Perceptual, motor and language deficits in backward readers of average intelligence and their relationship to developmental history.

A thesis presented for the Degree of Doctor of Philosophy.

Peter Bale,
University of Surrey,
Guildford.
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Initially an investigation was made to discover and demonstrate the relationships between visual and auditory perceptual difficulties, motor impairment, body concept and language difficulties in a group of backward readers—all boys, aged between 7½ and 11½ years from the primary schools in Eastbourne. A partial correlation, taking out age, and a factor analysis of the data obtained, indicated that though there was no single condition which could fully account for the relationship between the factors, the variable grouping did indicate that the difficulties of some backward readers could be the result of a neural impairment. It is suggested that the impairment results in the difficulty of some backward readers in discriminating and integrating aspects of their perceptual and motor inputs. This difficulty is indicated by a failure to coordinate simple motor activities, a weak cerebral dominance, language problems and perceptual difficulties.

The backward readers were then subdivided according to the number and severity of their scores on the perceptual and motor tests.

Using the same criteria for selection as for the initial selection of the backward readers, a control group of normal readers of similar age and intelligence was selected. A detailed questionnaire given to all the parents of the boys in both groups indicated the presence of a greater number of difficulties in pregnancy and during birth in the backward readers' group. However, analysis of variance indicated that with the exception of low birth weight, the differences between the normal and backward readers did not reach the level of significance. In contrast, when the backward readers with perceptual motor difficulties and the normal readers were compared, the incidence of toxaemia during pregnancy, difficulties during labour, prematurity and low birth weight were significantly higher in the perceptually motor impaired backward readers. These results support the hypothesis that backward readers with poor perceptual motor abilities are most likely to have a history of prenatal and perinatal difficulties, particularly those difficulties associated with anoxia in the early stages of the child's development. It is these difficulties that are thought to cause neurological impairment.

An examination of the number of language difficulties and the history of reading difficulties in the family indicated that a significantly greater number of language difficulties, especially poor
articulation, and a higher incidence of reading difficulties occurred within the family in the backward readers' group than in the control group. This incidence was greatest in the group of backward readers with no perceptual motor problems or only mild perceptual motor problems which suggests that these difficulties could be the cause of their backwardness when learning to read. The high incidence of boys with parents, grandparents, or other relations with a history of reading difficulty suggests a possible genetic origin. An alternative explanation might be that these parents who themselves read badly fail to provide adequate incentive and/or instruction for the development of reading and language ability.

Interviews and questionnaires completed by the parents and teachers of the normal and backward readers indicated that a significantly greater number of backward readers were maladjusted. The backward readers, particularly those with perceptual motor deficits, were more restless and uncontrolled in their behaviour and were more antisocial. This is an indication that these behavioural problems are associated with reading retardation. The poor concentration and restless behaviour in the antisocial backward readers but not in the antisocial normal readers suggests that these behaviour factors may play an important part both in the development of the reading disorder and the development of antisocial tendencies.

Comments made by parents and teachers of the backward readers indicate that, though hyperactive behaviour was present before the children started school, the factors associated with antisocial behaviour did not develop until later, when the children were experiencing difficulty with reading. This finding supports the view that the difficulty the child has in concentrating and in controlling his restless impulsive behaviour is a handicap when learning to read. The uncontrolled behaviour and the child's failure in learning to read in turn gives rise to his antisocial behaviour.

These findings, together with the evidence of a relationship between prenatal, perinatal difficulties and later perceptual motor problems, support the view that there exists a group of children with specific reading difficulty of neurological origin probably as a result of abnormal pregnancy or difficulties at birth.

The possible mechanisms of neurological disorder are discussed in relation to present theories of brain functioning and the incidence of reading difficulty resulting from neurological impairment is estimated on the basis of the present findings.
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The existence of a condition of severe reading backwardness, which does not result from poor schooling, adverse home conditions or low intelligence, is debatable. The literature is full of exchanges between those who assert that no specific reading retardation exists and those who try to demonstrate its existence. Severe reading disability, often called "Specific dyslexia" was defined by a research group under the chairmanship of the neurologist Dr. MacDonald Critchley in 1968, as "a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and sociocultural opportunity" (1).

This controversy has not been resolved because of the difficulty of many researchers in agreeing on the definition of dyslexia, its etiology, prognosis or treatment. The Tizard report to the Advisory Committee on Handicapped Children (1972) also questions the presence of a syndrome of dyslexia in which specific underlying causes and symptoms can be identified. The report therefore suggests the more descriptive term of "Specific Reading Difficulty" to identify those children with reading and spelling difficulties that are considerably below their abilities in other academic subjects.

The characteristics of dyslexia or specific reading difficulty have been described as follows - disorders of speech and language, difficulties in visual spatial perception, visual motor problems, poor auditory discrimination and memory, inability to integrate visual and auditory modalities, difficulties in motor coordination and lack of cerebral dominance characterised by right-left confusion and mixed laterality.

However, these characteristics are not all found in one child and the different combinations of these difficulties do not readily form a single syndrome. Perhaps the only clear difference in the nature of the reading performance of the specifically retarded reader is the severity of the reading problem in the absence of low intelligence, adverse environmental conditions and severe emotional handicaps.

The interest of the author in the relationship of specific reading difficulty with perceptual and motor factors arose during supervision of a group of physical education students in a local Primary school. The school had asked the students to teach physical education to two junior classes, a "normal" class and a class of boys and girls with learning difficulties.

(1) Tizard Report to Advisory Committee on Handicapped Children (1972 - Children with specific reading difficulties, Para. 4.)
While teaching the latter group it was noticed that some of the boys, though quick to understand the tasks presented to them, were very clumsy and uncoordinated in their movement and poor in articulation. In discussion with the class teacher it became clear that these children, though apparently of average or above average intelligence, were experiencing extreme difficulty in their academic work, particularly in learning to read and to spell.

This apparent relationship between poor motor performance and reading backwardness prompted the author into examining the perceptual motor and language factors in those boys of junior school age, of average or above average intelligence, but retarded in reading and spelling. For the purpose of this investigation it was decided that the criterion for initial selection of children with specific reading difficulty was the presence of a severe reading problem in the absence of other contributory factors. Thus the number of boys who fell into this category were originally selected from nearly one thousand five hundred boys in the County Borough of Eastbourne.

The investigation was divided into two parts. The first part examines the relationship between perceptual motor and language difficulties isolated in the group of backward readers and, secondly, it tests the hypothesis that these problems arose from difficulties in pregnancy and during birth which may have lead to neurological impairment.

For future identification the specifically retarded readers in this investigation will be referred to as the "Backward Readers' Group", the term I am using to distinguish my group from similar groups in other studies.
PART I

Chapter I

Possible Causes of Specific Reading Difficulty
While the results of reading retardation are frequently apparent, its underlying causes are far less easy to identify. As I shall explain later, there are various characteristics of behaviour and performance which are prevalent in backward readers but these may be contributory factors rather than the initial causes of their handicap. It is necessary to look further than signs and symptoms and try to establish their underlying causes. In my examination of these causes I shall consider maturational lag, hereditary factors, endocrine factors and, finally, neurological impairment. First I shall examine the possibility of a delay in the process of maturation.

Maturational Lag

Differences in age at which the central nervous system develops are generally attributed to a developmental or maturational lag in which certain functions of the cerebral cortex are slow to differentiate and become established. Honey (1966 p. 34) for example, comments that many cases of reading disability may be classified as representative of a lag in the functional development of the brain and nervous system that subserves the learning of reading. Investigators who consider that this concept may explain children's lack of interest or ability in learning to read think that their problems will disappear as the central nervous system continues to mature.

Bender (1954, 1956, 1957, 1968, 1970) suggests that the brain develops longitudinally to a recognizable pattern and that any delay in this development results in immaturity in personality and academic ability. The severity of the problem extends through a continuum from very mild to most severe. A child with reading difficulties will have perceptual and motor abilities which are less complex, less differentiated, more global and less well integrated than a child with no developmental lag.

De Hirsch et al (1966) consider that chronological age does not reflect the developmental level in children who are of normal intelligence but backward in reading. These children suffer maturational lags and therefore present a high risk of academic failure. In their study of children aged five to six years who were very backward in reading, they found that many of the subjects' perceptual motor and linguistic abilities resembled the profiles of much younger children. De Hirsch also noted that the general behaviour and physical development of many backward readers were more characteristic of younger children.

Ingram et al (1970) in their study of dyslexic children found that those
children with specific reading difficulties had audio phonic and visuo-spatial problems. They also found that the specific reading difficulty could exist without any evidence of brain damage and suggested that it "... may be associated with a developmental lag in basic perceptual or motor function." (1)

These views are supported by Satz, Rardin and Ross (1971) who found that their younger dyslexic group aged between seven and eight years were noticeably delayed in visual motor integration. They are also supported by Goyen and Lyle (1971) whose younger readers had most difficulty on tachistoscopic tasks involving visual recognition.

Birch (1962) and Birch and Belmont (1964) have shown that backward readers have difficulty in integrating visual and auditory modes just as younger children do. These findings are similar to those of Bender (1970) who considered that the inability to discriminate geometric shapes and relate parts to their whole gestalt was indicative of immaturity of development.

Critchley (1964) observed perceptual motor and directional difficulties in backward readers which, he suggests, are the result of a "Specific Cerebral Immaturity". He noted that many dyslexic children of average intelligence showed spontaneous improvement in reading and writing skills, even with little remedial help, when they reached puberty.

Cohen and Glass (1968) found that difficulties in directionality and laterality observed in first grade children had disappeared by the fourth grade. Harris (1957) showed that, whereas at the ages of seven and nine years backward readers had poor laterality compared with normal readers, there were no differences between the two groups by the age of eleven years.

Evidence of maturational lag, however, does not adequately explain why some children can be taught to read as early as three years or why older backward readers still have perceptual and motor difficulties even after puberty is complete. De Hirsch et al (1966) found that many of their older backward readers between eleven and fifteen years still had these perceptual and motor problems experienced by their five to six year olds. They considered that the problems of these so called "dyslexics" were the result of a "profound and basic maturation deficit so severe that one might speculate that it is rooted in the biological matrix, and constitutes a type of cerebral disfunction".

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Vernon (1971) in a discussion of maturation lag, notes that the types of spelling difficulty of dyslexics (Yulea 1967) and some Bender visual motor gestalt reproductions of dyslexics (Crosby 1968 and Zangwill 1960) were more similar to those experienced by adult patients with parietal lobe injuries than to those of young children.

Grodler (1971, 1972), in a discussion of severe reading disability, cites the work of Anthony (1968) who found in his study of dyslexic children of normal intelligence with a mean chronological age of eight and a half years, that his dyslexics had a number of difficulties including mixed dominance, poor perceptual abilities, poor auditory visual integration and directional difficulties. He attributed these difficulties to a "maturation lag" which made the dyslexic child more vulnerable to unsuitable environmental pressures. Commenting on the "maturation lag" theory, Grodler suggests the concept of "immaturity" should be avoided at all costs. He suggests that the term "matuational lag" should be used to indicate a delay in the development of the cerebral cortex or a degree of neurological impairment.

To summarise, it is possible that the processes of differentiation and integration related to learning to read may be affected by a delay in the maturation of part of the central nervous system. Such a delay is indicated by delayed speech development, poor lateral dominance, immature motor development and immature perceptual organisation. This matuational lag may be further aggravated by immaturity of personality, poor motivation or emotional stress (Vernon 1971). However, older backward readers may have similar difficulties which cannot be attributed to the concept of delayed development. I suggest, therefore, that these difficulties may be the result of a disfunction of the central nervous system of a more permanent nature.

Many studies provide evidence that is equivocal between the delayed maturation and the permanent damage theories. Thus matuational lag, alone, is not in most cases, a sufficient explanation. Permanent damage to the central nervous system will be discussed later.

Hereditary factors

Studies of identical twins reveal that the similarity of their appearance and intellect are the result of a genetic factor which plays a dominant role in normal neurophysiological development. A similar genetic factor may be the cause of a possible hereditary disposition towards reading backwardness. Hallgren (1950) studied the family histories of 276 children with reading problems and found that in over 80% there was
evidence of a reading disability in the immediate family. He suggested that an inherited factor was the cause of reading difficulty and that it might be a Mendelian trait. Few investigators have been able to substantiate Hallgren's findings. Reported familial difficulty is not necessarily evidence of genetic origin and, in conditions where environmental as well as genetic factors are important, the hypothesis is difficult to prove.

Some support for a genetic factor in reading comes from the twin studies of Hermann (1959). He re-examined the twins in the studies of both Hallgren and of Edith Norrie of the World Blind Institute in Copenhagen and found that the identical twins were all dyslexic, while of the fraternal twins only in a third of the cases studied were both twins dyslexic. As the genetic disposition of monozygotic twins is identical, where that of dizygotic twins is no greater than that of normal brothers or sisters, Hermann claimed that his findings supported an inherited factor. In support of these claims, Kelson and Kaluger (1963) considered that the retarded readers of normal intelligence in their study who did not improve with remedial help might have reading difficulty because of an inherited disposition. In my view this is an unlikely explanation. Twin studies, moreover, are perhaps less indicative of hereditary factor than is at first apparent. External factors such as the high degree of conformity between twins and the uniformity imposed on them by parents and teachers must also affect development.

Ingram (1959) noted that in some dyslexics a family history of speech problems was frequent. In 1964 he noted that more girls than boy dyslexics had a family history of reading difficulties. This observation is contrary to Critchley's view that dyslexia is a sex-linked genetic characteristic which affects males more than females.

Other researchers, though not so clearly convinced of a genetic factor as Hallgren or Hermann, do claim that the reading difficulties of some children are possibly hereditary. Relationships have been obtained between directional difficulties and a family history of poor lateral development in some retarded readers by Zangwill (1960) and by Ettlinger and Jackson (1955). Doehring (1968) found that 40% of his backward readers had parents who themselves experienced difficulty in learning to read. Similarly, Weinschenk et al (1970), in their study of backward readers with average intelligence, noted that they too had siblings, relatives and at least one parent with a similar achievement pattern.
Similar findings were obtained by Rutter et al (1970) and Naidoo (1972) but, as Rutter comments, although these results suggest a genetic origin, an alternative explanation might be that parents who are themselves bad readers may not adequately stimulate a child's interest in reading.

To summarise, the interesting twin studies of Hermann provide the best, if tentative, support for a hereditary disposition in some cases of specific reading difficulty, but the evidence linking these difficulties to a sex-linked gene or a Mendelian recessive or dominant trait is at present purely speculative.

**Endocrine factors**

Because hormones produced by the endocrine glands are responsible for the rate of metabolic activity of the body's cells, including nerve cell metabolism, these hormones affect both motivation and learning processes. Though the significance of endocrine abnormalities as factors associated with reading backwardness are not yet proven, two neuro-chemical investigations suggest a possible relationship.

Park (1959) found that 20% of his backward readers showed symptoms of hypothyroidism, a slowing down of the metabolic rate resulting in slowness in speech and movement and a retardation in cognitive activity. He, therefore, suggested that normal thyroid function was an essential to reading.

Smith and Carrigan (1959) postulated a "synaptic transmission model" suggesting that severe reading difficulty is caused either by abnormal synaptic transmission or by a failure to achieve adequate reverberatory activity of neural systems. As both are influenced by endocrine functioning, imbalances in acetylcholine and cholinesterase at the synaptic junction of nerves will accelerate or slow down neural transmission affecting both perception and behaviour related to learning to read. Smith and Carrigan isolated a group of retarded readers who showed evidence of mild hypothyroidism characterised by metabolic insufficiency similar to the group studied by Park. They suggest that a primary cause of this condition in their backward readers is faulty cholinesterase production which results in inadequate metabolism.

Many physiologists would agree that there is a relationship between a person's emotional state and his endocrine activity. However, as Westman (1965) suggests, such changes are more likely the result of another, more basic, process rather than a specific factor related to learning. Money (1962) is even more critical suggesting that Smith and Carrigan's work is just "another faddism" based upon "improbable and improperly tested hypotheses". (1)

(1) J. Money (1962) Reading Disability: Progress and research needs in Dyslexia, P.30
In the past century physicians, psychologists and educators have been interested in the relationship between disfunction of the central nervous system and learning difficulties, particularly reading retardation. The early documented cases of specific reading retardation resulting from minimal brain injury were reported by Broca (1872). The reading retardation in children of normal intelligence described by Kussmaul (1877 cited by Naido, 1972) and by Kerr (1897) was also considered to be neurological in origin and Kawi and Fasananick (1959) in their study of prenatal and perinatal factors of children's reading disorders describe various studies in the first half of this century which gave rise to the hypothesis that certain disorders of reading were the result of cerebral insult produced by complications of pregnancy, during delivery, or in the neonatal period of a child's development.

Hinchcliff (1895, 1900, 1917) in his discussion of word blindness associated with reading retardation considered that specific reading difficulty was the result of an injury to the visual centres of the brain and thus agreed with the term "word blindness" suggested by Kussmaul.

Rabinovitch et al (1954) observed that in their study of retarded readers many had significantly poor motor performance, motor clumsiness and right left discrimination difficulties. He and his co-workers classified retarded readers on the basis of their degree of neurological impairment. Those retarded readers with clear cut neurological signs he classified as "organic" as a result of their clearly demonstrable neurological damage. The second group had only "soft" neurological signs and specific perceptual difficulties in which they were unable to discriminate and integrate letters as symbols. Rabinovitch considers the reading difficulties of this group to be the result of a basic disturbance of neurological organisation rather than specific damage to the brain. He calls this group "children with primary reading difficulties". In the third group he places backward readers with a normal reading potential whose progress is impaired as a result of exogenous factors such as emotional upset, anxiety or limited school opportunities. This third group he called "children with secondary reading difficulties".

Rabinovitch suggested that insult to parietal and parietal occipital regions of the brain accounted for the "primary disabilities" and suggested that reading retardation of neurological origin accounted for nearly 50% of his backward readers.
Early researchers stressed the opinion that reading retardation resulted from an actual lesion of the brain located at the angular and supramarginal gyrus, Morgan (1896), Minshewood (1917). Later researchers like Hallgren (1950) contested the concept of a specific lesion and the investigations of Gerschwind (1962, 1964) demonstrated that location of language and its subfunctions was not simply one of specific areas of the cortex.

However, the hypothesis of reading retardation from actual damage to the brain is given some support in the research of Drew (1956), Casey and Ettinger (1960), Ettinger and Hurvitz (1962) and Kinsbourne and Warrington (1962), all of whom reported association of partial occipital damage with dyslexia in adults.

Nyholm and Boshes (1960) reported that 5% of children in America had "psychoneurological" learning problems as a result of "minimal brain damage" to the occipital parietal lobe, which they consider resembles parietal occipital atrophy in adults, a condition which causes spatial orientation difficulties in recognition of words. Left hemisphere impairment has also been associated with reading difficulties in adults. The symptoms resulting from injury to the temporal lobe of the left hemisphere, which cause aphasia in adults, are similar to those of developmental dyslexia in children, Vernon (1971). Kepes, cited by Sperry (1970), and Gazzaniga (1971) also comment upon the relationship between speech, language and reading difficulties and damage to the corpus callosum, the nerve tract linking the two halves of the brain. Their experiments suggest a link between language and reading with the left hemisphere as the dominant hemisphere. Letters and words were seen but not comprehended when they were projected to the non dominant hemisphere of adult patients with their corpus callosum sectioned.

Therefore, because reading retardation of some backward readers resembles disturbances of function seen with parietal occipital or temporal lesions in adults, these neurologists believe that the underlying pathology for many cases of reading difficulty is an anatomically verifiable lesion in the brain. However, Kinsbourne and Warrington (1965), in their study of dyslexic children, note that although at the functional level the similarity between the symptoms of adult dyslexics and those of the children in their own study is striking:
"The fact that a lesion in a certain part of the brain may cause a particular syndrome in the adult in no way implies that the child with an analogous developmental syndrome has a similarly localized cerebral lesion or indeed any gross cerebral damage at all". (1)

Evidence of neurological impairment in retarded readers is sometimes based upon the high incidence of abnormal EEG's in the traces of these backward readers. Stratton (1953) observed particularly slow EEG rhythms in the occipital region of the cortex in backward readers. These children also had poor performance scores on the W.I.S.C. A higher incidence of abnormal EEG's in retarded readers was also reported by Silver and Hagan (1960), Goldberg et al (1960), Cohn (1961), Benton and Bird (1965), and by Healee (1969) and Black (1973), both of whom associated EEG disorders with poor visual perceptual ability in retarded readers.

Stephens, Cunningham and Stigler (1967) in a review of many of the above studies, commented that problems related to the validity and the reliability of EEG measures and to the researchers' definition of reading difficulty, leave many of these investigations open to criticism. Vernon (1971) criticises the wide estimate of the frequency of EEG abnormalities, the methods of selection and the different criteria of EEG abnormality that the investigators used.

Poor motor coordination, motor clumsiness or actual motor impairment have often been associated with neurological impairment in retarded readers. Rabinovitch (1954), Cohn (1961), Frechtl (1962), Lucas et al (1965) and Goldberg (1968) have noted the poor motor ability and uncontrolled movements of backward readers in their studies.

Gubbay et al (1965), in a study of motor impaired children between nine and a half and seventeen years who showed signs of "minimal brain damage" including parietal lobe EEG abnormalities, poor maturation, and weak cerebral dominance, found evidence of structural anatomical damage. He attributed this disorder to a focal parietal lobe lesion rather than to a physiological abnormality of the central nervous system. However, he did suggest that some of the difficulties of his clumsy children might be the result of defective establishment of physiological dominance.

Several investigators have commented on the incidence of incomplete lateralization and poor cerebral dominance in backward readers as indicative of neurological impairment. Belacato (1959, 1963, 1966) and Baksin and Bakwin (1960) consider that the poor hand-eye dominance shown by some backward readers is an important indicator of incomplete cerebral dominance resulting from minimal brain damage. Glass and Robins (1967) severely criticize Belacato's theories and those investigations that support them. Kefic (1952, 1963) does not suggest that a pathological lesion in the cortex is a factor in reading retardation but considers that reading difficulty might be associated with a deficit in cerebral organization.

Critchley (1964) and Birch (1962) have both discussed reading difficulties in relation to poor body concept, right-left discrimination, motor incoordination and laterality, but they also would not support a concept of minimal brain damage in which the neurophysiological disturbance is the result of damage to the cortex. They favour a developmental concept in which the retarded reader's difficulty is related to maturation and development of cerebral dominance.

Vernon (1971) in her book "Reading and its difficulties" comments on Newton's study (1970) on the neurological functions associated with lateral dominance in backward readers. She compared the EEG tracings from the right and left temporal parietal and occipital areas of the cortex in a group of eight to thirteen year old dyslexics who are of normal intelligence but retarded in reading by four years. Newton found that the backward readers' tracings indicated more alpha and theta rhythms, demonstrating a lower arousal level in their dominant hemisphere than the tracings obtained from her control group of normal readers. The controls, however, showed more but similar activity in their non-dominant hemisphere suggesting that lateral dominance in arousal was less complete in the dyslexics. Vernon commented that of those dyslexics studied, the reading difficulty of forty per cent could be attributed to a neurological impairment, and the reading problems of thirty-five per cent to genetic factors. Both these factors combined were responsible for a further twenty per cent of cases.

Crosby (1968), like many of the above researchers, objects to the term "minimal brain damage" as being non specific as it does not describe the nature of the difficulty and it suggests permanent injury. He refers to the cause of dyslexia as a "neurological dysfunction" and suggests that reading difficulties resulting from neurological causes
are related to visual and auditory perceptual problems, motor disability and weak laterality which he assesses using a simple neurological examination and perceptual motor tests. Crosby, like Vernon, is sceptical of EEG findings which in his view rarely contribute to a diagnosis of reading disorders.

Hardy (1962) and Gershwind (1962, 1964) take a functional view of neurological impairment in their studies of language difficulties. Hardy (1962) for example, considers that these difficulties are associated with an impairment in the central nervous pathways which affect the discrimination of auditory perception, attention and memory. He suggests that this impairment affects the various reverberatory circuits of the brain resulting in inadequacies in the feedback circuitry, the reinforcing mechanism which makes processing, pattern formation and retention possible. This hypothesis is similar to that of Strauss and Kopt (1955) and Strauss and Lehtinen (1947) in their studies of brain-damaged children.

Whether neurological impairment is structural or functional has not been resolved but examination of dyslexic children as adults suggests that their impairment persists, Rason (1968). Silver and Hagan (1964) in a longitudinal study of children with specific reading disability designated their retarded readers into groups similar to the subgroups suggested by Rabinovitch and his co-workers. They found that, although, as children, the neurological and perceptual difference between the "developmental group", those with a primary reading disability, and the "organic group" were not marked, the organic group in adulthood retained their perceptual difficulties in all areas, while the developmental group, had partially recovered or adopted cues which enabled them to cope with their perceptual problems.

The concept of minimal brain damage in which no clear signs of organic impairment are diagnosed has been criticised by Bar and MacKeith (1963) and Herbert (1964). Langwill (1960, 1962), however, considers that there is some support for this concept especially in those backward readers with poor laterality, slow speech dominance and motor in-coordination. However, he considers that minimal brain damage accounts for only a small minority of retarded readers. Drew (1956) also suggested that "specific developmental dyslexia" might be due to minimal brain damage and claimed that clinical examination
revealed minor neurological abnormalities in his backward readers although such abnormalities were not indicated by their level of intelligence. Other researchers, though, while agreeing that a neurological impairment could in part be the cause of reading difficulty in some children, have been unable to find evidence in their investigations to support the concept (Jutter et al 1970), Ingram et al, (1970).

Factor analytical studies of the difficulties of children diagnosed as "minimally brain damaged" have not provided evidence to support this syndrome. Rodin et al (1964) in their factor analytical study of children with school difficulties isolated several factors associated with minimal brain damage such as poor motor ability, abnormal EEG's hyperactivity and anti-social behaviour, but these factors were independent of each other.

Schulman et al (1965) used a cluster analysis to examine the relationship between retarded children with neurological, neurophysiological and perceptual difficulties, but the analysis did not isolate a group of retardates who could be clearly defined as neurologically impaired.

Worry et al (1967) in their study of hyperactive children of normal intelligence obtained similar perceptual and behavioural factors to those of Rodin and, like Rodin, they could not find a relationship between their factors. Paine et al (1968) studied children of normal intelligence referred to them because of suspicion of minimal brain damage with motor clumsiness, poor school achievement and hyperactivity. They concluded that as there was no single underlying dimension which accounted for all the factors isolated, which the concept of minimal brain damage implied, minimal brain damage was a way of describing a variety of minor neurological, behavioural and cognitive disfunctions.

Kennard (1960) could find no correlation between reading achievement and neurological difficulties and Stephens, Cunningham and Stigler (1967) found no evidence to support the hypothesis that reading retardation was the result of impaired neurological function of a minimal type.
Very few studies have attempted to relate minimal brain damage and reading retardation using factor or cluster analysis. In their factor analysis of perceptual motor and language abilities of nine to ten year old backward readers, Lovell and Gorton (1968) obtained high loadings of perceptual motor and reading deficits on their first factor which they called "a dimension of neurological integrity impairment". Raidsco (1972) used cluster analysis in an attempt to isolate clearly defined types of dyslexia including one of minimal brain damage. Though she concluded that her results indicated a multiple rather than a unitary causation for dyslexia, in one of her cluster groups the minor neurological signs and history of perinatal difficulties strongly suggested that "specific reading retardation is associated with some form of cerebral insult". The boys who clustered in this group also had visual spatial and visual retention difficulties characteristic of brain injured children.

To summarise, the review of the above research indicates that, though the concept of neurological impairment is not accepted by all, the evidence suggests that reading backwardness in some children could be the result of impaired neural function of a minimal type. This neurological impairment is evidenced by perceptual difficulties, weak body concept and an inadequately established cerebral dominance, directional difficulties, language problems and poor motor coordination. Whether such impairment in the absence of gross neurological signs, represents actual anatomical damage, failure to integrate incoming neurological impulses, impairment of the feedback circuitry, derangement of the bio-electrical circuits in some other way or delay in the development of those pathways concerned in the development of cerebral dominance, is yet to be resolved.

(1) S. Haidoo (1972) "Specific Dyslexia", P.106.
Summary

I have described the concept of Specific Reading Difficulty and outlined some of the causes to which this Difficulty might be attributed. In discussion of these etiological factors it has been suggested that the reading problem may result from a number of pre-disposing perceptual motor and language defects. In the introduction it was emphasized that these defects were not all present in the profile of any one child with reading difficulty and even when one or more does appear it has not so far been proved that its relationship with reading is a causal one. Thus a perceptual, motor or language defect may, like reading difficulty, form part of a problem whose basic cause is even more fundamental.

At first sight, therefore, it would appear difficult to establish criteria which unequivocally distinguish Specific Reading Difficulty from other forms of reading backwardness. However, numerous studies over the past twenty-five years have indicated that problems of perception, particularly visual and auditory perceptual difficulties, and motor and language difficulties, are frequently observed in children with Specific Reading Difficulty. These problems, particularly those linked with sex differences and the etiological factors described, will be discussed in the next two chapters.

The problems, their frequency and their nature prompted the choice of tests which I selected for the test battery.
Sex Differences in Reading
Many investigations from different countries indicate that more boys than girls have difficulties in learning to read. However, reports of the proportion of boys to girls with these difficulties vary from one investigation to another. Goodacre (1972) in her book "Children learning to read" quotes the I.L.T.A. survey of over thirty-one thousand eight year olds which found that nearly 21% boys to 10% girls were poor readers, a ratio of two to one. Similar findings have been reported by Honey (1962), Bentzen (1963), Clark (1970), and Davie et al (1972).

The proportion of boys who attend clinics or centres for children with reading difficulties is much higher. For example, Monroe (1932) reported that 84% of her clinical cases were boys.

The number of children with specific reading difficulty in the general school population is difficult to assess, but it has been estimated as being between three and ten per cent, Rabinovitch (1968), Newton (1970). Though the exact ratio of boys to girls with specific reading difficulty is not known, many more boys than girls of normal intelligence, but reading backwardness, are referred to clinics and remedial teachers. Critchley (1964) for example reported a ratio of four boys to one girl with Specific Reading Difficulty.

In their study of children with "specific reading retardation" in which the effect of intelligence on their reading scores had been partialled out, Rutler et al (1970) had a ratio of boys to girls of 3.3 to 1, 77% boys to 23% girls. Loseley (1971) claims that at high levels of intelligence it is not uncommon to find five boys to every one girl attending a clinic or centre because they are experiencing difficulties with learning to read. However, though Farr and Leigh (1972) found a predominance of failure in boys in their clinical groups this disparity in reading was not seen among the high achievers. In this group there was an approximately even distribution. Farr and Leigh's findings contrast with many other studies, including that of Kaidoo (1972) in which the ratio of boys to girls studied at the Lord Blind Centre was five boys to every one girl.

Possible explanations for the Sex Differences

Boys mature physically at a slower rate than girls, Tanner (1955, 1960, 1961), Simon (1959), Cheek (1968). It has, therefore, been suggested that girls learn to read earlier as a result of these maturational differences, Witty & Kopel (1959). In his discussion on the "Biological Foundations of Language" Lenneberg (1967) suggests that various parts of the brain mature at different rates so that any delay in,
for example, that area of the brain controlling speech would result in delayed speech development. Reading, motor coordination and certain perceptual skills are also thought to be affected by similar variations in maturation of the central nervous system (British Medical Journal, 1962; De Hirsch et al, 1966). Thus, as boys appear to have a greater degree of biological immaturity, especially in relation to the more specific disorders above, they are slower at learning to read and have a higher incidence of reading difficulties for their age.

The slower maturation and development of boys may be of genetic origin, possibly due to the influence of those genes attached to the "Y" chromosome, the male sex chromosome, Tanner (1959). Critchley (1970) suggests, therefore, that the high proportion of boys with reading difficulty may be linked with a hereditary factor. However, Vernon (1971) in a comment on Critchley's hypothesis suggests that, though there may be a hereditary disposition in some cases of reading difficulty, these differences were probably associated with more general developmental differences between the sexes than with a sex linked dominant trait.

Leton (1962) considers that, in addition to the developmental differences, the incidence of minimal neurological handicap is greater among boys than girls. He suggests that certain unknown genetic or constitutional factors which predispose males to these neurological difficulties could explain the greater proportion of boys who require remedial help in learning to read. Similarly Eisenberg (1966) relates the disproportion of boy backward readers to their greater biological vulnerability from conception onwards. However, as Rutter et al (1970) point out, the excess of boys who have reading difficulties, especially specific reading retardation, is much greater than those who suffer perinatal complications and other neurological insults.

In his study of language and intelligence, Moore (1967) found that girls at the infant stage showed early verbal superiority but by school age boys had caught up. However, because the girls had greater auditory sensitivity, which had been an asset in learning to talk, he concluded that their superior auditory ability gives them an advantage when they begin to read. Ingram and Reid (1956) and Davie (1972) found that many more boys had delayed speech development than girls. Thackray (1965) found a superior auditory ability in girls than boys. Bannatyne (1966) and Critchley (1964) suggest that though boys have a superior visual spatial ability, they have a lower verbal ability which, they claim, requires a
well established lateral dominance and the interpretation of auditory processes also necessary in learning to read. Kellmer Pringle et al (1966) found that girls talked earlier and made fewer mistakes in pronunciation which in their opinion was the result of superior auditory acuity.

Goodacre (1971) considers that social and environmental factors are the most important causes of differences in those perceptual aspects related to reading which exist between the sexes. Kagan (1964) considers that to primary school boys reading is not congruent with their masculine role. Vernon (1957) also emphasises the differences in personality and motivation between boys and girls and suggests that girls are more docile, more conforming and more interested in reading as it suits their female role in society. Other researchers agree that boys are less interested in reading activities and more concerned with the approval of their classmates than with pleasing their teacher. Mosesley (1971) suggests that the learning needs of boys, especially of "bright" boys, are not met in schools. The intelligent boy learns by discovery and activity and seeks immediate feedback, while girls tend to be more conforming and are therefore more interested in the "passive" activity of reading.

In their study of eleven thousand seven year olds, Kellmer Pringle et al (1966) found that, judged by their teachers, boys were "more aware of the world around" but less home-centred than girls. As many early reading schemes tend to be more "home orientated" and have no clear link with the outside world, this early reading material does not capture the boys' interests.

McNeil (1964) found that there were no sex differences in reading when boys and girls were taught using programmed instruction, but when these same children were taught by women teachers the girls made greater progress. These results would suggest that teaching methods used by women teachers are less suitable for teaching boys. Goodacre, in discussing McNeil's findings, suggests that a boy's constructive interests may be more satisfied, therefore, if taught by a word building phonic approach which appeals to the "masculine" desire to know how things work.

Summary

To summarise, it is accepted that, in general, girls are superior at learning to read. However, the explanations for this sex difference are varied and often based on little experimental evidence. The theory of delay in development of specific areas of the brain, the genetic and neurological theories, are interesting but hypothetical. The theories
in which differences in role of boys and girls are affected by attitudes of society and the effect of these differences on attitudes in learning to read, require further investigation before they, too, could be accepted as satisfactory explanations.

The early superior language and auditory ability of girls, no doubt is an important factor in influencing their superior reading but, as in the case of delayed maturation, one would expect that boys would overcome these initial disadvantages. Though the gap between the sexes does narrow, it does not disappear completely, possibly because many of the above difficulties are not resolved for all boys.

In addition, perhaps their initial failure in learning to read has made some boys lose confidence, perseverance and motivation to overcome their initial difficulties, with a result that not only reading problems, but also associated behaviour problems, develop. These factors are further discussed in the chapter on behaviour and reading backwardness.
Chapter 5

Review of the literature relating Perceptual, Motor and Language difficulties to reading difficulty.
Although reading is generally accepted as a cognitive process, perceptual motor processes, particularly in the early stages of learning to read, are also essential. Many of these different perceptual aspects related to reading have been investigated experimentally. However, these studies have so far been isolated attempts and have yet to be fully integrated.

The following chapter attempts to collate studies of perceptual and motor ability related to reading and, in addition, to evaluate the relationship between speech, language and reading.

**Visual Perceptual Pattern**

Studies in the development of perceptual abilities indicate that a child first learns to perceive general form and from this goes on to develop an awareness and accurate perception of detail. Neub (1949) describes three levels of perception, firstly, a primitive sensory perception, then the ability to segregate a figure from its background; finally the child learns to differentiate the finer details of the figure, to perceive the essential parts and to manipulate them in the formation of concepts.

As reading involves the visual perception of printed symbols, an essential prerequisite in the process of learning to read is the perception of pattern, the ability to perceive and organize spatial relationships, to analyze and reproduce complex form and appreciate the significance of sequential order. Gibson (1966) in a discussion of the visual aspects of learning to read, not only includes the ability to differentiate the graphic symbols but also the ability to associate the shape of letters with sounds and the ability to manipulate more complicated units of structure, as illustrated by spelling patterns.

Numerous studies have shown that visual perceptual difficulties are present in children learning to read and it is suggested that these become antecedents of reading difficulty.

Fildes (1921) noted that backward readers who scored badly on tests of visual discrimination of form and spatial orientation had particular problems in differentiating letters, had weak visual memory and made reversal errors. Monroe (1932) described two similar aspects of visual perceptual difficulty, poor form perception, characterized by an inability to distinguish words as units and poor spatial ability, demonstrated by a reversal in left right orientation of letters and words.
In contrast, Gates (1922) questioned the validity of a concept of visual perceptual difficulty related to reading. He found no differences between his retarded and normal readers on tasks of visual discrimination or memory. Halquist (1953) found positive but non significant correlations between visual perceptual abilities and reading in his investigations.

Benton (1962) in a discussion of various studies of visual perception and reading, including those of Feldes and Gates, concluded that visual form perception was not an important correlate of reading retardation except in younger children who were just beginning to learn to read. He observed that older children with reading difficulties show poor visual perception and directional sense only "when the task requires implicit verbal mediation for optimal performance." (1) Thus if a child is visually perceptually impaired, it is a general impairment involving difficulties of non linguistic and non symbolic visual stimuli as well as symbolic material.

Vernon (1957) also considered that the relationship between poor visual perceptual ability and learning to read had been over-emphasised. She notes that the poor visual perception of the backward reader may be partly the result of continued immaturity but partly also because of his general cognitive confusion. She considers that the ability to analyse, abstract and generalise are the components of cognitive ability that are of greater importance in learning to read.

Frostig and her co-workers (1961, 1964, 1966) place much more importance on visual perceptual development and reading ability. They examined five areas, position in space, spatial relationships, figure-ground perception, form constancy and visual motor ability related to learning to read. They considered these areas to be so important that they have developed a "Programme for Development of Visual Perception," Frostig and Horns (1964). However, from a factor analysis of the Frostig tests of visual perception, Olson and Johnson (1970) concluded that, as a predictor of reading achievement the test was not a multifactor but a unifactor test in which the variance could be accounted for by one or two common factors. Similar findings were obtained by Huefle (1967) and by Frets (1970). Olson and Johnson claimed that the Frostig Test was the least predictive test of reading and suggest that in order to read a child must be at a perceptual level beyond that measured by the Frostig test. Thus they would support Benton's view that visual perception is less important to reading as the child develops.

Though Nelson and Ringo (1969) found no difference between their nine to ten year old remedial readers and normal readers on the Frostig Tests, Du Bois (1973) in a study of boys and girls, who were selected at random, did obtain significant relationships between the Frostig Tests and the Gates Macdonald Reading Survey. However, when partial correlations were computed, controlling for intelligence, these relationships did not remain significant.

Other researchers using similar tests of spatial orientation have clearly established a relationship between this perceptual ability and reading difficulty (Coins, 1959; Redmonsky, 1968). Wechsler and Hagan (1964) found significant differences between retarded and normal readers up to the age of ten years and Leader (1968) obtained a correlation of 0.5 between spatial orientation and word recognition in eight and a half to ten and a half year olds. Silver (1968) and Silver and Hagan (1964) found that their retarded readers had difficulties in figure ground discrimination and Goyen and Lyde (1973) found that visual discrimination was poor in their retarded readers. This was particularly true in those errors which occurred when two non identical shaped words were judged to be the same. Goyen considers that visual discrimination difficulty is either the result of a failure in the retarded reader's initial input process or in the final discrimination process. Other studies such as that of Jastak (1965) and Gibson (1968) emphasise the difficulty of backward readers in picking out the essential features of letters. Gibson et al (1962) studied visual discrimination in a group of children aged between four and eight years. They found that most errors were in tilting and rotation rather than confusion between open and closed shapes both in letter and letter like forms. Popp (1968) and Dunn-Rankin (1968) noted the difficulty of children in differentiating between letters with similar features such as "a" and "e" and "t" and "f". Trieschman (1968), using the Gibson material, concluded that these difficulties were the result of a child's inability to remember relevant details and in attending to the space and directional aspects of letters.

Hesseley (1971) in a discussion of visual spatial ability related to reading, notes that spatial tests which show highest correlations with reading and spelling are those which require sequential processing of information. In a survey of over twelve hundred and fifty second year juniors he found that almost half of those children with low visual spatial ability were unable to spell three letter words reliably.
Bonhoeffer, in his study of good and poor readers of average intelligence (1970), noted that his poor readers were unable to match three letter words where the match involved the order of letters within words. He associated this difficulty with the backward readers' lack of lateral awareness of their body parts. He also observed (1) that poor performance on a spatial test by older children is often the consequence rather than a cause of reading difficulty and suggests that emotional factors or environmental influences play a mediating role in the association between spatial ability and reading. Ndico (1972) found that her dyslexic boys were poorest at sequencing ability. Thus she supports Doehring's conclusion (1960) that sequential difficulties could be the root of specific reading difficulties. In his study of boys aged between ten and fourteen years who were retarded in reading by at least three years, there was a high incidence of visuo-spatial sequential difficulties.

