

**THE INCIDENCE OF LEARNING PROBLEMS IN A GROUP OF
PRETERM CHILDREN**

Kate Bailey

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ABSTRACT

The incidence of learning problems in a group of Normal and At-Risk preterm children was determined in this study. The children were allocated to Normal and At-Risk groups using the Neurodevelopmental Assessment Scale (NDS). The NDS was designed by Muriel Goodman for her thesis, "Evaluation of Physiotherapy on Preterm Infants", submitted to the Faculty of Medicine, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the Degree of Doctor of Philosophy, 1987.

In Goodman's study, 80 very low birthweight infants, (<1700 grams), were assigned in their first year of life to neurologically Normal or At-Risk groups on the basis of the NDS.

In this present study, 40 of Goodman's original 80 infants were followed-up at between seven and nine years of age. These children were assessed for learning problems using perceptual, motor and language assessments. They were also rated in terms of school performance, and it was noted whether they had received previous therapy. The At-Risk and Normal groups were then compared, and the predictive value of the NDS for learning problems and school performance was thus determined.

The results of this study showed that no statistical significance was found between the two groups in terms of either learning problems or school performance. This suggests that, with age, those children assessed as At-Risk during infancy using the NDS, catch up developmentally, to those assessed as Normal.

There were, however, differences between the two groups that were not statistically significant, but may be clinically significant. More children from the At-Risk group had had previous therapy or were recommended for therapy as a result of the assessments done by the author. Also, the At-Risk group had generally poorer school performance than the Normal group. If the sample group had been larger, a more significant difference may have been found between the two groups, thus suggesting that the NDS may be predictive of later learning problems in children assigned in infancy to the At Risk group.

It was concluded, that those children assessed as At-Risk using the NDS, should be closely monitored up to, and during school-going age.

DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the degree of Masters in Occupational Therapy, in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

KATE BAILEY

This 2 day of September, 1992.

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CHAPTER 1

1. INTRODUCTION

The objective of this study was to determine the incidence of learning problems in a group of Normal and At-Risk preterm children. The term "Learning Problems" is defined in this study as the motor and perceptual difficulties that interfere with the acquisition of learning, and which are evaluated by the assessment tools used in this study.

A group of preterm infants was assigned to neurologically Normal and At-Risk groups at three months (age corrected for prematurity), using the Neurodevelopmental Assessment Scale (NDS) in a study by Goodman (1987).

Thus, the author of this study wished to determine the incidence of learning problems in the Normal and At-Risk groups of preterm children as defined by Goodman, using the NDS. A reliable screening test to measure the outcome of preterm children, would be a valuable diagnostic tool to help determine which of these children need therapeutic intervention to prevent future problems.

The development of preterm infants has been studied for a number of years and is a widely researched topic, characterised by different findings. The discrepancies in the findings of these studies may be due, in part, to the distribution of birth weights in the preterm populations, the age of the infants at the time of assessment, or the developmental skill being evaluated, (Scott and Spiker, 1989). However, in general it has been found that infants born preterm suffer a number of prenatal and perinatal complications, and the neurodevelopmental outcome of these infants is of concern. Longitudinal studies of preterm infants have been used to monitor the infant's development, to provide hypotheses concerning underlying causes of brain dysfunction, and to predict and understand developmental problems.

A number of studies have concluded that although the group itself generally shows a high rate of intellectual, motor, school-related, and behavioural problems, many of the individual children do well, (Portnoy et al. 1988; Greenberg and Crnic 1988; Saigal et al. 1989). Many recent studies have also attempted to correctly identify specific predictors of outcome for individual children. (Marlow et al. 1988; Mazer et al. 1983; Ludman et al. 1987; Hunt et al. 1988; Costello et al. 1988; Ford et al. 1989; Bozynski et al. 1987).

1.1. PREDICTORS OF DEVELOPMENTAL OUTCOME

The purpose of many longitudinal studies is the early prediction of infants at risk, so as to select children in need of intervention programs. Much research is aimed at finding single factors, clusters of factors, and risk indices to predict outcome as early in the infant's life as possible.

BIOLOGICAL AND MEDICAL FACTORS

Biological descriptions such as birthweight, gestational age, and being small for dates have been found to be general predictors of developmental outcome, (Dunn 1986; Neligan et al. 1976; Hadders-Algra et al. 1988; Holmqvist et al. 1987). Some studies report that birthweight and gestational age are related to later performance, probably because these variables are highly related to the occurrence of neurological and medical problems, (Marlow et al. 1988; Rubin et al. 1973; Hunt et al. 1988; Hadders-Algra et al. 1988; Ross et al. 1986). Thus, less favourable outcomes are associated with early medical complications such as intraventricular haemorrhage, bronchopulmonary dysplasia, respiratory distress syndrome and ventilation.

NEUROLOGICAL ABNORMALITIES

Neurological abnormalities in the first year of life have been noted in many longitudinal studies, (Holwerda-Kuipers 1986; Wehner and Hafez 1975; Portnoy et al. 1988; Ross et al. 1986). Although data are reported relating neurologic dysfunction in early infancy to "major" neurological handicap in childhood, (Knobloch et al. 1982), fewer studies indicate a relationship between early neurological signs and later "minor" signs in the preterm infant, (Drillien et al. 1980; Hadders-Algra et al. 1988; Ford et al. 1989).

SOCIAL INFLUENCES

Other factors reported to relate to the developmental outcome of preterm infants, are social factors. The confounding of social factors with both preterm birth and neurodevelopmental outcome has made it difficult to establish if poor outcome is a result of the preterm birth and its complications or the unfavorable social circumstances. A more realistic view of the role of social factors may be seen in studies that measured specific environmental variables (e.g. caregiving and parental attitudes), rather than using broader categories of social class or maternal education, (Neligan et al. 1976).

It does appear that medical factors become less powerful predictors, especially of cognitive outcome, over time, but socioeconomic status and environmental factors increase in predictive power, (Bozynski et al. 1987).

1.2. DEVELOPMENTAL OUTCOME OF PRETERM CHILDREN

The long-term outcome of very small preterm infants has been of much interest since the introduction of neonatal intensive care units in the 1960's. With a decline in mortality due to new technological changes, there remains a very considerable degree of uncertainty about the prevalence of "mild" or "minor" impairments. These less severe handicaps might go undetected until later childhood, as they often cannot be verified before school age. The importance of longitudinal studies has therefore gained emphasis in determining the true risk status of preterm, ^{and} low birthweight infants, (Taeusch and Yogman 1987).

The more common focus of clinical follow-up studies until recently, has been to compile data on mortality, neurological status, and performance on standardized tests of cognitive ability, such as Intelligence Quotient (IQ) tests. However, there has been a growing interest in the learning problems of preterm and low birthweight children at school age. This is due to the

fact that there is accumulating evidence for an increased prevalence of learning disabilities (ie, impaired academic achievement) among preterm infants at school age, even when the IQ is in the normal range, (Scott and Spiker 1989; Schwartz and Schwartz 1977; Holwerda-Kuipers 1986; Wehner and Hafez 1975; Nickel et al. 1982; Lloyd 1984; Hunt et al. 1988; Ford et al. 1989). The processing deficits that may serve as the reasons for these learning problems are not yet clear. Deficits have been found in mathematics, reading comprehension, and in gross and fine motor skills, (Nickel et al. 1982), and in visual-spatial deficits, (Hunt et al. 1988; Klein et al. 1985 and 1989). Evidence of language problems have also been found, (Michalsson et al. 1984).

