEd groups to be similar on the Performance scores. This pattern of verbal differences and nonverbal similarities is similar to those presented earlier and tends to reinforce the belief that the two low achieving groups are intrinsically similar, differing only in cultural experience.

APPENDIX C

Intervention Tasks
Used with Groups I and II (Hobbema)

Maximum Treatment (Group I)

Individual presentation

Sequence Story Boards
Parquetry Designs
Serial Recall
Coding
Matrix Serialization
Auditory Discrimination and Digit Span

Group presentation

Sesame Street
Filmstrips - Visual discrimination and spatial orientation
- Visual-motor co-ordination
- Visual memory
- Figure and ground
- Visualization

Minimum Treatment (Group II)

Group presentation

Filmstrips - Visual discrimination and spatial orientation
- Visual-motor co-ordination
- Visual memory
- Figure and ground
- Visualization