Sabatino and Haydon (1970) also support the view that visual sequential ability is important to reading success. Wiener et al (1970), however, could find no relationship between this ability and reading. Lyle (1969) found that his retarded readers were poor in making sequence reversals in reading but concluded that this difficulty was not a factor of perceptual distortion but a verbal learning factor in which the production of letters in sequence involved more verbal rehearsal than perceptual memory. Similar conclusions were made by Aseo and Lyle (1970) in their study of visual discrimination, verbal comprehension and spatial ability in a group of younger children.

Visual perceptual difficulties have been linked with other difficulties of Backward Readers, particularly with poor coordination of muscles controlling the movements of the eyes, Loton (1962), Nodine & Lang (1971), Loserove (1963). Prochtl and Stember (1962) found that hyperactive children with reading difficulties had poor spatial perception and orientation. They concluded that these errors and errors made in word recognition were related to involuntary eye movements made during reading which cause instability in concentration and lead to difficulty in learning to read.

Gutman and Kone (1964) put forward a similar view. However, other investigations do not support a relationship between eye movements and reading, Tinker (1958) and Taylor (1965). Critchley (1970), for example, suggests that faulty eye movements are the result and not the cause of reading difficulty; a view supported by Professor Vernon.

Do Hirsh et al. (1966) associated poor visual perception with weak body concept, poor right-left orientation and language defects which, as has already been discussed, she considers to be the result of a "maturation lag". Lovell and Gorton (1963) associated visual perception, especially visual-spatial ability and rotations, with auditory visual integration difficulties and poor motor coordination, as well as right-left discrimination weaknesses. They, like Cohn (1960) and Bodes and Ryklebroeck (1964), suggest that a neurological factor is the underlying cause of these difficulties.

To summarise, though difficulties in spatial orientation and figure-ground discrimination have been associated with reading difficulties, the extent of their importance in reading retardation, especially in older backward readers, has not been established. However, most studies into the psychological basis of reading and dyslexia in England, like those of Goodacre (1971), Bearde (1972), Clarke (1970) and Vernon (1971) and Weidell (1973) suggest that visual perceptual ability is an essential factor in learning to read.

**Visual Motor Ability**

Visual motor perception involves both the visual perception of printed material and the motor act of reproducing what has been perceived. Ability to perceive and reproduce complex geometric shapes, as demonstrated in performance of the visual motor gestalt test (Bender 1938), has frequently been used to assess this aspect of perception. The test consists of nine figures of different shape and complexity which have to be copied. The figures were first designed by Wertheimer (1923) cited by Koppitz (1964) and used later by Kohla (1935) to demonstrate various gestalt effects in which form is fundamental and once it exists tends to persist. Gestalt perception is global: an object is perceived as a whole but parts of the perceptual field are ignored. Bender developed her test as a means of evaluating maturation of this gestalt function in children aged between four and eleven years. She defined gestalt ability as the "function of the integrated organism or brain whereby it responds to a given constellation of stimuli as a whole, the response itself being a motor process of patterning the perceived gestalt", Bender (1970). (1)

By the age of six to eight years the basic principles of visual motor gestalt ability have developed but it is not until the age of eleven that the difficult aspects of the figures are clearly perceived. Bender describes four stages of maturation of visual motor ability: control.

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of circular movements, figure ground differentiation, horizontal vertical and diagonal orientation, the differentiation of figures and their parts and relation of parts to wholes.

Numerous studies have been reported relating to B.V.H.G.T. and reading achievement. Koppitz et al (1958, 1961, 1964) used the Bender test to study children aged between six and eleven years. She found that, though no single item on the test was exclusively related to reading and number problems, particularly significant was the perception and reproduction of shapes, angles, curves and dots and the integration and directionality of whole and part whole relationships. It was on these findings that she constructed her own developmental Bender scoring system for young children, Koppitz (1964).

Thweatt (1963) used the B.V.H.G.T. (Koppitz scoring system) to predict reading achievement. He gave the test to six year olds and assessed their reading vocabulary and comprehension at eight years. Over three quarters of the children in one group and half in another who had poor Bender scores at the age of six had reading difficulties at eight, whereas those with very good Bender scores were up to their reading level. Similar findings have been obtained by Goins (1958), Smith and Keogh (1962), Keogh (1965), De Hirsch et al (1966), Dykstra (1967) and Bell and Aftanus (1972). However, Keogh (1965) and Keogh and Smith (1967) in a longitudinal study found that, though the Bender scores of their children at five to six years were significantly related to reading ability, by the age of eight to nine years the correlation with reading was not significant of poor performance but was still predictive of good performance. When the same children were retested at eleven to twelve years both good and poor scores predicted reading ability. Chang and Chang (1967) could only find a relationship between Bender scores and reading achievement in their group of young superior gifted pupils.

Vernon (1971) in a review of the B.V.H.G.T. as a predictor of reading achievement concluded that young children tended to revert to more primitive forms when reproducing the figures and made errors in size of angles, in integration and rotation errors, and failed to perceive parts with the whole. She supports the view that these errors, which are associated with immaturity in perception, are more frequent and persist longer in backward than normal readers. Various studies relating poor Bender profiles and difficulties in reading indicate
that backward readers have difficulty in integration of the gestalt and difficulties in discriminating between dots and circles and curves and angles. These studies also report a greater incidence of rotation and perseveration amongst backward readers. (Silver and Hagin, 1960; Leckmann, 1960; Koppitz, 1964; De Hirsch et al., 1966; Werner et al., 1967; Tansley, 1967; Snyder and Kallal, 1968; Crosby, 1968; Clark, 1970).

Poor visual motor ability has also been associated with difficulties in spelling and arithmetic. (Koppitz, 1964; Brenner et al., 1966; Vedell and Hone, 1969; Rosen and Simon, 1971; Rosen, 1973) with Apraxia (Ayres, 1965) and with motor impairment (Brenner et al., 1967).

Thus the relationship of poor Bender visual motor gestalt ability with reading difficulty has often been demonstrated, particularly the ability to discriminate and reproduce angles and integrate parts of a figure with its whole. However, whether this difficulty is the result of an immaturity of perceptual motor skill or of neurological origin is yet to be resolved.

Auditory Perceptual Patterning

Research by Gibson (1969) emphasised the importance of discrimination in the development of understanding speech: contrasting phonemes must be discriminated from the total phonic pattern. Malphant, Supramaniam and Saraga (1974) would go even further. They state that auditory skills do not necessarily result from perception of phonemes. Electronic analysis of sound patterns has shown that the acoustic features of these units are extremely complex, especially in the acoustic pattern of vowels, for example, when presented with different consonants. As Goodacre (1971) observes, a child when learning to read, must not only differentiate the sounds of his language from other sounds, but make accurate comparisons of the sound he discriminates with its representation on the printed page.

Auditory discrimination of speech sounds develops with age in the following sequence: first the vowel consonant contrast is discriminated. Then at an early age the labial dental contrast and the breaks in continuous sound are appreciated. Discrimination of combined vowels and multiple consonants comes later (Vernon, 1971). This development of auditory discrimination is not complete until about seven and a half years and Thompson (1963) found that even some eight year olds had difficulties. Sims and Williams' (1969) study of phonics skills and reading ability indicated that children with a reading age over seven and three quarters still had difficulty with long vowels and vowel combinations, especially words formed from a consonant blend, vowel and single consonants.
Even when pairs of words have only one phoneme feature between them they are often confused, especially in children with reading difficulties, Wopman (1960, 1962), Deutsch (1964, 1966), Katz and Deutsch (1964).

Reesor (1973) claims that reading is biased towards auditory perceptual ability. In a study of over four hundred first and second grade children he found that while visual motor scores were significantly related to arithmetic ability, auditory perceptual scores were highly related to reading. He argued that reading requires analysis of spoken words into phonemes which depend upon auditory perceptual skills while arithmetic requires the ability to analyze spatial relationships. Thus a child with poor auditory perception will have difficulty in reading because he is unable to discover the general principles of letter sound relationships.

Deutsch (1964) and Olson (1966) agree that auditory perception is more highly correlated with reading and they claim that poor auditory perception results in failure to learn spoken language which in turn gives rise to the reading difficulties. Other research supports the view that reading achievement is related to early linguistic ability, Monroe (1932), Wopman (1960).

Certainly some children with normal hearing do have difficulties in discrimination of similar sounds and various experiments have shown that auditory discrimination is poorer in backward readers, Wopman (1960, 1962), Goettinger, Barks and Beer (1960), Monroe (1932), Harrington, Jones and Durwell (1955), De Hirsch et al (1966), Silver (1968), Evans (1969), Clark (1970).

Blank (1966) considers that auditory discrimination is not a simple auditory perceptual process as it would first appear because the pairs of words must be "attended to, retained internally and sequentially compared, and a judgment of their similarity must be made." (1). This opinion is supported by Cheney and Rebart (1966). They, like VandeVoort, Sonf and Benton (1972), consider that auditory figure-background ability is dependent upon auditory attention. If a child

is weak in auditory attention he becomes easily distracted by other stimuli, does not attend to key words and, as a result, develops language and reading difficulties. However, Silver and Hagin (1964) in a longitudinal study of backward and normal readers using both the Monroe and Wepman tests of auditory discrimination did not find any significant differences between their reading disability group as children and as adults, or between the reading disability group and the control group of normal readers.

Heidoo (1972) could find no significant differences between the mean auditory discrimination scores of reading and spelling retardates or between dyslexics and controls. She did find that her dyslexic group had a greater proportion of difficulties with short vowel sounds "a-e" and "e-i" and with consonants "b-d", "d-g", "th-sh" and "sh-th" on the Wepman test, Wepman (1958). Johnson and Nyklebust (1967) also found that their backward readers had difficulties discriminating short vowel sounds.

Difficulties in sound blending of letter sounds in backward readers have been reported by Vernon (1957), Johnson et al (1969), Chall et al (cited by Vernon 1971), Moseley (1971) and Heidoo (1972).

Vernon argues that this difficulty is not only due to difficulties in auditory perception and discrimination but also an inability to synthesise the sounds.

To summarise, auditory perception, especially the discrimination of vowel and consonant sounds, is a developmental phenomenon which is complete by about eight years. This ability is poorer in backward readers who it is suggested have difficulties in auditory attention, the analysis of words into their constituent sounds and in synthesizing sounds into whole words.

**Auditory Visual Integration and Auditory Memory**

It has already been noted that reading involves the association of an auditory pattern of sound with the visual pattern of words on the printed page. This association of two sense modalities implies that auditory visual integration may be an important factor in learning to read. In a discussion of auditory visual integration, Evans (1969) quotes various investigations which show that poor readers have difficulty in shifting from one sense modality to another and in the integration of two sense modalities. Wedell (1973) considers that these difficulties are in the simultaneous analysis of the two modalities rather than in, for example, the analysis of sound sequence only.
Auditory visual integration develops rapidly in children between ages five to seven and then continues to develop at a slower rate until about the age of ten years when it is complete. Kahn and Birch (1968) found that children could match groups of dots presented visually with a rhythmical auditory sequence of taps by seven, confirming similar findings by Birch and Belmont (1964). Rudnie, Sterritt, and Flax (1967) found that performance in matching sequences of flashing lights and dots improved up to the age of eight years. Birch and Belmont demonstrated in their study (1965) that the auditory visual integration of backward readers was highly correlated with reading up to age seven and eight and, in their 1964 study, they found that retarded readers between nine and ten years were significantly poorer at auditory visual integration than a group of normal readers.

Kahn (1965) also obtained good positive correlations of .57 to .57 between auditory visual integration and reading achievement in children from grades two to six. However, when IQ was held constant, this relationship became insignificant except in regard to word knowledge. Ford (1967) also found that the relationship of auditory visual integration and reading in a group of nine year olds was due to the correlation of both with intelligence when this is partialled out the correlation disappears.

In their investigations, Sterritt and Rudnie, (1966) asked nine year olds to match sequences of taps, rhythms of tones and flashes of light. They found these skills, especially the sequence of tones and taps, related to reading achievement. Though they found that intelligence accounted for 50% of the variance in reading, auditory visual integration accounted for 25% variance independently of intelligence. However, in a later investigation, Rudnie, Sterritt, and Flax (1967) found no relationship between the matching of visual and auditory sequences and reading in eight to ten year olds. Similarly, Vicner et al (1970) in a study of auditory, visual and tactual modalities in good and bad readers, mean age 9.9 years, did not obtain any significant relationships between reading and sequencing abilities.

Berry (1967) tested auditory visual integration in eight to eleven and a half years old retarded and normal readers matched for age, IQ and sex. He concluded that the Belmont and Birch test (1964) discriminated well those children with reading difficulties.
Kahn and Birch (1968) in a study of 350 boys between seven and twelve years, found a significant correlation of AV integration to reading up to the age of twelve. Even when the effect of intelligence was partialled out the correlations, though lower, were still significant. They did not find that visual and auditory discrimination or auditory memory greatly influenced performance in auditory visual integration. They concluded that, as those children who visualized the auditory patterns in the auditory visual integration test were more successful than those who applied verbal labels to the test stimuli by using counting procedures, that auditory visual integration was more related to visual aspects of reading than reading comprehension.

Blank and Bridger (1966) and Blank et al (1968) considered that poor auditory visual integration was a deficiency in verbal labelling by the backward reader. Their backward readers were able to label special groupings but were poor in labelling temporal sequences. Leone and Decker, cited by Haliphant et al (1974) in their investigation on the relationship of temporal order to reading found that children who were classified as poor-temporal order perceivers, because of their inability to perceive changes of letter or word sequences, made four times as many reading errors as the good temporal order perceivers. In a later study by Decker (1972) of temporal ordering between auditory and visual modalities, it was found that this ability was significantly associated with age, sex and reading ability, with girls performing better than boys. This finding is also supported by Reilly (1971) who suggests that auditory visual integration skills develop earlier in girls than in boys. These conclusions are particularly relevant in view of the much higher incidence of reading backwardness amongst boys. Gregory and Gregory (1973) using a morse test and the Birch test to test auditory visual integration ability in children between six and eleven years also obtained significant correlations of .5 and .21 with reading. They concluded that verbal mediation is not necessary for coding temporal sequences, as suggested by Blank and Bridger (1966).

As Piaget and Inhelder (1956) have demonstrated, children can perceive and remember shapes accurately long before they can remember their order in sequence but whether visual or auditory sequencing is the more important to reading is debatable. We have noted that Doehring (1968) considered that visual sequential ability was most important in children with specific reading ability while Damatyan
(1966) considered it to be essentially an auditory one, a view supported by Iona (1969) and by Storrit and Faudinck (1966). Sabatino and Hayden (1970) concluded that both auditory and visual sequential ability, which was poor in their group of children with learning difficulties, were most important to reading success, a view supported by Tansley (1967) and Vernon (1957, 1971) and other researchers who have demonstrated relationships between auditory visual integration and reading ability. However, in the initial stages of learning to read, the relevant sequence is not auditory-visual, as suggested in many of the above investigations, but principally a visual presentation followed by auditory response. As Haliprant et al. (1974) suggest, studies of children using verbal material on a visual-auditory matching task require further investigation.

**Auditory Memory**

The ability to retain and reproduce a sequence of sounds in their correct order depends on auditory memory. Just as there is a controversy between the significance of intelligence on the relationship between auditory visual integration and reading, there is also controversy about the importance of auditory memory and reading ability.

James Hinchlcock as early as 1917 noted that poor auditory memory could lead to backwardness in reading but he considered that auditory memory in "word blind" children was normal and in many cases exceptionally good.

Kosley (1971) reported significantly poor Digit Span sub-test scores in boys who were poor readers and poor spellers, and auditory memory in backward readers has been reported by Hydeleback and Johnson (1962), Do Hirsch et al. (1966), Doehring (1968) and Ndido (1972).

Ndido (1972) suggests that poor auditory memory in backward readers may be the result of neural dysfunction or delay. She bases her opinion on the research of Milnor (1962) in which adults with lesions of the left temporal lobe had a "selective impairment in the recall of verbal material." (1) Ndido found that the dyslexics at the Word Blind Centre had a similar difficulty in recalling verbal material, had poor digit span scores, made slow progress and were difficult to teach. Ability to recall and manipulate sequences was reported by Kinsborne and Warrington (1962) to be impaired in these adults with damage to their dominant parietal lobe. In their later study of developmental factors related

(1) S. Ndido (1972) Specific Dyslexia, P.91.
to reading and writing difficulties in children, Kinebourne and Warrington (1965) found that these difficulties were present in their group of children with low performance high verbal W.I.C. scores.

Thus, auditory visual integration has been associated with reading ability though the relationship of both with intelligence questions the significance of this relationship. Of equal consideration appears to be visual and auditory sequential skills which themselves are dependent upon visual and auditory memory.

**Body Concept**


Whiting (1973) defines Body Concept as a global term which involves "information pertaining to mental representations of the body gathered from a number of different view points". (1) This general definition would also encompass other synonymous or very similar terms such as "body image" and "body schema". Witkin (1965) emphasises the importance of perceptual and cognitive factors and learning involved in development of body concept which he defines as "The systematic impression an individual has of his body cognitive and affective, conscious and unconscious, formed in the process of growing up". (2)

Witkin and his co-workers (1962, 1965, 1967) relate the degree of sophistication of body concept to a mode of perceptual and cognitive functioning which they call "field dependence/independence". Thus a child who is "Field dependent" would have a poorly developed body concept in which he has a global field approach to perceiving, would leave stimulus material unorganised and experience his surroundings in global fashion conforming to the influence of the prevailing field or context.

He may lack self-confidence, have a low critical ability, have a poor comprehension of relationships, a poor sense of awareness and a lack of insight. The "field independent" child shows greater self differentiation. He has an analytical field approach to perception and intellectual behaviour and therefore has a more articulated body concept and is more able to structure his experiences.

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Within and his co-workers have shown that there is considerable
stability in body concept between eight and thirteen years and between
ten and twenty-four years of age. He suggests that, in general, boys
tend to be more field independent and girls more field dependent,
though the younger the child the lower the level of differentiation.
He further suggests that, though both personalities may develop a
degree of language ability which he calls "verbal expressiveness"
and which he defines as "the ability to give extended fluent verbal
accounts", this aspect is less well developed in the field dependent
child. Thus the field dependent child may develop a language ability
which requires rote learning and application of mechanical rules, but
he may have difficulties in language and reading which involve verbal
skills and places more emphasis on relations and abstractions. This
view is supported by Cariden (1958) and Isaac and Cariden (1961) and by
Within et al. (1962) who found a significant correlation in a sample of
boys between reading ability and perceptual field independence as
measured by the embedded figures test. The scores of this same test
by girls were in the same direction but did not reach significance.

Kephart (1960) would also consider that body concept develops as
a result of perceptual differentiation and that perceptual
differentiation is a result of exploration of the body in space and
coordination and organization of movement experiences. Thus any
deficiency in the development of body concept would result in problems
of directionality reflected in letter reversals and the twisting of
letters within words. Hermann (1959) in a neurological study of word
blindness, considered that poor development of body schema was one of
the behaviour deficits associated with dyslexia and resulted in a
difficulty in orientation of symbols such as letters, numbers and notes.
Rosenberger (1970) also associated the problems of his backward readers
of average intelligence with a lack of awareness of body parts.
Benton (1962) on the other hand considers that these difficulties are
expressions of a deficit in "symbolic formulation" rather than the
result of a disturbance in body schema and, though Rabinovitch (1962)
expresses the view that body image is one of the factors associated with
reading problems, he does comment that it is one that is much less
clearly demonstrated.
Fansley (1967) considers that development of body concept is the result of "neurological organisation", perceptual development and experience and is reflected in the way a child "draws-a-man". He considers that children with motor difficulties, perceptual disturbance and minimal brain injury usually produce drawings which reflect their poor body concept; all of which he associates with difficulties in learning to read.

Ritchie-Russell (1958), like Kephart and Fansley, emphasises the importance of movement in relation to development of body concept which itself affects spatial relationships. He suggests that the sensory pathways to the posterior half of the cerebral hemispheres, especially the posterior central gyrus and the calcarine cortex, are most concerned with the development of body concept and any defect in motor control may result in faulty development of body image.

Ansbacher (1952) using the draw-a-man test as a test of body concept found the test correlated highly with reasoning, spatial and perceptual factors but not with verbal meaning and number in a group of ten year olds. Bremer et al (1967) also found significant differences between a group of eight to nine year olds with average intelligence who had poor motor coordination, poor spelling, handwriting and poor arithmetical and a control group on the Goodenough draw-a-man test. Though similar studies, some of which have been quoted above, do suggest a relationship of body concept with perceptual-cognitive abilities and academic achievement, evidence of a causal relationship between body concept and reading ability is sparse indeed. Fansley (1964) reported a correlation of .64 between the draw-a-man test and reading achievement, and Sinha (1970) obtained correlations between the Goodenough draw-a-man test and reading of between .05 and .62 in groups of seven to ten year olds. Benyon (1968) reported that many of the six to eight year olds who had language difficulties and were unable to read in her clinic, had a poor body image. The present author in a study of good and bad readers aged between seven and eight found significant differences between the two groups on the draw-a-man test (1971). Silver and Hagin (1967) in a longitudinal study found that adult retarded readers continued to produce human figure drawings suggesting tonic posture problems. Characteristics of the reading retardates' drawings, such as slanting of the figure and its displacement, significantly differentiated them from a group of normal readers. Critchley (1970) found confusions in
perspective in the drawings of dyslexics and Shankweiller (1964) and De Hirsch et al (1966) reported difficulties in draw-a-man profiles in a group of dyslexics and older backward readers respectively. De Hirsch considered that, like reading, writing and spelling, human figure drawing requires the ability to organise a gestalt into a meaningful whole and suggests that a poor body concept indicates a low level of integration pointing to a severe nauturalional lag.

Other researchers have included a test of body concept, especially the draw-a-man test, in their battery of tests on retarded readers, but have not established a clear relationship between this aspect and ability to read. Bell and Aftanas (1972), for example, obtained differences between draw-a-man and reading ability but these differences did not reach the level of significance. Brom (1963) in a study to examine the effect of a motor programme on perceptual motor skills, including body concept, and reading performance in children who were reading below their grade level, found that though the motor activities considerably improved body concept, there was no significant difference between the backward readers and control group in body concept on either the pre or post tests. Also of interest, the motor programme did not improve the children's relative position in reading.

Lateral Dominance, Right Left Discrimination and Reading

Various theories have been postulated which suggest a relationship between lateral development of the cerebral hemispheres of the brain and reading achievement or lack of laterality and reading backwardness. Though there are few statistical studies supporting this relationship, there is considerable evidence indicating its possibility. Man has hemispheric dominance with lateralisation of function and he also has a preference with respect to side in use of limbs and sensory organs such as the eye.

Lateral dominance is not present at birth but is a naturalational process which is not complete in children until the age of six or seven, the time when they are beginning to read. (Seth, 1973).

Gesell et al (1940) suggest that even in the first few months of life the tonic reflex position of the child indicates the emergence of lateral dominance. A marked preference for the use of one hand is clearly distinguished by the time the child is aged eighteen months.
Lenneburg (1958) suggests that Lenneburg and Orton (1937) and Critchley (1964) claim that the tendency to develop predominant use of either the right or left lateral hemisphere is a hereditary tendency. Studies of laterality in animals such as rats show that a majority of animals, like humans, favour the right hand, and destruction of parts of the cerebral cortex by drugs reversed hand preference. This suggests that laterality is physiologically determined.

Hamfrew (1972) claims that development of handedness is closely linked with speech development. This view is supported by Orton (1937) and by Roberts (1951) who considers that as handedness develops after the beginning of speech, it is clearly determined by speech. Orr and Cappannari (1967) do not claim that speech directs the development of handedness but that the hand with its complex dexterity evolves at the same time as the cerebral cortex. Both parallel the development of language. As the motor and speech areas of the cortex lie in close proximity and are linked with each other neurologically, the manipulative skills, motor skills and speech have evolved together.

Kephart (1960) considers that development of laterality is the result of early motor experiences. These motor experiences provide the basis by which a child learns to discriminate between the right and left sides of the body. As a result of the integration of the visual information of external objects with the established kinesthetic and motor experiences, the child develops a concept of laterality and directionality.

Delacato (1966) suggests a further dimension to the hemisphere motor and speech relationship in his discussion of the phylogenetic evolution of man. He claims that man first developed lateral dominance through the use of tools. Then man began to draw and used his tools and eyes for near point distances on a two dimensional surface, with the result that there was a neurovisual adjustment from binocularity to development of a dominant eye. Because the preferred eye is in a better position for seeing the preferred hand, both developed on the same side. Thus, Delacato claims that handedness started development of lateral dominance and dominant eyehandness followed in response to environmental demand. As man evolved, sufficient development of hemisphere dominance occurred for the development of a dominant language hemisphere from which developed speech. Delacato further claims that this phylogenetic process is "recapitulated" in the autogenetic development of the child beginning at gestation and is complete at six and a half years of age.
Money (1962) does not support such a view and refers to Zangwill's study (1962) in which he comments that "no clear evidence has been adduced that one hemisphere exercises direct control over its fellow in speech or motor activity", (1) as being completely incompatible with "current fascist therapies of dyslexia on the basis of hypotheses of cerebral dominance. (Palermo, 1959)." (2).

It was Orton (1937) who put forward the view that many defects in language function and the development of language were due to failure to establish lateral dominance. In studying reading disorders, he considered that one must also consider language and motor development. Therefore, incomplete lateral dominance is related to reading retardation, left handedness, ambidexterity and cross laterality. Orton suggested that in early visual development the storage of memory images of letters and words necessary in the development of reading occurs in both cerebral hemispheres but, as the child learns to read, he suppresses the confusing memory images of the non dominant hemisphere. Therefore, in cases of reading disability the memory patterns in this non-dominant hemisphere are incompletely suppressed so the child has difficulty in recognising symbols and confuses letters and words with their mirror image. More recent investigations by Penfield and Rasmussen (1950), Penfield and Roberts (1959) and by Roberts (1951) criticised Orton's theories on the role of the dominant hemisphere and development of speech and also his findings on the incidence of left handedness and mixed laterality in retarded readers.

It is true that many people who are considered "Dyslexic" or who have reading difficulty are left handed or have mixed lateral dominance, (Monroe, 1932; Vernon, 1957). Goodacre (1971) notes, for example, that because the left handed writer moves his hand over the word he is writing he obscures the letters as he forms them and as a result his visual feedback may be impaired, which in turn may lead to right left confusions and reversals of letters. She quoted the work of Cohen and Glass (1968) to support her view that left and right directionality and hand dominance are related. Defects in either, she claims, indicate poorly developed laterality and development of directional discrimination, which result in reading difficulty. However, she does comment that in Cohen and Glass's opinion poor directional confusion and laterality may result from general emotional confusion rather than a neurological impairment or a developmental lag which she favours.

(2) J. Money (1962) op cit, P.30.
Critchley (1964) quotes a number of investigations indicating that a greater proportion of poor readers have mixed dominance and the research of Harris (1957), Neidoc (1961), Zengwill (1960, 1962), Delacato (1965), Kosen (1964) and Silver and Nogin (1964) support the view that incomplete dominance is a cause of reading retardation.

Critchley considers that mixed laterality, in which there is no clear cerebral dominance, is a more significant etiological factor than sinistralia, a view supported by Bannatyna (1966). However, many other investigations, Gates and Bennett (1933), Gates and Bond (1936), Hammond (1962), Croft (1962), Be Hirsch et al (1966), Stephens et al (1968), Bond and Tinker (1957), Shearer (1968), Lyle (1969) and Rutter et al (1970), dispute the relationship between lack of dominance and reading disability. Lyle (1969) found no relationship of reading retardation with mixed laterality, eyedness, or cross hand eye dominance. He supports Harris's view (1957) that the incidence of cross hand eye dominance reflects the low incidence of left handedness among retarded readers.

Zeman (1967) reviewed various investigations on the relationship between laterality and reading. He demonstrates that in four studies involving the use of matched pairs no significant differences were found to exist between handedness, reversals, hand eye dominance and reading disability.

One of the problems in assessing the relationship between dominance and reading is the difficulty in measuring cerebral dominance. (Silver, 1963; Boc, 1972). Researchers often cannot agree on what combination of handedness, eyedness and footedness comprises dominance. For example, Tansley (1970) would claim that the dominant hand and foot should be an indicator of laterality while the dominance of the eye is less important because the eye is a bilateral organ from a neuro-physiological point of view. This would be contested by Delacato (1965) who places much more emphasis on eye dominance.

Neidoc (1972) for example tested handedness, eyedness, footedness and cross laterality in her study of dyslexic children. She found that though the incidence of left handedness, left eyedness, left footedness, cross laterality and mixed hand eye foot dominance was higher in those children attending the Lord Blind Centre rather than a group of controls, the differences did not reach significance. However, there were differences at the 5% level between the retarded readers in her study of dyslexia and a control group. There were more left handed writers, more ambilateral s and fewer strongly right handed retarded readers.
Gross laterality and mixed eyedness were more frequent among the spelling retardates than their controls. Neidoo supports Orten's view and that of Niliner et al (1964) and Newton (1970) that left handedness and ambilaterality may be the result of incomplete cerebral dominance. She associates these factors with slow speech development, poor visual motor and spatial orientation and poor left right orientation.

Farr and Leigh (1972) tested eye hand and foot dominance in nearly twelve hundred Tasmanian primary school children. They obtained a significant association between retarded reading and indeterminate eye dominance, and between reading retardation and ambidexterity. However, in an examination of older boys between ten and twelve years ambidexterity was less significant.

Variations in findings related to cerebral dominance may be as much affected by the age and type of population studied than differences between retarded and non retarded readers. Clark (1970) for example, found a higher incidence of left handedness among boys. In a study of fifteen hundred seven year olds, she found that 6.8% wrote with their left hand. The percentage for boys was 10.9% and for girls 6.5%. This finding is similar to that of Kasten (1962) who in a large population study found that 11.1% children were left handed, 12.5% boys and 9.7% girls and by Kolliner Pringle et al (1966) and the Flodden Report (1967). Clark (1970) found that 34.8% of the children in her study were left eyed and 39% were cross lateral.

Douglas (1963) related the incidence of handedness in a study of over three thousand children to social class. Of the 10% children with inconsistent hand preferences the highest proportion came from the manual working class. He found that more working class boys than working class girls were left handed or inconsistent and suggests that handedness at eleven years may be socially or culturally determined.

When the children were tested at eight years the right handed boys and girls achieved higher scores in reading than left handed and inconsistently handed children, but he found no relationship between disturbed laterality and reading ability when the same children were tested at the age of fifteen.
Benton and Birch (1965) did not find any association between left-handedness or cross laterality and reading difficulty but they did find that poor readers showed significantly greater confusion in left-right orientation - the awareness of the right and left of one's own body and objects in space. Their conclusion is supported by the research of Benton (1959, 1962), Critchley (1962), Minburn and Warrington (1962), Shearer (1963), Lovell and Corten (1963), Rutter et al (1970), Crossen and Lytton (1971) and Haidoo (1972). All the above researchers found that children with poor left-right discrimination were more likely to be retarded readers; a view I can support from my own investigations (1970). Wedell (1973) comments on similar orientation difficulties in children with problems in number work.

Benton (1959) found disturbances of right-left discrimination in backward readers up to the age of nine years but above this age their right-left discrimination difficulties were not significantly different from that of a control group. Farr and Leigh (1972) noted that 50% of their retarded readers showed some degree of right-left confusion which persisted up to twelve years of age. Silver and Nagin (1964) in a longitudinal study of retarded readers as children and as adults, found that, though 69% of their retarded readers as children had difficulties in right-left discrimination; as adults their difficulties were significantly decreased with the result that the discrimination between retarded readers and a control group was similar. However, on a test of cerebral dominance devised by Silver significant differences were still found in the establishment of clear cerebral dominance between the retarded readers as adults and the adult controls.

Though she found no clear evidence that retarded reading was the cause or effect of right-left discrimination, cross laterality or finger localization, Shearer (1963) did isolate a group of backward readers with these difficulties which she claims could be the result rather than the cause of difficulties in reading and writing. She suggests that reading and writing could be important factors in helping children to establish strong hand preference to discriminate between right and left. However, as Crossen and Lytton (1971) comment, Shearer, like Belmont and Birch (1965) and Lovell and Corten (1963) did not match her control group by socioeconomic status or non-verbal intelligence and she provided no data on the significant differences between groups.

Gerstmann (1958) considers that both poor finger agnosia and right-left discrimination are disorders of bodily image. However, Benton (1959) and Benton and Kemble (1960) suggest that they are symptoms of symbolic expression and are related to language function rather than a basic
inability to distinguish between right and left. Their view is supported by Haideo (1972) but not by Belmont and Birch (1965), Lovell and Corton (1968), Shearer (1968) or Croxon and Lytton (1971). They believe that reading difficulty is most likely associated with a general spatial perceptual or perceptual motor deficit of neurological origin which is manifested in a difficulty in spatial orientation, integration, body schema and praxis.

Ayres (1965) in her factor analytical study of patterns of perceptual motor dysfunction considered that right left discrimination was related to the tendency of a child to cross or avoid crossing the mid line of the body. She supports Benton's conclusion that right left discrimination is a function of somesthesia and motor integration but she does not agree with Benton that it is the result of proprioceptive innervation or that it is related to symbolic language function. Ayres suggests that both right left discrimination and difficulty in crossing the mid line of the body are the result of a lack of inter-hemispherical integration, according to the theory of the centrencephalic system of Penfield and Roberts (1959). Crosby (1968) agrees that "disordered dominance is not a cause of neurological reading disorders, but an effect of the same neurological process that caused the reading disability", (1) a view supported by Brain (1945) and by Sangwill (1960, 1962).

Goosby and Reinfhold (1962) suggest that reading difficulty is an expression of immaturity of cerebral dominance in which there is delayed myelination of the motor and associated nerve tracts resulting in slower neuro muscular maturation. Asymmetry of hemisphere dominance which develops as the child matures, is related to performance in reading and writing. Thus a child with developmental dyslexia fails to establish asymmetry of function in the cerebral hemispheres.

Sangwill (1962) considers that children with poor laterality often present associated speech retardation and reading problems, defective spatial perception, motor clumsiness and ambivalent handedness. He suggests that both poor laterality and discrimination problems may be the result of a cerebral lesion, a constitutional maturational lag, of stress, minimal cerebral dysfunction or a combination of these factors. Thus, poor cerebral dominance is an effect of neurological disorders, not a cause, and a fuller understanding of the development of hemisphere dominance is a prerequisite of a fuller understanding of reading and its disorders.

(1) R.M.K. Crosby (1968) "Reading and the Dyslexic Child," P.112
To conclude, there is much support for the view that a close relationship exists between laterality and development of speech, and moreover, that there may be a connection between lack of dominance, poor directional discrimination and retardation in speech and reading. Many investigators remain sceptical, however. Whether incomplete laterality is a cause of retardation or just another symptom of a more general neurological disorder remains essentially unresolved.

Motor Factors

In the view of Kephart (1966) and Cheney and Kephart (1968), motor development proceeds according to two principles from gross general movement to more refined specific movements and from specific control to more generalized systems of movement. These two systems of motor development give rise to movement patterns which, when they have developed, become relatively automatic. Nodd (1949), Gessell (1940), Piaget (1953), Kephart (1960) and Hold (1965) have all emphasised the importance of movement experience in relation to development of perceptual judgements and early cognitive development.

These neurological theories of perceptual motor and cognitive development are built upon the basic assumption that the relationship between perceptual and motor responses acts through the cerebral cortex and brain stem so that any restriction of movement experience at an early age is likely to affect the development of the learned behaviour patterns on which later perceptual and intellectual development depends. Ismail and Kerkendale (1969), for example, in a study of primary school children aged ten and eleven years obtained significant positive correlations between items of intelligence and motor items, especially between balance, coordination, IQ and academic ability and Kerkendale (1963) using discriminant function analysis differentiated between high, medium and low academic achievers with coordination and motor items. In an earlier factor analytical study, Ismail and Gruber (1967) concluded that the best motor predictors for estimating intellectual performance were coordination, balance and growth items, in that order. Ismail (1969) suggests that there is either a common neurophysiological process involved in both cognitive ability and motor coordination or that there is a similarity in the perceptual processes involved in motor coordination and cognitive tasks.
As those areas in the cortex controlling movement are associated with other cortical areas controlling some perceptual processes, difficulties in visual perceptual ability may be connected with different ways of storing and integrating the experience of fine movements, such as hand eye coordination and manual dexterity, and whole body movements such as those movements involved in orientating and balancing the body. Abercrombie (1964, 1970), Ayres (1965), Proetz (1970), and Craity (1969) have all observed the relationship between various aspects of visual perceptual ability and motor impairment.

Bromer et al (1967) identified fifty four children (6.7% of their sample) of average intelligence who were poor at spelling, arithmetic and writing. These abilities were related to poor visual motor ability, clumsiness in movement and gait and poor control of fine motor abilities. Lewis, Bell and Anderson (1970) used the Sloan revision of the Kincochisky test (Sloan, 1955) to test motor proficiency between a group of retarded readers and a group of normal readers. Their results indicate that the performance of the retarded readers was significantly weaker on the Oseretsky test. On the basis of their overall motor proficiency 78% of the children studied could be correctly identified as retarded or adequate readers. From the evidence of the results on the individual test items, Lewis, Bell and Anderson concluded that performance on definite motor deficits rather than a lack of motor development accounted for these differences. The retarded readers had greatest difficulty with the items measuring locomotion, bilateral movements, synchrony and sequential movements. Bannatyne et al (1969) in a factor analytical study of spelling, sequencing and motor ability in children found that scores on spelling clustered with total body balance and balance on one foot, and Bangston (1966) in a study of the inter-relationship between perceptual, motor, intellectual performance and school achievement in nine year old boys obtained significant relationships between school achievement, word knowledge, reading and perceptual motor aspects. She also concluded that the relationship between motor tasks supported the view that there is no general motor ability but a number of specific motor skills.

Studies of specific reading difficulty have also associated poor motor coordination with reading difficulty especially when these difficulties have been linked with the concept of neurological impairment or incomplete cerebral dominance. Both Critchley (1962, 1964) and
Orton (1937) considered that one of the characteristics of reading disability was the incomplete establishment of motor preferences, and motor clumsiness. Walton et al (1962) discuss the relationship between motor clumsiness and dyslexia and concluded that "it is the pathways concerned with the organisation of skilled movement or the recognition of tactile and sensory stimuli which are poorly organised, rather than those concerned with the recognition of word symbols necessary for acquisition of the ability to read" (1). Walton considered that cerebral organisation rather than injury to the brain was a probable cause of dyslexia.

Rabinovitch et al (1954) referred to a "definite impression of non-specific awkwardness and clumsiness in motor function" in his retarded readers. Prechtel (1962) in a study of nine to twelve year olds with choreiform movements and with reading difficulties found that many had poor coordination which he considered to be the result of dyskinesia.

Other studies have linked poor reading performance and motor clumsiness with hyperactivity. Lucas et al (1965) found that poor general muscular coordination was associated with hyperactivity, "over-shooting movements" and reading disability. Anderson (1964) in a study of hyperactive children between eight and twelve years found that 93% had motor difficulties, 60% had delayed motor development, 53% had visual perceptual difficulties and 87% were reading at least two years below the age level expected on the basis of their IQ scores. He concluded that reading, perception and motor difficulties were the result of the child's inability to analyse and integrate incoming sensory stimuli.

It is interesting to note that in the last five studies the children's difficulties were also associated with abnormal pregnancy especially toxaemia, prematurity and ence. In a more recent study Black (1975) selected a group of six to ten year olds who were at least six months below their grade level at reading with a minimum W.I.S.C. score of 63. He then divided his group into high perceptual and low visual perceivers and found significant differences between the groups. The poor visual perceivers were significantly poorer in motor ability and had a higher frequency of birth abnormalities, abnormal IQ's and hyperactivity.

Black noted that the incidences of neurological factors were not limited to the lower visual perceivers and he concluded that a multifactor classification encompassing organic psychogenic and environmental factors such as that suggested by Connolly (1966), and Rabinovitch et al (1956)

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(1) Walton, J.N; Ellis, B; Court, S.D. (1962) "Brain", Vol. 85, P.610
may be more appropriate than a system stressing a single component.

In their study of over two thousand children in the Isle of Wight - Rutter, Bizard and Whitmore (1970) found that their specifically retarded readers were significantly poorer than the controls in motor coordination, constructional ability and in delayed motor development. Lovell and Corton (1960) also found significant differences between normal and backward readers on the Stott test of motor impairment. In a principal component factor analysis, motor performance was associated with reading age, visual spatial and orientation abilities on a factor which Lovell and Corton suggested was a dimension of "neurological integrity - impairment" and which accounted for 40% of the variance.

Other researchers who have observed significant differences between normal and retarded readers on tests of motor ability tend to favour causes other than neurological impairment particularly those factors related to growth and maturation of the nervous system and involving the concept of integrative development. Cohn (1961) and De Hirsch et al. (1965), for example, have suggested a maturational or developmental lag as a cause of both the reading difficulties and poor motor coordination. De Hirsch et al. (1965) in a study of young children considered that the acquisition of gross motor skills was a prerequisite for academic functioning and used tests of balance, hopping, throwing, and also tests of fine motor patterning in their study of reading failure. Only the tests of fine motor patterning were significantly related to reading achievement and writing skills and this led de Hirsch and her co-workers to conclude that the gross motor skills were too well established by the age of five to serve as a basis for differentiation. However, they did observe that motor difficulties were present in a group of older backward readers.