1.3. THE BASIS OF THIS STUDY

Goodman (1987), in her dissertation "Evaluation of Physiotherapy on Preterm Infants", studied the effect of physiotherapy in high risk preterm infants (<34 weeks and <1700 grams). Her study also attempted to identify neurodevelopmental signs which may be predictive of outcome in these infants.

Goodman selected 80 preterm neonates who were admitted to the Neonatal Intensive Care Unit of Johannesburg Hospital, between July 1981 and July 1983. Infants with

major congenital abnormalities or identifiable syndromes were excluded from the study. On discharge from the Intensive Care Unit, the infants were referred to the Neonatal Follow-up Clinic at the Johannesburg Hospital to be examined and assessed at six weeks, three months, nine months, and one year of age. All ages were corrected for prematurity. According to a 12-point assessment designed by Goodman (1987), Appendix I, a neurodevelopmental score was assigned to each infant. On the basis of this assessment, the infants were assigned to Normal and At-Risk groups.

Both groups were further divided into treatment and non-treatment subgroups. During the first year of life, infants from the treatment subgroups were given physiotherapy monthly at the hospital, and in addition, were given a home programme of daily exercises. At one year corrected age, all infants were reassessed by means of the NDS and by an independent psychologist, using the Griffiths Mental Development Scale (1954). It was found that in neither Normal nor At-Risk groups did physiotherapy treatment alter the pattern of development or the outcome at one year of age. It was, however, found that At-Risk infants had poorer neurodevelopmental scores and developmental quotients on the Griffiths Mental Developmental Scale (1954), than the Normal group, indicating more abnormalities in the At Risk group.

Between January 1988 and December 1989, infants from the original study were followed up by Goodman and reassessed, using the Griffiths Scale 2 (1970), for children two to eight years. At this six year assessment, 49 of the original 80 subjects were available for full evaluation. A school readiness test was administered and the assessors also noted the presence or absence of soft neurological signs, e.g. clumsiness or inco-ordination, fine motor abnormalities or brisk reflexes. On these results, recommendations were made regarding special education or remedial therapy for speech, motor or visual problems.

As had been observed at the one year assessment, at six years there was again no difference between the physiotherapy treatment and non-treatment groups. Therefore, the subgroups of treatment and non-treatment were combined by Goodman (1987) to form only the two major groups of At-Risk and Normal.

In contrast to the major differences between Normal and At-Risk groups at one year, at the six year assessment infants were similar in all Griffiths test areas, except the locomotor score. At-Risk infants were significantly below that of Normal infants on this subtest.

In terms of predictive value of the NDS for "major" neurological handicap, cerebral palsy occurred in six of 24 At-Risk versus zero of 25 Normal infants. In terms of "minor" neurological signs, remedial therapy was recommended in 17 of 24 At-Risk infants versus six of 25 Normals. These results confirm that the NDS predicts a risk for either cerebral palsy or soft neurological problems. Goodman(1987), however, felt that more specific testing for learning problems and school performance was necessary once the children were at school age, in order to determine the incidence of learning problems in the At-Risk and Normal groups.

Accurate prediction of outcome for prematurely born children is important in early intervention. However, to ensure effectiveness of early intervention programs, we need criteria for establishing who shall and who shall not be treated. The present study was therefore undertaken to evaluate the longitudinal outcome in terms of learning problems and school performance among the population of At-Risk and Normal, preterm children, as defined in Goodman's study, (1987).

CHAPTER 2

2. LITERATURE REVIEW

2.1. PREDICTORS OF DEVELOPMENTAL OUTCOME

Accurate prediction of outcome for prematurely born children is important, since early identification enables intervention while the child is still young. Premature infants are known to be at high risk for later developmental and neurological sequelae. However, many have good outcomes despite early difficulties. At present, it is difficult to determine which of these children do well. Numerous studies have attempted to identify infant variables associated with later mental and motor deficits.

2.1.1. LOW BIRTHWEIGHT

On the whole, there is an increasing incidence of mental retardation and neurological defect as the birthweight decreases. Dunn (1986), reviewed several prior studies of outcome in low birthweight infants. He concluded that, at least for birthweights below 2000g, less favourable outcomes were found with decreasing birthweight.

The effect of very low birthweight on later developmental outcome has been investigated by many authors. The age at which the outcome has been assessed varies amongst studies. In the first year of life, those infants weighing <1500g when compared to those weighing >1500g, had a considerable increase in mortality and handicap (Marlow et al. 1988); were found to perform consistently more poorly on developmental tests (Mazer et al. 1988); neurological examination (Wehner and Hafez 1975; Drillian 1972); and intellectual tests (Ludman et al. 1987). However, Ludman et al. (1987), found that the significance of birthweight diminished with increasing age.

Fewer studies have considered the effects of very low birthweight on risk for educational problems at school-going age. Carran et al. (1989), found that the more severely impaired children belonged to the very low birthweight (<1400g) group. However, as the sample group of children aged, the cumulative incidence rate of "mild" problems increased in the low birthweight (1501-2500g) group. This suggests that as the child ages, no matter which of the two birthweight groups the child belonged to, there is an increasing chance of experiencing learning problems.

Portnoy et al. (1988), and Rickards et al. (1987), both reported favourable cognitive, behavioural and emotional outcome at two years and five years respectively, in extremely low birthweight children (<1000g). This is contradictory to the previous literature, and is probably due to sample selection. In both these studies, infants were selected if no serious neurological, neurosensory or cognitive impairment was found. These findings are, however, substantiated by Greenberg and Crnic (1988), who found that except in the case of serious abnormalities at birth, individual differences in preterm birth status do not have a strong influence in determining later outcomes.

Low birthweight children can be divided into two major categories - those who are born too early but from their weight are assumed to have grown appropriately, and those born at the right time but who are assumed to be undergrown, (small for gestational age). Dunn (1986), found that children who had been small for gestational age were at increased risk. Neligan et al. (1976), carried out a study to determine whether the effect of being born too soon carries the same implication as being born too small. It was found that both groups of children showed impaired performance when they reached school age, but those born too small were at a greater disadvantage.

2.1.2. GESTATIONAL AGE

Holmqvist et al. (1987), considered the problem of gestational age and compared very preterm and moderate preterm infants. It was found that infants born after 29-33 weeks gestation had more neurological handicaps at four years of age, and those born after 34-36 weeks gestation had more "minor" psychomotor developmental problems.

Thus, it was concluded that while long term follow-up efforts at present concentrate on very preterm survivors after complicated deliveries, the moderately preterm infants should not be forgotten. Such infants with only small neurodevelopmental abnormalities may, later in childhood, develop learning problems. Hadders-Algra et al. (1988), found that preterm birth (<34 weeks) was the sole obstetric variable directly related to some of the outcome variables at nine years of age.

Contradictory to this, Piper et al. (1989), found that the early neuromotor development of the normally developing preterm infant is essentially unaffected by the gestational age at birth. Rubin et al. (1973), found that birthweight rather than gestational age was the major correlate of neurological, psychological, and educational impairment at seven years of age.

2.1.3. MEDICAL COMPLICATIONS

Much research has considered the medical problems influencing the development of preterm and low birthweight infants. Marlow et al. (1988), Rubin et al. (1973) and Hunt et al. (1988), concluded that handicap may be predicted from the medical complications of a low birthweight baby, as they found most impairments in children who had perinatal complications. Infants with ventricular dilatation, hydrocephalus and cerebral atrophy, as diagnosed on ultrasound, are all at high risk of major disability and neurological impairments, (Costello et al. 1988); motor, behavioural, and cognitive impairments, (Marlow et al. 1989).

Intracranial haemorrhage was found by Ford et al. (1989), to correlate with neurological sequelae seen at one and five year follow-up examinations, however, cognitive outcomes at five years did not correlate with intracranial haemorrhage severity. Bozynski et al. (1987), found that uncomplicated intracranial haemorrhage is not associated with cognitive impairment in the absence of chronic lung disease, and instead, found prolonged mechanical ventilation to be a powerful predictor of motor and cognitive performance at 18 months.

Ludman et al. (1987), compared "healthy" premature infants to those with complications of very low birthweight or respiratory distress syndrome. No significant difference was found between children who had and did not have respiratory distress syndrome during the neonatal period. These negative findings may, in part, be due to the relatively small number of subjects (30) in this investigation.

2.1.4. EARLY NEUROLOGICAL FINDINGS

Holwerda-Kuipers, (1986), in discussing early assessments as predictors of later outcome, reviewed other authors, and concluded that even if it does not lead to overt handicap, neurological abnormality present shortly after birth may lead to developmental disturbances. Transient and persistent neurological abnormalities during the first year of life seem to be important precursors of persistent neurological deficits, (Ford et al. 1989); lower Intelligent Quotients, (Holwerda-Kuipers, 1986); and poor general outcome, (Wahmer and Hafez, 1975; Portnoy et al. 1988).

Hadders-Algra et al. (1988), in studying the perinatal risk factors and minor neurological dysfunction as related to behaviour and school achievement at nine years, found that definite neonatal neurological abnormalities contributed directly, and indirectly, to

cognitive and behavioural difficulties at nine years of age. Thus, it was concluded from this study that neurological morbidity at birth appears to be a better indicator for a risk of learning and behavioural problems than prenatal or perinatal events.

In a similar study to Goodman (1987), Ross et al. (1986), studied the predictive value of multiple items from a single neurodevelopmental examination performed in the Premature Infant Follow-up Programme. The study indicates that a single neurodevelopmental examination during infancy is useful in predicting outcome at three years of very low birthweight premature infants. The twelve month examination was highly predictive of the neurological classification at three to four years of age and also of Intelligence Quotient. It was thus concluded that neurodevelopmental examination of high-risk infants in the last quarter of the first year of life should assist paediatricians in predicting which children will be normal and which will require early intervention.

2.1.5. MULTIPLE FACTORS

There appears to be a combination of potential modifying factors which exist and affect the outcome of premature infants: Social background, clinical complications of pregnancy and the neonatal period, and

biological factors. The relevant associated biological and social factors will need to be included in some sort of multivariate analysis before reaching any firm conclusion concerning the question of prematurity, (Neligan et al. 1976). Lindahl et al. (1988), also concluded that the aetiology of developmental disturbances is multifactorial and trans-actional, and he noted that numerous reports have been published on the follow-up of infants using only single neonatal risk factors.

Many authors have looked at a combination of prenatal, neonatal, familial and socio-economic factors, and have found them to be significant predictors of later outcome, (Lindahl et al. 1988; Pederson et al. 1988; Ross et al. 1982; Hunt et al. 1988; Neligan et al. 1976; Dunn 1986; Kitcher et al. 1980; Klein et al. 1985). Drillien et al. (1980), found that problems in primary school were related to social grade, evidence of early intra-uterine insults, sex, postnatal complications and neurological and developmental status in the first year of life. It was also noted that comparisons of school performance, of low birthweight and control children, may be affected by the likelihood of there being much variety in teaching methods because of the large schools they were attending.

Tausch and Yogman (1987), suggest that there is a growing interest in minimizing the use of single developmental test scores to characterize a child's level of functioning, and maximizing the use of qualitative and descriptive assessments of the child's abilities eg: achievement in school, motivational-emotional variables and physical health. They felt that early developmental testing primarily measures biologic functions and maturation of the neuromotor system.

As the child ages, development becomes increasingly influenced by a broader range of factors, many of which have strong environmentally influenced determinants. They therefore concluded that identification of positive and negative aspects of an infant's home environment combined with developmental test results may increase accuracy of prediction, particularly in borderline situations.

In conclusion, accurate prediction of outcome for prematurely born children is dependent on what predicting factors are considered. In many studies that have been published on the follow-up of infants with single neonatal risk factors, e.g. low birthweight, gestational age and medical influences, a variety of findings exists. There does, however, appear to be more consistency amongst studies that consider early neurological findings as predictors of developmental

outcome, and those studies that consider a combination of biological, social and clinical factors.

2.2. DEVELOPMENTAL OUTCOME OF PRETERM CHILDREN

Results from longitudinal studies with high-risk children show that infant tests are effective predictors of continued patterns of neurological, cognitive, behavioural, language and learning problems. Many authors, when investigating cognitive outcome have found some residual developmental lag, especially for preterm children with greater perinatal risk.

(Greenberg and Crnic, 1988).

2.2.1. INTELLIGENCE

It has been found that even when low birthweight children had normal IQ scores, they were more likely than normal birthweight children to function at school below the level suggested by their IQs, (Scott and Spiker, 1989). Schwartz and Schwartz (1977), found that high risk children were at least as bright as the normal population, but for 54% of these children, therapy was recommended due to poor performance at school. Holwerda-Kuipers (1986), found no difference in IQ between those born with low birthweights and those born with normal birthweights, but did find that there

was a developmental lag and poor rational thinking amongst the low birthweight group. He concluded that this may lead to language, spatial and social problems. Wehner and Hafez (1975), concluded that even when intelligence is not impaired, low birthweight children show specific cognitive, perceptual and behavioural signs of organic brain damage.

Similar findings have also been reported by other authors. Nickel et al. (1982), found that even though the average Full Scale IQ was low-average, the educational experience of these children was cause for worry: 64% had been referred for special education services, and only 28% were functioning at or above grade level in school. Lloyd (1984), evaluated very low birthweight children and compared them to their normal birthweight siblings. The two groups showed only modest differences on IQ tests, but there were substantial differences on their performance in school. Hunt et al. (1988) and Ford et al. (1939) also found evidence for unusual discrepancies between IQ and achievement.

The above authors found that although preterm children had similar IQ scores to full-term children, their school performance was poorer than their full-term counterparts. Differing from these results, Greenberg and Crnic (1982), found that with the exception of

motor development, no difference between preterm and full-term children was found on a wide range of measures, including mental development and language skills.

However, the following three studies of extremely low birthweight children (<1000g), found a difference between preterm and full-term children on all scales. It was found that these extremely low birthweight children had more minor neurological, lower intelligence quotients, and more behavioural traits than their controls, (Mills et al. 1989); lower mean verbal IQs than performance IQs, (Joffe et al. 1988); and a greater variability within this birthweight group, (Portnoy et al. 1988).

In conclusion, the majority of studies that compared the intelligence of preterm children to full-term children, found little difference between the two groups. They did, however, find that there was a discrepancy between intelligence and achievement in the preterm group. These children performed poorly at school and showed specific cognitive, perceptual and behavioral problems, even though their IQ's were found to be within the normal range. Greenberg and Crnic (1988), found that the preterm group had poorer motor development than the full-term group.

These findings are consistent with those of Goodman (1987), who found that the preterm children who were diagnosed as At-Risk in the first year of life, had similar scores in almost all Griffiths test areas at the six year assessment as the group diagnosed as Normal (using the NDS). However, the At-Risk group had poorer locomotor scores, and remedial therapy was recommended in 17 of 24 At-Risk children versus six of 25 Normals, due to the presence of soft neurological signs and performance on the tests administered.

2.2.2. LEARNING PROBLEMS AND SCHOOL PERFORMANCE

Although advances in the treatment and management of children born prematurely have reduced severe developmental compromise, these improved results have not been reflected in the more complex arena of school performance. Many authors have found that school age children, who were the beneficiaries of modern medical technology as very low birthweight infants, appear to be at risk for learning problems, and poor progress at school.