Haado (1972) in her study of dyslexic children of average intelligence, reported that her backward readers as a group showed clumsiness at an earlier age, and were significantly poorer in motor coordination, possibly, she asserts, as a result of neurological, genetic or maturational factors.

Though Plack (1960) obtained correlations between reading achievement and tests of agility and coordination ranging from .69 and as high as .67, and Thomas and Chisson (1973) obtained a correlation of .64 between a motor skill and reading achievement, Cratty (1970) considers that reading scores and motor ability reveal only low relationships. He considers that balance measures are not related to reading achievement and those do not usually exceed .4. Even this correlation does not indicate causality. As Cratty claims
it may simply indicate "some similar kind of ocular efficiency is needed both in tasks involving static and dynamic balance and when moving the eye across a page while reading." (1)

Many investigators dispute the relationship between motor ability and cognitive and academic achievement including reading. Oord (1925), for example, found only low correlations between motor ability and intelligence in adults, and Bruce (1932), Berley (1931) and Ray (1940) obtained low non significant relationships between motor ability and mental ability in children. Redd (1963) the examined intellectual, psychomotor and motor ability in a group of good and bad readers found that the verbal sub tests of the W.J.6. showed the greatest differentiation between the groups. The tactile tests of psychomotor ability were moderately related to reading but the motor tests did not discriminate between good and bad readers. He concluded that motor ability had very little to do with reading performance. Taviley et al. (1960) in a similar study also concluded that motor ability and reading were not related.

Trussell (1960) in a factor analytical study concluded that motor skills are specific and are not associated with reading. Her factor analysis indicated that reading, perceptual ability and motor skills formed patterns of association among themselves and tended to exhibit independence rather than interdependence with each other.

In a study by Allen (1971), relationships between motor ability (Stott test), handwriting, motor impairment, psychomotor ability and laterality were tested in a small group of boys but she found no connection between motor ability and the other abilities. However, in a discussion of results Allen suggested there may be possible connection between motor ability and ability to read as over half the children in the study who were motor impaired were also backward readers.

To summarize, though few of the above researchers have obtained direct relationships between reading performance and motor ability, many investigators have shown that poor motor coordination is frequently observed in groups of backward readers. These investigations have linked motor clumsiness with poor perceptual and cognitive abilities in backward readers which they claim indicate a disturbance in the common neurophysiological processes involved in these abilities. However, some investigators do not support the view that motor ability is related in any way to perceptual or cognitive abilities or therefore, to the ability to read. The present evidence from research is certainly equivocal.

One of the symptoms of behaviour associated with neural impairment is the inability to maintain certain voluntary movements for short periods of time. Leonardowsky (1907) and Pinares (1924) both concluded that the inability to maintain the eyes closed was an example of such behaviour and Burt (1950) noticed that his patients were also unable to keep their mouths open or keep the tongue protruded. In 1955 Berlin confirmed Burt's observations and himself noted that these three difficulties occurred in a compulsive manner and were present even though the facial muscles were quite strong.

Fisher (1955) first introduced the term "Motor Impersistence" to describe this behaviour and he noted two more characteristics - the difficulty in making a prolonged "ah" sound and the difficulty in exerting a steady grip. He observed that not only was motor impersistence common in patients with non-dominant right hemisphere damage, but many had perceptual and motor difficulties.

It was Joynt, Benton and Fegel (1962) who went on to investigate these observations in a clinical group. They gave nine timed tests of motor impersistence to over a hundred neurologically impaired patients diagnosed on the basis of lesions of the cerebral hemispheres, and a control group using tests suggested by the findings of Berlin and Fisher. They identified 23% of the brain damaged patients and less than 2% of the control group as having motor impersistence which they associated with damage to either the right or left cerebral hemisphere but more commonly to the right cerebral hemisphere.

Frechtl and Steiner (1962) reported similar motor problems in children. They investigated behaviour problems in nine to twelve year olds who were hyperkinetic, showing signs of excessive activity and restlessness, and who had difficulties at school including backwardness in reading. They observed that the movements of the children were jerky and brief, especially in the tongue, face and neck, indicating choreiform activity.

Gerrard (1962) studied aspects of motor impersistence in 165 children with IQ between 80-119 (twenty-five of whom were diagnosed as being neurologically impaired) and one hundred and forty children who were matched for sex, age and IQ serving as controls. His tests comprised eight of the nine tasks used by Joynt, Benton and Fegel (1962) in their studies of adults. On six of the eight tasks the
scores of the neurologically impaired children were significantly inferior to those of the controls. When Garfield defined motor impersistence as failure on two or more of the eight tasks, he found that seventeen of the twenty-five neurologically impaired children and four of the one hundred and forty normal children were impersistent. Thus 153 of the 165 children were correctly classified - a screening efficiency of 93%. Garfield criticised Fisher's explanation that motor impersistence was the result of impaired cortical motor control and suggested that the poor performance of the neurologically impaired children represented a qualified measure of the child's distractability or short attention span.

In the same year Benton, Garfield and Chiorini (1964) studied motor impersistence in a group of retarded and a group of normal children and concluded that both chronological and mental age, particularly mental age, affected performance on tasks designed to measure motor impersistence. Benton, Garfield and Macken (1966) in a later study concluded that motor impersistence was less affected by intelligence but, because it was frequent in normal children up to the age of five years without impaired motor control, physical immaturity was an important factor.

The above developments in the understanding of motor impersistence are described by Yule, Tizard and Graham (1967). It was from this study that many of the above references have been cited. In their study of 1,000 children, Yule et al (1967), and Rutter et al (1970) examined the incidence of motor impersistence and its association with reading, neurological and psychological factors in nine to ten year old children. Over 600 children, four hundred and fifty of whom were selected because of their poor educational performance, and over one hundred and fifty controls were tested for motor impersistence, motor ability, reading and spelling. Those children who failed two or more tests of motor impersistence were considered to be pathologically motor-impersistent. Even when low intelligence was accounted for, motor impersistence was significantly associated with motor clumsiness, dyspraxia (an inability to carry out purposive movement not explicable by weakness or paralysis), choreiform movements and right left discrimination. It was not related to eyecness, footedness, handedness, nystagmus or abnormal tongue, lip, hearing or ocular movements.

Yule et al (1967) and Rutter et al (1970) also found that the percentage of retarded readers (mean IQ 92) with motor impersistence was significantly higher than within their control group. 15.1%
specifically retarded readers were motor impersistent compared with 5.43 in the control group. The percentage of retarded readers with motor impersistence was even slightly higher when six retarded readers with low IQ were excluded from the analysis (16.35 - 15.13).

To conclude, the inability of a child to maintain certain voluntary movements has, like motor impairment and perceptual difficulties, been associated with impaired cortical motor control, distractability and short attention span. This lack of voluntary control is dependent upon chronological age and intelligence but even when these factors are considered, research suggests that motor impersistence is more frequent in children with specific reading retardation.

Psychomotor Behaviour

The relationship between performance on a psychomotor test known as the "Cambridge cockpit" and personality and behaviour was demonstrated by Davis (1948) who found an association between psychomotor ability, and neurotic behaviour and accident proneness in trainee pilots and again by Veneables (1955) and by Anthony (1960) who related psychomotor responses to neurotic behaviour and minor criminal activities. Anthony, for example, studied the records of R.A.F. candidates after they had been given psychomotor tests and found that abnormal performance on these tests was predictive of later criminal behaviour.

Porteus (1942, 1959) during the first half of this century developed and revised a series of paper and pencil mazes to evaluate a person's ability to find his way out of a printed maze or labyrinth. Not only was the time taken in completing the maze, but also the quality of performance was considered. A careless untidy performance was given a high "9" score in which a poor psychomotor performance was indicated by errors resulting from inaccurate lines, cutting corners, and touching the borders of the maze.

Gibson (1964) developed a spiral maze which, though based on the Porteous mazes, is much quicker to administer and easier to score. The initial studies by Gibson (1964) to validate the test were made on primary school boys. He found the performance by the boys was related to their degree of "naughtiness" in school as rated by their class teachers. The "naughty" boys were plotted predominately in the "careless" zones of a bivariate distribution showing both time and error
scores while the good - and averagely - behaved boys tended to fall in the "accurate" zones of the scatter plot.

In a later study Gibson (1965) found that performance on the spiral maze indicated that older delinquent boys tended to sacrifice accuracy for speed. The error scores discriminated significantly between approved school children and junior and secondary children.

Morris and Whiting (1971) suggests that the Gibson Spiral Maze is particularly sensitive to motor impairment and the effects of neurological impairment. They claim that the test scores can expose weaknesses of maturation which may be responsible for difficulties in learning and in the performance of physical skills. Whiting et al. (1969b) used the spiral maze test as a possible screening device for motor impairment in a group of S.S.N. children and found a strong correlation between the boys' error scores and tests of motor and neurological impairment. A high percentage of children who achieved scores in the "slow and careless" zone of the scatter plot failed the Stott test of motor impairment and two tests of neurological impairment, — the memory for designs test and the test of motor impairment.

These findings are further supported by Davis et al (1969) and Lumley (1972) both of whom studied approved school boys. In the former study, of sixteen boys (27%) who were assessed as motor impaired on the Stott test (1966) nine appeared in the "slow and careless quadrant" and two were borderline cases on this zone. In the study by Lumley, of the 13 boys (37%) classified as motor impaired on the Stott test eight fell into the "slow and careless" quadrant, three in the "quick and careless" area and one in each of the other two quadrants. These findings indicate that the careless quadrants, especially the "slow and careless" quadrant, contain those boys who are assessed as motor impaired.

Lumley (1972) found significant differences in the error scores on the Gibson Spiral Maze test between his approved school boys and a control group. However, as there were no differences in speed scores he did not support Gibson's theory (1965) that delinquents sacrifice accuracy for speed but concluded rather that their lack of accuracy was due to poor motor coordination.

There does not appear to have been any study relating psychomotor performance specifically as measured by the Gibson Spiral Maze to reading difficulty. However, as numerous studies of retarded readers suggest a strong relationship between behaviour problems and reading
problems, Morris (1966), Roc (1965, Douglas and Ross (1968),
Gregory (1965), Sampson (1960), Yule (1969), the Gibson Spiral Maze
test was included in the test battery of the present study to investigate
the relationship of perceptual motor ability to behaviour in boys with
specific reading difficulty.

Speech and Language Ability related to Reading

Until the late fifties it was thought that a child learned to
speak by imitating the speech of other children or adults, especially
the mother. Early attempts to talk were reinforced by social
encouragement and by the intrinsic satisfaction of being able to name
and describe objects. Within the last two decades considerable changes
have occurred in theories of language development which suggest that
development of language is not just the acquisition of a myriad of
conditional responses as argued by behaviourist psychologists but "a
species-specific phenomenon related physiologically, structurally and
developmentally to the other two typically human characteristics,
cerebral dominance and maturational history", Lenneberg (1967).

Chomsky (1968) suggests that children are born already equipped
with a complex capacity to acquire language, "a deep structure".
Consequently the child is able to combine some words and produce utterances
consisting of groups of words according to a set of rules which Chomsky
refers to as "a universal grammar". Similarly McNeill (1966) suggests that
children are born with a biologically based innate capacity and that this
innate capacity takes the form of "linguistic universals". Brown (1962,
1965) suggests that language development is reminiscent of the biological
development of the embryo.

Slobin (1968) also supports the view that language capacity is
innate but he favours a process model in which the child is born with
the mechanism to process linguistic data. This suggests that language
development is the result of an "innate cognitive competence" and not
of an innate "content".

Though the child appears, therefore, to develop the basic sound
units and is able to discriminate vowel and consonant contrast early
in life (Gibson 1966), he does not usually become proficient in
articulation until he is seven or eight years of age (Kiszenin, 1969).

As Vernon (1971) points out, speech and language are important
factors in learning to read. Thus it is not surprising that learning
to read is particularly difficult when, whether or not there is

(1) E.H.Lenneberg (1967) Biological foundations of Language, P.175
auditory impairment, language is inadequate, either in simple speech or in the more highly developed linguistic functions. Vodell (1973) comments that a facility in language can help a child to discriminate the visual features relevant to reading. He cites Luria's study (1961) which demonstrated how verbal formulation aids visual discrimination and the work of Goodman (1968) who emphasizes the importance of verbal fluency to reading development. Rutter et al (1970) suggest that, as reading involves the ability to utilize a written language as well as to recognize the shape of letters and words, reading retardation may be considered as one manifestation of a developmental language disorder. Support for this view comes from various investigations including Rutter's, which linked delayed speech and language development with reading retardation. Rutter et al found that even when children with low intelligence were removed from their sample of specifically retarded readers, the remaining retarded readers were significantly delayed in their speech development. They had relatively higher frequency of articulation difficulties, poor complexity of language and poor descriptive powers. Other researchers have noted the relationship between delayed language development and poor articulation (Hockey, 1957; Andrews and Harris, 1964; Lyle, 1970). Ingram (1959) arrived at a similar conclusion from a study of two to seven year olds many of whom were experiencing difficulty in learning to read. Similarly, in a study of boys aged between six and fourteen who were above average in intelligence, Rawson (1968) found that many of the boys with reading problems also had language difficulties. Haldero (1972) found that both her retarded readers and her retarded spellers were slower at acquiring speech but the delay did not reach statistical significance except when full sentences were used. Both groups were poor at blending sounds and both had a higher frequency of articulation difficulties than their control groups. Though the parents of her retarded readers reported a significantly greater number of early language difficulties than those of the controls, comprehension, as measured by the W.I.S.C., was normal.

De Hirsch et al (1966) in a study of children of normal intelligence but who were born prematurely found that the children had difficulty in naming familiar objects, had limited vocabularies and found it difficult to express themselves and understand questions. They were also significantly poorer than a similar group of children born at full term in learning to read and write. Subsequently they used tests of language ability involving memory for words, naming of objects and the number of
words used in a story. All these tests accurately predicted subsequent failure in learning to read. De Hirsch et al. consider that the majority of children with language disorders have difficulties with the decoding and encoding of printed and written language associated with reading. They quote the studies of Veynor et al. (1960), Xedianack (1949) and Davis (1955) to support their view that poor articulation affects the learning of phonics which is frequently retarded in children with reading difficulties. With difficulties of consonant articulation, De Hirsch et al. associate "cluttered speech" which, like Weiss (1964), they consider to be related to spelling difficulties.

De Hirsch et al. (1966) found poor language development in a group of retarded readers of high intelligence aged between eleven and fifteen years and Dechurin (1963) found that his group of dyslexics aged between ten and fourteen were poorer than their controls on verbal tasks of written and spoken language. Other researchers, Belmont and Birsch (1966), Robinovitch et al. (1965), Xelinquist (1958), Banwartyno (1966), Gorch et al. (1965) have related difficulties of receptive and expressive language symbols to reading impairment in older children.

In a small clinical neurological sample of dyslexic children of normal intelligence, Kinsbourne and Warrington (1965) isolated two groups on the basis of their W.I.S.C. scores. One group with high verbal but poor performance ability and a second group with poor verbal abilities which they called the "language retardation" group. This group had delayed acquisition of speech, difficulties in verbal comprehension and defects of expression similar to aphasia in adults. Kinsbourne and Warrington considered that their language retardates resembled those of Robinovitch et al. (1965) and clinically conformed to the description by Ingram (1959) of "developmental dyslexia" secondary to retardation of language development.

Crookes and Greeve (1963) studied a group of children aged five to eleven years who came to their clinic because of speech and language defects. The children were also very retarded in reading and had particular difficulties with reversal of letters. Crookes and Greeve also observed two types of language problem - an articulatory problem associated with delayed motor development and one involving poor auditory memory and confused speech. De Hirsch et al. (1966) also associated auditory perceptual difficulties with language difficulties in their backward readers.
Colin (1962) showed that the speech control and language ability were poor in nearly all the dyslexics studied in his sample, a finding which he ascribed to impaired muscular control.

Lovell and Gorton (1968) used the Illinois Test of Psycholinguistic Abilities (McGeary and Kirt 1961) to examine language ability in a group of nine to ten year old retarded readers. They were significantly poorer than their controls on this test and in a factor analysis the language of backward readers was associated with auditory discrimination and, to a lesser degree, with right/left discrimination. In the discussion of right/left discrimination it was noted that Benton and Konhol (1960) considered that children who showed systematic reversal in right left orientation also had retarded language development. Other investigators have noted the relationship between language and right left orientation and laterality (Haidee, 1961). Although Do Hirsch et al. (1966) and Poehring (1969) associated language difficulties in their backward readers with visual spatial problems they did not find that laterality or right left discrimination were associated with these language difficulties.

Rutter et al. (1970) support Benton’s view (1962) and that of Belmont and Birch (1966) that at the age of ten poor visual perceptual and visual motor skills are less important in reading retardation than are language handicaps. However, they suggest that the explanation may simply be that the backward readers are delayed in their development. Therefore perceptual and motor problems may be less evident than language defects in older retarded readers merely because perceptual motor development precedes language development which has not reached its asymptote in development. This view gains support in the studies of specific developmental dyslexia by Seth, Hardin and Ross (1971), and of language development by Lonnoberg (1963) who believes that there is a concurrent relationship between motor and speech development with both being regulated by a maturational process.

Some researchers do not find support for the view that language ability is highly related to reading ability. Martin (1955) found no relationship between oral language and reading readiness or reading achievement and Silver (1960) found that retarded readers had no difficulty in understanding word meaning.
A further factor which affects language and which may therefore influence ability to read is social environment. Bernstein's studies (1965) for example have demonstrated that linguistic behaviour is greatly affected by social factors which may limit a child's range of vocabulary, articulation, comprehension and self-expression. Both his research and the studies of Werner et al (1967) indicate that poor (or actually divergent) language at home often characterises those children with reading problems at school. Werner et al in a study of language related to reading found that poor readers were significantly less able to use syntactic clues in short term memory of sentences. They conclude that poor language function, particularly a lack of verbal comprehension, and poor language habits rather than perceptual motor difficulties are characteristic of backward readers at ten to eleven years.

Vernon (1971) in a study of the research concerned with the relationship between reading and language (which includes many of the investigations quoted in this chapter), suggests two syndromes which may be involved in dyslexia. These were also employed by Neidoe and Cotterell in "Assessment and Teaching of Dyslexic Children" 1970. One syndrome is linked with difficulty in perception of complex forms and in their orientation and the other syndrome is one of linguistic impairment. However, Vernon notes that in the majority of cases of reading difficulty both syndromes are present and that both may arise as a result of an essential disability "in the process of conceptualisation involved in the sequential processing of the visual and linguistic symbols employed in reading." (1)

Fraser and Blockley (1973) comment that, because of a disordered appreciation of temporal and spatial relationships in some children with language difficulties, they are unable to transform the deep structure of language to surface structure. They consider that such perceptual disorders are a common factor in language disorders and suggest that because of similar perceptual problems in dyslexic children these backward readers are unable to transform the surface structure of what they read to a deep structure, even though spoken language may be unaffected.

Vernon, K.D. (1971) "Reading and its difficulties", p.149
on the basis that dyslexia represents a disorder in the child's perception of space, time and distance.

In their view perception follows both a biological and hierarchial sequence in which auditory perception is the most complex. Auditory perception works through symbolism and it, like visual perception is the process on which the comprehension of and expression by speech depends.

Summary

Difficulty in learning to read has been associated with a wide range of perceptual, motor and language problems. This suggests that reading is a very complex process which requires many skills. An interpretation of many of the investigations in this chapter must, however, be tentative, as controls for sex, age and social environmental factors were not always explicit. Methods of selecting subjects and analysis of research make some conclusions questionable. Though relationships have been demonstrated between perceptual abilities, motor co-ordination, language development and learning to read, the interrelation of these skills and the contribution of each one to the reading process have not been clarified. The nature of the link between poor reading performance and problems in these variables and the link between one variable and another is the basis of the first part of this investigation.
Chapter 4

Methods and Procedures
This investigation sets out to examine a broad area of perceptual, motor and language problems in children with average intelligence who are retarded readers. It attempts to clarify the factors contributing to the reading problem by examining their relationship to reading and to each other. As I have suggested in the review of the literature it is essential that these problems should not be treated in isolation. Thus a battery of tests is used to examine an essential aspect of each of the areas reviewed in the previous chapter.

As sex differences have been shown to exist in reading retardation and because reading problems are more common in boys than in girls, I decided to select only boys for this investigation. They were selected from seven of the nine junior schools in Eastbourne. The other two schools were excluded, as their poor facilities and overcrowding were such that the pupils' reading ability was likely to be strongly influenced by environmental factors.

Initially, 141 boys from a school population of 1456 boys aged between seven years seven months and eleven years six months were referred because they were considered by their school to be of average or above average intelligence but were at least two years behind other boys of the same age at reading. These 141 boys were given the English Picture Vocabulary Test of Intelligence (Brimer & Dunn 1963) and the Schonell Graded Word Reading Test (Schonell 1960). Eighty-two boys who met the following criteria were selected for the study.

1. Their score on the E.P.V.T. test of intelligence was not less than 85 points.
2. They had no medical history of physical bad health, hearing or uncorrected visual defects.
3. They had no prolonged absence from school and had not changed schools more than once apart from the normal transfer from infants to junior school.
4. All boys were of British origin, were caucasian, and all had English speaking parents.
5. All were at least two years below their reading age on the Schonell test of reading ability.
6. None had severe emotional difficulties as diagnosed by the Educational Psychologist.
In addition to the fifty-seven boys excluded on the above grounds, one
boy was later removed from the sample because he broke his leg and a
second boy was removed because he was found to have inadequate vision.
The table of exclusions for omission of boys from the experimental group
is found in Appendix I.

The mean chronological age of the boys in the sample is 112.76
months. (Standard deviation 12.14 months).

The test selected to test intelligence was the English Picture
Vocabulary Test 2 (age range 7.0 - 11.11 years) developed and standardised
by Brimer & Dunn (1965). It was chosen because of its high degree of
reliability (0.92) in which the corresponding standard error of
standardised score was 4.25. The test tests the I.Q. of children
independent of their reading ability and its value as a measurement of
intelligence rests on its high correlations with W.I.S.C. and Stanford-
Binet scores. It is a group intelligence test and is quick to administer
and easy to score. The scores on E.P.V.T. are converted to standardised
scores with a mean of 100 and standard deviation of 15.

The mean I.Q. score of the backward readers in the investigation was
99.84 points (standard deviation 8.17 points).

Reading ability was assessed by the Schonell graded word reading test
(Schonell 1960). This test is scored according to the total number of
words correctly pronounced and this total is converted to a reading age.
Its disadvantage is that the test assesses the accuracy of reading words
out of context, but it is a quick and accurate measure of reading ability.
As stated, the reading age of each subject was at least two years below
his chronological age. The mean reading age was 81.11 months (standard
development 11.83 months). Reading backwardness in relation to mean
chronological age for the total group was minus 31.6 months.

Because of the close relationship between difficulty in learning to
read and poor spelling ability (Venesy, 1967; Clark, 1970; Vernon, 1971;
Haidoo, 1972) a spelling test was included in the investigation.

Spelling ability was assessed using the Schonell graded word spelling
test A (Schonell 1971). As expected, the mean spelling age of 78.45 months
(standard deviation 10.55 months) is lower than the mean reading age. As
the Schonell tests of reading and spelling were standardised on different
populations, the reading and spelling ages cannot be compared directly.
However, other investigations support the view that if a child has difficulty
in recognising words, it is very probable that he will have difficulty in
spelling them. In the present study the correlation between reading and
spelling was high at .78. Even when the effect of age was partialled out, the relationship remained high at .63, suggesting that those abilities which underlie reading and spelling are closely related.

An examination of the spelling errors of all the subjects suggested that some boys made reversal errors and incorrectly transposed letters within words while some words were so badly spelt that they bore little resemblance to the sound of the word. However, especially in the younger boys, because so few words were actually written no specific pattern of spelling difficulty could be reliably adduced. No support can therefore be given to the suggestion that children with reading difficulties are prone to specific errors in spelling words.

The degree of reading and spelling retardation in the sample was such that the backward readers were not merely slow readers but boys who had as yet failed to master the basic elements of the task.

The Test Battery

A battery of perceptual and motor tests were given and these tests were selected in the belief that each test reflected an aspect of perceptual or motor ability which was a prerequisite for success in reading. Of particular interest to the present investigation were tests which explore areas of psychological function dependent upon developmental weaknesses such as neurological impairment, delayed maturation and incomplete cerebral dominance. As the initial purpose of the study was to discover and determine the severity and nature of the reading difficulty, an objective assessment procedure was necessary in which, wherever possible, each child's performance could be compared with normative standards. Most of the tests employed, therefore, were those for which dependable published norms are available. In the few cases where norms were unavailable or considered inadequate, other boys from the sample schools were tested in order that a basis for comparison should be established. The tests had high quoted reliability coefficients and were suitable for the wide age range of boys in the study. They were also sensitive to expected improvement in performance with increasing age. These tests moreover satisfied my two main criteria for selection that they should be discriminating and comprehensive and, in addition, expose possible underlying causes.

As the time available in each school was limited and prolonged testing of the boys could affect both their motivation and performance, the tests selected were generally quick, easy to administer and interesting to the subject.
1. Visual perceptual patterning

A. Visual spatial ability

The test selected to measure this ability was the "Problems of Position" test developed and standardised by D. Moseley (1968) in which the child has to identify a pattern of dots within a matrix of dots. The test was initially standardised on 1254 junior children and an internal consistency reliability coefficient of 0.94 was obtained from a sample of over two hundred of the original children when retested after eighteen months. Moseley suggests that this spatial skill is associated with reading and spelling ability in which the poor reader and poor speller make the following types of errors — simplification, distortions of size and angle, and lateral and inverted mirror images.

B. Visual motor gestalt ability

The Bonder Visual Motor Gestalt test with the Koppitz scoring method (Koppitz 1964) was selected to test this ability. Reliability of the Koppitz scoring system is high. Agreement among different scorers using the system independently results in inter-rater correlations ranging from .88 to .96 and test score reliability using the test-retest method gives correlations between .6 and .66, all of which are significant at the P < .001 level. The subject has to copy nine figures one at a time on a blank piece of paper. These figures are scored for distortion of shape, rotation, integration and perseveration and the presence of any of these deviations is given one point. All scoring points are added to give a composite error score.

C. Word recognition

The Carver test (Carver 1970) was selected to measure word recognition. Carver reported that reliability of the test using the split half (odd even) method gave a correlation of .95 and validity studies with other tests of word recognition, including the Burt and the Schonell Graded Word Reading Tests, were between .86 and .90. The test consists of 50 stimulus words which are spoken one at a time by the experimenter. The subject has to underline the word spoken from a choice of five or six words of similar shape or sound. This test was particularly suitable because as well as indicating the child's ability to recognise the sound of a word and to relate the word to its visual pattern on the printed page, it diagnoses the types of errors in word recognition that the child makes.
2. **Auditory Visual Integration**

The test selected to measure this ability was the Auditory Visual Integration Test developed by H.C. Birch and L. Belmont (1964). The subject is asked to select the correct one of three visual dot patterns which he judges to be the same as a pattern of taps that he hears. Thus the test explores the ability to equate a temporally structured set of auditory stimuli with a spatially distributed set of visual ones.

3. **Auditory Perceptual Patterning**

A. **Auditory Discrimination**

The Wepman Test of Auditory Discrimination Form A (Wepman 1958) was selected. It consists of 40 pairs of words, ten of which are both the same and thirty which differ in one phoneme. Though all the subjects selected had normal hearing, if any boy scored badly on this test he was referred for audiological examination to ensure that his performance was not the result of hearing loss but rather of the inability to perceive the fine differences in the sounds of similar words.

B. **Auditory Memory Span**

The Digit Span sub-test of the Wechsler Intelligence Scale for Children was selected to measure auditory memory. The subject has to repeat a series of numbers in precise sequential order. The test is divided into two halves. In the first half the subject is required to repeat the numbers forward and in the second half to reproduce similar numbers in sequential backwards order.

This test is particularly suitable because it examines immediate memory and, as it requires that the digits remembered should be repeated in a sequential order, it is also indicative of sequential ability.

4. **Body Concept**

The test selected to measure a child's level of body sophistication was the Human Figure Drawing Test (Witkin 1962), scored using the Hanna Karlens scale. The draw-a-man test was originally developed by Goodenough (1926) and revised by Harris (1965) to measure intellectual maturity. The Witkin test is also based on the Goodenough draw-a-man scale but it scores the drawings of a man and a woman made by each subject for their level of form, identity, sex differentiation, and degree of detail; as well as for their overall global impression of the sophistication of the body.

A single rating score of between one (most sophisticated) and five (most primitive) is assigned to each subject.
5. **Right-Left Orientation**

   The awareness of the right and left sides of one's body and of objects in space was assessed using a test developed by Benton (1958) and Benton and Kemble (1960) and adapted by Birch and Belmont (1965). The subject is required to execute localizing movements to oral command which involve localization of his own body parts.

6. **Laterality**

   The sub-tests 2, 3 and 4 for hand preference and tests 8 and 9 the monocular and binocular tests for eye dominance of the Harris test of Laterality (Harris 1958) were selected to examine this aspect. These sub-tests are the shortened form of the Harris Test of Laterality.

7. **Motor-Patterning**

   This ability was assessed by the individual administration of three sub-tests of the Stott Test of Motor Impairment (5th revision 1971). The test is based on the revision of the Oseretsky Test of Motor Development by Collins and the three aspects of motor skill tested were balance (item 1), coordination of the upper part of the body (item 2) and manual dexterity (item 4). These items were selected because:

   a) They were thought most likely to be associated with scholastic abilities such as reading (Haidoo, 1972; Whiting et al, 1969; Bengston, 1966; Allen, 1971).

   b) In an investigation by Whiting, Clarke and Morris (1969) a correlation coefficient of .95 was obtained between the scores on items 1, 2 and 4 and all five items on the test. This suggested that a score based on these three sub-tests would be as significant of motor impairment as using the complete Stott test.

   The motor impairment score was assessed using the scoring method suggested by Stott and his co-workers (1966, 1971). For each year at chronological age and years below a child is given two points for a failure on any complete item and one point for failure on one hand or foot only when both hands or both feet are tested separately.

   Stott claims that this test is particularly sensitive to motor impairment of functional or neurological origin.

8. **Motor Impersistence**

   The ability to sustain a voluntary initiated motor activity was tested using the test of motor impersistence developed and standardised by Garfield (1964) and used by Rutter et al (1970) in their Isle of
A subject is considered pathologically impersistent if he fails two or more of the following seven tasks—keeping the eyes closed, protruding the tongue blindfolded and with the eyes open, fixation of gaze in the lateral visual fields, keeping the mouth open, fixation of experimenter's nose during the testing of visual fields and saying "eek".

9. Psychomotor Behaviour

Behaviour in psychomotor terms was assessed by the Gibson Spiral Maze Test developed and standardised by H. E. Gibson (1964). The test measures speed and accuracy of a movement in reply to carefully controlled stimuli but, unlike the Porteus maze test (Porteus 1942, 1959) from which it was developed, it is easy to administer and score yet has a high degree of reliability. The validity of the test was partially demonstrated by Gibson (1964). In his study of primary school boys he found that performance on the maze related to the child's degree of "naughtiness" in school as rated by his class teacher. The maze consists of a spiral path bordered by thick black lines in which are obstacles represented by circular dots placed at irregular intervals along the spiral pathway. The time taken to complete the maze and the number of errors made by touching the borders or the obstacles is scored. A degree of stress is introduced into the test by verbal comments given by the experimenter every fifteen seconds until the maze is completed.

In addition to testing the foregoing abilities, the scores on several of the tests are considered by their authors or other investigators to indicate a degree of "minimal brain damage" or neurological impairment i.e. visual motor Gestalt ability, motor impairment, motor impersistence, psychomotor performance and visual spatial ability. As the concept of "minimal brain damage" is open to question, it follows that the validity of the tests on this criterion is also questionable. However, as the tests have been partially validated against physiological and clinical criteria such as EEG's and neurological examination of children with less equivocal symptoms of brain damage, (Joynt, Benton and Vogel, 1962; Garfield, 1964; Koppits, 1964; Stott, 1966; Morris and Whitnig, 1971), it was considered that their use would serve the present purpose.

Language and Speech

The assessment of language ability was made by noting each boy's articulation, vocabulary, grammar etc. as suggested by Benfrow (1972).
During the test situation and in a short interview with each subject, his choice of words to describe and name objects and in answering questions was noted. Also noted were his use of different parts of speech (adverbs, pronouns, vowels, constant omissions or substitutions, adjectives, etc.), and his sentence construction. Grammar was assessed by the subject's use of pronouns, plurals, past and future tenses both regular and irregular forms. As in the Isle of Wight study, articulation was regarded as normal if a child's consonant omissions or substitutions were part of the local dialect.

A note was also made of any of the following speech defects - stammering (or stuttering), "cluttering" of speech (in which the child talks too fast and cannot control his fine articulatory movements with the result that he omits sounds and syllables of words or even whole words in a sentence), and lisping.

The above information was supplemented by information given by the class teacher or the headmaster of any speech or language problem, particularly the backward reader's language ability in relation to the rest of the class and to children of similar age and ability.

A child was assessed on a binary classification as having a language/speech problem if he had poor articulation, if his speech was not clear, if he lisped, stammered or stuttered.

Testing Procedures

Test Area

All testing took place in the school. Group testing was conducted in a normal classroom and the school medical room or the staff room was used for individual testing. Any materials that might have caused distraction during the test period were either covered or removed from the room.

Test Administration

The Human Figure Drawing Test, the Auditory Visual Integration Test and the Word Recognition Test were given as group tests. The other tests were individually administered. The group tests were given first. Apart from the Word Recognition Test and the Auditory Discrimination Test, the tests were given by the same experimenter. As the author has a West Country accent which might affect the children's discrimination of sounds on these two tests, they were administered by an experimenter who had a Home Counties accent similar to that of the children.
Time of Testing

All the tests were given between nine o'clock and eleven thirty a.m. over a period of between two to three weeks depending upon the number of boys in each school to be tested.
Chapter 5

Methods of Analysis. Discussion of the factors isolated and of the individual test variables.
Analysis of the Test Data

The means and standard deviations of the test scores before conversion to standard scores were computed (Table 5:1). The raw scores of the English Picture Vocabulary Test of intelligence and those of spelling and reading were then converted to quotients and the raw scores of the perceptual and motor tests were converted to standard scores. As most of the tests were age related, "Z" scores were calculated using means and standard deviations of each variable at different age levels. The "Z" scores were then converted to a standard score using a mean of 100 and a standard deviation of 15.

Using the Pearson Product moment analysis the intercorrelations between the tests were computed (Table 5:2). As expected, there were highly significant relationships between the reading, spelling variables and word recognition, and also between eyedness and cross laterality. Lower, though significant, correlations were also obtained between the perceptual variables, motor ability and language. These relationships will be discussed first in combination in the principal component factor analysis and then in relation to the scores on the individual tests.

Because of the age differences and the effect of age on the perceptual tests and reading and spelling, it was decided to use raw scores and partial out the effect of age on the variables. The resulting partial correlation matrix was entered directly into the analysis programme and subjected to a principal component factor analysis with a varimax orthogonal rotation of the factor matrix (Kaiser, 1958; Child, 1970). The number of component factors rotated were those equal to the number of eigenvalues greater than zero (Nie, Bent and Hadlai Hull 1970).
### TABLE 5.1 Mean Scores and Standard Deviations of the Perceptual and Motor Tests of Backward Readers

<table>
<thead>
<tr>
<th>Perceptual and Motor Tests</th>
<th>Mean Scores</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P.O.P. Test - Visual Spatial Ability</td>
<td>12.01</td>
<td>5.7</td>
</tr>
<tr>
<td>Bender Test - Visual Motor Gestalt Ability</td>
<td>3.93</td>
<td>2.9</td>
</tr>
<tr>
<td>Wepman Test - Word Recognition</td>
<td>37.1</td>
<td>10.2</td>
</tr>
<tr>
<td>Birch and Belmont Test - Auditory Visual Integration</td>
<td>7.2</td>
<td>2.5</td>
</tr>
<tr>
<td>W.I.S.C. Digit Span Test - Auditory Memory</td>
<td>7.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Within Test - Human Figure Drawing</td>
<td>3.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Benton Test - Right Left Discrimination</td>
<td>6.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Handedness</td>
<td>1.3</td>
<td>.69</td>
</tr>
<tr>
<td>Eyedness</td>
<td>1.9</td>
<td>.98</td>
</tr>
<tr>
<td>Cross Laterality</td>
<td>4.3</td>
<td>.50</td>
</tr>
<tr>
<td>Stott Test - Motor Impairment</td>
<td>2.7</td>
<td>2.9</td>
</tr>
<tr>
<td>Garfield Test - Motor Impersistence</td>
<td>6.5</td>
<td>.71</td>
</tr>
<tr>
<td>Gibson Spiral Maze - Psychomotor Ability</td>
<td>59.3</td>
<td>24.6</td>
</tr>
<tr>
<td>Chronological Age (months)</td>
<td>112.77</td>
<td>12.1</td>
</tr>
<tr>
<td>English Picture Vocabulary Test - Intelligence Quotient</td>
<td>99.84</td>
<td>8.2</td>
</tr>
<tr>
<td>Schonell Test of Reading (Age (months))</td>
<td>81.1</td>
<td>11.8</td>
</tr>
<tr>
<td>Schonell Test of Spelling (Age (months))</td>
<td>78.5</td>
<td>10.6</td>
</tr>
</tbody>
</table>
The Principal Component Factor Analysis

The principal component analysis isolated seven component factors associated with roots greater than one. These seven factors, which accounted for 66.3% of the total variance of the eighteen variables, were then rotated orthogonally according to the varimax criterion (Kaiser 1958). The initial component factors and the rotated factor loadings are given in Table 5:3. Rotated factor loadings less than .30 for the test variables and the three independent variables were omitted from the table.

The first factor accounted for 21.6% of the total variance and suggests a dimension of perceptual motor performance which, as it contains those tests purported to be indicators of neurological impairment, would seem to indicate a possible underlying neurological factor. Although Factor I has low correlations with intelligence and verbal factors it links visual spatial, visual motor gestalt ability, auditory visual integrative ability, motor impairment, motor incoherence and psychomotor ability which suggests that some of the backward readers have difficulty in discriminating, integrating and coordinating their auditory, visual, and motor inputs.

In view of the high loadings for motor ability measured by the Stott test, auditory visual integration, and visual spatial ability, it is possible to relate Factor I to the dimension of "neurological integrity impairment" factor of Lovell and Gorton (1968) which also accounted for the highest percentage of variance in their study of backward readers. However, unlike Factor I in Lovell and Gorton's study, reading and left right discrimination were not associated with this factor but occurred in factor II. Lovell and Gorton did not include the tests of motor incoherence or psychomotor ability in their test battery.

Factor II accounted for 11.4% of the total variance and can be considered as a verbal factor. Apart from loadings of auditory visual integration it did not have these perceptual or motor aspects found in Factor I, but it does contain those aspects most related to reading performance - spelling ability and word recognition. Just as word recognition can be considered to be a prerequisite for reading, if one cannot read it is unlikely that one will be able to spell either. (Crosby, 1968; Rawson, 1968; G Ritchley, 1970; Vernon, 1971). As stated, Lovell and Gorton also found that auditory visual integration and right left discrimination were associated with reading, and other researchers
<table>
<thead>
<tr>
<th></th>
<th>unrotated</th>
<th>rotated factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>E.P.V.T.</td>
<td>-31</td>
<td>19</td>
</tr>
<tr>
<td>(Intelligence)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td>-57</td>
<td>67</td>
</tr>
<tr>
<td>Spelling</td>
<td>-59</td>
<td>63</td>
</tr>
<tr>
<td>Visual Spatial</td>
<td>4.7</td>
<td>22</td>
</tr>
<tr>
<td>Ability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Motor</td>
<td>4.6</td>
<td>05</td>
</tr>
<tr>
<td>Gestalt Ability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word</td>
<td>-63</td>
<td>55</td>
</tr>
<tr>
<td>Recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditory Discrimination</td>
<td>-28</td>
<td>-18</td>
</tr>
<tr>
<td>Auditory Visual</td>
<td>52</td>
<td>11</td>
</tr>
<tr>
<td>Integration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditory Memory</td>
<td>-18</td>
<td>-12</td>
</tr>
<tr>
<td>Human Figure</td>
<td>-34</td>
<td>01</td>
</tr>
<tr>
<td>Drawing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Left</td>
<td>-16</td>
<td>29</td>
</tr>
<tr>
<td>Discrimination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handedness</td>
<td>-03</td>
<td>-01</td>
</tr>
<tr>
<td>Eyedness</td>
<td>-15</td>
<td>-10</td>
</tr>
<tr>
<td>Cross Laterality</td>
<td>-12</td>
<td>-11</td>
</tr>
<tr>
<td>Motor Impairment</td>
<td>4.9</td>
<td>38</td>
</tr>
<tr>
<td>Motor Impersistence</td>
<td>4.8</td>
<td>25</td>
</tr>
<tr>
<td>Psychomotor Ability</td>
<td>22</td>
<td>37</td>
</tr>
<tr>
<td>Language</td>
<td>12</td>
<td>05</td>
</tr>
<tr>
<td>Percentage variance</td>
<td>21.6</td>
<td>11</td>
</tr>
</tbody>
</table>
(see the review of the literature) have associated both auditory visual integration and right left discrimination with reading, spelling and word recognition.