These school related problems manifest as subtle motor, visual-motor, perceptual, language and reading difficulties often accompanied by inappropriate classroom behaviour. Kleir et al. (1985), feels that it is of some concern that even those children with

normal intelligence and no overt neurological abnormality are functioning significantly less well on several outcome measures at preschool when compared with matched class mates.

Recent literature has concentrated on the incidence of learning and school related problems amongst children born premature. The following studies have tried to identify the processing deficits that may serve as the substrate for these learning problems. Saigal et al. (1989) in studying the intellectual and behavioural status of children with birthweights of 501 to 1000g, at 5 years of age, found that results showed a wide scatter in performance, but the lowest scores obtained were for visual-motor integration. Ford et al. (1989), also found that while most of the children demonstrated normal overall cognitive function, they displayed subtle dysfunction in the form of visual-motor integration, and other learning disabilities. Klein et al. (1985), found that very low birthweight infants (<1500g), performed significantly less well on spatial relations subtests and on visual-motor integration. Nickel et al. (1982), found deficits in mathematics, in reading comprehension, and in gross and fine motor skills.

Lindahl et al. (1988), found that low birthweight infants at the age of nine years, had neurological problems, motor impairment, reading, writing, language and intelligence problems, and poor school performance.

Relevant to the objectives of the present study, two authors have considered the significance of neurological dysfunction to school achievement, and found contradicting results. Ford et al. (1989), found that the one year neurological score did not correlate with five and six year IQ and visual-motor integration test scores. Hadders-Algra et al. (1988), found that children with definite neonatal neurological abnormalities showed school failure and problems in reading, spelling and arithmetic more often than children without or with only mild neonatal abnormalities.

MOTOR PERFORMANCE

Although major motor impairment or cerebral palsy is a common finding among very low birthweight infants who survive, few studies have considered the less severe impairments. Marlow et al. (1989), in a study of motor skills in very low birthweight children (<1251g) at the age of six years, found that these children had significantly more motor difficulties than controls. Kay and Whitfield (1989), demonstrated that although there is a low incidence of major motor handicap among

infants weighing 800g or less, the majority of these children have evidence of fine motor dysfunction at school entry. Greenberg and Crnic (1988), and Saigal et al. (1989), also found that premature, low birthweight children were significantly poorer in motor skills than full term infants.

LANGUAGE

Schwartz and Schwartz (1977), used the Illinois Test of Psycholinguistic Abilities (ITPA) together with many other tests to determine specific learning problems. Their results showed poor language and auditory perceptual skills in preterm, low birthweight children, and concluded that more attention needed to be focused on these functions. Lindahl et al. (1988), also using the ITPA, found that at nine years of age, low birthweight infants scored significantly poorer than their controls.

Lower mean verbal IQ's than performance IQ's have been found by Lefebvre et al. (1988) and Portnoy et al. (1988). They conclude that some children's weakness in verbal intelligence, in the spheres of abstract thinking and reasoning, may limit their learning abilities at school.

Poor language comprehension and reasoning performance have also been reported among low birthweight children, by Nickel et al. (1982); Michelsson et al. (1984); Rubin et al. 1973); and Holmqvist et al. (1987).

BEHAVIOUR

The literature is not very consistent for behavioural problems. Results of studies have to be interpreted with caution as clearly other factors besides neonatal and follow-up neurological status can be involved in the generation of behavioural difficulties. Findings of studies investigating behaviour, suggest important behavioural style variations among preterm infants. These differences may have important implications for infant learning, as they can influence how infants explore their environments, participate in learning opportunities, and interact with their parents, (Scott and Spiker 1989).

Marlow et al. (1989), found that in children weighing less than 1251g, there was an excess of adverse behavioural characteristics. The index group was significantly more overactive, easily frightened, inattentive and distractible. Hadders-Algra et al. (1988), in studying school achievement and behaviour at nine years found that distractibility was related to adverse neurological findings. Portnoy et al. (1988), in a five year follow-up in a study of infants weighing

less than 1000g, found that the low birthweight children were more active and more intense in their behaviour than their controls.

It appears that maladaptive behaviour is more common among low birthweight children. Dunn (1986), described a negative attitude towards school amongst this group when they become teenagers. It was found that 37 of a sample of 40 low birthweight children had at least some symptoms of an attention deficit disorder at six years, six months. At 13 years of age, hyperkinesis, temper tantrums and perseveration had subsided markedly, but brief attention span, distractability, irritability and/or low thresholds of frustration continued to be a major problem for this group of children.

2.3. CONCLUSION

The longitudinal studies described above, attempt to monitor the development of preterm infants, to provide hypotheses concerning underlying causes of dysfunction, and to predict and understand the developmental problems. In general, preterm infants suffer a number of prenatal and perinatal complications, resulting in varying degrees of neurological dysfunction. As the neurological outcome of these children is of concern, longitudinal studies are important to be able to

accurately predict which infants are at risk. Many of the results are contradictory, and as mentioned before, this may be due to the distribution of birthweights in the preterm population, the age of the infants at the time of assessment, or the developmental skill being evaluated.

It is, however, generally agreed that adverse neurological findings early on in the infants life tend to lead to poorer developmental outcome. With the advent of neonatal intensive care units, there has been a decline in mortality and major neurological impairment amongst preterms. There has been an increased interest in less severe handicap that may go undetected until school age. Latest research emphasises that although preterm children have been found to have, in general, normal intelligence, they have school related, learning, motor, language and behavioural problems.

CHAPTER 3

3. RESEARCH DESIGN

3.1. OBJECTIVES

The objective of this study was to determine the incidence of learning problems in a group of Normal and At-Risk preterm children. The children were allocated to Normal and At-Risk groups, during infancy, using the Neurodevelopmental Assessment Scale (NDS) designed by Goodman (1987). The incidence of specific learning problems that may serve as the reasons for poor school performance in the above population of preterm children was also determined. This study was an eight year follow-up on 40 of the original 80 children born preterm who were assessed in the first year of life by Goodman (1987), using the NDS.

3.2. HYPOTHESIS

The children diagnosed as At-Risk using the NDS in their first year of life, do not have more learning problems and poorer school performance than those children diagnosed as Normal.

3.3. MEASUREMENT TOOLS

The following measurement tools were selected to evaluate longterm outcome, as they measure aspects of function and processing abilities that are related to learning problems and school performance, Ayres (1980).

3.3.1. SOUTHERN CALIFORNIA SENSORY INTEGRATION

TEST (SCSIT) - (Ayres, 1980)

The SCSIT is a battery of standardised tests to identify neural system dysfunction in children with learning disorders. Most of the tests are intended not only to help determine a child's sensory integrative development relative to the normative sample, but also to evaluate the nature of irregular development or dysfunction. Ayres(1979), states that slow learning and poor behaviour in children are often caused by inadequate sensory integration within the child's brain. Sensory integration is the processing and organisation of sensory input for use.

Standardised norms are available for children aged four to nine years. Dysfunction is defined in terms of syndromes which constitute meaningful clusters of test scores that fall a standard deviation or more below age expectations. To interpret the SCSIT, scores are considered individually or they may be grouped to form a picture of the child's dysfunctional areas.

The subtests and their groupings are as follows:
(For detailed descriptions of each subtest, see
Appendix II)

A. VISUAL PERCEPTION -

These tests measure visual, spatial and visual-motor abilities.

- 1) Space Visualization (SV)
- 2) Figure-Ground Perception (FG)
- 3) Position in Space (PS)
- 4) Design Copying (DC)

B. SOMATOSENSORY PERCEPTION -

These tests measure the child's ability to perceive sensory stimuli from the skin, muscles and joints, i.e. the sense of touch and movement.

- 1) Kinesthesia (KIN)
- 2) Manual Form Perception (MFP)
- 3) Finger Identification (FI)
- 4) Graphesthesia (GRA)
- 5) Localization of Tactile Stimuli (LTS)
- 6) Double Tactile Stimuli Perception (DTS)

C. MOTOR PERFORMANCE -

These tests measure motor co-ordination, motor planning and balance.

- 1) Imitation of Postures (IP)
- 2) Bilateral Motor Co-ordination (BMC)

3) Standing Balance -

with eyes closed (SBC); with eyes open (SBO)

4) Motor Accuracy -

with right hand (MAR); with left hand (MAL)

D. OTHER

These tests do not fall under any of the above categories and therefore stand alone. They measure the integration of the two sides of the body and the knowledge of left and right.

1) Crossing the Midline of the Body (CML)

Crossing Midline - Crossed items only (CMX)

2) Right-Left Discrimination (RLD)

3.3.2. DEVELOPMENTAL TEST OF VISUAL-MOTOR

INTEGRATION (VMI) -(Beery, 1989)

The following test is a form-copying test that was used to assess children's sensorimotor development. It requires the integration of sensory inputs and motor actions. The primary purpose of the VMI was to help prevent learning and behavioural problems through early screening identification. This test is based on theories and evidence to support a sensory-motor basis for development of intelligence and achievement. Higher levels of thinking and behaviour require integration among sensory inputs and motor action, (Beery 1989).

The VMI is a pencil and paper test in which 24 graded geometric forms have to be copied. The test was designed for use with preschool and early grade level children. Norms are provided for children from the age of two years, 11 months to 14 years, six months, in the form of age equivalents for raw scores, percentiles and standard scores.

3.3.3. ILLINOIS TEST OF PSYCHOLINGUISTIC ABILITIES

(ITPA) - (Kirk, McCarthy, Kirk, 1968)

The ITPA provides a sampling of several aspects of communication. The individual test scores delineate areas of difficulty in auditory and visual perception and language ability. Included here are the modalities through which sense impressions are received and the forms of expression through which a response is made. The ITPA incorporates the auditory-vocal and the visual-motor channels.

In analysing behaviour which occurs in the acquisition and use of language, the ITPA considers three main processes:

- a) The receptive process - the ability necessary to recognise and/or understand what is seen or heard.

- b) The expressive process - those skills necessary to express ideas or to respond either vocally or by gesture or movement.
- c) An organizing process - this involves the internal manipulation of percepts, concepts, and linguistic symbols.

Two levels of organisation are postulated:

- (i) The representational level - this requires the more complex mediating process of utilising symbols which carry the meaning of an object.
- (ii) The automatic level - the individual's habits of functioning are less voluntary but highly organized and integrated. This level is involved in such activities as visual and auditory closure, speed of perception, ability to reproduce a sequence seen or heard, synthesising isolated sounds into a word, and utilising the redundancies of experience.

The ITPA consists of the following 12 subtests:

THE RECEPTIVE PROCESS:

- 1) Auditory Reception (AR)
- 2) Visual Reception (VR)

THE ORGANISING PROCESS:

- 3) Auditory Association (AA)
- 4) Visual Association (VA)

THE EXPRESSIVE PROCESS:

- 5) Verbal Expression (VE)
- 6) Manual Expression (ME)

FUNCTIONS TESTED ON THE AUTOMATIC LEVEL:

- 7) Grammatical Closure (GC)
- 8) Auditory Closure (Supplementary test)
- 9) Sound Blending (Supplementary test)
- 10) Visual Closure (VC)
- 11) Auditory Sequential Memory (AM)
- 12) Visual Sequential Memory (VM)

A composite score is calculated as an average score for the above subtests, (ITPA comp.).

Psycholinguistic age norms and scaled score norms for the 12 ITPA subtests are available in the ITPA manual for children ranging from two years, four months to ten years, three months. Composite age norms are available for the ten basic subtests, i.e. excluding Auditory Closure and Sound Blending. For this reason, these two supplementary tests were not administered in this study. All individual test scores were converted to standard scores for comparison purposes.

3.3.4. SCHOOL PERFORMANCE

The class teacher of each child was interviewed by telephone, after the assessments described above had been administered. As each school has a different system of recording a child's performance, the teacher was asked to evaluate each subject according to the following grading:

- 1 - GOOD
- 2 - ABOVE AVERAGE
- 3 - AVERAGE
- 4 - BELOW AVERAGE
- 5 - FAIL

A score below three, i.e. a score of four or five, was considered to be dysfunctional.

The teacher was asked to rate the following categories of school performance using the above scale:

- Maths
- English
- Afrikaans
- Writing
- Reading
- Spelling
- Neatness
- Concentration

A note was made as to whether the child had had previous Occupational Therapy or was at a special school.

3.4. STUDY POPULATION

The original population as selected by Goodman (1987), consisted of 80 very low birthweight infants, (<34 weeks and <1700 grams). These infants were assigned to neurologically Normal or At-Risk groups on the basis of the Neurodevelopmental Assessment Scale. Infants were further divided into physiotherapy treatment or non-treatment subgroups, and the effect of physiotherapy was assessed at one year. It was found that in neither Normal nor At-Risk groups did physiotherapy treatment alter the pattern of development.

Between January 1988 and December 1989, at the age of six years two months, 49 of the original 80 infants were re-assessed. As had been observed at the one year assessment, at six years there was again no difference between the physiotherapy treatment and non-treatment groups. Therefore, the subgroups of treatment and non-treatment were combined to form only the two major groups of At-Risk and Normal. In the present study, 40 of the original 80 infants were followed up at between 7 and 9 years of age. There were 21 children in the At-Risk group and 19 in the Normal group.

3.5. STUDY METHOD

- 1) The telephone numbers of the 49 children who were located between 1988 and 1989, was made available to the author. The aims and details of the study were explained to the parents, over the telephone, and they were given the choice as to whether they wanted to participate or not. The parents were also given a letter of consent, explaining the study in further detail (See Appendix III), which they were required to sign. Of the 49 children tested at a mean age of six years, ten months. 40 were traced by the author for this present study. All 40 parents gave their consent.
- 2) Each child was assessed by the author between July 1990 and November 1990, at ages ranging from seven to nine years. The author did not know to which group the children belonged (i.e. At-Risk or Normal), or who had been receiving Occupational Therapy since the termination of Goodman's (1987) treatment, or who was at a remedial school. The assessments were administered at each child's home, so as not to inconvenience the parents, or cause stress to the child. To ensure that each child was assessed in as similar a manner as possible, an adjustable table and two chairs of the correct height were provided by the author. The assessments

took place in a quiet part of the house, usually the child's bedroom, to ensure optimal concentration. English or Afrikaans instructions were used, depending on the child's home language. The SCSIT is published in English, but has been translated into Afrikaans and published by the South African Institute of Sensory Integration. The ITPA has been translated directly into Afrikaans, (see Appendix IV). Administration of the assessments took two hours, and the child was given a 15 minute break after the first hour.

- 3) After the child was assessed and the tests scored, on permission of the parents, the school teachers of the children were contacted by telephone and their school performances were discussed.
- 4) Once the tests were scored, the parents were informed of the results by telephone. However, if problems were noted and recommendations concerning therapy needed to be made, the author visited the parents to give them feedback.
- 5) All the tests were scored according to their individual scoring instructions. The raw scores for all the tests were converted to standard scores (z scores), using tables adjusted for age. A standard deviation of < -0.9 was considered below average.