Factor III is considerably more difficult to interpret. It has high loadings of motor impersistance, a test associated with neurological impairment Garfield (1964) and with reading difficulty, Yule (1967). Human figure drawing and language were also associated with factor III. Within and his co-workers (1962) have linked poor human figure drawing with the dimension of "field dependence" and they also associate this dimension with language difficulties that involve verbal skills that place emphasis on relations and abstractions. The correlation of human figure drawing and language on factor III is also consonant with the findings of Benyon (1968) who reported that children in her Clinic with language difficulties also had a weak body image. De Hirsch et al (1966) suggest that a poor body concept as demonstrated by difficulty in human figure drawing indicates a low level of integration, pointing to a severe maturational lag, and Ingram et al (1970) suggest that immaturity of perceptual or motor functions could result both in a delay of development of language and the ability to draw a man. However, because of such a high loading of motor impersistance on this factor, it would seem that neurological impairment is as likely to be the underlying problem as delayed maturation. Factor III and factor VII are probably best considered concurrently since both had similar loadings on human figure drawing. In factor VII, which accounted for only 5.4% of the variance, human figure drawing was associated with motor impairment, another test claimed by its author to indicate neurological impairment, Stott (1966), and with intelligence. However, both these variables had loadings only just above the correlation cut off point of .30.

Factor IV is clearly a factor of auditory perceptual ability as it is distinguished by high loadings on auditory discrimination and auditory memory and to a lesser degree with language. It is possible to relate factor IV with Lovell and Gorton's (1965) factor VI and factor I for the learning disabilities group noted by Sabatino and Hayden (1970). Lovell and Gorton also associated auditory discrimination with language on their factor VI and suggested that the factor could be linked with aphasia. However, they also found right left discrimination loaded on this factor while right left discrimination in the present analysis was solely linked with reading and spelling abilities on factor II.
Sabatino and Haydon considered that their auditory perceptual language factor supported the assumption that children with learning disabilities including reading "have specific perceptual and language (receptive - expressive) behavioural relationships to academic achievement". (1) The loadings of auditory perceptual factors and language on factor IV is in accord with the findings of Clark (1966) who demonstrated the relationship between poor articulation, poor auditory discrimination and poor auditory memory in a study of young primary school children, and with those of Crookes and Greene (1963). They isolated a group of five to eleven year olds with language problems associated with speech difficulties and auditory memory. De Hirsch et al (1966) and Rosner (1971) also considered the difficulty to differentiate sounds, language difficulty and poor auditory memory both in listening and speaking to be important factors associated with reading difficulty.

Factor V is a bipolar factor. The fact that it has its highest loading on the English Picture Vocabulary Test suggests that this factor is best considered as a factor of intelligence; as though why "handedness" should also negatively load on this factor is difficult to interpret. One would have expected it to load on factor VI with eyelidness and cross laterality. As Ayres (1965) comments "Laterality functions do not lend themselves easily to analysis by parametric statistics". (2) In her study of perceptual and motor factors related to perceptual motor disfunction in children, she also found that eye hand dominance and strength of unilateral hand dominance tended not to share their variance with other variables including each other and concluded that neither were related to perceptual motor disfunction, at least in her study. However, the high loadings of lateral dominance and hand-eye dominance found by Lyle (1969) on his factor VI strongly supports the view that these two abilities are significantly related. Lyle's lateral dominance test was similar to the test of handedness in the present study and his hand-eye dominance test was a different description given to the present test of cross laterality. Yet the strong association of these abilities in his factor VI and the complete lack of association of them here, clearly indicate the problems of analysis and interpretation of factors associated with laterality. In neither case were any of the tests of laterality related to reading ability.

Discussion of the Individual Perceptual and Motor Tests and Language

Visual Spatial Ability

A comparison of the scores of the backward readers on the "Problems of Position" test of visual spatial ability with their age norms indicates that 28.1% of the subjects were at least one standard deviation below the norm for their age and of these 10% were two standard deviations below their age norm.

As expected, the raw visual spatial scores indicate that this ability improves with age. However, when the mean raw scores of the backward readers are compared with their equivalent age norms, the backward readers are poor in visual spatial ability (Table 2, Appendix).

An examination of the individual errors on the P.O.P. Test indicate that the greatest ratio of lateral and inverted mirror images occurred in the profiles of the younger backward readers. When the frequency of these errors on the visual spatial test were compared with the reversal of letters and twisting of letters on the word recognition test, those backward readers who made the most reversal errors also made the greatest number of reversals on the visual spatial test. This finding suggests that the possible cause of letter reversals in backward readers is their poor ability in recognizing position in space. This view is supported by many of the researchers quoted in chapter 3.

The correlational analysis (Table 5:2) shows that visual spatial ability as measured by the P.O.P. test is moderately related to visual motor gestalt ability, to auditory visual integration and to the Gibson Spiral Maze Test of psychomotor behaviour. Though to a lesser degree, visual spatial scores also correlated significantly with motor impairment.

These findings are similar to those of Lovell and Gorton (1963) who found that visual spatial ability in their backward readers was also related to auditory visual integration, rotation of designs and motor performance. However, the visual spatial results in the present study do not support the findings of Benton (1962) and De Hirsch et al (1966) that spatial ability is related to poor body concept and right left orientation. Only twelve of the eighty two backward readers in the present study had poor right left discrimination as tested by a shortened version of the Benton Test; though, of these twelve, five subjects had poor visual spatial ability.
Visual Motor Gestalt Ability

The scores made by the backward readers on the Bender Visual Motor Gestalt Test were compared with the norms published by Kopitz (1964) (Table 5 and Graph 1 in the Appendix). They indicate that the backward readers are poorer in reproducing the nine figures than are children of the same age without reading difficulty.

The backward readers had particular difficulty in discriminating between dots and circles, they were inaccurate when reproducing angles, when integrating the parts of a figure with its whole, and they made frequent errors of rotation. These findings are similar to those obtained in other studies of backward readers including those by Baxman (1960), Kopitz (1967, 1984), Pe Fischer et al. (1966) and Croddy (1969).

An analysis of the extent of difficulties on this test indicate that 24 subjects (41.5%) were at least one standard deviation below the norm for their age. Of these, eighteen boys (22.4%) were one standard deviation, eleven boys (15.6%) were over two standard deviations, and five boys (6.5%) were over three standard deviations below their age norm.

As expected, the younger boys in the backward readers group were poorer in this aspect of perceptual ability than their older counterparts. They made more errors of rotation, distortion of shape, and integration. All age groups made approximately the same number of errors of perseveration (Table 5, Appendix).

It is accepted that visual motor gestalt ability is age related and the types of errors and their greater frequency made by younger children is associated with immaturity of perceptual ability. Moreover, the backward readers of all ages produced Bender profiles below those expected of children of their age level. Baxman (1970) would support the view that their poor performance reflects a developmental lag, while other researchers such as Kopitz (1964) would consider their visual motor gestalt difficulties to be the result of a neurological impairment. Indeed, Kopitz suggests that the visual motor gestalt test is an indicator of neurological impairment.

Word Recognition

More boys had difficulty on the test of Word Recognition than any other test (63.2%). This is to be expected, considering the high correlation between word recognition scores and the Schonell test of reading ability (.65) and between word recognition and spelling ability (.61). Obviously the ability to recognize the sound of a word and to relate it to its visual pattern is a pre-requisite to reading.
When the backward readers' word recognition scores were converted to a word recognition age (Carver 1970), as Table 5.4 indicates, the backward readers were significantly below their chronological age norms at the P .001 level of confidence.

Table 5.4: Word Recognition Scores of the Backward Readers

<table>
<thead>
<tr>
<th>Backward Readers Age Groups</th>
<th>Backward Readers mean Chronological Age</th>
<th>Backward Readers mean Word Rec Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 - 8.5 years</td>
<td>7.94 years</td>
<td>5.74 years</td>
</tr>
<tr>
<td>8.6 - 9.5 &quot;</td>
<td>9.06 &quot;</td>
<td>6.85 &quot;</td>
</tr>
<tr>
<td>9.6 - 10.5 &quot;</td>
<td>10.05 &quot;</td>
<td>7.49 &quot;</td>
</tr>
<tr>
<td>10.6 - 11.5 &quot;</td>
<td>10.95 &quot;</td>
<td>7.85 &quot;</td>
</tr>
<tr>
<td>Total mean C.A. 9.39 years</td>
<td>Total mean W.R. age 6.96 years</td>
<td></td>
</tr>
</tbody>
</table>

In an analysis of the types of word recognition errors, though the younger backward readers made more errors in all aspects of word recognition, the backward readers at all age levels made consonant errors, combined vowel errors, reversal errors, twisted letters within words, and errors in word endings. Fewer mistakes were made in recognizing initial letters and the short vowel sounds.

An examination of the correlation matrix indicates that word recognition in this group of backward readers is related to visual motor gestalt ability, auditory discrimination, auditory visual interaction and, though to a lesser degree, to motor factors, right left discrimination and human figure drawing.

An examination of the perceptual and language abilities of each subject with a poor performance in word recognition indicates that more boys have visual perceptual than auditory discrimination difficulties, and more boys have weak visual perception in combination with poor auditory visual integration. These results suggest that visual perception and auditory visual integration are the most important factors in word recognition. However, examination of the possible combinations of perceptual problems related to word recognition in this group, supports the view that word recognition depends on a combination of both auditory and visual perceptual factors.
The Wapman Test of Auditory Discrimination was individually administered to each subject. Wopman (1958) considered that four or more errors made by children of eight years or over indicates a difficulty in auditory discrimination. However, as four errors could be made by confusing the "v-th" and "f-th" sounds, and, as Haides (1972) reported that both her dyslexic and normal readers frequently made these errors, a score of five or more is regarded as indicative of a weakness in auditory discrimination.

The number of boys scoring between 0 - 4 errors and those scoring above 5 errors is shown in Table 5.

<table>
<thead>
<tr>
<th>Score</th>
<th>Number of subjects</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>67</td>
<td>61.76</td>
</tr>
<tr>
<td>5 and above</td>
<td>15</td>
<td>18.24</td>
</tr>
</tbody>
</table>

These results correspond very closely to those of Haides' reading retardates (62.1% and 17.9%) and to those of her control group (80.4% and 19.6%).

A comparison of the mean scores for the different age groups indicates that auditory discrimination is poorer in the younger backward readers. Nearly twice as many boys between eight and nine and a half years had scores over five than boys between nine and a half and eleven and a half years of age.

The distribution of errors for each word pair on the test indicates that the "v-th" sounds as in "vor" and "thou", the "th-q" sounds of "clothe" and "clove", and the "f-th" sounds, as in "sheaf" and "sheath", were common to all age groups. The younger boys also had difficulty in discrimination between the consonants "h" and "p", between "z" and "n" and between the vowel sounds "oa" and "u" as in "shoal" and "shawl". Similar difficulties were reported by Haides (1972) for her retarded readers.

The backward readers in the present study had most difficulty with word pairs that had different endings rather than those pairs with different word beginnings, even when the same phonemes were discriminated. The ratio of errors in word endings to word beginnings was four to one. Blank (1968) suggests that poor discrimination of word endings may be the result of a tendency by backward readers to "perseverate" one word of a pair of similar words because of a lack of attention to the word sounds.
Half of the backward readers with scores of 5 and above in this study were considered by their teachers to be impulsive, inattentive and lacking concentration. This finding supports Blank’s opinion that backward readers lack the ability to overcome impulsivity, tend to separate the word from its context and fail to mediate their response through conceptualization.

The correlation matrix indicates that auditory discrimination did not correlate with reading performance but significant correlations were obtained between this ability and word recognition, auditory memory, language and spelling ability. These results are similar to those of Lovell and Gorton (1968) who, though they found no relationship between auditory discrimination and reading in their backward readers, did find a relationship with language ability, as measured by the Illinois Test of Psycholinguistic ability.

**Auditory Memory/Sequencing Ability**

This ability, as stated in the test procedures, was measured by the Digit Span sub-test of the W.I.S.C. A standard score of 6 was considered a very poor auditory memory. Eighteen of the eighty-two backward readers had a score of six or below, which represents 22% of the backward readers in the investigation. The mean raw score of 8.45 (S.D. 1.64) and the mean scaled score of 8.96 (S.D. 3.7) were similar to those of Naidoo (1972). The mean scores of her retarded readers were 8.3 (S.D. 2.27) and her spelling retardates 9.6 (S.D. 2.42), both of which were significantly lower than the Digit Span scores of her control groups. She concluded that the poor performance of these dyslexic boys on this test was "unlikely to be the effect of the reading retardation" but evidence of a general difficulty of backward readers in recall of verbal material.

The poor Digit Span scores of the backward readers in this study are also similar to those obtained by Moseley (1971) on a group of 87 junior school boys of average intelligence who were backward readers, and by Sabatino and Hayden (1970) on a group of children with learning difficulties which included poor reading ability.

Poor performance by backward readers on the Digit Span sub-test has been found by a number of investigators using the W.I.S.C. test of intelligence. A summary by Margaret Deal of these investigations can be found in "Readings for Diagnostic and Remedial Reading" edited by Wilson and Geyer (1972).
Auditory memory, as measured by the Digit Span test, was associated with very few other perceptual variables. It was most related to language difficulty but even in this relationship the correlation of .33 was low.

The lack of relationship between Digit Span and auditory visual integration in the present study is similar to that obtained by Kahn and Birch (1969) and supports their view that "auditory rote memory skills are not associated with auditory visual integrative competence".

**Auditory Visual Integration**

As the test developed by Birch and Belmont (1964, 1965) was used to test this ability of the backward readers in the present study, a direct comparison was made of the grade norms of the Primary school children aged between 5.25 years and 12.1 years in Birch and Belmont's 1965 investigation. As the Table 5 in the Appendix and Graph 2 indicate, the backward readers in the present study are poorer than those children of similar age in the Birch and Belmont study up to 10½ years. The mean scores of the eleven year olds are very similar.

As the number of subjects in my study over the age of eleven was only five, this number is far too small to provide any confident prediction of auditory visual integration ability. However, when the backward readers are regrouped according to four age groups with mean ages of eight, nine, ten and eleven years (range +6 months) the mean auditory visual integration scores of the oldest group is equal to that of the 8½ year olds in the Birch and Belmont (1965) study.

This result lends support to Birch and Belmont's view that auditory visual integration is significantly associated with reading ability up to the age of eight years. It further supports Kahn and Birch's study (1968) using an expanded test of auditory visual integration. They found significant correlations with reading up to twelve years of age and Gregory (1973) found significant correlations of auditory visual integration with reading in children between the ages of six and eleven.

The mean score of the backward readers on the Auditory Visual Integration Test was 7.22 (S.D. 3.5) which was similar to that obtained by Lovell and Gorton (1968) on a group of backward readers of a similar age and intelligence, and by backward readers with I.Q.'s over 100 in a study by Birch and Belmont (1964). These two studies found statistically significant differences between the backward and normal readers in auditory visual integration.
The correlation matrix (Table 5:2) indicates that auditory visual integration is related to reading and spelling at the 5% level, and to intelligence at the 1% level. It is moderately related to visual spatial ability, visual motor gestalt ability, word recognition and motor impairment.

Other researchers have found that auditory visual integration is related to intelligence (Kahn 1965, Sterrit and Rudnick 1966, and Ford 1967). Lovell and Gorton (1968) also obtained a relationship between auditory visual integration, spatial orientation and motor performance.

The lack of relationship between auditory memory, auditory discrimination and auditory visual integration in the present study is in agreement with the findings of Kahn and Birch (1968) and does not support the view that these mechanisms are essential to auditory visual integration competence.

**Body Concept**

In order to cross validate and check reliability of scoring of the Human Figure Drawing Test (Witkin et al 1962) with the Hanna Marlin's scale, the author and a second independent judge rated the drawings of all eighty-two backward readers. The correlation of .81 between the two ratings indicates the degree of reliability of scoring.

As no age norms of Human Figure drawing using the Marlin's scale have been published, drawings by boys from the same classes as those boys in the investigation group were also assessed and compared with those of the backward readers. In addition, the Human Figure drawings of the backward readers were assessed using the Goodenough-Harris Drawing Test Scale (1965) which contains 73 scoring items for both draw-a-man and draw-a-woman and formulae for conversion to a composite standard score. Harris (1963) claims that his test measures intellectual maturity and the ability to do abstract thinking while Witkin claims that his test focuses on aspects of the drawings which reflect the extent of articulation of body concept. The raw scores of the two scales correlated with each other \( r = .88 \), indicating a very strong relationship. Within (1962) reported a similar correlation (.74) between his Sophistication of Body Scale and the original Goodenough Draw a Man Scale (Goodenough 1926) which was developed to test non-verbal intelligence. When age was partialled out from the raw scores of both tests, the correlations between intelligence (E.P.V.T.) and the scores on the Human Figure Drawing Test Marlin's scale and the Draw-a-Man Test Goodenough-Harris scale were .40 and .54 respectively.
Phillips, Smith and Broadhurst (1973) also used the Goodenough-Harris test and the E.P.V.T. as measures of intelligence and obtained correlations of .26 and .47 between these tests among groups of five and of eleven years old. Within obtained correlations of .55 between the Goodenough scale and the total W.I.S.C. I.Q., and between the Harlen's scale and the W.I.S.C. I.Q. Yule (1967) using the Goodenough-Harris test obtained correlations of between .21 and .41 with four sub-tests of the W.I.S.C.

As Phillips, Smith and Broadhurst (1975) point out, the test of Human Figure drawing is easy and very inexpensive to administer but very difficult to interpret and score, and it would appear that Human Figure drawing is as much related to intelligence as it is to sophistication of body concept.

An examination of the individual scores of the backward readers on the Harlen's scale indicated that nineteen of the subjects (23.2%) were given a score of 5 (most primitive) compared with only seven (8.5%) in my comparison group, a difference significant at the P<.05 level of confidence.

On the Goodenough-Harris scale the mean standard score was 94.23 (S.D. 13.3). When the standard scores were converted to a percentile rank those twenty two subjects (27.3%) with a standard score of 84 or less (one standard deviation below the standard mean of 100) were in the bottom 15% of the population.

The low but significant correlation of reading with human figure drawing is much lower than that obtained by Easley (1964) and the relationships of human figure drawing with perceptual motor abilities are again similar but lower than that obtained by Within (1962) and Ansbacher (1952). Its relationship with intelligence has already been commented upon.

Laterality

The Harlen test of laterality was used to examine this aspect. First, handedness was tested by asking the boys to perform a series of tasks such as writing first with the right then with the left hand, simultaneously writing with both hands and demonstrating how to throw a ball, brush teeth, wind a watch etc. Eyedness was then tested using monocular tests and binocular tests which involved sighting a rifle, looking down a kaleidoscope, down different size cones and through a hole in a card. Gross laterality and hand-eye dominance were derived from the results of the above tests.
The tests of handedness were scored in terms of strong right, moderate right, mixed, moderate left and strong left. As in Heidoo's study (1972), the intermediate categories have been combined and are referred to as "ambilateral". (Table 5:6)

Table 5:6 Latentivity in Backward Readers

| Writing - right | 75 | 95% |
| Writing - left  | 4  | 5%  |
| Strong right-handed | 67 | 82% |
| Strong left-handed  | 2  | 2.5%|
| Ambilateral        | 13 | 15.5%|
| Eyedness - right   | 45 | 55% |
| Eyedness - left    | 34 | 41.5%|
| Eyedness - mixed   | 5  | 6.7% |
| Cross laterality   | 47 | 57.5%|
| not cross lateral  | 39 | 42.5%|
| cross lateral      | 8  | 9.5% |

These findings indicate that the incidence of left handedness in this study is even lower than that found in the general school population, (Clark, 1957; Enstrom, 1962; and Kollmer-Pringle et al, 1966) and considerably lower than that obtained by other researchers in their studies of dyslexic or specifically retarded readers (Harris, 1957; Heidoo, 1961, 1972; Sangwill, 1960, and Rutter et al, 1970). They support Johnson's (1957) report that retarded readers are usually found to be right handed. Left eyedness was found among two fifths of the backward readers, which is slightly higher than the incidence of left eyedness found by Clark (1957), Harris (1957), Kollmer-Pringle et al (1966), Rutter et al (1970) and Heidoo (1972) all of whom found left eyedness in approximately one third of the children studied. The incidence of cross laterality was similar to that found in the general population.

An examination of the incidence of ambilaterality with age indicates that there is a decrease with age in the number of backward readers with either mixed handedness or weak hand preference. (Table 5:7)

Table 5:7

<table>
<thead>
<tr>
<th>Are in Years</th>
<th>Subjects</th>
<th>Ambilaterality</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 - 8.5</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>8.6 - 9.5</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>9.6 - 10.5</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>10.6 - 11.5</td>
<td>12</td>
<td>1</td>
</tr>
</tbody>
</table>
The low incidence of left handedness and ambilateriality in this study of backward readers does not support the view that laterality is an important factor in specific reading difficulty and is in agreement with other research (Helmeqist, 1958; Belmont and Birch, 1969; Douglas et al., 1967; Rutter et al., 1970) in failing to find any significant excess of left handedness or ambilateriality in a group of backward readers. The number of boys with left or mixed eyeness and cross laterality was high but is not significantly higher than that found in large population studies of children of similar age, Clark (1957). As Vernon (1971) comments "Since more people are left eyed than are left handed it is inevitable that a considerable number are cross lateral". (1)

Right Left discrimination

Of the eighty two subjects studied 30.5% failed one or more of the right left discrimination tasks. Using the same tasks to assess right left discrimination, Belmont and Birch (1965) found that 24% of their nine to ten year old backward readers failed one or more tasks compared with 2% in their control group (P<.01). The results of the backward readers in the present study support the view that right left discrimination is a developmental phenomenon and is strongly related to age. As the mean scores and the percentage of subjects who had difficulty show (Table 6 Appendix), a tendency for confusion of right and left is more prevalent among the younger backward readers.

These results support the findings of Harris (1957) in which he found that 38% of seven year olds, 10% of eight year olds and 6% of nine year olds with reading retardation showed directional confusion. The results of Harris's nine year old retarded readers were within normal limits but, as Belmont and Birch comment, Harris only used a three item test.

An examination of the individual scores on this test indicates that twelve boys (14.6%) were very poor, in that they failed between four and seven of the seven tasks. These twelve boys were evenly distributed throughout the whole age range of the backward readers group. Three of the twelve boys showed systematic reversal in right left discrimination in which, even though the object of the test was clearly explained to them and they could tell the experimenter which was their right hand, they pointed to the left side when asked to identify a body part on the right and vice versa. Difficulties in right left orientation in groups of backward readers was also found by Kinsburn and Warrington (1967), Shearer (1968), Benton (1959), Lovell and Gorton (1968), Rutter et al. (1970), Crossen and Lytton (1970) and Kallado (1972).

(1) H.J.Vernon (1971) Reading and its Difficulties, P.145
An examination of the correlation matrix indicates that as well as the relationship with laterality, low but significant positive correlations were obtained between right left discrimination and reading and word recognition.

The lack of relationship between language difficulties and difficulties of right left discrimination does not support Benton's (1959) view that this difficulty is a symptom of symbolic expression related to language function. However, the poor relationship of right left discrimination with the draw-a-person test does not support Gerstmann's (1958) opinion that it is a disorder of body image either.

Motor Impairment

In the present study an impairment score of between one and three on the three sub tests of the Stott Test of Motor Impairment is considered to be mildly motor clumsy. Those boys with an impairment score of four to seven are considered moderately impaired and boys with a score of eight or above are considered severely motor impaired. A score of eight or more means that the subject is at least two years behind his age group on at least two of the three sub tests.

An examination of the scores on the Stott Test indicates that performance on three sub tests commensurate with chronological age was exhibited by 26 boys - 31.7% of the backward readers in the study. 30 boys (36.6%) were identified as mildly motor clumsy, 19 (23.2%) were assessed as moderately motor impaired and 7 (8.5%) were severely motor impaired.

These results compare very closely with those of Naidoo (1972) in her study of dyslexic children of average intelligence. In her study 53% of the 54 retarded readers passed at their age level on the Stott Test or the shortened form of the Oseretsky Test of Motor Performance compared with 58.2% of the 55 controls (significantly different at the 2% level). In Naidoo's study 27.9% retarded readers had an impairment score of four or above compared with 31.7% in the present study.

Rutter et al (1970) used the Oseretsky test to assess motor ability in their group of 86 specifically retarded readers and their control group. They found 12.6% compared with 4.8% of the controls had very poor motor ability (significant at 5% level). As stated, in the present study, seven boys (8.5%) were considered to be very poor in motor ability and unlike the Isle of Wight's specifically retarded readers no boy had an I.Q. of below 85 points.
As in Naidoo's study, failure was more common in some aspects of motor functioning than in others. In the present study 53.6% of the backward readers failed the test of balance, 14.63% were below their age level at coordination and 32.9% failed manual dexterity. In Naidoo's group of retarded readers the percentage failures were 35.2, 27.8 and 37.2 per cent respectively compared with 12.7, 11 and 16.4 per cent in one of her control groups and 7.1, 1.5 and 19.1 per cent in the other.

An analysis of the failures on each of the sub tests according to age suggests that weakness in manual dexterity diminishes with age (Table 7 Appendix). The variation of balancing ability between the four age groups is difficult to explain but it may be that, as Morris and Whiting (1971) have suggested, a further analysis of the individual balance items is necessary. With regard to the percentage of children passing at different age levels, Stott (private communication) tested each child at his own age level and those above and below. As a result, he intends to switch some of the tasks one age level up or down in his next revision of the test. Since the children in the present study were tested over their age level as well as below, any failure at any single age level was checked and corrected if any child subsequently passed at a higher level.

Intercorrelation between the three sub tests and overall motor impairment was very high, balance correlated with motor impairment by .81, coordination by .75 and manual dexterity by .86.

Although the Stott Test has been widely used to assess motor impairment the validity of the test has not been clearly established, (Whiting, 1969a, 1969b, 1971; Dyton et al, 1969; Lumley, 1972). Lumley, for example, comments that validity is linked with the establishment of a meaningful and reliable cut-off point between what is considered normal and impaired motor ability. However, motor coordination may be a true continuum and thus a cut-off point should be considered an arbitrary standard adapted for practical purposes. As in the Lumley study, although a cut-off point has been used to define impaired and non impaired backward readers, raw scores were used in statistical analysis of the scores on the Stott test with other data in the investigation.
Scores on the test of motor impairment correlated significantly at the 0.1% level with motor impersistence and also with an assessment of motor incoordination made by the author while observing and examining the backward readers throughout the test period. The criteria used to assess motor incoordination in this way are tabulated in the Appendix A. Motor impairment also correlated significantly with the tests of visual spatial ability, word recognition, auditory visual integration, psychomotor behaviour and language difficulties (Table 5:2).

If the Stott test is a valid test of neurological impairment as claimed by its author, the high percentage of boys with moderate or severe motor impairment would suggest that some of the subjects in the study revealed evidence of neurological dysfunction. Some support for the validity of such a statement is found in the poor performance of the motor impaired backward readers on other tests claimed either by their authors or other investigators to be indicators of neurological impairment. Three tests in particular have been used to discriminate neurologically impaired children - motor impersistence, visual motor ability and psychomotor behaviour.

Motor Impersistence

This is a developmental phenomenon but, though related to age, it is generally assumed that it can be induced by damage to the central nervous system. In the present study 33 subjects (40.2%) failed at least one of the seven tests of impersistence, Garfield (1964), and seven (8.5%) were diagnosed as motor impersistent. This number is just a little more than half the number of a similar sample of retarded readers assessed as motor impersistent in the Isle of Wight study, Rutter et al (1970).

Of the seven boys in the present study diagnosed as motor impersistent, three were aged between eight and nine years, two were aged between nine and ten, and two were aged between ten and eleven. Their mean I.Q. was 100.4 points. Five were diagnosed as motor clumsy and five had language difficulties, four boys had visual spatial and visual motor difficulties, three had auditory visual integration problems, poor psychomotor ability and were cross lateral, and five of the seven boys drew primitive human figure drawings.

The correlation matrix indicates that motor impersistence is significantly associated with motor impairment and with visual perceptual abilities. A strong relationship of motor impersistence with motor impairment was found, by Rutter et al (1970), and by Whiting et al (1969b) in a factor analytical study of perceptual and motor abilities in E.S.N.
children. Whiting also obtained a relationship of motor impersistence with the Gibson Spiral Maze Test of psychomotor ability in which those failures in motor impersistence were placed in the "slow and careless" and "quick and careless" quadrants of the scatter plot. This finding is discussed in relation to the Gibson Spiral Maze results in the present study in the section that follows.

**Psychomotor Ability**

The raw time and error scores on the Gibson Spiral Maze Test were converted to percentile scores using the percentile norms developed by Gibson (1964) in a study of nearly 400 primary school boys. However, as the age range of these norms was between eight and a half years to ten years it was decided in consultation with Gibson (1972) that, as subjects in this investigation were near in age to the upper and lower limits of the normative table in the Manual, I should extrapolate the norms upwards and downwards assuming a linear regression of Time on Age.

The percentile scores were plotted on a bivariate frequency distribution the ordinate of which was "Time" in seconds and the abscissa of which was "Error" scores. Regression lines of time on error and error on time were calculated to produce four quadrants designated as "quick-and-careless", "slow-and-careless", "slow-and-accurate" and "quick-and-accurate". Thus the scatter plot (Figure 1) indicates the relative position of each subject.

As Table 5:6 indicates a large percentage of the boys in the investigation were in the two careless quadrants of the scatter plot, particularly in the "quick and careless" sector. This result is very similar to that of the "naughty boys" group in Gibson's study of primary school boys. However, there were fewer boys in the "slow and accurate" quadrant and more subjects in the "quick and accurate" sector than in Gibson's group.

<table>
<thead>
<tr>
<th>Backward Headers</th>
<th>Quick and Careless</th>
<th>Slow and Careless</th>
<th>Slow and Accurate</th>
<th>Quick and Accurate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>35</td>
<td>23</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>Readers' Group</td>
<td>43%</td>
<td>23%</td>
<td>4%</td>
<td>26%</td>
</tr>
</tbody>
</table>
4 quick & accurate
3 slow & accurate
2 slow & careless
1 quick & careless

Fig. 1. Gibson spiral maze scores of backward readers.

% error scores
0 10 20 30 40 50 60 70 80 90 100 time scores %
Of the 26 boys (32%) regarded as moderately or severely motor impaired on the three sub tests of the Stott test, thirteen (50%) appeared in the "quick and careless" sector and two boys (7.6%) were borderline, seven (27%) appeared in the "slow and careless" sector, three (11.4%) were in the "quick and accurate" sector and one (3.8%) in the "slow and accurate" sector. When only the seven severely motor impaired boys are considered, five appeared in the "quick and careless" area and the other two appeared in the "slow and careless" area of the scatter plot.

Thus the two "careless" quadrants of the Gibson Spiral Maze were able to discriminate most of the moderately motor impaired subjects and all the severely motor impaired backward readers. Though nearly two-thirds of those backward readers assessed as careless on the Gibson Spiral Maze Test were motor impaired, the difference just fell short of significance at the 5% level (Table 5:9). However, whereas in the Whiting et al study of E.S.N. children (1969) and the Davis et al (1969) and Lumley (1972) studies of Approved School boys, the majority of motor impaired boys appeared in the "slow and careless" quadrant, the majority of motor impaired backward readers in the present study fell in the "quick and careless" sector. Factors other than motor impairment and linked with the particular behaviour of the backward readers are thought to explain these differences. These factors will be discussed in relation to the behaviour of the backward readers in Chapter II.

Table 5:9. A comparison of motor impaired and non impaired Backward Readers on the Gibson Spiral Maze Test.

<table>
<thead>
<tr>
<th>Assessment of Motor Ability on the Stott Test</th>
<th>Position on the Gibson Spiral Maze Scatter Plot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects with Moderate/Severe motor impairment</td>
<td>Careless Quadrants</td>
</tr>
<tr>
<td>Subjects not motor impaired</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
</tr>
</tbody>
</table>

Chi Square = 2.63, 1 d.f. (not significant)
All the subjects diagnosed as motor impersistent and a high percentage of those assessed as neurologically impaired on the Bender Visual Motor Gestalt test (Koppitz, 1964) appeared in the careless quadrants of the scatter plot lending support to Morris and Whiting's view (1971) that the Gibson Spiral Maze Test of Psychomotor Competency is an indicator of neurological impairment. It must be noted, however, that as scatter plots and quadrants are formulated according to the population being examined, biased populations will produce biased scatter plots and quadrants. As Lamley (1972) observes, this must be overcome by further research and the establishment of reliable norms.

In order to correlate the backward readers' scores on the Gibson Spiral Maze with their perceptual and motor scores, a single measure of psychomotor ability was needed. Therefore, a regression of the error scores with respect to time was calculated (as suggested by Gibson (1964)), and a single adjusted error score produced, with Time partialled out.

Correlation of this adjusted error score with the other perceptual and motor tests indicates that psychomotor behaviour is, as expected, associated with motor impairment, motor impersistence and visual motor gestalt ability and, to a lesser degree, with language and human figure drawing. It was most closely related to visual spatial ability, which supports the view that both visual spatial and visual motor skills are important factors in success on the Gibson Spiral Maze test.

To conclude, psychomotor ability appears to be related to certain aspects of behaviour, to visual perceptual and motor competence and possibly to neurological impairment in backward readers of average intelligence.

**Speech and Language Problems**

From assessments of each boy's articulation, sentence construction, vocabulary and grammar during a short interview and while answering questions (for a more detailed explanation of the assessment refer to Chapter 4), nineteen boys in the backward readers' group were considered to have a speech or language problem (Table 8 Appendix). This number represents 25.2% of the investigation group. A further four boys were considered to have slight language problems in that they made errors in their choice of words and sentence construction or were slightly inarticulate for their age. However, these mistakes could be attributed
to laziness in speaking and the influence of the Home Counties dialect rather than to a definite language difficulty.

In addition, answers to questions on speech and language given by the parents of the backward readers in this study and by parents of a control group of normal readers indicated that the incidence of speech and language problems in the backward readers' group is significantly higher at the $P<.01$ level. The details and a discussion of these findings are further considered in Chapter 9.

The percentage number of language difficulties in the present study is similar to those of Naidoo (1972) in which 26.5% of her dyslexic boys had mildly defective articulation and 6.2% had moderate or severely defective articulation on an Articulation Attainment Test devised by Renfrew. These percentages were significantly higher at the $<.01$ level of significance than her 7.1% of control subjects with mildly defective articulation.

In the Isle of Wight study (1970) the incidence of poor articulation in the specifically retarded readers' group was 14% and the number of children with a poor complexity of language was 15.1% compared with 6.8% and 6.2% in the control group. Butter's results, therefore, are not as high as those found in the present study or compared with those of Naidoo, but poor language ability was still significantly poorer (at the 1% level) than in the control subjects.

A comparison of the language difficulties in the backward readers and their perceptual and motor problems (Table 5:2) indicates that language ability was significantly related to auditory discrimination and auditory memory, suggesting that if a child has difficulties in auditory perceptual ability these difficulties will be expressed in his poor language performance. Language difficulty was also associated with poor motor performance, poor psychomotor behaviour and motor inperseistence which suggests a possible link between neurological impairment as measured by these tests and poor language ability.

A review of the literature related to poor language and speech problems suggests a direct link between these abilities and reading performance. However, language did not correlate with either reading, spelling or word recognition in the study, suggesting that if language is an important factor in learning to read, then poor speech and or language, like poor perceptual and motor performance, are indirectly associated with reading.
Summary and Discussion

The investigation so far has indicated that many backward readers have perceptual, motor and language problems. The intercorrelation matrix of their scores shows that, though the perceptual motor and language variables are associated with one another, few variables clearly relate to reading and spelling as measured by the Schonell Tests or to intelligence as measured by the English Picture Vocabulary Test.

An examination of the difficulties experienced by each boy in the investigation shows that few boys have problems which are exclusively either visual, auditory or motor. Naturally, there are degrees of difficulty within each variable. There is a group of backward readers who have only mild perceptual motor problems or no problems at all as measured by the tests in the battery. Clearly the reading difficulties of this group cannot be specifically associated with problems of perception, motor clumsiness or speech difficulty. Perhaps their reading retardation may be explained by genetic, socio-economic, educational or emotional factors which were not apparent when the original selection was made. This group represented approximately one third of the backward readers examined.

Of the remaining two thirds - those with perceptual motor problems - half had difficulties in at least three of the test variables. Their score in one of these variables was at least two standard deviations below the norm for that age. The other half had less serious perceptual motor difficulties and were below their norm in two of the variables tested. (Table 8 Appendix).

It was difficult to isolate a group of boys with only visual, only auditory, only motor or only language difficulties. This suggests that the backward readers' problems may be in selecting or integrating the perceptual and motor inputs rather than in the actual process of receiving information.

Language problems did not occur in isolation with sufficient independence to be considered on their own but were experienced by four boys who had no perceptual or motor problems and by four others whose perceptual motor difficulties were only very mild. These eight subjects suggest the existence of a group of children, as recognised by other investigators, whose reading difficulties stem largely from language problems.
Factor analysis of the data obtained on all boys in the investigation suggests that the difficulties of some backward readers could be the result of neurological impairment. This hypothesis is supported by the association of scores on the Denier Visual Motor Gestalt Test, the test of visual spatial ability, the test of auditory visual integration, the Stott Test of Motor Impairment, the test of motor impersistence and the Gibson Spiral Maze Test of psychomotor behaviour on a factor with the largest amount of variance. The above tests have been extensively associated with neurological impairment, a term referred to by some researchers as "minimal brain damage" or "minimal brain disfunction" and defined by the author as

"a condition of neurological impairment which, though not sufficiently severe to cause clearly identifiable syndromes of cerebral palsy or mental retardation, is severe enough to cause perceptual and language difficulties, minor motor disfunctions, learning difficulties or abnormalities of behaviour".

This definition is based upon suggestions made at a conference of neurologists, paediatricians and psychologists held in 1962 (Box and MacKeith, 1963).

It is further suggested that this impairment accounts for the difficulties in selecting and integrating perceptual, motor and language inputs, which are experienced by some backward readers. These difficulties are related to their problems in reading and spelling, as both of these skills depend upon a high degree of differentiation and integration.

These conclusions lead to a deductive hypothesis linking reading difficulties in a causal relationship with developmental, behavioural and birth stresses and the investigation of this hypothesis will be discussed in the next chapter.
PART 2

Chapter 6

The relationship of prenatal and perinatal factors
to neurological impairment and reading backwardness

The Hypotheses
In the review of the literature relating neurological impairment and reading problems, the concept of minimal brain damage was discussed. In this condition there are no clear neurological signs of actual anatomical damage, but disturbances of perceptual ability and motor performance associated with distractibility and impulsive behaviour are apparent and these imply that anatomical damage may have occurred.

The relevance of minimal brain damage or neurological impairment is given strong support by the findings of Pasamanick and his co-workers, especially by Kawi and Pasamanick (1958, 1959) who have demonstrated a high incidence of prenatal complications in the history of children with reading difficulty.

The incidence of difficulties during pregnancy and birth resulting in possible neurological impairment have been observed by Knoblock and Pasamanick (1966), Strauss and Lehtinen (1947), Strauss and Kephart (1955) and Stott (1962, 1964) and pre and perinatal difficulties were observed in the histories of retarded readers by Busis (1947), James (1955), and Black (1973), but the best known studies are associated with the investigations of Pasamanick, Knoblock, Kawi and Lilienfeld and their co-workers (Pasamanick and Lilienfeld, 1955; Kawi and Pasamanick, 1958; Knoblock and Pasamanick (1966), who proposed the concept of "a continuum of reproductive causality" in which events during pregnancy and birth can produce effects extending in severity from foetal death through an ascending gradient of cerebral dysfunction manifested in cerebral palsy, epilepsy, mental retardation, to minor behaviour disorders including reading difficulty - depending on the degree or extent of the damage.

The various investigations of this group of investigators is discussed in detail because their work forms the basis of the author's own hypothesis and because, as Joffe (1969) comments, "it would be difficult to surpass the reliability of the data in a retrospective epidemiological study, such as the one with which it was collected and evaluated". (1)

Rogers, Pasamanick and Lilienfeld (1955) and Pasamanick, Rogers and Lilienfeld (1955) in a study of pregnancy disorders related to behaviour difficulties in children in Baltimore, found that those children with behaviour difficulties had experienced significantly more complications during gestation and at birth than their controls. The 1956 study excluded children with low I.Q.'s and similar findings were obtained in both studies in which these complications most related to behaviour difficulties were toxemia and high blood pressure though

mechanical difficulties such as forceps delivery, breech birth or cesarean section were not significant. There was also a significantly higher incidence of prematurity amongst the disturbed children, even when the complication of pregnancy in the mothers was excluded. The investigators concluded that there was a relationship between pre- and perinatal difficulties and the development of behaviour difficulties. The relationship was even higher for those children who were hyperactive and impulsive.

Stott (1959) assessed behaviour on the Bristol Social Adjustment guides in a group of retarded children, backward children from normal schools and a group of backward readers. He found that the behaviour variable of "unforthcomingness" was most related to stress on the developing foetus during pregnancy. Stott, however, did not use a control group for these investigations. Pederson and Bell (1970) obtained significant relationships between the high incidence of aggressive behaviour and minimal brain damage which they suggest results from complications during pregnancy and delivery. Elitzin, Perber and Cohen (1964) also obtained a relationship between behaviour problems and prematurity including children diagnosed as schizophrenic and neurologically impaired. Differences between the behaviour group and their controls were not significant, however, for complications during pregnancy or birth.

Lucas et al (1965) found that difficulties during pregnancy were related to poor motor coordination and feeding difficulties while birth difficulties correlated with poor performance on the Bender Visual Motor Gestalt Test. Lucas supports Pasamanick and Lilienfeld's view that toxemia and bleeding during pregnancy were more important etiologically than mechanical factors at delivery. They suggest that damage during pregnancy affects motor functions in a general way while problems at birth result in perceptual motor difficulties. Other researchers have reported the relationship between difficulties during pregnancy, perinatal difficulties, prematurity and low birth weight and poor motor ability, speech problems and visual perceptual problems, (Walton et al, 1962; Gubbay et al, 1957; Erenner et al 1967; Wright et al 1972; Black, 1973).