The number of children in each group i.e. At-Risk and Normal, who obtained scores below and above the average were used for comparative purposes.

- 6) The two groups i.e. At-Risk and Normal, were compared in terms of the incidence of learning problems occurring in each group, and the types of learning problems found in each group.

The incidence of learning problems:

Those children who were attending special schools, and/or those who had been receiving Occupational Therapy after Goodman (1987) had terminated her treatment, were considered by the author as having learning problems. Those children who were referred to therapy by the author as a result of the assessments done in this study were also considered as having learning problems. Children were referred for therapy by the author on the basis of the scores and their performance at school.

Thus, the children were either given a score of "1" or "2" for the above categories. A "1" indicated "Yes" and "2" indicated "No" i.e. Yes/1 if the child had attended a special school; Yes/1 if the child had received previous treatment; and Yes/1 if the author had recommended the child for therapy.

To determine the incidence of learning problems, the Normal and At-Risk groups were also compared in terms of number of subtests scoring below average, and number of school performance items below average.

Types of learning problems:

In analysing the results, the author also tried to identify specific dysfunctional areas to determine the types of learning problems present in the two groups.

- 1) Within the At-Risk and Normal groups, Goodman's (1987) subgroups of treatment and non-treatment were taken into consideration when looking at the results of the assessment and analysing the data of this present study. During this analysis of data, no significant difference was found between the four groups. Therefore, for this study, the subgroups of treatment and non-treatment were combined to form only the two major groups of At-Risk and Normal. Only these two major groups were included in the results of this study.

3.6. ANALYSIS OF DATA

Statistical analysis was carried out by Doctor G. Reinach at the Medical Research Council, Southern Transvaal branch.

Because of the small sample size, the Fisher Exact, non-parametric Test or the Mann-Whitney, non-parametric tests were used for the two-way tables when comparing the Normal and At-Risk groups. To look for any significance between physiotherapy treated and non-treated subgroups within the At-Risk and Normal groups, multivariant analysis was used to analyse the data. As no significant difference was found between the four groups mentioned above, two-way tables were used to consider only the main effect i.e. At-Risk and Normal groups.

The mean and standard deviations for all the statistical variables can be located in Appendix V. Differences were considered to be significant at a probability level of $p < 0.05$.

CHAPTER 4

4. RESULTS

The incidence of learning problems in the Normal and At-Risk groups was examined to determine whether those preterm children diagnosed as At-Risk have more learning problems than those diagnosed as Normal.

4.1. SAMPLE ANALYSIS

At the six year follow-up assessment carried out by Goodman (1987), 49 of the original 80 subjects were available for full evaluation. Of the children who had dropped out, several had moved to another country, while others had moved from the area without leaving a forwarding address. Those remaining in the study were found to be similar to those who had been lost over the years, in terms of NDS and Griffiths assessments at one year, Socioeconomic Scores, and various clinical indicators of severity of disease. When analysed according to original groups, there was no significant difference between returning Normal and At-Risk infants and the original sample, in terms of birthweight and gestational age, one year NDS and Griffiths scores,

(Goodman 1987). In the present study, 40 of the above 49 subjects could be traced for evaluation. As only nine children were lost to follow-up, it was not thought necessary to analyse the sample according to Goodman's original group, as this had already been done at the six year follow-up, where no significant intergroup differences were noted.

4.2. COMPARISON OF NORMAL AND AT-RISK GROUPS

These two groups were compared in terms of the incidence of learning problems occurring in each group, and the types of learning problems found in each group.

4.2.1. INCIDENCE OF LEARNING PROBLEMS

The following criteria to determine a learning problem were analysed:

- (A) Whether the child had had previous treatment (i.e. Occupational Therapy) and/or whether therapy had been recommended by the author as a result of the assessments administered in this study;
- (B) The number of subtests for each child scoring below average (< -0.9 standard deviations);
- (C) The number of school performance items for each child scoring below average (4 or 5).

(A) **PREVIOUS TREATMENT AND RECOMMENDED TREATMENT -**

If the child had either of the above, it was considered that learning problems were present, regardless of the scores obtained on testing. No significant difference was found between the Normal and At-Risk groups in terms of learning problems (see Table I). Although not statistically significant, these results might possibly be clinically significant, as 14 of the 21 At-Risk children had problems compared to seven of the 19 Normal children.

TABLE I

**LEARNING PROBLEMS VERSUS NO LEARNING PROBLEMS IN
THE AT-RISK AND NORMAL GROUPS**

	AT-RISK	NORMAL
LEARNING PROBLEMS	14 (66.7%)	7 (36.8%)
NO LEARNING PROBLEMS	7 (33.3%)	12 (63.2%)
TOTAL (n)	21 (100%)	19 (100%)

Fisher Exact Test (2-tail) p Value = 0.1119 NS

(B) **NUMBER OF SUBTESTS SCORING BELOW AVERAGE -**

Combined perceptual-motor, sensori-motor and language scores were considered together. The number of subtests failed, (i.e. below < -0.9 standard deviations), for each individual were counted.

The average number of failures in the At-Risk group was compared with the average number of failures in the Normal group, (mean of At-Risk group = 5.71; mean of Normal group = 5.11). Due to the small data set, the Mann-Whitney, non-parametric test was used, and no statistical difference was found between the two groups, ($p = 0.8093$). See Appendix VI.

(C) NUMBER OF SCHOOL PERFORMANCE ITEMS BELOW AVERAGE -

The same statistical procedure as in (B) was used to analyse this data. Although there was no significant difference between At-Risk and Normal groups, there was perhaps a trend towards significance, with the p value = 0.055 (the At-Risk group tending to have a greater number of school items below average (mean = 4.00) than the Normal group (mean = 2.13). See Appendix VI.

4.2.2. TYPES OF LEARNING PROBLEMS:

The Normal and At-Risk groups were also compared in terms of types of learning problems present. To identify specific dysfunctional areas the subtests were dealt with in the following ways:

- (i) Subtests were grouped into five categories according to the area of function they were testing (see Appendix VII);
- (ii) Individual subtests were considered separately. The number of children scoring below average, (< -0.9 standard deviations), in each individual test were counted, and compared according to At-Risk and Normal groupings.
- (iii) Differences in individual school performance scores. The number of children scoring below average (< 3) on specific school performance items in the At-Risk and Normal groups.

(1) COMPARING THE CATEGORIES OF DYSFUNCTION

The 29 subtests administered were grouped into the five functional areas of Visual Perception, Somato-Sensory Perception, Motor Performance, Bilateral Integration and Language. The two groups of Normal and At-Risk were compared in terms of their performance in each category.

No significant difference was found between these two groups in any of the five categories of function, (see Table II).

TABLE II
DIFFERENCES IN SPECIFIC AREAS OF FUNCTION

AREAS OF FUNCTION	AT RISK (n=21)		NORMAL (n=19)		P
	mean	sd	mean	sd	
VISUAL PERCEPTION	-0.01	0.71	0.15	0.69	>.15 NS
SOMATO- SENSORY	-0.05	0.59	0.08	0.63	>.05 NS
MOTOR	-0.84	0.70	-0.50	0.68	>.05 NS
BILATERAL INTEGRATION	-0.60	1.16	-0.83	1.00	>.05 NS
LANGUAGE	-0.08	0.80	-0.18	0.60	>.05 NS

(ii) DIFFERENCES IN INDIVIDUAL SUBTESTS

For each subtest administered, the Normal and At-Risk groups were compared in terms of number of children scoring below average in each group. The Fisher Exact Test, 2-way tables, was used.

In the majority of the subtests, no significance was found. The two tests demonstrating significance were SBO (Standing Balance with Eyes Open), $P = 0.0014$; and BMC (Bilateral Motor Coordination), $P = 0.0211$. For SBO, the At-Risk

group had significantly lower scores than the Normal group. In BMC, however, the Normal group had significantly lower scores than the At-Risk group, (see Table III). Due to the large number of subtests administered, these scores may have been co-incidence, and do not necessarily indicate a difference between the two groups.

TABLE III
NUMBER AND PERCENTAGE OF CHILDREN SCORING BELOW
AVERAGE FOR THE INDIVIDUAL SUBTESTS

SUBTESTS	AT-RISK (n=21) n	NORMAL (n=19) n	P
SV *	8 (38.1%)	6 (31.6%)	>.05 NS
PG *	3 (14.3%)	1 (5.3%)	>.05 NS
PS *	3 (14.3%)	2 (10.5%)	>.05 NS
DC *	4 (19.0%)	3 (15.8%)	>.05 NS
VMI	2 (9.5%)	2 (10.5%)	>.05 NS
KIN *	3 (14.3%)	1 (5.3%)	>.05 NS
MFP *	3 (14.3%)	1 (5.3%)	>.05 NS
PI *	6 (28.6%)	1 (5.3%)	>.05 NS
GRA *	8 (38.1%)	6 (31.6%)	>.05 NS
LTS *	5 (23.8%)	3 (15.8%)	>.05 NS
DTS	0 (00.0%)	1 (5.3%)	>.05 NS
IP *	2 (9.5%)	1 (5.3%)	>.05 NS
SBO *	9 (42.9%)	0 (00.0%)	<.05 B
SBC *	4 (19.0%)	2 (10.5%)	>.05 NS
MAR *	18 (85.7%)	13 (68.4%)	>.05 NS
MAL *	18 (85.7%)	13 (68.4%)	>.05 NS
CML	7 (33.3%)	8 (42.1%)	>.05 NS
CMX	8 (38.1%)	10 (52.6%)	>.05 NS
BMC	4 (19.0%)	11 (57.9%)	<.05 B
RLD	2 (9.5%)	5 (26.3%)	>.05 NS
ITPA (COM) *	3 (14.6%)	1 (5.3%)	>.05 NS
VR *	5 (23.8%)	4 (21.1%)	>.05 NS
VA *	6 (28.6%)	5 (26.3%)	>.05 NS

VN	4 (19.0%)	4 (21.1%)	>.05 NS
VC *	7 (33.3%)	6 (31.6%)	>.05 NS
AR *	7 (33.3%)	5 (26.3%)	>.05 NS
AA *	7 (33.3%)	4 (21.1%)	>.05 NS
AM *	6 (28.6%)	3 (15.8%)	>.05 NS
VZ	3 (14.3%)	7 (36.8%)	>.05 NS
ME *	3 (14.3%)	2 (10.5%)	>.05 NS
GC *	5 (23.8%)	3 (15.8%)	>.05 NS

The * indicates subtests where the At-Risk group scored lower than the Normal group.

The few tests found to show significant differences At-Risk and Normal groups for each individual test, may be due to the small sample number, and the difference between groups can only be improved by increasing the sample number. In general, the At-Risk group had consistently lower scores than the Normal group (as indicated by * in Table III). This may imply that although there is no statistical significance, there may be a clinical difference.

(iii) DIFFERENCE IN INDIVIDUAL SCHOOL PERFORMANCE SCORES

The number of children scoring below average for each school performance item i.e. Maths, English, Afrikaans, Writing, Reading, Spelling, Neatness and Concentration were counted and compared in the Normal and At-Risk groups. The Fisher Exact Test was used. Statistical significance was only found in the Maths variable. However, the At-Risk group show consistently more subjects below average than the Normal group. This appears to be clinically significant, and if larger numbers had been available, statistical significance may have been achieved. (see Table IV).

TABLE IV
NUMBER AND PERCENTAGE OF CHILDREN SCORING BELOW AVERAGE
IN SCHOOL PERFORMANCE ITEMS

SCHOOL ITEMS	AT-RISK (n=21) n	NORMAL (n=19)	P
MATHS	8 (38.1%)	1 (5.3%)	0.021 S
ENGLISH	5 (23.8%)	2 (10.5%)	>.05 NS
AFRYKAANS	5 (23.8%)	2 (10.5%)	>.05 NS
WRITING	6 (28.6%)	1 (5.3%)	>.05 NS
READING	5 (23.8%)	1 (5.3%)	>.05 NS
SPELLING	6 (28.6%)	1 (5.3%)	>.05 NS
NEATNESS	7 (33.3%)	4 (21.1%)	>.05 NS
CONCENTRA- TION	6 (28.6%)	5 (26.3%)	>.05 NS

4.3. SUMMARY

In most of the results, very little significance was found. Although there is an indication towards clinical significance in some of the results, the only statistical significance was found in the subtests of Standing Balance with Eyes Open (SBO), Bilateral Motor Co-ordination (BMC) and Maths. For SBO and Maths, the At-Risk group had poorer scores than the Normal group. However, for BMC, the Normal group has poorer scores than the At-Risk group.

There is a trend towards significance in school performance when considering the number of scores below average per child ($p = 0.056$). This indicates that the At-Risk group tend to have a greater number of school items below average than the Normal group. However, it must be noted, that a level of $p < 0.05$ is probably significant versus almost certainly significant at $p < 0.01$.

CHAPTER 5

5. DISCUSSION AND CONCLUSION

5.1. DISCUSSION

At the one year assessment, and again at six years there was no difference between the physiotherapy treatment and non-treatment groups of preterm children, i.e. those children who were given physiotherapy by Goodman (1987) in their first year of life, did not do better on the NDS or Griffiths test at one and six years, than those children who were not given physiotherapy. These two subgroups were thus combined to yield only the two major groups, At-Risk and Normal.

In this present study, again no differences were found in the treatment and non-treatment subgroups as evaluated by the tools used in this thesis. Thus, the differences in At-Risk and Normal groups were analysed and will be discussed here.

CHAPTER 5

5. DISCUSSION AND CONCLUSION

5.1. DISCUSSION

At the one year assessment, and again at six years there was no difference between the physiotherapy treatment and non-treatment groups of preterm children, i.e. those children who were given physiotherapy by Goodman (1987) in their first year of life, did not do better on the NDS or Griffiths test at one and six years, than those children who were not given physiotherapy. These two subgroups were thus combined to yield only the two major groups, At-Risk and Normal.

In this present study, again no differences were found in the treatment and non-treatment subgroups as evaluated by the tools used in this thesis. Thus, the differences in At-Risk and Normal groups were analysed and will be discussed here.

The present study, assessed 40 of the original 80 subjects, at seven to nine years of age. Learning problems and school performance were assessed and compared in the At-Risk and Normal groups. Considering the lack of statistical significance of the results, no difference was found between the two groups. This suggests that with increasing age, the children assessed as At-Risk, catch up to those assessed as Normal. One must take into account, however, that the number of subjects in this study was very small, with 21 children in the At-Risk group, and 19 children in the Normal group.

In this study there do, however, appear to be differences between the At-Risk and Normal groups which, although not statistically significant, appear clinically significant. More of the children in the At-Risk group have had previous treatment or were recommended for treatment, (66.7% of the At-Risk group versus 36.8% of the Normal group). The At-Risk group also appeared to be poorer in school performance than the Normal group, ($p=0.056$). If the clinical differences are taken into account, it does appear as if the NDS during the first year of life is predictive of later developmental outcome. This finding should be taken into consideration when counselling parents, either by reassurance that the prognosis is probably good for future development if the early NDS is good,

or to emphasise the need for careful monitoring and follow-up if the NDS is poor.