Kawi and Pasamanick (1959) studied two hundred and five boys aged between ten and fourteen years, of normal intelligence, who were experiencing severe reading difficulties. These retarded readers were matched for race, sex, and age with controls by selecting the next
recorded local birth. As far as possible the mother of the control boy was of similar age to the mother of the retarded reader. The incidence of perinatal complications such as breech, placenta praevia, and premature separation of the placenta, were significantly higher in the retarded readers. The prenatal difficulties such as pre-eclampsia and hypertension, the toxemias of pregnancy in the mother, and bleeding during pregnancy, were all significantly higher in the histories of the retarded readers. Prematurity was also significantly higher in the retarded readers group, but though the retarded readers had a higher incidence of neonatal complications, the difference was not significant. Abnormal delivery during birth was very similar for both groups. Differences in the behaviour of the retarded readers and their controls could not be examined as children with behavioural problems were excluded from the study.

Thus as stated, Kawi and Pasamanick concluded that their findings supported their general hypothesis that the difficulties during pregnancy and at birth cause neurological damage resulting in reading disorders. This neurological impairment is minimal relative to the gross damage which would manifest itself as cerebral palsy, mental deficiency or epilepsy.

Strauss and Kephart (1955) in their studies of children with cerebral dysfunction give a detailed analysis of these factors in pregnancy and at birth and detail various possible forms of cortical damage which may result from these stresses similar to those of Pasamanick and his co-workers and to those of Pederson and Bell.

Other possible causes of neurological impairment during gestation and birth have been suggested by Morris and Whiting (1971) and include virus infections of the mother such as rubella, rhesus factor, precipitate labour, pelvic deformities, climate and twin pregnancies.

Prechtl and Stemmer (1962) in their study of neurological impairment related to hyperkinesis in a group of children, many of whom were backward readers, noted choreiform movements, spatial difficulties, right left discrimination difficulties, clumsiness and restless uncontrolled behaviour. They attributed these difficulties to problems during pregnancy and during birth possibly as a result of anoxia or injury to the basal ganglia. Fifty per cent of the mothers of the hyperkinetic retarded readers had toxemia during pregnancy, 46% of the children had neonatal difficulties, 23% had asphyxia, 14% had sucking difficulties, 36% suffered accidents and concussion and 6% were born prematurely.
Caputo and Kandell (1970) related low birth weight to hyperkinesia, language and reading deficits, poor physical growth and poor motor performance. They suggest that poor maternal nutrition and inadequate prenatal care may have caused both low birth weight and the attendant minimal brain damage. Chase et al (1972) in an analysis of the brains of "light for dates" and premature babies found that the area most affected by interuterine underdevelopment was the cerebellum, a region of the central nervous system which coordinates motor activities.

The National Child Development Study has shown that birth weight in relation to the time of pregnancy is a sensitive indicator of perinatal risk and "light for dates" babies, including premature babies, are more prone to neurological impairment. Davie, Butler and Goldstein (1972) found that premature babies, as measured by length of gestation and by low birth weight, and "light for dates" babies were all likely to be backward at learning to read by between three and four months.

In mothers who smoked heavily and those with pre eclampsia (raised blood pressure) during pregnancy, the growth rate of the fetus slowed down much earlier and long before delivery was due, (Butler and Alberman, 1969; Butler, Goldstein and Ross, 1972), with the apparent result that the children of these mothers were also retarded in their reading by approximately four months. Professor Butler (private communication 1973) suggests that adverse pre-natal and perinatal factors had a cumulative effect, and it is a combination of these factors rather than a single incident which leads to neurological impairment.

In their book "From birth to seven", Davie et al (1972) also comment on the effect on parietal in the family and size of family and their effect, in turn, on reading backwardness.

Lyle (1970) used a multiple regression analysis to examine the relationship between pre-natal, perinatal and speech variables and perceptual motor and verbal factors in a group of retarded readers of normal intelligence aged between six and twelve years. He found that the incidence of neurological impairment related to perinatal factors was related to both perceptual motor and verbal difficulties in the retarded readers, but he considered that the relationship of reading retardation to pre and perinatal difficulties as suggested by Kawi and Pasamanick (1958) could only be partially substantiated. Lyle found that toxemia in pregnancy and complications in the uterus were insignificantly correlated with reading retardation and birth weight.
correlated only with the perceptual motor factor related to reading ability. The most significant of the birth variables was the variable termed "symptoms of possible brain injury at birth" which included cyanosis, pallor, jaundice and possible perinatal and postnatal asphyxia which was one of the least significant of Kazi and Pasamanick's variables. The most clear-cut relation with reading difficulty was shown by the three speech variables especially early speech defects. Lyle suggests that this result supports a hypothesis of a general lag in verbal learning which is reflected in reading retardation.

Three other more recent studies of backward readers have shown only a low relationship between pre-natal, perinatal factors and reading difficulty.  

Keidee (1972) found no differences in the frequency of perinatal conditions or abnormal histories between her dyslexics and control groups, but neonatal problems were more frequent among the dyslexic boys. Though mean birth weights did not differentiate the groups, all six boys in her sample who were premature by birth weight, were dyslexic. In the study of backward readers by Bell and Atman (1972) mean birth weight tended to be lower in the backward readers than controls but the differences were not significant.

Complications of pregnancy such as toxemia, high blood pressure, bleeding during pregnancy and rubella were no higher among mothers of reading retarded children than among those of the control children in Butter Tizard and Whitmore's study of Isle of Wight children (1970). However, low birth weight occurred twice as frequently in the retarded readers (11%) than in the control group (7.5%) although this difference fell just short of statistical significance.

Simpson (1957) was the first to show that birth weight was lower in mothers who smoked during pregnancy and Lowe (1959), Fraser et al (1961), Peterson et al (1965), Russell (1969) and Butler et al (1972) have all reported the high incidence of prematurity in mothers who smoke, though it was Butler (1970) who first indicated a relationship between smoking during pregnancy and reading backwardness independent of social class, age of mother and parity.

How smoking, prematurity, toxemia and high blood pressure and possible perinatal difficulties affect the child to cause a neurological impairment and subsequently leading to reading retardation is a matter of much conjecture. Unfortunately, there are no clearly established

In their hypothesis that anoxia produces brain damage, Corah et al (1965) quote various experiments on animals which demonstrate the effects of oxygen deprivation which paralleled observations on humans, including the experiments of Windle (1960, 1963). He demonstrated that a period of asphyxia will produce brain lesions without resulting in behaviour defects that could be measured.

Anoxia in children and its effect upon their neural status have been reported by Fraser and Wilks (1959), Preston (1945), Schachter and Appar (1959) and by Graham et al (1962) who examined the same children from birth to three years as did Corah et al (1965) who examined them at seven years. In this study Corah et al found that anoxics were significantly poorer in perceptual motor abilities and vocabulary ability as measured by the W.J.S.C. Significant differences were also found for distractability and impulsivity, but the authors did not consider these differences great enough to be of "clinically predictive significance". Accuracy and reading rate scores were also significantly lower in the post natal anoxics but the reading tests did not differentiate between the control group and the perinatal or prenatal anoxics. However, they noted that "there was a marked tendency in the sub group analyses for the anoxics to show impairment in the test of reading ability".

Two recent studies of oxygen deficiency have indicated a link between anoxia and neural impairment. Flick (1975) in a study of sickle cell anaemia in which erythrocytes are deficient in carrying oxygen found that the sickle cell children were poorer than controls on the draw-a-man test and Bender test of visual motor gestalt. They were also motor clumsy, suggesting neurological impairment. Hatoth et al (1971) found that children with chronic thrombocytopenia were significantly poorer than their controls on the Bender visual motor test and a third of the children were motor clumsy, hyperactive and had short attention spans.

Joffe considers that anoxia is more likely to be the result of various complications of pregnancy, particularly those associated with placental insufficiency. Pasmanick and his co-workers favour the idea that various difficulties during pregnancy are the cause of anoxic disorders resulting in later behavioural effects including reading backwardness, particularly the toxemias of pregnancy and placenta complications. To quote Joffe (1969) "in common with most epidemiological investigations, studies on this topic are usually able to do little more than demonstrate an association of variables - they cannot provide evidence of causal relationships".

---

The problem of establishing a clear causal relationship is interestingly demonstrated by Yerushalmy's experiments (1962, 1964) cited by Joffe (1969). The effect of smoking on foetal size is attributed to many intervening mechanisms. Fraser et al. (1961) suggested that smoking depresses the mother's appetite while Buncher (1969) considers that the effect of nicotine may cause vasoconstriction of the mother's placenta or that the high concentration of carbon monoxide in the cigarette smoke may be a factor. Longo (1970) and Yerushalmy (1964) suggested that the nicotine produced biochemical changes in the foetal nutrition. Underwood et al. (1965) and Scott-Russell (1969) found that smoking caused a reduction in maternal blood pressure masking other difficulties which tend to raise blood pressure. However, Yerushalmy cast doubt on many of these possible causes when he demonstrated that the father's cigarette smoking is related to the child's birth weight, and not only this, but that the rate of prematurity increases with the amount that the fathers in his sample smoked. This finding suggested that an offspring genotype rather than a prenatal difficulty was responsible. Nonetheless, weight attainment of the foetus during pregnancy is generally attributed to smoking by the mother rather than associated factors. (Smithells and Morgan, 1970).

To summarise, although an association between prenatal, perinatal and neonatal stress and neurological impairment does not prove a causality, a review of the literature strongly suggests that neurological impairment is the result of an insult to the central nervous system during pregnancy, at or just after, birth. Prenatal, perinatal and neonatal difficulties and prematurity have regularly been observed in the histories of children with reading difficulties.

On the basis of the investigation of perceptual motor and language factors in the present group of backward readers and from the strong implications of previous research, it is hypothesised that:

1. Subjects with poor perceptual, motor and language defects will have suffered a higher incidence of prenatal, perinatal and neonatal difficulties, particularly those difficulties associated with anoxia in this early stage of the child's development.
2. The backward readers with extremely poor perceptual and motor skills will have most difficulty in selecting and integrating the information necessary to reading and, as a result, will develop a mode of behaviour characterised by short attention span, distractibility, inability to concentrate, impulsiveness and restlessness. This, combined with frustration over their failure to read, will result in anti-social behaviour. As a result one would expect to find a much higher incidence of poor concentration, restlessness and anti-social behaviour in the more severely perceptual motor impaired backward readers than in

A. Backward readers with nil or only mild perceptual motor problems and
B. Normal readers of similar background, age and intelligence.

3. Those subjects with only mild or no perceptual motor defects will have a higher incidence of reading, spelling and speech difficulties within the family, suggesting that their reading difficulties may be of a genetic origin or that the family does not provide sufficient incentive to develop verbal proficiency.

A model can be constructed to illustrate the possible causative relationships between prenatal and perinatal difficulties, perceptual motor difficulties, reading and behaviour problems.

- Anti-social behaviour
- Poor concentration, impulsive restless behaviour
- Reading and spelling difficulties
- Perceptual motor problems, poor body concept and weak cerebral dominance
- Problems in the ability to select, integrate and coordinate information
- Neurological impairment as a result of difficulties during pregnancy and at birth
Chapter 7

The selection of sub-groups of the Backward Readers according to their degree of perceptual motor impairment and the selection of a control group of Normal Readers.

The Teacher and Parental questionnaires.
The backward readers' group were sub-divided according to the number and severity of their scores on the perceptual motor tests. The boys in sub-group 1 were the boys with a severe degree of perceptual motor difficulty in that they were poor in at least three perceptual motor tests. One or more scores were at least two standard deviations below their age norm. Thus, if one point is given for a score one standard deviation below an age norm and two points are given for a score two or more standard deviations below the age norm on a given test, the boys in this group had total scores of four or over.

Boys in sub-group 2 were poor in at least two perceptual motor tests and had a score of between two or three points. This group was considered to be moderately perceptually motor impaired. Boys with only one test score one standard deviation below the norm for their age or with all their scores up to their age norm, were given a score of 0 or 1. On the basis of this division, twenty-nine boys were placed in sub-group 1, twenty-three in sub-group 2, and thirty in sub-group 3.

In order to examine the relationship between all the boys with perceptual motor deficits and backward readers without these difficulties, a fourth sub-group was selected by combining sub-group 1 and sub-group 2. These perceptually motor impaired backward readers in sub-group 4 accounted for 63% (52 boys) of the total group of backward readers. The mean perceptual motor scores and standard deviations of all the groups are presented in table 7:1 together with their mean ages, I.Q.s and reading ages.
TABLE 7: I Sub-groups of the Backward Readers' group sub-divided according to their degree of perceptual motor difficulty

<table>
<thead>
<tr>
<th>Sub-group 1</th>
<th>Sub-group 2</th>
<th>Sub-group 3</th>
<th>Sub-group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronological age (months)</td>
<td>111.45</td>
<td>111.39</td>
<td>115.1</td>
</tr>
<tr>
<td>I.Q. (E.P.V.T.)</td>
<td>96.89</td>
<td>96.6</td>
<td>101.43</td>
</tr>
<tr>
<td>Reading age (months)</td>
<td>78.07*</td>
<td>79.69</td>
<td>85.1</td>
</tr>
<tr>
<td>Number of perceptual deficits</td>
<td>4.62 *</td>
<td>2.13 *</td>
<td>.554</td>
</tr>
<tr>
<td>Degree of perceptual motor impairment</td>
<td>6.0 *</td>
<td>2.57 *</td>
<td>.554</td>
</tr>
<tr>
<td>Number of subjects in group</td>
<td>29</td>
<td>23</td>
<td>30</td>
</tr>
</tbody>
</table>

two-tailed $F = 1.05$, d.f. = 57

* Difference from mild/non perceptual motor impaired group (Group 3) at the $P < .05$ level of significance.

$^*$ Difference from mild/non perceptual motor impaired group at the $P < .001$ level of significance.

A control group of eighty-two boys was then selected from the same classes as the backward readers to equate for curricula and teaching method. The boys in this group satisfied the same criteria for selection as the backward readers in that they were from middle class districts, from English speaking homes and none had a history of absenteeism or had changed schools more than once apart from the normal transfer from infants to junior school. No boy in the control group had a history of bad health, poor hearing, uncorrected visual defects or severe emotional difficulties as diagnosed by the educational psychologist or a medical practitioner. They were the same age and I.Q. as the backward readers but they were up to their age level or above on the Schonell test of reading ability. The chronological ages, I.Q.s, and reading ages of the control and backward readers' groups are compared in TABLE 7:2.
Comparison of the Backward Readers and Control Group
for mean age, I.Q., and Reading Age

<table>
<thead>
<tr>
<th>Backward Readers' Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronological age (months)</td>
<td>112.76 S.D. 12.1</td>
</tr>
<tr>
<td>I.Q. (EFVT)</td>
<td>99.84 S.D. 8.2</td>
</tr>
<tr>
<td>Reading age (months)</td>
<td>81.11 S.D. 11.6</td>
</tr>
</tbody>
</table>

Two-tailed $F = 1.50$, d.f. = 126, $^\dagger$ difference between means at the $P < 0.001$ level of significance.

Procedure

To examine the hypotheses a detailed questionnaire (see Appendix B) was given to the parents of all the subjects. It asked for information on prenatal, perinatal, neonatal and postnatal factors, of their son’s motor and speech development and any motor or language difficulties. The questionnaire was devised with the help of Dr. Vigfield, the Assistant Medical Officer of Health for Eastbourne. Every question was asked even if the parents, particularly the mothers, thought that certain questions did not apply. The mothers, who were unaware of the exact purpose of the questionnaire, were encouraged to give further details to any positive responses.

The main criticism of detailed questionnaires that request retrospective information have been clearly delineated by Illingworth (1963) (cited by Joffé 1969) who noted firstly that the questionnaires are apt to give an exaggerated idea of the importance of perinatal factors and secondly, that the information obtained is likely to be inadequate as the events may have been forgotten or simply unknown. Haggard et al (1960) and Yarrow (1963) have noted the problems of accuracy of parental recall of events during pregnancy. In mitigation, as Kavi and Pasamanick (1958) and Igle (1970) point out, the under-reporting of data serves as a bias against the hypothesis being tested.

Though the information by parents of the older children was expected to be more liable to under-reporting, it was, in fact, no less detailed than that provided by parents of the younger children. Where possible, checks on the mother’s memory were made; in particular a direct check of the mother’s estimate of birth weight was made by reference to Health files. This information corresponded very closely with the
information from the mothers. Any slight inaccuracies by the mothers regarding birth weight was because they were asked to give the weight to the nearest half pound and therefore the mothers rounded their estimates. Where independent information was obtained regarding illness or developmental difficulties, it confirmed the parents’ answers. Indeed some mothers gave even more detail than was required or expected.

An assessment of behaviour was obtained with the assistance of the class teachers who completed the "Rutter Child Scale", Rutter (1967). As this questionnaire was developed in parallel with the questionnaire for completion by parents, this teacher questionnaire was given to the class teacher of each boy in the investigation (see Appendix C).

The questionnaire was developed by Dr. Rutter (1967, 1970) for the age range seven to thirteen years and has been used with children attending Haeviley Hospital, London, with Aberdeen school children, and with Rutter, Tizard and Whitmore's study of children on the Isle of Wight (1970). Clarke (1970) also used the teachers' behaviour scale in the study of school children in the County of Dumbarton, Scotland.

Rutter, Tizard and Whitmore reported a test-retest reliability of .74 and interrater reliability of .64 for the parental questionnaire and of .69 and .72 respectively for the teacher's questionnaire. In both questionnaires the parent or teacher is asked whether each item "certainly applies", "applies somewhat" or "doesn't apply". These answers are scored as 2, 1 or 0 respectively and a total behaviour score is obtained for each child.

A cut-off score of 13 on the parental questionnaire and of 9 on the teacher questionnaire is designated as showing some behaviour disorder. For children with these or even higher scores, a comparison is also made between scores on the neurotic and the anti-social items of each questionnaire. Children with a neurotic subscore exceeding the anti-social subscore are designated "neurotic" and those with an anti-social subscore exceeding their neurotic score are designated "anti-social". Children with equal neurotic and anti-social subscores remain "undifferentiated". Rutter et al (1970) in discussion of the validity of their behavioural questionnaire noted that, when compared with the results of the psychiatric interviews, the findings of their Isle of Wight study "indicate that when teacher questionnaires and parent questionnaires are used in combination they provide a very efficient screening procedure provided they have been carefully piloted and the correct cut off points have been used". (1)

To obtain an estimate of each boy's uncontrolled hyperactive behaviour his scores on those behaviour problems referring to restlessness, squirming fidgety behaviour and inability to concentrate were summed. Using the same scoring method of 2 for "certainly applies" and 1 for "applies somewhat" a score of five or six out of a possible six was considered as indicative of uncontrolled hyperactive behaviour.

The parents were also asked if they or the grandparents or any close relatives had experienced difficulty in learning to read, to spell, or had experienced a speech or language problem.

Of the one hundred and sixty contacted, parents of one hundred and twenty four boys replied. Of these, eighty-two boys were matched with the eighty-two boys in the backward readers' group using the criteria discussed at the beginning of this chapter. All the parents of these boys answered questions on prenatal, birth, familial and behaviour factors. However, not all the parents of the backward readers were prepared to answer my questions, even when it was explained that the information received would remain confidential. Parents of 71 backward readers gave information when requested which represents nearly 67% of the total group. This data was available for 26 of the 29 boys in sub-group 1, 21 of the 23 boys in sub-group 2, 24 of the 30 boys in sub-group 3, and 47 of the 52 boys in sub-group 4 (sub-groups 1 and 2 combined).

The technique of analysis of variance was used in the comparison of mean scores and where the data are categorized the Chi-square test was employed. In addition Fisher's exact test was applied when there were fewer than twenty one cases and Yates corrected Chi-square was used for all other 2 x 2 tables. Only p values less than 0.05 were regarded as significant.
Chapter 8

The prenatal, perinatal, neonatal and postnatal histories of the Backward Readers and their controls
In the review of the literature in Chapter 6, which discussed complications during pregnancy and at birth, it was noted that these problems were frequently found in the medical histories of retarded readers. However, not all those investigators referred to found evidence to support this relationship. The results of the present study lend support to both points of view, as I shall explain in the following chapter.

As indicated in Table 8:1 there was a higher incidence of abnormal pregnancy, shorter gestation period, late birth, abnormal delivery, neonatal difficulties, postnatal difficulties and mothers who smoked heavily in the backward readers' group than in the control group. However, the only significant difference between the two groups was in low birth weight. Only one boy in the control group compared with ten boys in the backward readers' group had a birth weight of 5\(\frac{1}{2}\)lbs. (2500 grams) or less. Kami and Pasamanick (1959) also found significantly lower birth weights in their retarded readers.

**Chi Square = 7.61, 1 d.f., P < .01**

Thus, with the exception of low birth weight, the results appear similar to those between the controls and retarded readers in the Isle of Wight survey, Rutter et al (1970). In this survey the low birth weight for reading retarded children was twice that for the controls but the difference just fell short of statistical significance.
Naidoo (1972) also found a higher incidence of abnormal pregnancy, abnormal delivery, low birth weight and some perinatal difficulties among her dyslexics as compared with normal readers but, apart from the number of mothers who reported illness during pregnancy, the differences were not significant. Similar results were obtained by Lyle (1970).

It would appear, therefore, that with the exception of low birth weight, the results do not confirm the view that prenatal, perinatal and neonatal factors are related to difficulty in reading. However, when the incidence of problems during pregnancy and birth of the backward readers who have various degrees of perceptual and motor difficulty are compared with those of the control group, the contrast between the groups becomes more marked. (Table 8:2).
<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Subgroups of Backward Readers</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>impaired</td>
<td>impaired</td>
<td>motor impairment</td>
<td>subjects with percep.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>motor difficulties</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low birth weight (5 lbs. or less)</td>
<td>1.2</td>
<td>26.9 *</td>
<td>9.5</td>
<td>4.2</td>
<td>19.2 *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premature birth (38 weeks or less)</td>
<td>13.6</td>
<td>34.6 *</td>
<td>14.3</td>
<td>12.5</td>
<td>25.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Premature birth (37 weeks or less)</td>
<td>2.5</td>
<td>15.3 *</td>
<td>14.3</td>
<td>4.2</td>
<td>14.9 *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late birth</td>
<td>18.5</td>
<td>19.2</td>
<td>14.3</td>
<td>2.5</td>
<td>17.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxaemia of pregnancy</td>
<td>2.5</td>
<td>26.9 *</td>
<td>4.8</td>
<td>8.3</td>
<td>17.0 **</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal delivery</td>
<td>14.8</td>
<td>34.6</td>
<td>38.1 *</td>
<td>8.3</td>
<td>36.2 *</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neonatal difficulties</td>
<td>19.5</td>
<td>30.7</td>
<td>28.6</td>
<td>2.5</td>
<td>29.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postnatal difficulties</td>
<td>11.0</td>
<td>15.3</td>
<td>19.1</td>
<td>8.3</td>
<td>17.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother smoked 10 cigarettes a day or more</td>
<td>23.2</td>
<td>30.7</td>
<td>33.3</td>
<td>29.2</td>
<td>31.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
<td>26</td>
<td>21</td>
<td>24</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Chi Square = 4.43
* Chi Square = 4.00
# Chi Square = 4.70
* Chi Square = 4.35
# Chi Square = 6.57

** Chi Square = 6.84, 1 d.f., P < .01
† Chi Square = 15.45
‡ Chi Square = 11.04, 1 d.f., P < .001
‡ Chi Square = 12.27
Prematurity and Low Birth Weight

As stated, the incidence of low birth weight (5½ lbs. or less) was significantly higher in the backward readers than the control group (Table 8:3) and substantiates a similar finding by Kandi and Pasmanick (1958) and by Davie et al (1972).

Table 8:3 Birth Weight in the Backward Readers and Control Group of Normal Readers

<table>
<thead>
<tr>
<th>Birth Weight</th>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5½ lbs.</td>
<td>0</td>
<td>1.4</td>
</tr>
<tr>
<td>Between 5½ lbs. and 7 lbs.</td>
<td>0</td>
<td>2.3</td>
</tr>
<tr>
<td>Between 7 lbs. and 9 lbs.</td>
<td>1.2</td>
<td>9.9</td>
</tr>
<tr>
<td>Between 9 lbs. and 11 lbs.</td>
<td>12.2</td>
<td>14.1</td>
</tr>
<tr>
<td>Between 11 lbs. and 13 lbs.</td>
<td>42.7</td>
<td>37.0</td>
</tr>
<tr>
<td>Over 13 lbs.</td>
<td>44.0</td>
<td>35.2</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
<td>71</td>
</tr>
<tr>
<td>Number of children with low birth weight (below 5½ lbs)</td>
<td>1.2%</td>
<td>14.1% **</td>
</tr>
</tbody>
</table>

** Chi Square = 7.61, 1 d.f., P < 0.01

Prematurity and low birth weight are highly related. Indeed, some researchers use low birth weight 5½ lbs. or below, as an indicator of prematurity. However, as Davie et al (1972) have shown, this is not necessarily the case. They describe a group of children as "light for dates" who may be only slightly premature or even born at full term but who are 5½ lbs. or less in weight.

In the present study 11 (13.5%) of the boys in the control group were born at thirty-eight weeks or less and of those 2 (2.5%) were three weeks early. In the backward readers' group 15 (21.3%) were born thirty-eight or less and 8 (11.3%) were three weeks premature (Table 8:4). Thus there were four times more boys born at thirty-seven weeks or less among the backward readers than in the control group, but the difference just fell short of the 5% level of significance. In the Isle of Wight Survey Rutter et al found that 15.9% of their retarded readers and 9.8% of the control group were born three weeks early.
TABLE 8:5. Gestation Periods of Boys in the Backward Readers* and Control Groups

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Child born at full time</td>
<td>32.1</td>
<td>46.5</td>
</tr>
<tr>
<td>one week early</td>
<td>13.6</td>
<td>4.2</td>
</tr>
<tr>
<td>two weeks early</td>
<td>11.1</td>
<td>9.9</td>
</tr>
<tr>
<td>three or more weeks early</td>
<td>2.5</td>
<td>11.3</td>
</tr>
<tr>
<td>one week late</td>
<td>21.0</td>
<td>8.5</td>
</tr>
<tr>
<td>two weeks late</td>
<td>16.1</td>
<td>14.1</td>
</tr>
<tr>
<td>three or more weeks late</td>
<td>2.5</td>
<td>5.6</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>61</td>
<td>71</td>
</tr>
<tr>
<td>Premature birth (38 weeks or less)</td>
<td>13.6%</td>
<td>21.1%</td>
</tr>
<tr>
<td>Chi Square = 1.03, 1 d.f. (not significant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late birth (42 weeks or more)</td>
<td>18.5%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Chi Square = .0003, 1 d.f. (not significant)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When the premature births between the subgroups of backward readers are compared with those of the control group (Table 8:5) the percentage number of three week premature births in the children with perceptual motor difficulties (group 4) is 14.9% and in the severely perceptual motor impaired subjects (group 1) the percentage is 15.3% compared with 2.5% in the control group (both significant at the 5% level).

Of the ten (12.5%) boys with a birth weight of 5.1 lbs. or less in the total group of backward readers, nine boys had perceptual motor difficulties and seven (27%) of these were in the severely perceptual motor impaired group, a difference from the control group at the 0.1% level of significance. (Table 8:6).
### Table 8:5 Gestation Period of Boys in the Subgroups of Backward Readers and the Control Group

<table>
<thead>
<tr>
<th>Child born</th>
<th>Control Group</th>
<th>Backward Readers Subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>at full time (40 weeks)</td>
<td>32.1</td>
<td>34.6 52.4 54.2 42.6</td>
</tr>
<tr>
<td>one week early</td>
<td>13.6</td>
<td>0 9.5 4.2 4.3</td>
</tr>
<tr>
<td>two weeks early</td>
<td>11.1</td>
<td>19.2 0 8.3 10.6</td>
</tr>
<tr>
<td>three or more weeks early</td>
<td>2.5</td>
<td>15.5* 14.3 4.2 14.9*</td>
</tr>
<tr>
<td>one week late</td>
<td>21.0</td>
<td>11.5 9.5 4.2 10.6</td>
</tr>
<tr>
<td>two weeks late</td>
<td>16.1</td>
<td>11.5 4.8 25.0 8.5</td>
</tr>
<tr>
<td>three or more weeks late</td>
<td>2.5</td>
<td>7.7 9.5 0 8.5</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>81</td>
<td>26 21 24 47</td>
</tr>
<tr>
<td>Premature birth (33 weeks or less)</td>
<td>13.5%</td>
<td>34.6% 14.3% 12.5% 25.5%</td>
</tr>
<tr>
<td>Late birth (42 weeks or more)</td>
<td>15.5%</td>
<td>19.2% 14.3% 25% 17%</td>
</tr>
</tbody>
</table>

* Chi Square = 4.00
* Chi Square = 4.73 1 d.f., P < .05
* Chi Square = 4.45

### Table 8:6 Birth Weight in the Subgroups of Backward Readers and the Control Group

<table>
<thead>
<tr>
<th>Birth Weight</th>
<th>Control Group</th>
<th>Backward Readers Subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 lbs. 8 ozs.</td>
<td>0</td>
<td>3.8 0 0 2.1</td>
</tr>
<tr>
<td>3 lbs. 9 ozs. and 4 lbs. 8 ozs.</td>
<td>0</td>
<td>7.7 0 0 4.3</td>
</tr>
<tr>
<td>4 lbs. 9 ozs. and 5 lbs. 8 ozs.</td>
<td>1.2</td>
<td>15.3 9.5 4.2 12.8</td>
</tr>
<tr>
<td>5 lbs. 9 ozs. and 6 lbs. 8 ozs.</td>
<td>12.2</td>
<td>11.5 23.8 8.3 17.0</td>
</tr>
<tr>
<td>6 lbs. 9 ozs. and 6 lbs. 8 ozs.</td>
<td>4.2%</td>
<td>26.9 33.1 45.8 31.9</td>
</tr>
<tr>
<td>Over 7 lbs. 8 ozs.</td>
<td>4.0%</td>
<td>34.6 28.6 41.7 31.9</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
<td>26 21 24 47</td>
</tr>
<tr>
<td>Number of children with</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low birth weight (below 5 lbs.)</td>
<td>1.2%</td>
<td>26.9% 9.5% 4.2% 19.2%</td>
</tr>
</tbody>
</table>

* Chi Square = 15.45
* Chi Square = 11.04 1 d.f., P < .001
From the birth weight and gestational age the number of children who were "small for dates" was calculated in which a child born after 38 weeks is 5 1/2 lbs. or less. The only boy below 5 1/2 lbs. in the control group was also born three weeks premature so he did not qualify as "small for dates." In the Backward Readers' group five boys were "small for dates", four in the severely perceptual motor impaired group and one in the non or very mildly impaired group. The same percentage (6.1%) of "small for dates" boys was found in Futter et al's (1970) retarded readers.

The higher incidence of low birth weight and prematurity, especially amongst the backward readers with perceptual motor difficulties, supports other similar findings De Hirsch et al (1966) that these factors are related to reading backwardness. It also suggests that important factors in the etiology of perceptual and motor difficulties are prematurity and low birth weight; a view supported by the findings of De Hirsch et al (1966), Caputo and Randell (1970) and by Wright et al (1972). In a large scale study of five thousand deliveries, Cole (1959) concluded that prematurity and low birth weight were the cause of asphyxia. If one accepts this view my findings support my first hypothesis that those backward readers with poor perceptual motor language deficits will have suffered a higher incidence of prenatal difficulties, particularly those associated with anoxia.

The number of boys who were born after forty-two weeks or more was very similar in both the control and backward readers group (Table 8:4).

Abnormal Pregnancy

Although there was no significant difference between the total number of abnormal pregnancies in the group of backward readers and the control group, the percentage number of mothers who had toxaemia during pregnancy in the backward readers' group was nearly six times that of the mothers in the control group (Table 8:7), a difference significant at the 2% level.

The mothers of two subjects in the control group and seven in the backward readers' group had both toxaemia and high blood pressure. Both these conditions are considered by Kawi and Pasamanick (1959) and Lucas et al (1965) to be associated with anoxia in the foetus. The difference in toxaemia in the mothers of the control group and those of the severely perceptually impaired group was even higher at the .01% level of significance (Table 8:8) of the seven boys in this group, the mothers of five also had high blood pressure.
TABLE 8:7 The incidence of abnormal pregnancy in the Backward Readers' Group and the Control Group of Normal Readers

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxaemia</td>
<td>2.5</td>
<td>14.1 **</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>12.3</td>
<td>14.1</td>
</tr>
<tr>
<td>Rubella (German measles)</td>
<td>0</td>
<td>4.2</td>
</tr>
<tr>
<td>Bleeding before 7 months</td>
<td>3.7</td>
<td>0</td>
</tr>
<tr>
<td>Bleeding after 7 months</td>
<td>3.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Other complications</td>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Normal pregnancy</td>
<td>79</td>
<td>71.8</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>81</td>
<td>71</td>
</tr>
<tr>
<td>Subjects where mothers had abnormal pregnancy</td>
<td>21.6</td>
<td>28.2 %</td>
</tr>
</tbody>
</table>

** Chi Square = 5.51, 1 d.f., P < 0.02

The total number of difficulties is greater than the number of subjects because more than one difficulty was indicated in some subjects.

TABLE 8:8 The number of subjects in the subgroups of Backward Readers and Control Group with toxaemia, high blood pressure and abnormal pregnancy

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers' Subgroups 1 2 3 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxaemia</td>
<td>2.5</td>
<td>26.9 4.8 0.3 17 **</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>12.3</td>
<td>23.1 9.5 0.3 17</td>
</tr>
<tr>
<td>Abnormal pregnancy</td>
<td>21</td>
<td>4.2 23.8 16.7 32.6</td>
</tr>
</tbody>
</table>

/ Chi Square = 12.27, 1 d.f., P < 0.01

** Chi Square = 6.02, 1 d.f., P < 0.01

In their study of two hundred and five boys with reading retardation, Kami and Pasmanick found that toxaemia and high blood pressure together with bleeding during pregnancy were most associated with reading difficulty. Prechtl (1962) also found that 50% of the hyperkinetic children that he had studied, 50% of whom were retarded readers, had mothers who suffered from toxaemia. However, Lyle (1970) and Rutter et al (1970) found no relationship between maternal toxaemia and hypertension and difficulty in learning to read.
The total number of difficulties during pregnancy in the severely perceptually motor impaired subgroup was 11 (42.3%) compared with 17 (21.5%) in the control group which just failed to reach the 5% level of significance. (Table 8:3). This result is very similar to that of Kawi and Pasamanick (1958) who reported that 45.4% of their retarded readers had one or more maternal complications compared with 21.4% in their control group (significant at the 5% level).

Abnormal Delivery

Though there were nearly twice as many abnormal deliveries in the births of the backward readers, there was no significant difference between the control group and the backward readers' group as a whole. (Table 8:9). As in Kawi and Pasamanick's study (1958) forceps and dry deliveries accounted for most of the difficulties in both groups.

<table>
<thead>
<tr>
<th>Type of birth difficulty</th>
<th>Control Group</th>
<th>Backward Readers Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caesarian</td>
<td>0</td>
<td>2.8</td>
</tr>
<tr>
<td>Breech delivered</td>
<td>0</td>
<td>2.8</td>
</tr>
<tr>
<td>Forceps delivery</td>
<td>8.6</td>
<td>9.9</td>
</tr>
<tr>
<td>Dry delivery</td>
<td>3.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Precipitate birth</td>
<td>1.2</td>
<td>5.6</td>
</tr>
<tr>
<td>Other difficulties</td>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Normal delivery</td>
<td>85.2</td>
<td>75.2</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>61</td>
<td>71</td>
</tr>
<tr>
<td>Number of subjects with birth difficulty</td>
<td>14.8%</td>
<td>26.8%</td>
</tr>
</tbody>
</table>

Chi Square = 2.63, 1 d.f. (not significant).

When the incidences of abnormal delivery between the backward readers with or without perceptual and motor difficulties are examined, significant differences between the subgroups of backward readers and the control group are present. (Table 8:10). The number of abnormal deliveries between the total group of perceptual motor impaired backward readers (group 4) and the control group and between the moderately perceptual motor impaired group (group 2) and the control group were significantly higher. The frequency of abnormal deliveries in the severely perceptually motor impaired group and the control group just fell short of significance at the 5% level.
TABLE 6:10 Complications during birth between the subjects in the subgroups of Backward Readers and the control group

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers Subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>1</td>
</tr>
<tr>
<td>Number of subjects with birth difficulties</td>
<td>14.8</td>
<td>34.6</td>
</tr>
</tbody>
</table>

* Chi Square = 4.85, 1 d.f. P < .05

** Chi Square = 6.57, 1 d.f. P < .02

These results support the hypothesis that backward readers with perceptual motor difficulties are more likely to have had difficulties during birth. However, because of the greater incidence of toxemia, especially toxemia combined with high blood pressure in the severely perceptual motor impaired backward readers, the present evidence supports the view of Pasamanick and Lilienfeld (1955) and of Kori and Pasamanick (1953, 1959) that the combined factors of toxemia and high blood pressure during pregnancy are more important etiologically than mechanical factors of delivery. This view is supported by Lucas (1965) and by Davie, Butler and Goldstein (1972) who found that obstetric complications, while carrying a high risk of perinatal mortality, do not seem to be generally linked to adverse development in surviving children. In the Isle of Wight study Rutter et al (1970) found a greater incidence of abnormal delivery in their control group (20.4%) than in their retarded readers (12.2%), a finding which contradicts the present results and those of the researchers quoted above.

Difficulties in the first four weeks

There was a higher but not significant percentage of boys in the backward readers' group with neonatal difficulties. Persistent crying and jaundice accounted for most of the problems in both the backward readers and the control group. (Table 6:11). Only one boy (control group) had convulsions. Asphyxia was reported for five boys in the backward readers' group, four of whom were home confinements. There were no significant differences between the perceptual motor impaired backward readers and the control group on any of the neonatal difficulties.

Rutter, Fizard and Whitmore (1970), Kaidoo (1972) and Kori and Pasamanick (1953, 1959), all found few or no incidences of convulsions or abnormally high temperatures in their backward readers, though both Kori and Pasamanick (1953, 1959) and Kaidoo (1972) reported a higher incidence of jaundice in their backward readers.
### TABLE 8:11 Difficulties in the first four weeks of life

<table>
<thead>
<tr>
<th>Difficulty in sucking</th>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jaundice</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Convulsions</td>
<td>1.2</td>
<td>0</td>
</tr>
<tr>
<td>Abnormally high temperature</td>
<td>0</td>
<td>1.4</td>
</tr>
<tr>
<td>Persistent crying</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>White asphyxia</td>
<td>0</td>
<td>4.2</td>
</tr>
<tr>
<td>Blue asphyxia</td>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>No difficulties</td>
<td>79.3</td>
<td>71.3</td>
</tr>
</tbody>
</table>

Total number of reports: 82

Number of subjects with neonatal difficulties: 19.5

Chi Square = 1.14, 1 d.f. (not significant)

The total number of difficulties is greater than the number of subjects because more than one difficulty was indicated in some subjects.

The results of the difficulties in the first four weeks replicate the results of similar investigations, none of which revealed significant relationships between these difficulties and difficulty in learning to read.

#### Postnatal difficulties

Table 8:12 indicates the percentage number of illnesses and injuries during the pre-school and junior school period of both groups. No children in either group had meningitis, encephalitis, poliomyelitis or epilepsy. Measles and headaches were commonly reported in both groups. In retrospect it would have been more useful to have asked the mothers whether these two common illnesses had been associated with other complications such as fever or very high body temperature. As they were so common, measles or headaches were not included as one of the postnatal difficulties.

The distribution of postnatal difficulties is very similar in the backward readers and the control group. These findings do not support those of Prochtl (1962) who found that 38% of his hyperkinetic children, most of whom were backward readers, had a history of accidents and concussion and that 60% had a history of postnatal illness.
### TABLE 8:12 Postnatal History of Illness/Injury

<table>
<thead>
<tr>
<th>Condition</th>
<th>Control Group %</th>
<th>Backward Readers' Group %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poliomyelitis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Jaundice after first 4 weeks</td>
<td>4.9</td>
<td>4.2</td>
</tr>
<tr>
<td>Headaches</td>
<td>20.7</td>
<td>19.7</td>
</tr>
<tr>
<td>Painting spells</td>
<td>0</td>
<td>2.8</td>
</tr>
<tr>
<td>Meningitis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Encephalitis</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rickets</td>
<td>64.6</td>
<td>57.7</td>
</tr>
<tr>
<td>Convulsions after first 4 weeks</td>
<td>2.4</td>
<td>4.2</td>
</tr>
<tr>
<td>Head injuries</td>
<td>4.9</td>
<td>5.6</td>
</tr>
<tr>
<td>Unconscious for less than 10 mins</td>
<td>3.7</td>
<td>2.8</td>
</tr>
<tr>
<td>Unconscious for 10 mins or more</td>
<td>1.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
<td>71</td>
</tr>
<tr>
<td>Number of subjects with postnatal difficulties</td>
<td>10.9%</td>
<td>14.1%</td>
</tr>
</tbody>
</table>

Chi Square = 0.11, 1 d.f. (not significant).

The total number of difficulties is greater than the number of subjects because more than one difficulty was indicated in some subjects.

### Smoking during Pregnancy

Though a greater percentage of mothers of boys in the backward readers' group were heavy smokers, the differences between the control group and backward readers were not significant (Table 8:13).

### TABLE 8:13 Smoking during Pregnancy

<table>
<thead>
<tr>
<th>Mother smoked</th>
<th>Control Group %</th>
<th>Backward Readers' Group %</th>
</tr>
</thead>
<tbody>
<tr>
<td>very occasionally</td>
<td>14.6</td>
<td>14.1</td>
</tr>
<tr>
<td>5 cigarettes a day</td>
<td>3.7</td>
<td>8.5</td>
</tr>
<tr>
<td>10 cigarettes a day</td>
<td>11.0</td>
<td>11.3</td>
</tr>
<tr>
<td>20 cigarettes a day</td>
<td>9.8</td>
<td>18.3</td>
</tr>
<tr>
<td>over 20 a day</td>
<td>2.4</td>
<td>1.4</td>
</tr>
<tr>
<td>did not smoke</td>
<td>58.3</td>
<td>49.3</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
<td>71</td>
</tr>
<tr>
<td>Heavy smokers (10 cigarettes a day or over)</td>
<td>23.2%</td>
<td>31.5%</td>
</tr>
</tbody>
</table>

Chi Square = 0.32, 1 d.f. (not significant).
No significant differences were found between the mothers who were heavy smokers in the subgroups of the backward readers and the control group (Table 8:14). Twice as many mothers of those boys with perceptual motor difficulties smoked twenty cigarettes per day or over as compared with mothers of boys in the control group. However, the numbers failed to reach the 5% level of significance.

### Table 8:14

Heavy smoking during pregnancy of mothers of subjects in the subgroups of backward readers and of mothers in the control group.

<table>
<thead>
<tr>
<th>Mothers smoked</th>
<th>Control group</th>
<th>Backward Readers' Subgroups 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 cigarettes/day or over</td>
<td>23.2</td>
<td>30.7</td>
<td>33.5</td>
<td>29.2</td>
<td>31.9</td>
</tr>
<tr>
<td>20 cigarettes/day or over</td>
<td>12.2</td>
<td>19.2</td>
<td>22.6</td>
<td>12.4</td>
<td>25.4</td>
</tr>
</tbody>
</table>

Chi Square = 1.99, 1 d.f. (not significant)

**Combined Prenatal, Perinatal and Postnatal Difficulties**

Though the prenatal, perinatal, neonatal, and postnatal difficulties have been discussed separately, they do not occur in isolation. For example, many mothers who smoked heavily also had abnormal pregnancy, abnormal delivery and neonatal difficulties. Seven of the babies of mothers who smoked heavily were born prematurely. It was therefore decided to re-examine the findings by combining each subject's prenatal and birth difficulties.

Each subject was given one point for each of the following difficulties:
- if he had been born prematurely,
- had low birth weight,
- neonatal difficulties or
- postnatal difficulties.

One point each was also given if his mother had had an abnormal pregnancy, difficulties during delivery, or if she was a heavy smoker during her pregnancy.

An analysis of variance was made to examine for significant differences between mean scores of the control subjects and the backward readers' group and between the control group and the four subgroups of backward readers (Table 8:15).

Thus, as the table indicates, the backward readers as a whole have more combined prenatal and birth difficulties than their control group, a difference significant at the 1% level. The difference in the incidence of difficulties between the control group and the perceptual motor impaired backward readers is even higher at the 0.1% level of significance.
These findings support Dr. Butler's view (private communication, 1973) that a combination of factors rather than individual factors of prenatal and perinatal difficulty are most likely to cause neurological impairment.

### TABLE 8.15  $t$ test scores of combined prenatal, perinatal, and postnatal difficulties.

<table>
<thead>
<tr>
<th></th>
<th>Mean score</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>Value of $t$</th>
<th>2 tail probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Control Group</td>
<td>1.23</td>
<td>.512</td>
<td>.058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Backward Readers' Group</td>
<td>1.89</td>
<td>.539</td>
<td>.224</td>
<td>2.82</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>A. Control Group</td>
<td>1.23</td>
<td>.512</td>
<td>.058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Severely perceptual motor impaired group (subgroup 1)</td>
<td>2.32</td>
<td>1.72</td>
<td>.333</td>
<td>3.36</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>A. Control Group</td>
<td>1.23</td>
<td>.512</td>
<td>.058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Moderately perceptual motor impaired group (subgroup 2)</td>
<td>1.90</td>
<td>1.60</td>
<td>.550</td>
<td>1.90</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>A. Control Group</td>
<td>1.23</td>
<td>.512</td>
<td>.058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Non or mildly perceptual motor impaired group (subgroup 3)</td>
<td>1.32</td>
<td>1.21</td>
<td>.243</td>
<td>0.43</td>
<td></td>
</tr>
<tr>
<td>A. Control Group</td>
<td>1.23</td>
<td>.512</td>
<td>.058</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. All backward readers with perceptual motor difficulties (subgroup 4)</td>
<td>2.17</td>
<td>1.69</td>
<td>.246</td>
<td>3.71</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

**Summary**

When the backward readers who had perceptual motor difficulties are compared with normal readers, their significantly greater incidence of difficulties during pregnancy and at birth, especially those difficulties related to anoxia (low birth weight and toxemia of pregnancy) gives support to the first hypothesis. This suggests that backward readers with perceptual motor problems are most likely to suffer neurological impairment as a result of difficulties during pregnancy and at birth. It is further suggested that this impairment causes difficulties in the
child's ability to select, integrate and coordinate information resulting in perceptual motor and reading difficulties, all of which require the ability to discriminate and integrate incoming sensory information.
Chapter 9

Developmental Milestones

Delays in Walking and Speech.

Parental reports of Clumsiness and Language difficulty.
Many of the investigators whose studies were reviewed in Chapter 3 noted a history of poor language development, delayed speech and motor development, and motor clumsiness in their backward readers. As explained in the introduction to this thesis, the author observed that motor clumsiness and poor articulation were associated with reading difficulty. Indeed these observations were among those factors which lead to the present investigation. Did their problems develop at an early age even before the child began to read? What factors contribute to these difficulties? Did they arise as a result of, or in association with, the child's early attempts at reading?

In an attempt to answer these questions, information on developmental milestones was obtained from the parental questionnaire. To confirm the relationship of language difficulty with reading backwardness in my group of backward readers, the parents were also asked questions relating to speech problems in their children. In particular, they were asked to comment upon the child's clarity of speech, possible speech defects and articulation problems.

**Developmental Milestones - Parental Report**

Because of reports of the inaccuracies in parents' memory of early developmental milestones, (Donoghue and Shakespeare, 1967; Yarrow et al 1964), only long delays in walking and speaking were considered to be sufficiently reliable for inclusion. As Rutter et al (1970) noted in their study of the Isle of Wight children, the more extreme delays in development are likely to be remembered with greater accuracy.

**Delayed Walking**

As Table 9:1 indicates, five boys in the backward readers' group (7.5%) were stated by their parents not to have walked with help until between twenty-two to twenty-four months. In contrast, no parent of boys in the control group reported a delay in walking with help at this late stage. Four parents in the control group and a further three parents in the backward readers' group said that their sons did not learn to walk with help until eighteen to twenty-one months. Thus, the number of children in the backward readers' group with a delay in walking with help was eight (11.2%) compared with four (5%) in the control group, a difference which just fell short of significance at the 5% level.
**Table 9.1** Motor Development - Parental Report: Walking with help

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walked with help by 12 months</td>
<td>71.3%</td>
<td>54.9%</td>
</tr>
<tr>
<td>13 - 17 months</td>
<td>23.8%</td>
<td>33.6%</td>
</tr>
<tr>
<td>18 - 21 months</td>
<td>5%</td>
<td>4.2%</td>
</tr>
<tr>
<td>22 - 24 months</td>
<td>0%</td>
<td>7%</td>
</tr>
<tr>
<td>25 months or later</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>80</td>
<td>71</td>
</tr>
<tr>
<td>% number of subjects with a delay in walking with help</td>
<td>5%</td>
<td>11.3%</td>
</tr>
</tbody>
</table>

Chi Square = 1.25, 1 d.f. (not significant).

An examination of the incidence of delayed walking with help among the backward readers, subdivided according to their degree of perceptual motor impairment and in the control group (Table 9:2) indicates that there is a significantly greater number of boys with a delay in walking with help in the severely perceptual motor impaired backward readers. Of the eight delayed walkers six (25.1%) belonged to the severely perceptual motor impaired backward readers' group, a difference from the control at the 2% level of significance.

**Table 9.2** Motor Development of the subgroups of Backward Readers and the Control Group

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Subgroups of Backward Readers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walked with help by 12 months</td>
<td>71.3%</td>
<td>50 47.6 62.5 48.9</td>
</tr>
<tr>
<td>13 - 17 months</td>
<td>23.8%</td>
<td>26.9 42.9 33.5 34.0</td>
</tr>
<tr>
<td>18 - 21 months</td>
<td>5%</td>
<td>7.7 4.8 4.2 6.4</td>
</tr>
<tr>
<td>22 - 24 months</td>
<td>0%</td>
<td>15.4 4.3 0 10.6</td>
</tr>
<tr>
<td>25 months or later</td>
<td>0%</td>
<td>0 0 0 0</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>80</td>
<td>26 21 24 47</td>
</tr>
<tr>
<td>Number with delay in walking with help</td>
<td>5%</td>
<td>23.1% 9.5% 4.8% 17.8%</td>
</tr>
</tbody>
</table>

Chi Square = 5.54, 1 d.f., P 0.02

A similar finding occurred in the number of boys reported by their parents not to have walked without help until twenty-two months or later. (Tables 9:3 and 9:4).
TABLE 9:3  Motor Development - Walking without help - Parental report

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walked without help</td>
<td></td>
<td></td>
</tr>
<tr>
<td>by 12 months</td>
<td>33.7</td>
<td>21.4</td>
</tr>
<tr>
<td>13 - 17 months</td>
<td>48.8</td>
<td>57.1</td>
</tr>
<tr>
<td>18 - 21 months</td>
<td>8.75</td>
<td>11.4</td>
</tr>
<tr>
<td>22 - 24 months</td>
<td>3.75</td>
<td>8.6</td>
</tr>
<tr>
<td>25 months or later</td>
<td>0</td>
<td>1.43</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>80</td>
<td>70</td>
</tr>
</tbody>
</table>
% number with a delay in walking without help | 3.75% | 10.03% |

Chi Square = 1.88, 1 d.f. (not significant)

TABLE 9:4  Motor Development of the subgroups of Backward Readers and Control Group

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Subgroups of Backward Readers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walked without help</td>
<td></td>
<td></td>
</tr>
<tr>
<td>by 12 months</td>
<td>33.7</td>
<td>20</td>
</tr>
<tr>
<td>13 - 17 months</td>
<td>48.8</td>
<td>52</td>
</tr>
<tr>
<td>18 - 21 months</td>
<td>8.75</td>
<td>8</td>
</tr>
<tr>
<td>22 - 24 months</td>
<td>3.75</td>
<td>16</td>
</tr>
<tr>
<td>25 months or later</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>80</td>
<td>25</td>
</tr>
</tbody>
</table>
% with delay in walking    | 3.75%         | 20%                         |

* Chi Square = 5.53, 1 d.f., P < .02

Delayed Speech Development

Table 9:5 indicates that the incidence of delays in speaking the first words (other than mama, dada, hello, bye-bye), first using phrases and saying full sentences was greater in the backward readers than in the control group, but these differences were not significant.

Approximately 11% of the backward readers were considered by their parents to have delayed speech compared with 4% in the control group. These results, though similar to those of the specifically retarded readers and their controls in the Isle of Wight study (Rutter et al 1970), are much lower than the incidence of speech delay in Naidoo's dyslexic group (Naidoo 1972). Approximately a third of her backward readers were delayed in their development of speech, compared with approximately a tenth of the boys in her control group.
Belayed Speech Development

Control Group | Backward Readers' Group
--- | ---
Delay in using single words until 18 months or later | 2.6 | 9.9
Delay in using short sentences or phrases of 3-4 words until 25 months or later | 4.0 | 11.3
Delay in using sentences of several words until 31 months or later | 4.0 | 11.3
Total number of reports | 76 | 71

Chi Square = 1.83, 1 d.f. (not significant)

An examination of the speech delay in the subgroups of backward readers (Table 9:6) indicates that five boys (20.8%) in the non or mildly perceptual motor impaired subgroup (group 3) had delayed speech, which is approximately five times more boys than in the control group and two to five times more boys than the other subgroups of backward readers. As the numbers are so small, this finding can lend support only to (a) Ingram's (1960) view that some specifically retarded readers have a basic disturbance in language development and (b) the view of other investigators, (Ingram, 1963; Mason, 1967; Rutter et al, 1970; Naidoo, 1972) that children with early language problems may, as a consequence, grow up to become retarded readers.

Rutter et al (1970) suggest that in some cases reading retardation may "be merely one manifestation of a developmental language disorder". Six of the eight backward readers in the present study with a delay in the acquisition of language also had either unclear speech, poor articulation or both. This supports the view that the reading difficulty of some backward readers may be the result of a developmental language disorder.

The incidence of boys in the backward readers' group with delayed speech development and mixed laterality was no higher than the incidence of mixed laterality in the whole of the backward readers' group. This result contrasts with the finding of Naidoo (1961) and Zangwill (1960) who obtained a close relationship between delayed speech and mixed laterality in their investigations.

As Table 9.7 shows, the parents of subjects in both the backward readers and the control group were asked if they considered that their sons were very clumsy, slightly clumsy or not clumsy. Over one-third of both the control group and backward readers were considered by their parents to be clumsy children. Twice as many parents of backward readers as normal readers considered their son to be a very clumsy child and, as expected, most of these boys belonged to the severely perceptual motor impaired group (Table 9.8). Of the backward readers in this group, just under 20% were considered very clumsy by their parents compared with 3.7% in the control group, a difference significant at the 5% level.

Table 9.7 Degree of Clumsiness - Parental Report

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very clumsy child</td>
<td>3.7</td>
<td>9.2</td>
</tr>
<tr>
<td>Slightly clumsy child</td>
<td>30.5</td>
<td>26.3</td>
</tr>
<tr>
<td>Child not clumsy</td>
<td>65.9</td>
<td>63.4</td>
</tr>
<tr>
<td>Number of clumsy children</td>
<td>36.1%</td>
<td>36.6%</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
<td>71</td>
</tr>
</tbody>
</table>

Chi Square = .002, 1 d.f. (not significant)

In answer to similar questions on their son's clumsiness put to the parents of the dyslexic boys in Kaidoo's study (1972), 23.2% of the parents of the reading retardates and 28.6% of the parents of her spelling retardates considered their sons to be clumsy.

All the backward readers considered by their parents to be very clumsy and a high proportion of those considered slightly clumsy were also considered to be poorly coordinated by the author in his observations of the boys during the perceptual tests in the school gymnasium and in the...
school playground. There was a moderate relationship (.52) between motor impairment as measured by the Stott test and the degree of clumsiness reported by the parents.

**TABLE 9.8** Degree of Clumsiness – Subgroups of Backward Readers

<table>
<thead>
<tr>
<th>Control Group</th>
<th>Backward Readers subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>1</td>
</tr>
<tr>
<td>Very clumsy child</td>
<td>3.7</td>
</tr>
<tr>
<td>Slightly clumsy child</td>
<td>30.5</td>
</tr>
<tr>
<td>Child not clumsy</td>
<td>65.9</td>
</tr>
<tr>
<td>Number of clumsy children</td>
<td>34.1</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
</tr>
</tbody>
</table>

* Chi Square = 4.69, 1 d.f., P < .05

**Language Difficulties**

Examination of the answers on language difficulties by the parents (Table 9.9) indicated similar results to those of the teachers. Thirty-two and a half percentage of the boys in the backward readers' group were considered by their parents to have a language difficulty compared with thirteen per cent of boys in the control group – a difference significant at the 1% level. Though there were slightly more boys in the control group considered by their parents to have a stammer or stutter, the greatest differences between the control group and backward readers was in the greater frequency of backward readers with unclear speech and poor articulation (Table 9.10).

**TABLE 9.9** Language Difficulties – Parental Report

<table>
<thead>
<tr>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Stammer or stutter</td>
<td>7.3</td>
</tr>
<tr>
<td>Speech not clear</td>
<td>4.9</td>
</tr>
<tr>
<td>Poor articulation</td>
<td>4.9</td>
</tr>
<tr>
<td>Lisping</td>
<td>2.4</td>
</tr>
<tr>
<td>No language difficulty</td>
<td>84.2</td>
</tr>
<tr>
<td>Children with a language/speech difficulty</td>
<td>15.9</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
</tr>
</tbody>
</table>

* Chi Square = 4.66, 1 d.f., P < .05
** Chi Square = 7.64, 1 d.f., P < .05
*** Chi Square = 7.53, 1 d.f., P < .01
**TABLE 9.10** Language Difficulties - Subgroups of Backward Readers and Control Group

<table>
<thead>
<tr>
<th>Condition</th>
<th>Control Group</th>
<th>Backward Readers' Subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>1</td>
</tr>
<tr>
<td>Stammer or stutter</td>
<td>7.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Speech not clear</td>
<td>4.9</td>
<td>19.2</td>
</tr>
<tr>
<td>Poor articulation</td>
<td>4.9</td>
<td>15.3</td>
</tr>
<tr>
<td>Lisping</td>
<td>2.4</td>
<td>0</td>
</tr>
<tr>
<td>No language difficulty</td>
<td>84.2</td>
<td>65.4</td>
</tr>
<tr>
<td>Children with a speech/language difficulty</td>
<td>15.9</td>
<td>34.6</td>
</tr>
<tr>
<td>Total number of reports</td>
<td>82</td>
<td>26</td>
</tr>
</tbody>
</table>

* Chi Square = 5.63, 1 d.f., P < .05
** Chi Square = 5.84, 1 d.f., P < .01
# Chi Square = 9.31, 1 d.f., P < .005

Those backward readers with no perceptual or motor difficulties or only a mild impairment were significantly poorer in articulation than the control group at the .05 level. The perceptually motor impaired backward readers were also poorer in articulation than the control group at the 5% level of significance.

These results are very similar to those of Naidoo (1972) in which 39.2% of her dyslexic group had defective articulation compared with 5.4% of her control group and in line with the incidence of speech difficulty reported by the teachers on the backward readers in Clark's study (1970) of nine year olds in Dunbartonshire, Scotland. Mason (1970) and Ingram, Mason and Blackburn (1970) reported an even higher incidence of speech difficulty in their dyslexic groups. The parents of over half of their "specifically" retarded readers and exactly half of their "generally" retarded readers considered that their child had a speech problem.

The Parental Report of language difficulty in the Backward Readers is similar to the assessment of speech and language problems made by the author with the aid of the class teachers and headmasters (Chapter 5). Of the nineteen backward readers assessed as having a speech or language problem, twelve were also similarly assessed by their parents, a screening efficiency of 65.2%. 
The high percentage of backward readers with a speech or language difficulty from the group with nil or only mild perceptual motor problems is very significant. The particular weakness of these boys is their poor articulation and, as Chapter 10 indicates, the high incidence of reading difficulty in their families both of which will be discussed in the next chapter.

Summary

As Rutter (1967, 1969, 1970) suggests, it is important to distinguish between abnormalities of function such as spasticity, and a delay in the development of a normal function as indicated by poor speech and poor motor coordination. It is his opinion that developmental delays and clumsiness represent extreme variations in normal development rather than the emergence of abnormal patterns resulting, for example, from a lesion of the brain.

In their book "Education, Health and Behaviour", Rutter, Fisard and Whitmore comment that the assumption that delays in speech, language and motor development are indicative of brain damage, is unjustified. They consider that these delays often occur without any evidence of structural damage to the brain as judged from history or examination, and that the defects may clear up completely as the child grows older. They also consider that these difficulties are entirely normal in younger children and in children of lower intelligence.

Rutter et al also suggest that clumsiness, delayed speech and language development and right left confusion which occur in isolation in children of normal intelligence, may be related to incomplete maturation of a part of the brain, a view supported by Ingram, Mason and Blackburn (1970). The aetiology of these disorders, however, is not known. They suggest that immaturity in one of the basic perceptual or motor functions could affect both the development of language and cause specific reading difficulty.

Clearly, from the review of literature on the aetiology of specific reading difficulty, Chapter 1, many researchers consider that these developmental delays are associated with minimal brain damage. Indeed, clumsiness, delayed speech development and delays in sitting and walking are often used as indicators of "minimal brain damage".
It is true that these delays may be the result of delays in brain maturation. However, the evidence of prenatal and perinatal difficulties in the histories of some of the backward readers does suggest that their difficulties indicate a neurological impairment. This view is further supported by studies of children who have suffered cerebral palsy as a result of a neurological impairment. Many of these children have developmental delays, motor and language difficulties and their ability to read and spell is often well below that expected considering their level of intelligence and physical difficulties. As the investigations of Lord (1937); Punderson (1952) and Taylor (1959) cited by Ingram (1971) have demonstrated, many of the difficulties related to specific developmental dyslexia are observed in children with cerebral palsy. Wedell (1973) in a discussion of sensory motor and C.I.S. defects in children concludes that poor sensory and motor organisation appears to be related to cortical lesions even to minor hemisphere ones. He cites the investigations of Cobrinik (1959) Abercornbio et al (1964), Cruickshank et al (1965) and of Nielsen (1966) who linked perceptual motor problems and motor incoordination with cerebral palsy, especially in hemiplegic children. However, Wedell does add that the association of their factors does not prove a causal relationship.

Clearly the problems experienced by the backward readers in this study, though similar, are much less pronounced than those disorders described above. As stated, such minor difficulties have indeed lead some researchers to attribute these problems to a "minimal brain damage". It should, however, be emphasised that, lack of positive evidence of brain damage, but a similarity of symptoms does not justify such a diagnosis or invalidate it. The question remains open.
Chapter 10

Family Histories of Spelling, Speech and Reading Difficulty
Many investigators particularly Ingram and his co-workers (1959, 1970), Rutter, Tizard and Whitmore (1970), and Haith (1972), have commented upon the association of spelling, speech, and reading problems in the family histories of retarded readers. During the testing of perceptual, motor and language abilities of backward readers, many of their teachers and some of the parents mentioned that either a brother, sister, father or mother also had similar difficulties in learning to read or spell. Some parents were interested by the possibility that the reading now experienced by their sons might be the result of a hereditary weakness. Naturally it is difficult to substantiate a link between the children's present problems and hereditary factors. However, it was decided to ask parents of both the backward and normal readers to comment upon speech, spelling and reading difficulties in their other children, in close relatives and upon difficulties that they had themselves experienced while at school. The results of these enquiries are discussed in this chapter.

**Family History of Spelling Difficulties**

The percentage of parents or relations, other than siblings, with a family history of spelling difficulty was 38% in the backward readers' group compared with 25.3% in the control group. When siblings are also included there is a higher incidence of family histories of spelling difficulties in the backward readers' group (Table 10:1), but the difference from the control are not significant.

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent and other relations</td>
<td>19 (23.3%)</td>
<td>27 (38%)</td>
</tr>
<tr>
<td>Plus siblings</td>
<td>32 (39%)</td>
<td>38 (53.5%)</td>
</tr>
</tbody>
</table>

Chi Square 2.51, 1 d.f., (not significant).

Poor spelling in the family was reported more frequently than poor reading ability in both the control and backward readers' group. Of the twenty-seven backward readers who had spelling difficulties within the family, eighteen (66%) also had relatives who were poor readers.

In the control group there were only seven boys with a family history of poor reading but six of these seven also had a family history of spelling difficulty. It would appear that, just as backwardness in reading is associated with difficulty in learning to spell, the subjects with a family history of reading difficulty are also likely to have a parent or sibling who is unable to spell.
Family history of spelling difficulty in the backward readers' group was not related to size of the family. (See Appendix 9). It was, more related to family size in the control group and may be an artefact in which the chance of having spelling problems increases with the number of siblings. The 55.5% incidence of spelling difficulties in the family among the backward readers is similar to the incidence in Naidoo's retarded readers and spelling retardates (Naidoo 1972), 55.8% and 56.4% respectively. However, the number of boys in her control groups with a family history of spelling difficulty was much lower than that in the present control group of normal readers.

Family History of Speech Difficulties

Five of the eighty-two boys (6.1%) in the control group and seven of the boys (9.9%) in the backward readers' group had a family history of speech difficulties. When siblings were also included eight boys (9.6%) in the control group compared with thirteen boys (16.3%) in the backward readers' group had speech difficulties in the family. The difference in frequency between the two groups is not significant.

These findings are also similar to those obtained by Naidoo (1972). 16.6% of the boys in her combined group of spelling and reading retardates compared with 8.4% in her control group had a history of speech difficulties. The results in the present investigation also support the findings of Butler, Eizzard and Whitmore (1970) but the frequency of a family history of speech difficulty in both the control and backward readers' group is greater in the present study. In contrast, the incidence of a family history of speech difficulty in the dyslexic children in Ingram, Rason and Blackburn's study (1970) is much higher. They reported that 30% of their specifically retarded readers and 20% of their generally retarded readers of average intelligence had a history of speech difficulties within the family.

Of the thirteen backward readers with a history of speech difficulty, half had been assessed as having a language difficulty or were reported by their parents to have had one. Family history of speech difficulties was not strongly associated with the size of the family. (See Appendix 10).

Family History of Reading Difficulties

A third (32.4%) of the backward readers had a family history of reading difficulty compared with a twelfth (6.5%) of the control group of average or above average readers - a difference significant at the 0.1% level (Table 10:2). This finding is similar to that of Naidoo's
study (1972) in which 32.7% of her dyslexic group had a family history of reading difficulty compared with 14.5% of those in the control group. There is a further similarity with the specifically reading retarded group in Roth's study (1970) of the Isle of Wight children, and with the "Specific" and "General" groups of retarded readers in Ingram, Mason and Blackburn's study (1970) of dyslexic children.

<table>
<thead>
<tr>
<th>Table 10.2 Family History of Reading Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Number of family</td>
</tr>
<tr>
<td>Father</td>
</tr>
<tr>
<td>Mother</td>
</tr>
<tr>
<td>Grandparents</td>
</tr>
<tr>
<td>Number of subjects with a family</td>
</tr>
<tr>
<td>history of reading difficulty</td>
</tr>
</tbody>
</table>

\( \chi^2 = 12.27, 1 \text{ d.f.}, P < .001 \)

All the subgroups of the backward readers in the present investigation were significantly different from those of the control group (Table 10.3). The backward readers with the greatest number of relatives (parents and/or grandparents with a history of reading difficulty) belonged to the non-impaired or only mildly perceptual motor impaired group (41.7%). This suggests that their reading difficulties could be hereditary in origin. However, as Roth et al suggest (1970, page 69), an alternative reason might be that parents who read badly "may inculticate in the child a negative attitude to reading or fail to provide adequate verbal or other stimulation."

<table>
<thead>
<tr>
<th>Table 10.3 Family History of Reading Difficulty - Backward Readers' Subgroups and Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Number of family</td>
</tr>
<tr>
<td>Father</td>
</tr>
<tr>
<td>Mother</td>
</tr>
<tr>
<td>Grandparents</td>
</tr>
<tr>
<td>Subjects with a family history</td>
</tr>
<tr>
<td>of reading difficulty</td>
</tr>
</tbody>
</table>

\( \chi^2 = 14.0, 1 \text{ d.f.}, P < .05 \)  \( * \)  \( \chi^2 = 6.9, 1 \text{ d.f.}, P < .01 \)  \( ** \)  \( \chi^2 = 12.7, 1 \text{ d.f.}, P < .001 \)

Note: in some instances both parents or a parent and the grandparent of a boy had a history of reading difficulty.
When reading difficulties of brothers and sisters are also included, the percentage of siblings with reading problems in the backward readers' group is only slightly higher than that in the control group—twenty three and a half per cent compared with nineteen and a half per cent. When the association between family size and family history of reading difficulty was calculated (see Appendix II) it was clear that histories of reading difficulties were more common in children from larger families in the control group and, though to a lesser degree, in the backward readers' group. This finding was similar to that of Rutter et al (1970). They suggested that the higher incidence of histories of reading difficulty in the large families of their backward readers could merely be because the retarded readers had more brothers and sisters who could have had reading problems. However, when the rate of reading difficulties per family member was calculated, reading difficulties were still much more common in the retarded readers' group, a finding which Rutter and his co-workers attribute to social as well as genetic reasons.

Research by Douglas et al (1968) and by Davie, Butler and Goldstein (1972), as well as Rutter et al (1970), have all demonstrated the link between size of the family and educational retardation including reading difficulty. Davie et al (1972) also reported a significant relationship between parity in the family and reading retardation. They found that a difference in reading achievement between the first and fourth or subsequent children was equivalent to sixteen months of reading age.

The explanations for these findings have been discussed in terms of possible genetic and environmental influences. Rutter et al (1970) noted that specific reading retardation in their study was associated with families in which the father was a skilled manual worker rather than with socially deprived groups. Thus they concluded that some parents from middle class backgrounds who had specific educational difficulties, perhaps genetically determined, had chosen to do skilled manual jobs because of their poor reading skill. However, these investigators, like Davie et al, do emphasize the importance of environmental factors in which the low reading abilities of children of large families could have arisen because they had to "share" their parents' time and had less opportunity for verbal communication with an adult. Davie et al further suggest that the reading difficulties of children from large families may be "a reflection of the kinds of parents who have large families" in that they are less achievement orientated and are less concerned with
their standard of living and the kind of support they can give to the education of their children.

In the present study, family size was similar in the Control and Backward Readers' Group (see Appendix 12) and, although the number of children born fourth, fifth or sixth was highest in the backward readers' group, the difference just fell short of significance. Two fifths of the control subjects were only or first born children compared with just over a quarter of the backward readers. In contrast, only a twelfth of the boys in the control group were born fourth, fifth or sixth compared with nearly a fifth of the boys in the backward readers' group (see Appendix 13).

To summarise, it must be agreed that the reading difficulties of some of the present sample of backward readers could be attributed to a negative attitude to reading and a failure to provide adequate verbal stimulation by the parents, especially in the cases of fourth or later born children and in large families. However, the large and very significant differences in the family histories of reading difficulty between the control group and the backward readers' group, even in families with only one or two children, lend support to a genetic explanation of specific reading difficulty. Family histories of spelling difficulties were associated with family histories of reading difficulties and, as stated, half those backward readers with a family history of speech difficulties had a language problem. The highest frequency of histories of reading difficulty and also the highest incidence of language problems was in the backward readers' group with no or only mild perceptual motor problems.

The above findings support the third hypothesis, i.e. that the reading difficulties of some of the backward readers may be genetic in origin. This is particularly true of those with mild or no perceptual motor difficulties who have a higher incidence of reading difficulty in the family.
Chapter 11

Behaviour Problems and their relationship to Reading Difficulty.
During the tests of perceptual, motor and language abilities, the author observed the difficulty of many of the backward readers in controlling their impulsiveness, their restlessness and, in some cases, their aggressiveness toward their peers. Consequently, it was decided to examine the backward readers' group for the presence of these behaviour characteristics and to compare their frequency with findings in the control group of normal readers.

Much information about these characteristics was obtained by using the Parental and Teacher Questionnaires designed by Rutter (1967) and Rutter, Tizard and Whitmore (1970). These questionnaires indicated that scores of 15 plus and 9 plus were valid indicators of maladjustment when compared to an independent diagnosis made by a psychiatrist on the basis of intensive interviews. These questionnaire sub-scores also gave good indication of the type of maladjustment, either antisocial or neurotic, shown by the child.

On the basis of the questionnaires given to the parents, eleven boys in the control group (15.4%) and twenty-three boys (52.4%) in the backward readers' group obtained a score of over thirteen points, a difference significant at the 1% level (Table 11:1). When these behaviour questionnaires were scored for their number of "antisocial" and "neurotic" items as Table 11:1 indicates, a significantly higher percentage of the backward readers had antisocial tendencies than the maladjusted subjects in the control group. Antisocial behaviour was three times more prevalent in the backward readers' group than in the control group, whereas the frequency of neurotic behaviour was about the same in both groups.

<table>
<thead>
<tr>
<th>Table 11:1</th>
<th>Behaviour in the Backward Readers' Group and Control Group - Parental Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control Group</td>
</tr>
<tr>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Questionnaire 15 plus</td>
<td>15.4</td>
</tr>
<tr>
<td>Antisocial</td>
<td>7.5</td>
</tr>
<tr>
<td>Neurotic</td>
<td>4.9</td>
</tr>
<tr>
<td>Undesignated</td>
<td>1.2</td>
</tr>
<tr>
<td>Total number of questionnaires returned</td>
<td>N = 82</td>
</tr>
</tbody>
</table>

* Chi Square = 5.02, 1 d.f., P < 0.05
** Chi Square = 6.87, 1 d.f., P < 0.01
The results of the present study confirm those obtained from the parents of boys and girls with reading difficulty in the Isle of Wight study, in which Rutter et al. (1970) associated reading retardation with antisocial behaviour. In their study, 24.1% of the specific reading retardates obtained a score of thirteen plus compared with 7.7% in their control group and 12% of the backward readers were diagnosed as antisocial compared with 7.2% diagnosed as neurotic.

When an analysis is made of the incidence of maladjustment and of antisocial, neurotic or undifferentiated behaviour based on the results of the teachers' questionnaires (Table 11:2), it is clear that a significantly greater number of backward readers are considered maladjusted than boys in the control group. However, though the percentage number of boys assessed as antisocial in the backward readers' group was over twice that of the control group, the difference did not reach significance.

**TABLE 11:2 Behaviour in the Backward Readers' Group and Control Group - Teachers' questionnaire**

<table>
<thead>
<tr>
<th>Control Group</th>
<th>Backward Readers' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Questionnaire 9 plus</td>
<td>13.4</td>
</tr>
<tr>
<td>Antisocial</td>
<td>8.5</td>
</tr>
<tr>
<td>Neurotic</td>
<td>2.4</td>
</tr>
<tr>
<td>Undesignated</td>
<td>2.4</td>
</tr>
<tr>
<td>Total number of questionnaires returned</td>
<td>82</td>
</tr>
</tbody>
</table>

* Chi Square = 6.02, 1 d.f., P < .05

As Table 11:3 indicates, the incidence of antisocial behaviour in the backward readers based on the teacher questionnaires is again similar to the findings of Rutter et al. (1970) and of Clark (1970) in her study of eight-year-olds in Dumbartonshire.

**TABLE 11:3 Behaviour Problems in Backward Readers as assessed by Teachers**

<table>
<thead>
<tr>
<th>Present Study (Boys)</th>
<th>Isle of Wight Study (Boys &amp; Girls)</th>
<th>Dumbartonshire Study (Boys)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backward Readers</td>
<td>Control Readers</td>
<td>Backward Control Readers</td>
</tr>
<tr>
<td>Questionnaire Score 9 plus</td>
<td>30.5%</td>
<td>13.4%</td>
</tr>
<tr>
<td>Neurotic</td>
<td>4.9%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Antisocial</td>
<td>18.3%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Undifferentiated</td>
<td>4.9%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Number known</td>
<td>82</td>
<td>62</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>7.5 - 11.5</td>
<td>9 - 10</td>
</tr>
</tbody>
</table>
When the parental and teachers' questionnaires were examined for maladjustment between the subgroups of backward readers and the control group (Tables 11.4 and 11.5) both questionnaires indicated that there is a higher incidence of maladjustment in boys with perceptual motor difficulties (group 4). That maladjustment is linked with perceptual motor difficulties is further emphasised by the incidence of maladjustment in the severely perceptual motor impaired group in which nearly half the backward readers in this group obtained scores of 15 plus on the parental questionnaire and 9 plus on the teachers' questionnaire. The type of maladjusted behaviour exhibited by these backward readers with perceptual motor difficulties is antisocial tendencies. Both questionnaires indicate that the boys with perceptual motor difficulties in the backward readers' group are significantly more antisocial than the control group.

<table>
<thead>
<tr>
<th>TABLE 11.4</th>
<th>Behaviour in the subgroups of the Backward Readers and Control Group—Parental Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>%</td>
</tr>
<tr>
<td>Score 15 plus</td>
<td>15.4</td>
</tr>
<tr>
<td>Antisocial</td>
<td>7.3</td>
</tr>
<tr>
<td>Neurotic</td>
<td>4.9</td>
</tr>
<tr>
<td>Undesignated</td>
<td>1.2</td>
</tr>
<tr>
<td>Number known</td>
<td>82</td>
</tr>
</tbody>
</table>

χ² Chi Square = 10.75, 1 d.f., P < .001
χ² Chi Square = 10.12, 1 d.f., P < .005

<table>
<thead>
<tr>
<th>TABLE 11.5</th>
<th>Behaviour in the subgroups of the Backward Readers and Control Group—Teachers' Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>%</td>
</tr>
<tr>
<td>Score 9 plus</td>
<td>13.4</td>
</tr>
<tr>
<td>Antisocial</td>
<td>8.5</td>
</tr>
<tr>
<td>Neurotic</td>
<td>2.4</td>
</tr>
<tr>
<td>Undesignated</td>
<td>2.4</td>
</tr>
<tr>
<td>Number known</td>
<td>82</td>
</tr>
</tbody>
</table>

** Chi Square = 9.86, 1 d.f., P < .01
** Chi Square = 7.06, 1 d.f., P < .01
** Chi Square = 6.81, 1 d.f., P < .01

χ² Chi Square = 15.0, 1 d.f., P < .001
Whether these antisocial tendencies are the result or cause of their reading difficulty, the result or cause of the child's perceptual motor difficulties or a combination of both is difficult to assess. Before discussion of this question, reference will be made to the assessment of uncontrolled restless behaviour. As explained in Chapter 7, this assessment was based on those answers given by the parents and teachers referring to restless, squirming, fidgety behaviour and lack of concentration. The analysis of both the parental and the teachers' questionnaires indicate that the number of boys assessed as having restless uncontrolled behaviour was much higher in the backward readers' group and was significantly higher than the control group at the 0.1% level of confidence (Table 11:6).

Table 11:6 Restless uncontrolled behaviour in the Backward Readers and Control Group - Parental Report and Teachers' Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Backward Readers' Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>N=72</td>
<td>N=32</td>
</tr>
<tr>
<td>Restless/uncontrolled behaviour (parental questionnaire)</td>
<td>38.1%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Restless/uncontrolled behaviour (teachers' questionnaire)</td>
<td>35.4%</td>
<td>12.2%</td>
</tr>
</tbody>
</table>

\[ \chi^2 \text{ Chi Square } = 17.48 \] \[ 1 \text{ d.f.}, P < .001 \]

\[ \chi^2 \text{ Chi Square } = 10.90 \]

Of the eleven backward readers of parents who did not return their completed behaviour questionnaires, two were assessed as restless on the basis of the teachers answers and three were considered maladjusted. One of the three maladjusted boys was assessed as neurotic and the other two were undifferentiated. These findings replicate those of the National Child Development Study (Bellmer Pringle et al, 1966) but they do not confirm Rutter, Tizard and Whitmore's view (1970) that children of uncooperative parents are more likely to score highly on the teacher's scale.
When the number of boys in the subgroups of the backward readers' groups are compared with the control group, a higher percentage of boys with perceptual motor difficulties were assessed as having restless and uncontrolled behaviour. Half the backward readers in the severely perceptual motor impaired group were assessed as restless and uncontrolled in their behaviour compared with only a tenth in the control group when the assessment is based on the answers given by the parents. Similar though slightly lower findings were obtained from the answers given by the teachers (Table 11:7).

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Backward Readers' Subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Restless/uncontrolled behaviour (parental questionnaire)</td>
<td>8.5</td>
<td>50</td>
</tr>
<tr>
<td>Restless/uncontrolled behaviour (teachers' questionnaire)</td>
<td>12.2</td>
<td>44.6%</td>
</tr>
</tbody>
</table>

\[ \chi^2 \text{ Chi Square } = 19.03 \]
\[ \chi^2 \text{ Chi Square } = 16.03 \]
\[ \chi^2 \text{ Chi Square } = 11.97 \text{ d.f.}, P < .001 \]
\[ \chi^2 \text{ Chi Square } = 12.68 \]
\[ \chi^2 \text{ Chi Square } = 6.77, 1 \text{ d.f.}, P < .01 \]
\[ \chi^2 \text{ Chi Square } = 5.21 \text{ d.f.}, P < .05 \]
\[ \chi^2 \text{ Chi Square } = 4.96 \]
The finding that restless or hyperactive behaviour is associated with reading difficulty was also noted by Butter, Tigard and Whitmore (1970) and the present findings support the relationship found by Rutter et al and also by Robinovitch et al (1954). John (1961), Harston and Stott (1970) and Davie, Butler and Goldstein (1972) between restless behaviour, poor concentration, motor clumsiness and reading backwardness.

A comparison of the incidence of restless uncontrolled behaviour with performance in the perceptual and motor tests in this study lends support to recent studies which link hyperactive impulsive behaviour, perceptual difficulties and reading problems with different cognitive styles. Over 50% of the backward readers who produced primitive human figure drawings, which Within et al (1962) related to field dependence, were restless. This finding supports his view that children with undirected motor responses and impulsive behaviour respond globally and in a diffused manner.

A high percentage (62%) of restless impulsive backward readers were placed in the careless quadrants of the scattergram on the Gibson Spiral base test which Gibson suggests indicates naughtiness and possible antisocial tendencies in boys.

This high percentage of boys who were assessed as quick and careless are similar to those assessed as restless and impulsive by Kagan and his co-workers (1964, 1965, 1966). He (1965) explains that the difficulties impulsive children have in learning to read depend upon the child’s “reflection-impulsivity” in which the motor active, impulsive child has short reaction times, makes many errors and responds immediately and uncritically to his perceptual field. Kagan (1971) further suggests that such excessive motor restlessness and distractibility may have been caused by a congenital factor resulting from a neurological impairment which occurred during or soon after birth. This view is similar to that of Stott (1966) who considered that the “inconsequential” behaviour (restless activity, lack of persistence, and poor concentration) of the children in his study may also have resulted from some congenital neural impairment.

The restless uncontrolled subjects in this study also appear similar to those children with reading difficulties described by Santostefano et al (1965) who displayed poor attention and control of impulses which Klein (1958) considered reflected an inability to ignore distracting and contradictory cues and focus upon relevant perceptual stimuli.
Campbell, Douglas and Korganstern (1971) examined the above cognitive styles in a group of hyperactive children as part of a study to examine the effect of the drug methylphenidate on the cognitive processes of those children. Their findings confirm the view that restless impulsive children use a field dependent approach to problem solving, and, when faced with alternative and contradictory cues, are less able to monitor their responses, are careless and unable to concentrate.

They suggest that these behaviour problems are responsible for the child's disorganised written work, his careless reading, errors and generally haphazard approach to academic work regardless of level of intelligence. A view supported by the findings of Staats, Breuer and Gross (1970) cited by Hallahan and Cruickshank (1975). Their research indicates that attention is an important variable in the early stages of learning to read.

The observation that restlessness and antisocial behaviour is accompanied by educational failure is therefore, not new. Rutter, Tizard and Whitmore (1970), for example, quote several researchers from Burt (1925) to Gibbons (1965) who have demonstrated this relationship. Similarly Preston (1945), Pasamanick, Rogers and Lilienfeld (1956), and Pederson and Bell (1970) associated complications during pregnancy and delivery with the high incidence of minimal brain damage and hyperactive or aggressive behaviour. Anderson (1964) and Cohen, Weiss and Minde (1972) also observed that restless hyperactive children in their studies had perceptual difficulties. Other studies, including the present one, have demonstrated a relationship between abnormal pregnancy, perinatal factors and perceptual motor difficulties and the association of these factors with reading retardation. The present study has elicited a further dimension to this problem by demonstrating the strong relationship between restless, uncontrolled behaviour and antisocial tendencies in those backward readers with perceptual motor problems and between these developmental and behavioural problems and difficulties during pregnancy and at birth.
Which of the above factors are primary and which are secondary to reading retardation?

As Chase (1971) comments, this question is extremely difficult to answer. In support of the view that reading retardation results in behaviour difficulties Chase cites the study of over twelve hundred children by Hangus (1950). Hangus considers that failure in a basic subject, such as reading, damages the child's self confidence and leads to rejection by his teachers and peers. This in turn gives rise to maladjustment making the child more vulnerable to neurotic or delinquent behaviour. Could, therefore, the perceptual motor problems, restlessness and reading difficulty of some children aggravate the other, each exacerbating the other two and giving rise to maladjustment?

Haídoe (1972) and Rutter et al (1970) demonstrated the relationship of perceptual difficulties, motor clumsiness, delayed speech, language difficulties and a family history of reading and spelling difficulty with reading backwardness which Haídoe considered characteristic of dyslexia. Though questioning the validity of the concept of specific dyslexia, Rutter et al (1970) supported the view that such difficulties were of prime importance in the aetiology of reading retardation. They attempted to assess the relationship between antisocial behaviour and reading retardation by comparing the frequency of perceptual motor, language and familial history, in isolation and in combination, between antisocial backward readers and backward readers without antisocial behaviour. They found no significant difference between these two groups of backward readers for any characteristic, or any significant difference between a composite developmental deviation score and antisocial behaviour. Thus, Rutter, Tinard and Whitmore concluded that "either the antisocial difficulties developed as a response to reading backwardness or that both the reading problem and the antisocial behaviour arose on the basis of the same factors in the child." (1)

---

However, when the incidence of motor clumsiness, language difficulty, delayed walking, speech delay, restless uncontrolled behaviour and family history of reading and spelling difficulty was compared between the antisocial backward readers and normally behaved backward readers in the present study some significant differences between groups were found (Table 11:8).

**TABLE 11:8** Comparison of developmental difficulties between antisocial Backward Readers and the Backward Readers with normal behaviour

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Normal Backward Readers</th>
<th>Anti-social Backward Readers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very clumsy</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Speech difficulty</td>
<td>29</td>
<td>53</td>
</tr>
<tr>
<td>Walking delay</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Speech delay</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>Family history of reading</td>
<td>31</td>
<td>47</td>
</tr>
<tr>
<td>Family history of spelling</td>
<td>35</td>
<td>67</td>
</tr>
<tr>
<td>Restless uncontrolled behaviour</td>
<td>23</td>
<td>87</td>
</tr>
</tbody>
</table>

Children designated as "neurotic" and the "undesignated" maladjusted subjects on the questionnaire have been excluded from this comparison.

* Chi Square = 17.1, 1 df, P < .001
* Chi Square = 4.36, 1 df, P < .05

The significantly higher incidence of perceptual motor difficulties in the backward readers with antisocial behaviour is confirmed by Tables 11:9 and 11:10 in which the number of perceptual and motor difficulties and the degree of perceptual motor impairment are compared between the antisocial backward readers and the backward readers with normal behaviour.

**TABLE 11:9** Comparison of number of perceptual and motor difficulties between the antisocial Backward Readers and the Backward Readers of normal behaviour.

<table>
<thead>
<tr>
<th>Number of Perceptual Deficits</th>
<th>Antisocial Backward Readers</th>
<th>Backward Readers of normal behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
<td>7</td>
<td>47</td>
</tr>
<tr>
<td>2 - 3</td>
<td>33</td>
<td>57</td>
</tr>
<tr>
<td>4 - 6</td>
<td>60</td>
<td>19</td>
</tr>
</tbody>
</table>

Chi-Square = 11.66, 2 df, P < .01.
Comparison of the degree of perceptual and motor impairment and antisocial behaviour in Backward Readers

<table>
<thead>
<tr>
<th>Degree of impairment</th>
<th>Antisocial Backward Readers</th>
<th>Backward Readers of normal behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
<td>7</td>
<td>44</td>
</tr>
<tr>
<td>2 - 3</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td>4 - 5</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td>6 or over</td>
<td>33</td>
<td>12</td>
</tr>
</tbody>
</table>

Chi Square = 8.6, 3 d.f., P < 0.05

Children designated as "neurotic" and those "undesignated" maladjusted subjects on the questionnaire have been excluded from this comparison.

These findings suggest that either (1) children with perceptual motor and developmental difficulties are more likely to develop antisocial behaviour, or (2) that children with antisocial tendencies are more likely to develop perceptual motor and developmental difficulties, or (3) that the perceptual motor and developmental difficulties and antisocial tendencies develop as a result of the same pre-disposing factors in the child.

A further factor to be considered before any conclusions can be drawn is the relationship between restless uncontrolled behaviour and antisocial behaviour. Though only 57.6% of the backward readers with restless uncontrolled behaviour were considered antisocial, 86.8% of those backward readers assessed as antisocial were also considered restless and uncontrolled.

From discussions with parents and teachers of the backward readers then they began learning to read, it was clear that these backward readers experienced difficulty with reading right from the beginning. Parents of the boys who were considered to be hyperactive restless children also noted the fact that this type of behaviour had been present from a very early age. Most parents were of the opinion that such behaviour had developed long before the child had started school. Indeed many parents and teachers attributed the child's reading difficulty to their lack of concentration and restless behaviour.

In contrast, when questioned about those behavioural characteristics associated with antisocial behaviour such as damaging property, stealing, bullying, etc., many parents and teachers did not report the development of such behaviour until after the child had been at school for at least two or three years.
As with all retrospective information, one must be careful when drawing conclusions, but this evidence does suggest that the antisocial behaviour may have developed as a result of the inability of the child to control his impulsive restless behaviour, his inability to concentrate, plus his frustration at being unable to compete with his peers in learning to read.

If antisocial tendencies do develop as a result of the child's frustration with his reading difficulty, one would expect to find differences in the individual behaviour patterns of the antisocial backward readers and the antisocial normal readers, and that the backward readers would possess behaviour characteristics related to reading difficulty while the antisocial normal readers would possess characteristics not shared by the antisocial backward readers.

Though there were only seven boys in the control group who were designated as antisocial, it was considered worthwhile to compare the individual behavioural characteristics of these antisocial normal readers with the antisocial backward readers. As Table 11:11 indicates, the antisocial backward readers were more restless and had poor concentration while the antisocial normal readers were more destructive and bullying and more had eating difficulties. However, the number of subjects analysed was very small indeed, and only in poor concentration were there any significant differences between the two groups.

**Table 11:11** Comparison of Good and Backward Readers who are antisocial

<table>
<thead>
<tr>
<th>Teachers' Questionnaire</th>
<th>Antisocial Backward Readers</th>
<th>Antisocial Normal Readers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stealing</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Fighting</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Bullying</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Lies</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Destroys</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Worrying</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Miserable</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Restlessness</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Poor concentration</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Truanteing</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Squirming fidgety behaviour</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Number known</td>
<td>15/71</td>
<td>7/82</td>
</tr>
</tbody>
</table>

* Chi Square = 4.14, 1 d.f., P < .05

**Parental Questionnaire**

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating difficulty</td>
<td>1</td>
</tr>
<tr>
<td>Sleeping difficulty</td>
<td>3</td>
</tr>
<tr>
<td>Number known</td>
<td>15/71</td>
</tr>
</tbody>
</table>

* Chi Square = 7.5, 1 d.f., P < .05
Poor concentration and restlessness have already been shown to be significant factors associated with difficulties in learning to read. Though the numbers are very small, the above comparison lends support to the view that these problems are precursors of the reading difficulties. Rutter et al (1970) in their comparison of antisocial poor readers and antisocial good readers, also found that the antisocial poor readers were significantly poorer in their ability to concentrate. The antisocial good readers had more symptoms in relation to the home but it was for "sleeping difficulties" that the difference was significant. Though there was nearly twice the percentage of antisocial good readers assessed as bullying and nearly three times the number who worried than the antisocial poor readers in their study, the differences did not reach significance. As in Rutter et al's study, few children had truanted or refused to go to school and there was little difference between the good and bad readers. Therefore, the view that reading failure leads to delinquency via truancy cannot be supported.

Individual Items of Behaviour

Though evaluation of individual items of behaviour is particularly difficult unless age and the stage of development of the child are considered, some aspects of emotional distress and behavioural disturbance, especially if prolonged, may indicate particular problems associated with the reading difficulty.

Though the present study covered a four year age span, very few behaviour items showed variation with age. Thumb sucking, nail biting, temper tantrums and bed wetting showed a consistent decrease with age. The small number of children reported by parents of both the control group and backward readers' group as having stomach aches, biliousness and school tears were in the younger age group, while the few boys in the backward readers' group who played truant were members of the older age group.

High scores on individual items on the parental questionnaire were also commonly found on the individual items on the teacher's questionnaire. For example, children who scored highly on the antisocial items on one questionnaire generally scored highly on the same items in the other. However, fewer boys in both the control group and the backward readers' group were reported by their teachers than by their parents to worry, to steal, to be solitary, irritable, to have twitches, suck their thumbs, bite their nails, be disobedient, fearful, fussy and tell lies. More boys were considered by their teachers than their parents to be fidgety, not liked by their contemporaries, and to be destructive.
In the control group more parents than teachers reported the presence of restless behaviour, fighting and worries, while more teachers than the parents of the backward readers reported that their sons were fidgety, had fights and had poor concentration.

Comparison between the backward readers and control group on the individual items of the parental and teacher questionnaires (Tables 11:12 and 11:13) indicate that the incidence of restlessness, fidgetiness, twitches and poor concentration was significantly greater in the backward readers' group than the control group.

The individual items on the teachers' questionnaire indicate that more boys in the backward readers' group worry, fight with other children and are fearful of new situations. Significantly more boys in the control group were considered by their teachers to be fussy over particular children.
### Table 11:12 Individual Items on the Parental Behaviour Questionnaire

<table>
<thead>
<tr>
<th>Item</th>
<th>Control Group</th>
<th>Backward Benders' Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restlessness</td>
<td>34.2</td>
<td>50.3 **</td>
</tr>
<tr>
<td>Squirly fidgety</td>
<td>16.3</td>
<td>35.2 *</td>
</tr>
<tr>
<td>A Destructive</td>
<td>4.9</td>
<td>12.9 **</td>
</tr>
<tr>
<td>Fights with other children</td>
<td>25.2</td>
<td>39.6</td>
</tr>
<tr>
<td>Not liked by other children</td>
<td>7.3</td>
<td>16.3</td>
</tr>
<tr>
<td>N Often worries</td>
<td>58.5</td>
<td>43.7</td>
</tr>
<tr>
<td>Rather solitary</td>
<td>72.0</td>
<td>56.3</td>
</tr>
<tr>
<td>Irritable</td>
<td>46.5</td>
<td>25.2</td>
</tr>
<tr>
<td>Miserable or unhappy</td>
<td>13.4</td>
<td>16.9</td>
</tr>
<tr>
<td>Has twitches</td>
<td>8.5</td>
<td>25.4 **</td>
</tr>
<tr>
<td>Sucks thumb</td>
<td>11.0</td>
<td>15.5</td>
</tr>
<tr>
<td>Bites nails</td>
<td>35.4</td>
<td>26.6</td>
</tr>
<tr>
<td>A Disobedient</td>
<td>44.0.</td>
<td>50.7</td>
</tr>
<tr>
<td>Poor concentration</td>
<td>23.2</td>
<td>62.0 *</td>
</tr>
<tr>
<td>N Fearful of new situations</td>
<td>40.2</td>
<td>25.4</td>
</tr>
<tr>
<td>Fussy over particular child</td>
<td>25.3</td>
<td>16.3</td>
</tr>
<tr>
<td>A Often tells lies</td>
<td>25.6</td>
<td>35.8</td>
</tr>
<tr>
<td>A Bullies other children</td>
<td>9.0</td>
<td>19.5</td>
</tr>
<tr>
<td>Soils</td>
<td>0</td>
<td>2.6</td>
</tr>
<tr>
<td>N School tears</td>
<td>0</td>
<td>4.3</td>
</tr>
<tr>
<td>Truants from school</td>
<td>0</td>
<td>5.6</td>
</tr>
<tr>
<td>Headaches</td>
<td>20.7</td>
<td>19.7</td>
</tr>
<tr>
<td>Stomach aches</td>
<td>9.8</td>
<td>11.3</td>
</tr>
<tr>
<td>N Biliousness</td>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Wet's bed</td>
<td>3.7</td>
<td>12.7</td>
</tr>
<tr>
<td>A Steals</td>
<td>19.7</td>
<td>25.3</td>
</tr>
<tr>
<td>Difficulty in eating</td>
<td>20.5</td>
<td>15.5</td>
</tr>
<tr>
<td>N Difficulty in sleeping</td>
<td>30.1</td>
<td>16.3</td>
</tr>
<tr>
<td>Temper tantrums</td>
<td>23.2</td>
<td>33.6</td>
</tr>
</tbody>
</table>

$k = 62$  \quad n = 71

The above table shows the proportion of children in each group who scored 1 or 2 points on each item.

** Neurotic items**

*A = Antisocial items*

* Chi Square = 4.60, 1 d.f. \( P < .05 \)

** Chi Square = 6.72 \( P < .05 \) \( * * \)

* Chi Square = 6.71, 1 d.f. \( P < .01 \)

** Chi Square = 7.60 \( P < .01 \)

† Chi Square = 22.1, 1 d.f. \( P < .001 \)
<table>
<thead>
<tr>
<th>Incidence of</th>
<th>Control Group %</th>
<th>Backward Readers' Group %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restlessness</td>
<td>17.1</td>
<td>45.1 *</td>
</tr>
<tr>
<td>Squiny fidgety</td>
<td>20.7</td>
<td>53.4 *</td>
</tr>
<tr>
<td>A Destructive</td>
<td>12.2</td>
<td>17.1</td>
</tr>
<tr>
<td>Fights with other children</td>
<td>12.2</td>
<td>41.5 *</td>
</tr>
<tr>
<td>Not liked by other children</td>
<td>9.8</td>
<td>26.8 **</td>
</tr>
<tr>
<td>H Often worries</td>
<td>17.1</td>
<td>32.9 *</td>
</tr>
<tr>
<td>Rather solitary</td>
<td>24.4</td>
<td>32.9</td>
</tr>
<tr>
<td>Irritable</td>
<td>2.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Miserable or unhappy</td>
<td>9.8</td>
<td>13.4</td>
</tr>
<tr>
<td>Has twitches</td>
<td>2.4</td>
<td>13.4 *</td>
</tr>
<tr>
<td>Sucks thumb</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Bites nails</td>
<td>8.5</td>
<td>12.2</td>
</tr>
<tr>
<td>Absent for trivial reasons</td>
<td>4.9</td>
<td>7.3</td>
</tr>
<tr>
<td>A Disobedient</td>
<td>7.3</td>
<td>17.1</td>
</tr>
<tr>
<td>Poor concentration</td>
<td>17.1</td>
<td>65.9 *</td>
</tr>
<tr>
<td>H Fearful of new situations</td>
<td>17.1</td>
<td>32.9 *</td>
</tr>
<tr>
<td>H Pussy over particular child</td>
<td>28 *</td>
<td>4.9</td>
</tr>
<tr>
<td>A Often tells lies</td>
<td>9.8</td>
<td>12.2</td>
</tr>
<tr>
<td>A Steals</td>
<td>1.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Has soiled self at school</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Complains of pains</td>
<td>9.8</td>
<td>7.7</td>
</tr>
<tr>
<td>H School tears</td>
<td>0</td>
<td>1.2</td>
</tr>
<tr>
<td>A Bullies other children</td>
<td>6.1</td>
<td>12.2</td>
</tr>
<tr>
<td>Truants from school</td>
<td>2.4</td>
<td>6.1</td>
</tr>
</tbody>
</table>

The above table shows the proportion of children from each group who scored 1 or 2 points on each item.

N = Neurotic items

A = Antisocial items

* Chi Square = 4.68
* Chi Square = 5.35 1 d.f., P < .05
* Chi Square = 4.68

** Chi Square = 6.39, 1 d.f., P < .01

† Chi square = 11.72
† Chi square = 16.43
† Chi square = 17.93 1 d.f., P < .001
† Chi square = 16.21
† Chi square = 14.37
An examination of the individual items of behaviour between the subgroups of backward readers and the control group (Table 11:14) indicates that backward readers who have perceptual motor difficulties are more restless and fidgety, have twitches and are least able to concentrate. They are also less liked by other children than are the normal readers and the backward readers without or with only very mild perceptual problems.

### Table 11:14: Comparison between the Central Group and subgroups of the Backward Readers on the individual Behaviour Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Control Group</th>
<th>Backward Readers Subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restlessness</td>
<td>54.2</td>
<td>65 **</td>
</tr>
<tr>
<td>Squirmy Fidgety</td>
<td>18.5</td>
<td>39</td>
</tr>
<tr>
<td>Restless</td>
<td>4.9</td>
<td>19</td>
</tr>
<tr>
<td>Fidgety</td>
<td>23.2</td>
<td>39</td>
</tr>
<tr>
<td>Not liked</td>
<td>7.3</td>
<td>27 *</td>
</tr>
<tr>
<td>Wrinkles</td>
<td>53.5</td>
<td>54</td>
</tr>
<tr>
<td>Solitary</td>
<td>71</td>
<td>62</td>
</tr>
<tr>
<td>Irritable</td>
<td>46.3</td>
<td>46</td>
</tr>
<tr>
<td>Mischievous</td>
<td>15.4</td>
<td>15</td>
</tr>
<tr>
<td>Twitches</td>
<td>8.5</td>
<td>31 *</td>
</tr>
<tr>
<td>Suck thumb</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Bites nails</td>
<td>35.4</td>
<td>27</td>
</tr>
<tr>
<td>Discobidient</td>
<td>44</td>
<td>62</td>
</tr>
<tr>
<td>Poor concentration</td>
<td>23.2</td>
<td>62 *</td>
</tr>
<tr>
<td>Fearful</td>
<td>44.2</td>
<td>42</td>
</tr>
<tr>
<td>Fussy</td>
<td>29.3</td>
<td>15</td>
</tr>
<tr>
<td>Tells lies</td>
<td>25.6</td>
<td>33</td>
</tr>
<tr>
<td>Bullies</td>
<td>9.6</td>
<td>19</td>
</tr>
<tr>
<td>Difficulty in eating</td>
<td>30.5</td>
<td>15</td>
</tr>
<tr>
<td>Difficulty in sleeping</td>
<td>23.1</td>
<td>15</td>
</tr>
<tr>
<td>Temper tantrums</td>
<td>23.2</td>
<td>46</td>
</tr>
</tbody>
</table>

* Chi Square = 16.20
* Chi Square = 12.60 1 d.f., P < .001
* Chi Square = 18.31
** Chi Square = 6.69
** Chi Square = 6.69
** Chi Square = 7.01 1 d.f., P < .01
** Chi Square = 9.13

* Chi Square = 4.21
* Chi Square = 5.44 1 d.f.,
* Chi Square = 5.43 1 d.f., P < .05
* Chi Square = 6.41 1 d.f.,
To summarise both on the parental and the teacher's questionnaire, a significantly greater number of backward readers were maladjusted and presented antisocial behaviour. Similarly the backward readers were significantly more restless and uncontrolled in their behaviour supporting the hypothesis that reading retardation is associated with these behaviour problems. The degree of perceptual motor impairment was greater in the antisocial backward readers than in those backward readers without antisocial tendencies. The poor concentration and restlessness present in the profiles of the antisocial backward readers but not in the antisocial normal readers suggests that these behavioural factors play a part both in the development of reading difficulty and in the genesis of that antisocial behaviour associated with the reading difficulty.

If one accepts the retrospective comments of both parents and teachers, while hyperactive restless behaviour was present before the backward reader started school, the factors associated with antisocial behaviour did not develop until later when the child was experiencing difficulty with reading. Thus, there is support for the hypothesis that the child's difficulty in concentrating and controlling his restless impulsive behaviour handicaps his learning to read and is a predisposing factor giving rise to his antisocial tendencies.

Support for these conclusions comes from other investigations. Kallquist (1933), Thomas et al (1968) and Butter, Tizard and Whitmore (1970) found a lack of concentration and of persistence associated with reading difficulty, and Gregory (1965), Cohn (1951), Harston and Stott (1970) and Campbell et al (1971) noted the association of restless uncontrolled behaviour with reading retardation. These researchers also suggest that these behaviour characteristics plus the reading difficulty, give rise to maladjustment. Rabinovitch et al (1954) in a neurological study of reading retardation found that their backward readers had associated behaviour difficulties compatible with a diagnosis of restless uncontrolled behaviour. Frechtl and Stommer (1962) found that most of their hyperactive children had reading difficulties which they thought were caused by the child's hyperactivity. Schonell (1961) and Critchley (1964) note that failure in learning the read may lead to the compensatory satisfaction of antisocial behaviour. However, before any definite statements of cause or effect between behaviour and reading retardation can be made with reference to the present investigation much more research must be done, perhaps using a longitudinal approach.
In summarizing the findings linking behaviour problems with reading difficulty, an attempt has been made to explain this relationship in terms of cognitive styles. In the final chapter these behaviour problems and poor perceptual motor language abilities of the backward readers are discussed in relation to an interference in the neurophysiological processes of the brain which may result from neural impairment.
Chapter 12

Summary and Discussion
In the first part of the investigation, the relationship between visual auditory perceptual difficulties, motor problems, cerebral dominance and language difficulties in a group of backward readers was examined. Factor analysis of the data indicated that the difficulties of some of these backward readers could be the result of a neural impairment. Information provided by parents and supplemented by hospital reports indicated the presence of a greater number of difficulties of pregnancy and during birth in the backward readers' group than in a matched control group. With the exception of low birth weight, the higher incidence of these difficulties in the backward readers' group did not reach significance. However, when the backward readers with perceptual and motor difficulties and the normal readers were compared, the incidence of toxemia during pregnancy, difficulties during labour, prematurity and low birth weight were significantly higher in the perceptually motor impaired backward readers.

These results support the hypothesis that the backward readers with poor perceptual motor abilities are more likely to have a history of prenatal and perinatal difficulties and that these difficulties are thought to cause neurological impairment. The backward readers with perceptual motor problems in this investigation were similarly more restless and uncontrolled in their behaviour and more antisocial. They also show a higher family incidence of reading retardation.

The author is not claiming that the specific reading difficulty of all or even the majority of the backward readers in this study is the result of a neurological impairment caused during pregnancy or at birth. I would support the views of many of the researchers quoted in this investigation, that reading retardation is the result of a multiplicity of causal factors encompassing scholastic, environmental, genetic factors, delays in development, and neurological causes. However, my thesis is that there exists a group of children with specific reading difficulties of neurological origin as a result of prenatal and perinatal problems. Symptoms of this type of reading difficulty are the high incidence of perceptual and motor problems, particularly visual perceptual difficulty, visual motor problems, auditory perceptual difficulties, poor auditory visual integration, poor cerebral dominance as indicated by ambilaterality, confused left right discrimination and weak body concept, motor impersistance and poor motor coordination. Associated with these perceptual motor difficulties are language problems, poor concentration, impulsive, restless and uncontrolled behaviour.
Not all these symptoms will necessarily be present in the profiles of backward readers with neurological impairment, but their incidence and the degree of impairment in each symptom will be higher than in children with reading difficulties attributed to other causes.

I have described the symptoms of neurological impairment which are revealed by subsequent behaviour patterns. There is, however, a lack of non behavioural neurological confirmation of actual structural damage to the brain. Indeed it is conspicuous by its absence. Though I wished at least to do electroencephalographic studies on the backward readers, objections by some parents and concern by headmasters about the removal of the children from the school in order to complete this aspect of the study, forced me to abandon this approach. Thus the term "Neurological Impairment" refers to disturbance in the normal functioning of the brain as inferred from a common pattern or syndrome of behaviour and not from direct evidence of damage anatomical or physiological.

Moreover, as Joffe (1969) comments, common to all investigations involving maternal prenatal factors, it is not possible to separate the genetic variables and postnatal environmental factors from the prenatal ones. It is therefore possible that the behaviour difficulties described above could result from a genetic variable. Indeed, a genetic impairment of the developing foetus could itself affect the mother's pregnancy and cause her difficulties in giving birth. This would indicate that the abnormalities in the foetus produce the maternal difficulties. The difficulties in pregnancy of the mother may themselves be the result of aspects of maternal genotype causing a hereditary disposition in the child which in turn causes the difficulties in behaviour or predisposes him to weaknesses that modify the postnatal treatment he receives, particularly from his mother.

Kari and Pasamanick (1958) postulated a continuum of reproductive causality extending from foetal death through ascending gradient of neurological impairment to minor behaviour disorders, particularly those associated with maternal complications during pregnancy and at birth which can lead to foetal anoxia. This view suggests that there are varying degrees of neurological impairment, the results of which might also depend upon the interaction of other factors such as genetic predisposition and environment. Stott (1959) has, in fact, suggested the possibility of a multiple impairment factor in children selected on the basis of prenatal maternal difficulties in which the neurologically impaired child is more prone to minor social or environmental factors.
Though the comments above point to the dangers of drawing too
narrow a conclusion from evidence of prenatal, perinatal difficulties
and subsequent behaviour disorders, the more specific the nature of
the prenatal event, the more reliably it can be associated with later
symptoms of behaviour. It should also be noted that many animal
experiments, which allow for effective test procedures and greater
controls, have shown that prenatal variables and difficulties at birth,
particularly as a result of anoxia, can affect offspring behaviour.
These animal studies, therefore, give human studies a certain validity.
Though they do not confirm the validity of my hypothesis, they do
support it.

The discussion so far has raised important questions. If
neurological impairment is the primary disturbance in some backward
readers, why did some of the boys in the control group of normal readers
with a history of prenatal and perinatal difficulties not exhibit
reading difficulties? And why do some backward readers, particularly
those with perceptual motor deficits, not have a history of prenatal or
perinatal abnormality? In answer to the first question, perhaps those
boys in the control group with prenatal and perinatal difficulties are
neurologically impaired but to a much lesser degree. Other factors as
well as the neurological impairment may predispose some foetuses and
not others to these consequences. Perhaps it is the predisposing
neurological factor plus an environmental factor, therefore, that
results in or at least aggravates the child's difficulties in learning
to read. In contrast, there may be unknown factors which protect some
foetuses from the effects of maternal complications but these factors
are absent in those backward readers with neurological difficulties.

The second question is even more difficult to explain. Perhaps
the mothers of the backward readers without a history of birth
difficulties or abnormal pregnancies were not aware of these problems
or have forgotten them or the difficulties were not recorded by the
midwife, doctor or hospital? A much more likely explanation is that
the reading difficulty of these children is caused by factors other than
maternal abnormalities or birth injuries such as over-anxiety by the
parents, difficulties in the home, poor family relationships, etc.

Thus it would appear that in attempting to explain the results
which contradict my hypothesis, I am merely stimulating more questions
than providing answers. Though these questions indicate the danger
of drawing dogmatic conclusions, they do not necessarily invalidate my general conclusion that neurological impairment is a cause of some forms of reading difficulty. In the next section I will consider the present models of brain functioning and suggest some possible mechanisms by which impairment in these functions could occur.

What are the forms of neurological disorder which may underly the patterns of behaviour indicated by the perceptual motor and language deficits? Could neurological impairment be a generalized developmental deficit rather than a specific tissue damage? How does neurological impairment affect the reception, organization and integration of information?

In my discussion of the possible mechanisms involved, I wish to present a basic model which reflects those major systems involved in perception and motor response. This model will be used to illustrate areas of dysfunction which might give rise to later perceptual motor language and reading difficulties.

As figure 2 indicates, four primary subsystems are identified plus feedback. This model is an information processing one and is based upon concepts suggested by Broadbent (1956, 1958, 1971), Wolford (1968), Wiener (1948) and Whiting (1969) to identify inputs and determine outputs of the nervous system. As earlier investigations (Hobb, 1949; Hashley, 1951) have shown, the nervous system is a dynamic system in which neurons are constantly firing and impulses are reverberating along the neural circuits of the central nervous system. Thus the nervous system is in a continuous state of change. It is influenced by variations in both its internal and external environment which continually impinge upon the neural mechanisms.

Clearly, therefore, the model described is a very unsophisticated one. As Beer (1960), cited by Morris and Whiting (1971), comments "In information theory terms the amount of variety denoted by each box may be colossal ... How many vital features of the organic wholeness of the system have been utterly obliterated by this particular division". (1)

Figure 2 MODEL OF PERCEPTUAL MOTOR PERFORMANCE
Because he is unable to process all the information from his environment at any one time, a person selectively attends to specific areas of his display (environment) and selects the information he most requires. As Gibson (1966) emphasises, the senses therefore are more than just passive receivers of information. They actively seek out information from the environment. Therefore, either the central mechanisms or a change in the stimulus itself orientate the senses to particular parts of an individual's environment. The sensory information selected gives rise to patterns of neurological activity in the central mechanisms and this activity is interpreted on the basis of stored information acquired from past experience (memory). On the basis of these perceptions decisions are made with respect of new responses or are adjusted to ongoing responses. These responses result in a change in display which gives rise to feedback information about the effectiveness of the response (Morris and Whiting 1971).

Selective attention explains how a person selectively perceives relevant from irrelevant incoming sensory data. To prevent the brain itself from being bombarded by redundant information, these afferent impulses are filtered. Broadbent (1954, 1956, 1958) postulated a "filter theory" to explain selective attention in terms of the concept of information processing. Initially he suggested that there exists a filter mechanism in the periphery of the nervous system which both selects important sensory information for processing and protects the brain from overloading by rejecting "irrelevant" information. Thus the filter allows information to enter via one channel but information from other channels is not perceived. Broadbent, however, also demonstrated that a person can attend to material being presented to one ear and yet switch attention to another modality and retrieve material that has been presented during the preceding few seconds. As the brain cannot attend to several different sensory modalities at the same time, Broadbent suggests that this information must have been stored in correct sequence without the benefit of attention. Thus it is his view that the central mechanism itself is able to facilitate or inhibit sensory input by means of fibres linking both the cortex and afferent pathways, or by feedback mechanisms between the sense organs and the central nervous system (Broadbent 1971). Similar findings by Moray (1959) and Treisman (1960) indicate that information received by the unattended
channels is perceived. They too questioned Broadbent's initial suggestion that such information is filtered at the periphery of the nervous system. Treisman, for example, favours the view that information arriving at the unattended channel is reduced in intensity or "attenuated" rather than not perceived at all by a similar principle to that of decreasing the loudness control on a radio receiver. The current view is one proposed by Deutsch and Deutsch (1963) who suggest a "central filter theory" in which the filter mechanism is located deep in the central nervous system. According to this theory there is no limit to the amount of information that the central nervous system can process.

It is suggested, therefore, that any deficit in these self-regulating mechanisms above could result in a difficulty by the neurologically impaired backward reader to select, abstract, synthesise or integrate perceptual information. This deficit may occur because the backward reader:

A. is unable to orientate his attention to the display where the correct information can be obtained because of an impaired mechanism of selective attention,

B. though he attends to the correct perceptual information he is unable to filter this information from the mass of data received by the central mechanism,

C. though he selects the correct information and filters the relevant perceptual data, he makes the wrong interpretation because of a failure of his memory store or in his feedback mechanism.

Neisser (1967, emphasises an active process of perceptual attention, in contrast to the filter theory of Broadbent which implies that perception is a passive process. Neisser postulates a two stage theory of attention, an initial stage which he refers to as a pre-attentive level. This initial stage involves the processes of controlling immediate motor activity and the act of attending. The second stage Neisser refers to as "focal attention" which involves the analysis and synthesis of the perceptual material.

Hallahan and Cruickshank (1973) in a discussion of Neisser's theory suggest that "children with attention problems, especially those which are neurologically based, can be expected to experience more difficulties in focal attention than in pre-attention." (1) They cite Deutsch and

Schwitz's study (1967) to further support their view that an insult to the central nervous system is most likely to interrupt the higher integrative processes which involve integration of two perceptual modalities rather than a single sensory channel.

Though the models described can suggest possible deficits within the system which can affect later perceptual motor responses related to reading difficulty in terms of information processing, they do not explain where the actual neurological regions within the central nervous system are affected. Strauss and Kephart (1955) contend that, as the brain consists of a wide interacting network, impairment could result in a general disturbance affecting the processes of interaction. They suggest that such impairment results, not in the impairment of an actual process, but of a mechanism used in a variety of processes. Thus, interference in this mechanism can affect any function in which one of these processes is involved. They, too, suggest that the neurologically impaired child is unable to suppress or relegate to the periphery of awareness those extraneous percepts received by the cerebral cortex. This results in the inability of the child to structure his perceptual and cognitive fields and make the required responses. Strauss and Kephart relate these deficits to the gestalt view of perceptual organisation. The impaired child's perceptions are basically unstructured - there is no consistent relationship of parts to parts or parts to the whole gestalt. As a result, the child's perception recedes from awareness and he is easily distracted and unable to concentrate. Hebb (1949) was one of the first physiological psychologists to attempt a neurophysiological explanation of brain mechanisms. He argues that one perceives objects as wholes only after familiarity with them and suggests the repetitive stimulation produces closed neurological circuits which he calls "cell assemblies." These cortical circuits form more complex neural circuits as a result of repetitive fixations to form "phase sequences." The phase sequences operate in such a way that there is an interfacilitation between, for example, retinal input and visual memory in which eye movements comprise an inherent part of learning. He, like Piaget (1961) considers that systematic scanning by eye movements and successive fixation are, therefore, essential to perceptual activity. This neurophysiological view of perceptual motor learning can explain how an impairment in the cortex could interfere with the integration of perceptual information and the resulting motor response. The impairment could either inhibit
the facilitation and the development of the cell assemblies involved in selection and discrimination, or deprive other cell assemblies from gaining access to other perceptual processes, memory processes, or the motor response system and integration. For example, if the memory processes were impaired, this might cause a failure of the individual to appreciate the significance of incoming sensory information resulting in inadequate filtering and weak discrimination.

These earlier attempted explanations of neurological activity and resulting possible cortical impairment are now considered an oversimplification. More recent investigations of the reticular formation (figures 3 and 4) suggest that impairment in this system may also be responsible for perceptual motor difficulties. Studies of the mid-brain and brain stem have suggested that the reticular formation can be divided into two distinct areas - the brain stem reticular formation situated in the pons, midbrain, subthalamus and hypothalamus region and the thalamic reticular system of the thalamus. The brain stem reticular formation produces a slow tonic pattern of impulses which act upon the cortex in a global manner to ensure the correct level of activation of this area. The thalamic system produces a short phasic pattern of impulses which stimulate more specific areas of the cortex.

A more detailed account of the reticular system may be found in Chapter 14, "Foundations of Physiological Psychology" by Richard Thompson, 1967. More complex models of the reticular formation based on computer simulation suggested by Kilmer, McCulloch and Blum may be found in Unit 16, "Biological Basis of Behaviour", Open University, 1972.

Samuels (1959) provides evidence to suggest that the thalamic reticular system acts as a mediating mechanism both for arousal of cortical neurons and their inhibition, and studies by Ogawa (1965) have shown that the reticular cortical processes can even enhance the passage of impulses to the sensory cortex. Punter's (1959) investigations also suggest that the thalamic reticular system reinforces the sensory stimulation of the cortex, making perceptual discrimination more accurate.

The possible mechanism for this reinforcement may be to change the "amplification" of the sensory stimulus similar to the analogy already discussed of increasing the loudness control on a radio receiver.

Hernández-Peon and his co-workers (1956, 1957, 1961) in their well known cat experiments have demonstrated that the cortex may in turn have an efferent effect inhibiting information from the sense organs. They
Fig. 4 A schematic diagram of the input and output transmission of the reticular formation
Based on Lindsley p 507
further suggest that irrelevant sensory information from other modalities is suppressed by a gating mechanism in the sensory pathways, either as a result of a filtering mechanism near the peripheral sense organs or by the reticular formation. This explanation for the mechanism of attention is called "different Neuronal Inhibition," a similar theory to the information processing theory but explained in physiological terms. These findings suggest that the system gives prior entry to the cortex of more significant stimulation directing attention to anything of perceptual significance. The above investigations, especially those of Hernández-Peón, have been criticized by Horn (1965), Warden (1966) and by Hilner (1971).

Hilner suggests that the cortex processes sensory information before it is fed to the reticular formation and therefore perceptual selection and analysis occurs in the absence of attention or while attention is directed to different aspects of the perceptual field. He considers the reticular formation helps to "break up" the continuity of attention originally developed by the central perceptual networks (a cell assembly in Hobb's terminology).

The thalamic nuclei of the thalamic system are said to stimulate a "recruiting" or "orientating" response: this response can be blocked by the arousal response produced by the brain stem-reticular system. The exact functional significance of this phenomenon is not known but a possible deficit in this function would explain the difficulty the neurologically impaired backward reader has in synthesizing and integrating incoming perceptual information. If, for example, the system is over stimulated, as in over arousal, it may, in turn, so completely activate the brain that all selectivity of transmission is lost. This will have a disorganising effect resulting in two possible responses. The choice of response that the child has is decreased so that the child responds on the basis of those perceptions which he had developed previously and as a result he perseverates. Similarly, he may become perceptually less sensitive to the stimulus situation and, as a result, he perceives only limited aspects of his environment and responds in a disorganised manner. Fuster (1958), for example, has demonstrated that when a subject's reticular formation was over-stimulated his ability to discriminate between geometric forms decreased and Holzack (1968) suggests that when arousal level goes beyond a certain threshold the over-stimulation of the cortex decreases attention affecting performance. These views would support the suggestion by Birch (1967) that as the pathways from the
The reticular formation to the cortex provide a mechanism for cortico-reticular-cortical inhibition, any interference with those pathways will result in the inadequate integration of perceptual modalities and an inability to synthesise incoming stimuli which continuously bombard a disorganised perceptual system.

Blekemore (1969) cited in Harris and Whiting (1971) also considers that some neurological impairment interferes with the reciprocal exchange of impulses between the reticular formation and the cerebral cortex which results in an increased inhibition of the cortical neurons. Ho postulates that this inhibition results in a slow formation of conditioned responses but a swift accumulation of reactive inhibition affecting perception and causing extrovert behaviour similar to that suggested by Eysenck (1969).

Campennelli (1970) in an investigation of neural impairment in children of average intelligence concluded that poor attention and distractibility results from damage to the central nervous system. Ho considers that poor attention and poor concentration are most severe if the reticular formation is affected. Campennelli notes that his findings support Hobb's theories concerning the role of the reticular formation in the regulation of attention. Similarly Dymon et al (1970) cited by Hallahan and Cruchshank (1973) suggest that damage to the reticular formation may cause a diffuse cortical arousal because of defective cortical inhibitory networks. Thus the neural excitation essential to learning is distributed to other brain structures of low excitatory threshold such as the extrapyramidal motor system. An upset in the reciprocal relationship between the motor control and arousal systems as suggested above could explain why some backward readers have poor concentration and difficulties in focusing their attention when learning to read.

To summarise, the outline of the information processing model which incorporates the ideas of Broadbent, Welford and Whiting suggests a way of dealing with different kinds of information and provides a link between this cybernetic approach and the physiological psychological approach suggested by Hobb, Lashley and Hitch. The studies of Strauss
and Kephart suggest that neurological impairment in which there is no clear evidence of tissue damage could be the result of a deficit in neurophysiological function in which the impairment was general, affecting many processes involved in brain functioning, particularly those associated with the selection and integration of perceptual information. Earlier theories of neural mechanisms have suggested a deficit in the facilitation and development of neural circuits (cell assemblies and phase sequences) particularly those involved with the higher areas of the brain, the cerebral cortex. Newer theories suggest that the reticular formation is also important in the selection and integration of perception. However, these theories, rather than invalidating the earlier explanations of neural mechanisms, complement them and both views offer possible explanations for the impairment of perception and motor difficulties experienced by some backward readers. They suggest that the neurologically impaired reader tends towards independent rather than integrated perceptual development. Thus, the child is global in his approach and awkward and clumsy because of a failure of his perceptual system to provide clearly structured patterns on which to base his motor response. Thus he lacks the organization and integration of perceptual motor abilities on which the process of learning to read is based and is more restless, easily distracted and less able to concentrate.

The above theories of brain mechanisms and selective attention and their application to explanations of neural impairment, though plausible, are very speculative. Research for physiological correlates to explain neural processes have been inconclusive because of the difficulties of controlling behaviour in the experimental situation. Although EEG's and electrode implantations into single nuclear cells are able to demonstrate changes in the electrical potential of the brain in which characteristic rhythms appear in well defined circumstances, the physiological basis of these characteristic waves is not understood. Until an acceptable interpretation of these physiological mechanisms can be made, any application of the theories of brain mechanisms is of limited value.

What is the incidence of reading difficulty resulting from neurological impairment? If the findings of this study can be used to estimate the percentage children in a school population with these difficulties, this incidence is small. Of the eighty two backward readers selected from the original primary school population of 1436...
boys in the County Borough of Eastbourne, fifty two boys had perceptual motor difficulties. Of these, twenty nine were considered to have severe perceptual motor problems. On the assumption that approximately four times more boys than girls are so impaired, perhaps an estimate of between two and four per cent children in a primary school population could be considered as neurologically impaired with a specific reading difficulty. This estimate is well below estimates of reading difficulty attributed to neurological factors by many researchers in America. Crosby (1968) for example comments that "... ten per cent of all elementary children have a reading problem rooted in neurological disorders". (1)

Is this small percentage of backward readers of average intelligence a typical example of children described by the medical profession and some educational psychologists as Dyslexic? At first sight this would appear to be the case. Indeed in the introduction to this study it was noted that the terms Dyslexia and Specific Reading Difficulty were considered by many researchers to be synonymous. Yet Jessica Reid commented (1972) in her article "Dyslexia : A problem of Communication" that the idea of a syndrome of Dyslexia varies from expert to expert, unquestioningly accepted by some yet strongly contested by others. I do not claim that Dyslexia results from neurological impairment alone, but I do claim that children of average intelligence, without clear cut genetic, social and environmental problems, but with a history of prenatal and perinatal difficulties and perceptual motor problems, are those backward readers most likely to be neurologically impaired.

The perceptual problems, motor clumsiness, lack of cerebral dominance, language difficulties and behaviour disturbance, are part of this syndrome. It has its origins in some type of neurological impairment and is aggravated when the child is exposed to a stressful situation such as that which occurs when the child is learning to read.

It is particularly difficult to recommend methods to improve the reading difficulties of children with problems similar to those described in this investigation. The large number of possible contributory factors to the reading problem suggest an equally large number of possible solutions. However, an examination of present literature in the study of reading backwardness including dyslexia would suggest the following approaches.

There are many programmes such as those of Frostig and of Reppert for the development of those perceptual and motor factors related to reading. Though they appear to improve the child's perceptual and motor abilities they have little effect upon achievement in the specific problem of learning to read. For example, studies involving a remedial reading group participating in one of these programmes and a similar group participating in non specific "placebo" activities have found that, while both groups make some progress in reading, no significant differences in the gains of the experimental group over the control group have been obtained. Vellai (1975), for example, notes that, while a programme like the "Frostig Program for the development of Visual Perception" may well prepare a child for the attention to visual stimuli that learning to read requires, little further progress is likely without training in the application of these skills to reading. Though these programmes have no or only a very limited success in improving reading skills, results do suggest that these improvements in perception and motor organisation may also improve the child's confidence in himself and his relationship with his teacher. These improvements may modify his behaviour in class and motivate him in the general school situation.

It is debatable whether one should concentrate on improving the specific visual, auditory or motor weaknesses a backward reader has, or whether it would be better to develop those attributes in which the child is more adept. Radelo (1973), for example, recommends the latter approach while Bryant (1960) emphasises the importance of teaching phonics to all children with specific reading difficulty. Vernon (1971), in her discussion on remedial teaching, comments upon some specific methods including the Gillingham-Gillham method which involves naming, tracing and copying letter sound associations and Fernald's Kinesthetic method which emphasises tracing and writing as well as sounding letters in word context. The latter method is thought particularly helpful for backward
renders with poor visual memory, especially those with neurological impairment, while the former has been successful for those children with linguistic difficulties.

Tansley (1967) emphasises tactual, kinesthetic, visual, auditory and motor exercises in his book "Reading and Remedial Reading" and Goodacre (1971) suggests a similar comprehensive approach in her book "Children and Learning to read". Sandhya Naidoo in her boarding school for aphasic and dyslexic children (1) intends to emphasise language development and other intellectual stimuli by concentrating first on the child's language problems before returning to their general education. The Bloomfield Learning Centre at Guy's Hospital also stresses the importance of language and concept development in its remedial teaching. Similarly, the Dyslexic Institute at Staines provides a structured language course in which it uses a multisensory approach to teach reading. The child is taught to listen to a word, repeat its sound, feel the shape of its letters, write the word and read what he has written.

Caroline Moorhead (2) discusses these remedial programmes and refers to the work of the Tavistock Clinic which emphasises a psychoanalytical approach and combines psychotherapy with remedial teaching.

Whichever methods are adopted, as all these experts emphasise, detection and diagnosis of the reading difficulty should be made as early as possible and remedial help begun immediately. We must, however, first understand the nature of the reading process in order to develop and improve teaching methods and our concern must be for the whole child if we are to prevent the frustration and anxiety that many backward readers experience when learning to read. It must be remembered that reading is a means of communication not an end in itself. Every child deserves the opportunity to learn and not have his horizons limited by being unable to grasp this process.

(2) "To what extent is dyslexia at the root of reading problems?" by Caroline Moorhead. The Times, 9 December 1974.
Table 1
Exclusions for omission of boys from the experimental group of backward readers.

IQ below 85 points = 23 boys
Insufficient reading retardation = 25
Physical status = 4
Prolonged absence from school = 2

Total 59 boys excluded
Total in the Experimental group = 141 = 59 = 32 boys.

Table 2
The raw scores of the Backward Readers on the P.O.P Test of Visual Spatial Ability compared with their equivalent age norms.

<table>
<thead>
<tr>
<th>Age level</th>
<th>Mean age (years)</th>
<th>Scores of Backward Readers</th>
<th>P.O.P. age norms</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 - 8.5</td>
<td>8</td>
<td>6.7</td>
<td>12.6</td>
</tr>
<tr>
<td>8.6 - 9.5</td>
<td>9</td>
<td>11.6</td>
<td>15.6</td>
</tr>
<tr>
<td>9.6 -10.5</td>
<td>10</td>
<td>15.4</td>
<td>18.5</td>
</tr>
<tr>
<td>10.6 -11.5</td>
<td>11</td>
<td>14.3</td>
<td>20.0</td>
</tr>
</tbody>
</table>
Table 2
The scores of the Backward Readers on the B.V.M.G. Test compared with their age norms published by Kopitz (1964). (Perfect score = 0).

<table>
<thead>
<tr>
<th>Age level (years)</th>
<th>Backward Readers B.V.M.G. Scores</th>
<th>Reader Norms for boys (Kopitz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>5.6</td>
<td>4.9</td>
</tr>
<tr>
<td>8.0</td>
<td>5.9</td>
<td>3.9</td>
</tr>
<tr>
<td>8.5</td>
<td>5.7</td>
<td>2.6</td>
</tr>
<tr>
<td>9.0</td>
<td>4.3</td>
<td>1.5</td>
</tr>
<tr>
<td>9.5</td>
<td>3.4</td>
<td>1.6</td>
</tr>
<tr>
<td>10.0</td>
<td>2.6</td>
<td>1.5</td>
</tr>
<tr>
<td>10.5</td>
<td>2.7</td>
<td>1.4</td>
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<tr>
<td>11.0</td>
<td>3.0</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4:
Types of errors made by the Backward Readers on the B.V.M.G. Test related to age.

<table>
<thead>
<tr>
<th>Age level (years)</th>
<th>Distortion of shape</th>
<th>Rotation</th>
<th>Integration</th>
<th>Perseveration</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 - 8.5</td>
<td>57%</td>
<td>46%</td>
<td>31%</td>
<td>28%</td>
</tr>
<tr>
<td>8.6 - 9.5</td>
<td>27%</td>
<td>24%</td>
<td>35%</td>
<td>21%</td>
</tr>
<tr>
<td>9.6 - 10.5</td>
<td>18%</td>
<td>13%</td>
<td>18%</td>
<td>21%</td>
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<tr>
<td>10.6 - 11.5</td>
<td>18%</td>
<td>17%</td>
<td>17%</td>
<td>26%</td>
</tr>
</tbody>
</table>
Graph: Comparing Bender Mean Scores by Age for a Nomative Population of Boys (Koppitz 1964) Compared with the Mean Score by Age of the Backward Readers.

### Normal Readers (Birch & Belmont 1965)

<table>
<thead>
<tr>
<th>Age (years months)</th>
<th>Age range (months)</th>
<th>Mean Score</th>
<th>Standard deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 7</td>
<td>± 5.4</td>
<td>7.9</td>
<td>1.6</td>
<td>5 - 10</td>
</tr>
<tr>
<td>8 6</td>
<td>± 4.5</td>
<td>8.5</td>
<td>1.9</td>
<td>3 - 10</td>
</tr>
<tr>
<td>9 7</td>
<td>± 3.8</td>
<td>8.7</td>
<td>1.2</td>
<td>6 - 10</td>
</tr>
<tr>
<td>10 7</td>
<td>± 3.8</td>
<td>9.6</td>
<td>0.8</td>
<td>7 - 10</td>
</tr>
<tr>
<td>11 6</td>
<td>± 3.8</td>
<td>9.5</td>
<td>0.8</td>
<td>8 - 10</td>
</tr>
</tbody>
</table>

### Backward Readers (Present Study - 5 age groups)

<table>
<thead>
<tr>
<th>Age (years months)</th>
<th>Age range (months)</th>
<th>Mean Score</th>
<th>Standard deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 7</td>
<td>± 5.4</td>
<td>4.7</td>
<td>2.7</td>
<td>1 - 9</td>
</tr>
<tr>
<td>8 6</td>
<td>± 5.5</td>
<td>6.0</td>
<td>2.5</td>
<td>1 - 10</td>
</tr>
<tr>
<td>9 5</td>
<td>± 5.5</td>
<td>7.5</td>
<td>2.2</td>
<td>2 - 10</td>
</tr>
<tr>
<td>10 5</td>
<td>± 4.5</td>
<td>8.4</td>
<td>1.9</td>
<td>3 - 10</td>
</tr>
<tr>
<td>11 3</td>
<td>± 3.0</td>
<td>9.4</td>
<td>0.8</td>
<td>8 - 10</td>
</tr>
</tbody>
</table>

### Backward Readers (Present Study - 4 age groups)

<table>
<thead>
<tr>
<th>Age (years months)</th>
<th>Age range (months)</th>
<th>Mean Score</th>
<th>Standard deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 10</td>
<td>± 6</td>
<td>4.6</td>
<td>2.3</td>
<td>1 - 9</td>
</tr>
<tr>
<td>9 1</td>
<td>± 6</td>
<td>7.3</td>
<td>2.1</td>
<td>2 - 10</td>
</tr>
<tr>
<td>10 0</td>
<td>± 6</td>
<td>8.3</td>
<td>2.0</td>
<td>2 - 10</td>
</tr>
<tr>
<td>10 11</td>
<td>± 6</td>
<td>8.5</td>
<td>1.7</td>
<td>4 - 10</td>
</tr>
</tbody>
</table>
GRAPH 2. Auditory Visual Integration and Age

Correct number of AVI scores vs. Chronological Age (years)

- Normal Readers (Birch & Belmont 1965)
- Backward Readers (present study 5 age groups)
- Backward Readers (present study 4 age groups)
### Table 6

The mean scores and difficulties in Right Left discrimination made by the Backward Readers Group.

<table>
<thead>
<tr>
<th>Age level (years)</th>
<th>Mean Right/Left discrimination score</th>
<th>Standard deviation</th>
<th>One or more tasks incorrect</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 - 8.5</td>
<td>5.7</td>
<td>1.6</td>
<td>59%</td>
<td>12.2</td>
</tr>
<tr>
<td>8.6 - 9.5</td>
<td>6.0</td>
<td>1.8</td>
<td>32%</td>
<td>10.9</td>
</tr>
<tr>
<td>9.6 - 10.5</td>
<td>6.4</td>
<td>1.4</td>
<td>16%</td>
<td>4.9</td>
</tr>
<tr>
<td>10.6 - 11.5</td>
<td>6.0</td>
<td>2.3</td>
<td>12%</td>
<td>2.5</td>
</tr>
</tbody>
</table>

### Table 7

Failure of the Backward Readers on the sub-tests of The Stott test of motor Impairment.

<table>
<thead>
<tr>
<th>Age level (years)</th>
<th>Balance</th>
<th>Coordination</th>
<th>Manual Dexterity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 - 8.5</td>
<td>29</td>
<td>18</td>
<td>59</td>
</tr>
<tr>
<td>8.6 - 9.5</td>
<td>54</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>9.6 - 10.5</td>
<td>72</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>10.6 - 11.5</td>
<td>50</td>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td>Subject number</td>
<td>Visual spatial ability</td>
<td>Visual motor ability</td>
<td>Gestalt ability</td>
</tr>
<tr>
<td>----------------</td>
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<td>----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>1</td>
<td>x</td>
<td>x</td>
<td>xx</td>
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<tr>
<td>2</td>
<td>x</td>
<td>x</td>
<td>xx</td>
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<tr>
<td>3</td>
<td>x</td>
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<td>4</td>
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<td>5</td>
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<td>6</td>
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<td>7</td>
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<td>8</td>
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<tr>
<td>10</td>
<td>x</td>
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<tr>
<td>11</td>
<td>x</td>
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<td>27</td>
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</table>
Table 8  Patterns of Perceptual-Motor Difficulty in the Backward Readers

<table>
<thead>
<tr>
<th>Subject number</th>
<th>Visual spatial ability</th>
<th>Visual motor</th>
<th>Auditory</th>
<th>Auditory discrimination</th>
<th>Auditory Integration</th>
<th>Auditory memory</th>
<th>Human figure drawing</th>
<th>Right/Left discrimination</th>
<th>Visual figure</th>
<th>Motor</th>
<th>Impairment</th>
<th>Psychomotor ability</th>
<th>Motor</th>
<th>Impairment</th>
<th>Language difficulties</th>
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<tr>
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Table 6  Patterns of Perceptual-Motor Difficulty in the Backward Readers Group (continued)

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<thead>
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<th>Subject number</th>
<th>Visual spatial ability</th>
<th>Visual motor control ability</th>
<th>Auditory discrimination</th>
<th>Auditory visual integration</th>
<th>Auditory memory</th>
<th>Human figure drawing</th>
<th>Right left discrimination</th>
<th>Veral laterality</th>
<th>Motor impairment</th>
<th>Psychomotor ability</th>
<th>Motor Impairance</th>
<th>Language difficulties</th>
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X represents a moderate difficulty
XX " " severe
X XX " " very severe difficulty
Table 9
The Percentage number of children with a parent and/or sibling with a history of spelling difficulty related to size of the family
Spelling difficulty in parent and/or sib

<table>
<thead>
<tr>
<th>Difficulty present</th>
<th>Control Group</th>
<th>Backward Readers Group</th>
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<tbody>
<tr>
<td></td>
<td>Total known</td>
<td>%</td>
</tr>
<tr>
<td>Size of sibship</td>
<td>present</td>
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<tr>
<td>1-3 children</td>
<td>23</td>
<td>66 34.7%</td>
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<tr>
<td>4 or more children</td>
<td>9</td>
<td>16 56.3%</td>
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Table 10
The Percentage number of children with a parent and/or sibling with a history of speech difficulty related to size of the family
Speech difficulty in parent and/or sib

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<tr>
<th>Difficulty present</th>
<th>Control Group</th>
<th>Backward Readers Group</th>
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<tbody>
<tr>
<td></td>
<td>Total known</td>
<td>%</td>
</tr>
<tr>
<td>Size of sibship</td>
<td>present</td>
<td></td>
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<tr>
<td>1-3 children</td>
<td>6</td>
<td>66 9.1%</td>
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<tr>
<td>4 or more children</td>
<td>2</td>
<td>16 12.5%</td>
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</table>
The Percentage number of children with a parent and/or sibling with a history of reading difficulty related to size of family

<table>
<thead>
<tr>
<th>Size of sibship</th>
<th>Control Group</th>
<th>Backward Readers Group</th>
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<tbody>
<tr>
<td></td>
<td>Difficulty present</td>
<td>Total</td>
</tr>
<tr>
<td>1 - 3 children</td>
<td>13</td>
<td>66</td>
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<tr>
<td>4 or more children</td>
<td>7</td>
<td>16</td>
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Table 12

Number of children in the family

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<thead>
<tr>
<th>Children in family</th>
<th>Control Group</th>
<th>Backward Readers Group</th>
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</thead>
</table>
|                    | Incidence | Incidence |%
| 1                  | 8         | 7 | 9.3 |
| 2                  | 33        | 25 | 4.02 |
| 3                  | 25        | 19 | 30.6 |
| 4                  | 7         | 16 | 8.5 |
| 5                  | 4         | 3 | 4.3 |
| 6                  | 3         | - | 3.7 |
| 7                  | 2         | 1 | 2.4 |

Numbers known

Control Group | 82 | 100%
Backward Readers Group | 71 | 85.6%
Table 15

<table>
<thead>
<tr>
<th>Parity in the family</th>
<th>Control Group</th>
<th>Backward Readers Group</th>
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<tbody>
<tr>
<td></td>
<td>Incidence %</td>
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<tr>
<td>Only child or 1st born</td>
<td>35</td>
<td>40.2</td>
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<tr>
<td>Born 2nd</td>
<td>30</td>
<td>35.6</td>
</tr>
<tr>
<td>3rd</td>
<td>12</td>
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<tr>
<td>6th</td>
<td>2</td>
<td>2.4</td>
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</table>

Number known: 82 | 100% 71 | 86.6%

Chi Square = 2.40, 1 d.f. (not significant)
Appendix A  Assessment of Motor Inco-ordination

1. Are his movements awkward, jerky or uncontrolled?

2. Does he over estimate or under estimate a movement when required to complete a task?

3. Is he able to integrate bilateral, unilateral and contralateral movements?

4. Do other parts of his body, not called for, move?

5. Does he lack rhythm in his general motor activities such as walking, running, skipping, etc.? 

6. Does he have difficulty in balancing when stationary and when moving. For example, does he try to feel the bench or wall while balancing?

7. Does he hold his head in an awkward position during exercise. For example does he constantly look towards the ceiling or is he always watching his feet?

8. Does he reach the level of extension required to complete a movement successfully?

9. Does he have difficulty in manipulating small objects such as a pencil, or while opening a desk, using scissors, brushes, etc.?

10. Is there evidence of abortive movements? For example does he try to avoid a task, pause or hesitate because of lack of confidence?

11. Does he perseverate his movements?

12. Is he able to alternately pronate and supinate his hand one at a time, together and in opposite positions so that one is pronated while the other is supinated?

13. In completing the above task with one hand does the other move involuntarily? Can he keep this hand still only with effort?

14. Is he able to walk along a straight line on the floor with the heel of his front foot touching the toe of his back foot while still maintaining a balanced position and without moving his arms?
15. Is he able to rise from a back lying to a standing position without overbalancing, or without unnecessarily slow (two seconds or over) or confused movements?

16. When completing task 15 does he turn on his stomach first and then rise or is he able to remain facing forward when rising?
Appendix B
Parental Questionnaire

Name of Child ______________________________ Date of birth ____________________________

Primary School ____________________________

(Would you please ring the number in the column opposite the answer you wish to make. Please try to answer all the questions even if it's just to put "not known". Many of the questions will not apply to your child but it is important to me to know this.)

Parity in family (1st) Elder, 2nd, 3rd, 4th, 5th, 6th, 7th

Number of children in the family ________

Section A. Pre and Perinatal History to be completed by mother.

1. Did you have any of the following problems during pregnancy?
   1. Toxaemia
   2. High blood pressure
   3. Rubella (German measles) during first 4 months of pregnancy
   4. Bleeding before 7 months
   5. Bleeding at or after 7 months
   6. Any other complication - Please state where possible
   7. Normal pregnancy

2. Did you smoke during pregnancy?
   1. Never
   2. Very occasionally
   3. 5 cigarettes per day
   4. 10 cigarettes " "
   5. 20 cigarettes " "
   6. Over 20 cigarettes per day

3. Was the baby born?
   1. At full time (40 weeks)
   2. 1 week early
   3. 2 weeks early
   4. 3 weeks or more early
   5. 1 week late
   6. 2 weeks late
   7. 3 or more weeks late
   8. Don't know
4. Was the birth normal?
   1. Yes – normal delivery
   2. Caesarean section
   3. Breech delivered
   4. Forceps delivery
   5. Dry delivery
   6. Precipitate birth (unusually rapid labour due to too frequent or to very powerful contractions)
   7. Other – please state
   8. Not known

5. Was the birth weight?
   1. 3 lbs. 8 oz. or less
   2. 3 lbs. 9 oz. – 4 lbs. 8 oz.
   3. 4 lbs. 9 ozs. – 5 lbs. 8 ozs.
   4. 5 lbs. 9 ozs. – 6 lbs. 8 ozs.
   5. 6 lbs. 9 ozs. – 7 lbs. 8 ozs.
   6. Over 7 lbs. 8 ozs.
   7. Not known

6. In the first 4 weeks did the child have any of the following problems?
   1. Difficulty in sucking
   2. Jaundice
   3. Convulsions
   4. Abnormally high temperature/fever
   5. Persistent crying
   6. White asphyxia
   7. Blue asphyxia
   8. No difficulties
   9. Not known
Section B  Postnatal History

1. Has your child had any of the following accidents or illnesses?
   Please underline the appropriate answer
   1. Poliomyelitis No/Yes
   2. Epilepsy No/Yes
   3. Jaundice No/Yes
   4. Headaches No/Yes
   5. Fainting spells No/Yes
   6. Head injuries No/Yes
   7. Meningitis No/Yes
   8. Encephalitis No/Yes
   9. Measles No/Yes
   10. Convulsions No/Yes

2. Has your child been knocked out or lost consciousness for any reason?
   1. No
   2. Unconscious for less than 10 minutes
   3. Unconscious for 10 minutes or longer
   4. Not known
      If yes please explain cause, if possible.

3. Would you say that your child was?
   1. Very clumsy
   2. Slightly clumsy
   3. Not clumsy

4. Have you noticed any speech or language difficulties?
   1. No
   2. Stammer or stutter
   3. Speech not always clear to strangers
   4. Poor articulation - has difficulty in expressing himself
   5. Lisp

5. Is your child
   1. Short sighted
   2. Long sighted
   3. Normally sighted
   4. Has other difficulties in vision - if yes please state the difficulties
6. Has your child any hearing difficulties
   1. Yes - in one ear
   2. Yes - in both ears
   3. No hearing difficulties as far as known

**Section C Developmental History**

1. **Walking**
   Was your child walking with help by
   1. 12 months or earlier
   2. 13 - 17 months
   3. 18 - 21 months
   4. 22 - 24 months
   5. 25 months or later
   6. Not known
   Was your child walking without help by
   1. 12 months or earlier
   2. 13 - 17 months
   3. 18 - 21 months
   4. 22 - 24 months
   5. 25 months or later
   6. Not known

2. **Speech/Language**
   Was your child using single words with meaning (excluding 'mum', 'dad', 'hullo' or 'bye-bye')
   1. 12 months or earlier
   2. 13 - 17 months
   3. 18 - 24 months
   4. 25 - 30 months
   5. 31 months or later
   6. Not known
   When did your child put 3 or 4 words together
   1. 17 months or earlier
   2. 18 - 24 months
   3. 25 - 30 months
   4. 31 - 36 months
   5. 37 months or later
   6. Not known
2. **Speech/Language** (cont.)

When did your child say full sentences of several words?
1. 24 months or earlier
2. 25 – 30 months
3. 31 – 36 months
4. 37 – 42 months
5. 43 months or later
6. Not known

**Section D Family History**

Have any members of the family had difficulty in:

1. **Reading**
   1. Father Yes/No
   2. Mother Yes/No
   3. Brothers Yes/No 1. 2. 3. 4.
   4. Sisters Yes/No 1. 2. 3. 4.
   5. Grandparents or other close members of the family —
      if yes please state relationship

2. **Spelling**
   1. Father Yes/No
   2. Mother Yes/No
   3. Brothers Yes/No 1. 2. 3. 4.
   4. Sisters Yes/No 1. 2. 3. 4.
   5. Grandparents or other close members of the family —
      if yes please state relationship

3. **Speech difficulty**
   1. Father Yes/No
   2. Mother Yes/No
   3. Brothers Yes/No 1. 2. 3. 4.
   4. Sisters Yes/No 1. 2. 3. 4.
   5. Grandparents or other close members of family —
      if yes please state relationship
Section B  Behaviour  Questionnaire for completion by parents

(Rutter et al 1970)

This section asks about various kinds of behaviour that many children show at some time. Please cross the answers according to the way your child is now.

1. Below is a list of minor problems which most children have. Please tell me how often each of these happens with your child by putting a cross in the correct box.

<table>
<thead>
<tr>
<th></th>
<th>Never in the last year</th>
<th>Less often than once per month</th>
<th>At least once per month</th>
<th>At least once per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Complains of headaches</td>
<td></td>
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<td></td>
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<tr>
<td>2. Has stomach ache or sickness</td>
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<tr>
<td>3. Complains of biliousness</td>
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<tr>
<td>4. Wets bed or pants</td>
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<tr>
<td>5. Has temper tantrums (loses temper with shouting, angry movements, etc.)</td>
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<tr>
<td>6. Has tears on arrival at school and he does not wish to go into the building</td>
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<tr>
<td>7. Truants from school</td>
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</tbody>
</table>
Please place a cross against the correct answers.

2. Does he ever steal things?

1. No
2. Yes - occasionally
3. Yes - frequently

If "Yes" occasionally or frequently does he steal

(a) in the home, or elsewhere.
   or both in the home and elsewhere.

(b) on his own, with other children.
   or sometimes on his own and sometimes with others.

(c) When he steals does it involve minor pilfering of sweets, pens, toys, small sums of money, etc., or big things.
   both minor pilfering and stealing of big things.
Please ring the number in the column opposite the answers you wish to make to questions 3 and 4.

3. Does he have any difficulty in eating?
   1. No
   2. Yes - mild
   3. Yes - severe
   If 'yes' is it:
   1. Faddiness
   2. Not eating enough
   3. Eating too much
   4. Other - please describe

4. Does he have difficulty in sleeping?
   1. No
   2. Yes - mild
   3. Yes - severe
   If 'yes' is it difficulty in:
   1. Getting off to sleep
   2. Waking during the night
   3. Waking early in the morning
   4. Other sleeping problems - please describe
5. Below are a series of descriptions of behaviour problems often shown by children. If your child definitely shows the behaviour described by the statement place a cross in the box under 'certainly applies'. If he shows the behaviour described by the statement but to a lesser degree or less often, place the cross under 'applies somewhat'. If, as far as you are aware, your son does not show the behaviour place a cross under 'Doesn't apply'.

Please put ONE cross against EACH statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Doesn't apply</th>
<th>Applies somewhat</th>
<th>Certainly applies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Very restless, hardly ever still. Often running about or jumping up and down.</td>
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</tr>
<tr>
<td>2. Squirming, fidgety child.</td>
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<tr>
<td>3. Often destroys own or others' belongings.</td>
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<tr>
<td>4. Frequently fights with other children.</td>
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<tr>
<td>5. Not much liked by other children.</td>
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<tr>
<td>6. Often worried; worries about many things.</td>
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<tr>
<td>7. Tends to do things on his own - rather solitary.</td>
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<tr>
<td>8. Irritable. Quick to 'fly off the handle'.</td>
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<tr>
<td>9. Often appears miserable, unhappy, tearful or distressed.</td>
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<tr>
<td>10. Has twitches or mannerisms or tics of the face or body.</td>
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<tr>
<td>11. Often sucks thumb or finger.</td>
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<tr>
<td>12. Frequently bites nails, or fingers.</td>
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<tr>
<td>13. Cannot settle to anything for more than a few moments - lacks concentration.</td>
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<tr>
<td>14. Tends to be fearful or afraid of new things or new situations.</td>
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<tr>
<td>Statement</td>
<td>Doesn't apply</td>
<td>Applies somewhat</td>
<td>Certainly applies</td>
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<tr>
<td>15. Fussy or over particular child</td>
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<tr>
<td>16. Often tells lies</td>
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<tr>
<td>17. Is often disobedient</td>
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<tr>
<td>18. Bullies other children</td>
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<td></td>
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</table>

6. Are there any other problems?

Signed ..........................

<table>
<thead>
<tr>
<th>Name of child</th>
<th>Date of birth</th>
<th>Primary School</th>
</tr>
</thead>
</table>

Below are a series of descriptions of behaviour often shown by children. After each statement are three columns: "Doesn't apply", "Applies somewhat", and "Certainly applies". If the child definitely shows the behaviour described by the statement place a cross in the box under "Certainly applies". If the child shows the behaviour described by the statement but to a lesser degree or less often place a cross in the box under "Applies somewhat". If, as far as you are aware, the child does not show the behaviour place a cross in the box under "Doesn't apply". Please put ONE cross against EACH statement. Thank you.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Doesn't apply</th>
<th>Applies somewhat</th>
<th>Certainly applies</th>
</tr>
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<tbody>
<tr>
<td>1. Very restless. Often running about or jumping up and down; hardly ever still.</td>
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<tr>
<td>2. Truants from school.</td>
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<td>3. Squirmy, fidgety child.</td>
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<td>4. Often destroy own or others' belongings.</td>
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<tr>
<td>5. Frequently fights with other children.</td>
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<td>6. Not much liked by other children.</td>
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<td>8. Tends to do things on his own - rather solitary.</td>
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<td>9. Irritable. Is quick to &quot;fly off the handle.&quot;</td>
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<td>10. Often appears miserable, unhappy, tearful or distressed.</td>
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<td>13. Frequently bites nails or fingers.</td>
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<td>[ ]</td>
</tr>
<tr>
<td>Statement</td>
<td>Doesn't apply</td>
<td>Applies somewhat</td>
<td>Certainly applies</td>
</tr>
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<td>--------------------------------------------------------------------------</td>
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<tr>
<td>14. Tends to be absent from school for trivial reasons.</td>
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<tr>
<td>15. Is often disobedient.</td>
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<tr>
<td>16. Has poor concentration or short attention spans.</td>
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<tr>
<td>17. Tends to be fearful or afraid of new things or new situations.</td>
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<tr>
<td>18. Fussy or over-particular child.</td>
<td></td>
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<tr>
<td>19. Often tells lies.</td>
<td></td>
<td></td>
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<tr>
<td>20. Has stolen things on one or more occasions.</td>
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<tr>
<td>21. Has wet or soiled self at school this year.</td>
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<tr>
<td>22. Often complains of pains or aches.</td>
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</tr>
<tr>
<td>23. Has had tears on arrival at school or has refused to come into the building this year.</td>
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<td></td>
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</tr>
<tr>
<td>24. Bullies other children</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Are there any other problems of behaviour?


SIGNATURE: Mr/Mrs/Miss

How well do you know this child?  Very well
Moderately well  Not very well

THANK YOU VERY MUCH FOR YOUR HELP.
Bibliography


Anderson, H.V. (1964) "The hyperkinetic child; a neurological appraisal". Neurology, 14, 966-973.


Ayres, J.A. (1965) "Patterns of Perceptual motor dysfunction in childhood, a factor analytic study". Perceptual and Motor skills, 20, 335-368.

Bakker, B.J. (1972) Temporal order in Disturbed Reading. Rotterdam University Press.


Bender, Lauretta (1957) "Specific Reading disability as a maturational lag." Bulletin of the Orton Society, 7, 9-10.


Benton, A.L. (1959) Right left discrimination and finger location:


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<tr>
<td>Burt, C.</td>
<td>1925</td>
<td>The Young Delinquent, University of London Press.</td>
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</table>


Clark, P. (1967) "Laterality characteristics and reading." Reading, 1, 3, 5-9.


Cocks, June (1975) "Survey of reading disability in a Scottish County (Dundee)." British Journal of Educational Psychology, 43, 2, 155-165.


Cohn, R. (1962) "Delayed acquisition of reading and writing abilities in children." Archives of Neurology, 4, 255-244.


Critchley, MacDonald (1964) "Developmental Dyslexia," Heinemann Medical Books.


Downing, J.A. (1963) "Is a 'Mental age of six' essential for reading readiness?" Educational Research, 6, 1, 16-28.


Ettlinger, C., and Harris, L. (1952) "Dyslexia and its associated disturbances." Neurology, 12, 447-480.


Evans, J.R. (1969) "Auditory and auditory-visual integration skills as they relate to reading." Reading Teacher, 22, 625-629.

Evans, J. (1967) "Field dependence and the Kaudsley Personality Inventory." Perceptual and Motor Skills, 24, 256.


E. M. P. F. (1972) "Factors associated with reading failure." Social Science and Medicine, 6, 241-251.

F. H. Fisher, L. G. (1921) "A psychological enquiry into the nature of the condition known as congenital word-blindness." Brain, 44, 296-307.


Gates, A.I. (1933) Reversal tendencies in reading.

and Bennett, C.C. New York: Columbia University Press.
Cattell, R. B. (1936) "Relation of handedness, eye sighting and
and Bond, G. scotopy dominance to reading." Journal of Educational
Psychology, 27, 450-456.

Cattell, R. B. (1936) "Relation of handedness, eye sighting and
and Bond, G. scotopy dominance to reading." Journal of Educational
Psychology, 27, 450-456.

Geschiirn, H. (1962) "The Anatomy of acquired disorders of reading." In J. Honey (ed.) Reading Disability: Programs and
Research Needs in Dyslexia. Baltimore: John Hopkins
Press.

Geschwind, H. (1964) "The development of the brain and the evolution
of language." Monograph Series on Learning and
Language, 17.

Geschwind, H. (1964) "The development of the brain and the evolution
of language." Monograph Series on Learning and
Language, 17.

Gibbons, B. J. (1963) "Psychiatric Studies of Borstal Lads."

Gibson, B. J. (1965) "Perceptual development." In H. W. Stevenson (ed.)
2nd Yearbook of National Society for the study of
Education. Chicago University Press.

Gibson, B. J. (1965) "Perceptual development." In H. W. Stevenson (ed.)
2nd Yearbook of National Society for the study of
Education. Chicago University Press.

Gibson, B. J. (1969) Principles of Perceptual Learning and

Gibson, B. J., Bishop, C. M., Schiff, W., and Smith, J. (1964)
"A comparison of meaningfulness and pronounceability
as grouping principles in the perception and retention
of verbal material." Journal of Experimental Psychology,
67, 173-182.

Gibson, B. J. (1969) Principles of Perceptual Learning and

"A developmental study of discrimination of letter-like
forms." Journal of Comparative and Physiological
Psychology, 55, 897-906.


Gibson, J.J. (1953) *The senses considered as perceptual systems*. Allan and Unwin.


Goodenough, P.B.*
and Eagle, G.J. &
Goo&onough** -ferric

Goodman, I.C.S.
Goo&on, v J « $
and BeiahoM* I I #
Cryen, J.B.

Goyon, 3*5)*
•  and Dyle, J.G.

Graham,'  r.Sd
Gro£Le?f G.E.
Gr odder, C-.K*
Gregory, A.fl,
and Gregory,■  1 2 .
Gregory, E.B.
Gregory, B.X*.
GroffyP.J.

(1963) "A modification of the Embedded Figures Test for use with young children." Journal of
Cognitive Psychology, 103, 67-74.

Goodenough-Harris

(1965) "Drawing test manual" by Bola Harris.
New York : Harcourt, Brace and World Incorporated.

Goodman, I.C.S.

Goody, E.
and Reinhold, M.

(1961) "Congenital dyslexia and asymmetry of
cerebral function." Brain, 84, 255-292.

Goyon, J.B.
and Lyle, J.C.

(1971) "Effect of incentives and age on visual
recognition and reading retardation." Journal

Goyon, J.B.,
and Lyle, J.C.

(1973) "Short term memory and visual
discrimination in retarded readers." Perceptual and Motor Skills, 36, 2, 405-408.

Coxhead, F.K.,

(1962) "Development three years after preliterate enucleation and other potentially damaging non-borne experiences." Psychological Monographs, 76. (Whole number 522).

Crotler, G.R.,

(1969) "A study of factors in childhood dyslexia." In J. Arons (ed.) Selected papers on learning
disabilities. Pittsburgh Association for children
with learning disabilities.

Crotler, G.R.,

(1971) "Severe reading disability, some important
correlates." In J. Herritt (ed.) Reading and the
Curriculum. United Kingdom Reading Association :
Word Lock Educational.

Crotler, G.R.,

(1972) "Severe reading disability : Some important
correlates" in Jocie F. Reid (ed.) Reading Problems

Crotler, G.R.,

(1973) "A new test of Auditory Visual Integration."

Gregory, A.N.,
and Gregory, N.

Fenencntal and Motor Skills, 36, 1055-1066.

Gregory, R.E.

(1965) "Unorthodoxy, maladjustment and reading
failure. A village study." British Journal of
Educational Psychology, 35, 63-68.

Gregory, R.N.

(1966) The eye and the Brain : the psychology of
seeing. World University Library.

Groffy, P.J.

(1962) "A study of handedness and reading
achievement." The Reading Teacher, 16, 1, 21-24.


Harrington, Sister Mary James, and Durrell, D.B. (1955) "Mental Maturity vs. Perceptual abilities in primary reading." Journal of Educational Psychology, 46, 875-880.


Hinselwood, J. (1900) Letter, Word and Hand Blindness. Lewis.


Ingram, T.T.S. (1963a) "Chronic Brain Syndromes in Childhood other than Cerebral Palsy, Epilepsy and Mental Defect" in M. Bax and R. Mackie (eds). Clinical Cerebral Dysfunction, London, National Spastics Society Medical Unit in Association with Heinemann Medical Books.

Ingram, T.T.S. (1963b) "Delayed Development of Speech with Special reference to Dyslexia." Proceedings of the Royal Society of Medicine, 56, 199-203.


University of Chicago Press.


Koppits, Elizabeth H. (1964) The Bender Gestalt Test for young children.
New York: Groves & Stratton.


Leahley, K.S. (1931) "The problem of serial order in behaviour"

Leahley, K.S. (1957) "Cerebral organisation and behaviour" in The Brain and Human Behaviour,
Williams & Wilkins Co.

Leahley, K.S. (1964) Brain Mechanisms and Intelligence.

Routledge and Kegan Paul.

Lazar, A.B. (1960) "Relationship of Visual perception to word discrimination" in E.K. Robinson and H.P. Smith (eds.) Clinical Studies in Reading, XXX.
Supplementary Education Monograph 97.


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<tr>
<td>and Lang, R.J.</td>
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<td>&quot;Relation of achievement test scores and specific reading abilities to the Frostig Developmental test of visual perception.&quot;</td>
<td>Perceptual and Motor Skills, 22, 179-184.</td>
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<td>&quot;Late behavioural aspects found in cases of prenatal, natal and postnatal anoxia.&quot; Journal of Pediatrics, 26, 353-366.</td>
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<td>Rey, H.C.</td>
<td>(1940)</td>
<td>&quot;Inter-relationships of high-school boys.&quot; Research Quarterly II, 129-141.</td>
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<tr>
<td>Reed, J.C.</td>
<td>(1967)</td>
<td>&quot;Lateralized finger agnosia and reading achievement at ages 6 and 10.&quot; Child Development, 38, 213-220.</td>
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Reilly, D.H. (1973) "Note on relation of auditory visual integration and intelligence." Perceptual and Motor Skills, 37, 139-


Robertson, E. (1951) "Localization of speech in the Cerebral Cortex." Transactions of the American Neurological Association, 43-50.


Roe Marie (1965) Survey in progress of maladjusted pupils. Inner London Education Authority.


Scott, R. (1968) "Perceptual readiness as a predictor of success in reading." Reading Teacher, 22, 156-159.


Shankweiller, D. (1964) "A study of developmental dyslexia." Neuropsychology 1, 267-266.


Snyder, R.T., and Kalil, J. (1968) "Item analysis, inter-examiner reliability, and scoring problems for Koppits scoring on the Bender Gestalt for six year olds." *Perceptual and Motor Skills*, 27, 1551.


Annual Meeting of American Psychiatric Association, Detroit.

Wertheimer, M. (1923) "Untersuchungen zur Lehre von der Gestalt.
Psychologische Forschung 4, 201.

Westman, J.C. (1965) "Reading retardation: an overview.


British Journal of Social Clinical Psychology 8, 270-274.


Wiglesworth, R. (1963) "The Importance of recognizing Minimal Cerebral Dysfunction in Paediatric Practice." In H. Bar and R. Mackeith (eds.) Minimal Cerebral Dysfunction, National Spastics Society / Heinsmann.


Yule, W. (1973) "Differential Prognosis of reading backwardness and specific reading retardation." British Journal of Educational Psychology, 43, 3, 244-246.


Zutt, J. (1950) "Über die unfähigkeit, die Augen geschlossen zu halten." Nervenartz, 21, 359.