Differing from the present study, Ross et al. (1986), in a follow-up of 79 premature infants, found that abnormal neurodevelopmental items in the first year of life predicted poorer developmental outcome at one and three years of age. These early examinations correctly classified 80% of the children as to the composite outcome at three years.

Hadders-Algra et al (1988), who carried out a study on 133 neurologically deviant infants, 205 with mild abnormalities and 230 normal newborns, found that definite neonatal neurological abnormalities contributed to cognitive and behavioural difficulties at nine years of age. To determine the child's performance, reading, spelling and arithmetic were assessed, and school achievement was considered to be unsatisfactory if the child attended a school for learning disorders or was not in the appropriate grade for age. It was thus concluded in this study, that neurological abnormalities at birth appears to be an indicator of a risk for learning and behavioural problems.

The above studies demonstrate that neurological abnormalities early on in life, predict poorer developmental outcome. Both studies used large sample numbers. In this present study, if the sample number had been larger, there may have been a significant difference between the At-Risk and Normal groups.

In trying to identify types of learning problems, by dividing tests into functional categories and dealing with individual subtests, no significant difference was found between the At-Risk and Normal groups. This suggests that although the At-Risk group tend to have more problems at school, and more therapy, no specific learning problems could be found. This may suggest that other factors come into play, for example, social, emotional, family and environmental factors. It also may suggest that the tests used in this study were not of a type that could pick up factors which may influence school performance, other than perceptual, sensory, motor and language problems.

A larger sample number may have shown a greater difference between the two groups. Unfortunately, as in most longitudinal studies, many children were lost to follow-up. Aspects of these results are discussed further in the following sub-sections.

5.1.1. INCIDENCE OF LEARNING PROBLEMS

PREVIOUS TREATMENT AND RECOMMENDED TREATMENT

Taking previous treatment and recommended treatment as indicators of learning problems, it was found that there was no significant difference between the At-Risk and Normal groups. However, as 66.7% of the At-Risk group and only 36.8% of the Normal group had had previous treatment or were recommended for treatment, there does appear to be a clinical difference here. This suggests that the At-Risk group has a greater chance of requiring therapy.

NUMBER OF TEST SCORES BELOW AVERAGE

Looking at the number of subtests per child scoring below average, no significant difference was found between the At-Risk and Normal groups. Thus, neither group had a greater incidence of learning problems as assessed by the tests administered in this study.

NUMBER OF SCHOOL PERFORMANCE ITEMS BELOW AVERAGE

Looking at the number of school performance results per child that were below average, the p-value only just missed significance, (0.056). This may be clinically significant, suggesting that the At-Risk children have more school subjects falling below average than the Normal group of children.

5.1.2. TYPES OF LEARNING PROBLEMS IDENTIFIED

CATEGORIES OF LEARNING PROBLEMS

When grouping the subjects into categories of perceptual, sensory, motor bilateral integration and language abilities, no significant difference was found between the At-Risk and Normal groups. Therefore, no difference in specific types of learning problems, as described by these categories, was found between the two groups.

INDIVIDUAL SUBTESTS

When looking at individual subtests, only two tests showed a significant difference between the At-Risk and Normal groups. The At-Risk had poorer Standing Balance with Eyes Open, and the Normal group had poorer Bilateral Motor co-ordination. As so many subtests were done, these scores could have been co-incidence, and do not really indicate a difference between the two groups. In general, the At-Risk group has lower scores than the Normal group, (in 23 of the 31 subtests). Although the majority are not statistically significant, if the numbers in the sample were increased, these differences may be more substantial.

INDIVIDUAL SCHOOL PERFORMANCE ITEMS

Looking at individual items testing school performance, statistical significance was only found in "maths", with 38.1% of the At-Risk group and only 5.3% of the Normal group scoring below average. However, the At-Risk group had consistently more school performance items below average than the Normal group, which appears to be clinically significant.

These results are similar to those of Nickel et al. (1982), in their study of a group of 25 preterm children with birthweights of 1000 g or less. They found that at a mean age of 10.6 years, even though the average Full Scale IQ was 90.5 (which is in the low-average range), the educational experience of these children was quite worrying: 64% had been referred for special education services, and only 28% were functioning at or above grade level in school. Arithmetic reasoning, mathematical achievement, and reading comprehension were specific weaknesses. Fine and gross motor skills were impaired. Perceptual skills were impaired to a lesser degree. Lloyd (1984), compared very low birthweight children to their normal birthweight siblings. The two groups exhibited only modest differences on IQ tests, but there were substantial differences on their performance in school.

5.1.3. SIX YEAR GRIFFITHS SCORES

In contrast to the major differences in Neurodevelopment Assessment Scores and Griffiths Developmental Quotients, (which is a measure of intelligence), between At-Risk and Normal groups at one year, at the six year assessment infants were similar in all Griffiths test areas other than on the locomotor sub-scale, (see Appendix IX). This suggests that, in Goodman's study (1987), even though more children from the At-Risk group were recommended for therapy by Goodman, (see Appendix VIII), few differences in test scores were found as a result of the Griffiths assessment.

This is similar to the results of the present study. Few differences were found in test scores between the two groups, but the At-Risk had more learning problems as identified by previous therapy and recommended therapy, and appeared to have poorer school performance scores.

5.1.4. VARIABLES AFFECTING OUTCOME

The variables listed below may influence the developmental outcome of a child to a lesser or greater extent, and therefore, have to be taken into account when considering the results of this study.

SOCIO-ECONOMIC STATUS

The socio-economic status of the family has been described by many authors as being a very important factor influencing the developmental outcome of infants, (Drillien et al. 1980, Klein et al. 1985, Kitchen et al. 1980, Dunn 1986, Meligan et al. 1976, Hunt et al. 1988, Ross et al. 1982, Pederson et al. 1988, Lindahl et al. 1988).

This suggests that there are strong influences of the environment on future development. Largo et al. (1986), states that the environmental influences such as socioeconomic status and the nature of the caregiver-infant interaction have been judged by many authors to play a more important role in cognitive and language development than biological factors.

At the six year assessment, Goodman (1987) found that socio-economic status was related to outcome in both groups, and was responsible for 19% of the Developmental Quotient variance in the At-Risk infants and 27% of the variance in the normal group.

NUMBER OF READMISSIONS TO HOSPITAL

Goodman (1987), found that in the original 80 infants, there were significant differences between Normal and At-Risk infants for number of readmissions to hospital during the first year of life. Goodman (1987), noted

that the higher readmission rate for At-Risk infants could not be explained in terms of a larger number of infants with bronchopulmonary dysplasia or complicated intraventricular haemorrhage. Rather, it appeared that At-Risk infants may have been socially and economically more dependent on the hospital for health care.

Hospitalisation may influence mother-child interaction. Cohen and Beckwith (1979), found that the quality of caregiver-infant interaction at one and eight months was the best predictor of two year intelligence. Also, the emotional status of the child could have been influenced by repeated hospitalisation. These factors may have contributed to the poorer school performance of the At-Risk group compared to the Normal group.

BEHAVIOUR AND EMOTIONAL STATUS OF THE CHILD

These aspects were not considered in this study, but should be mentioned here, as they are important in the process of learning. Also, it was felt by the author that some of the children assessed, although achieving good results on the assessments, showed emotional immaturity. This subjective observation was confirmed by four telephone calls received from worried parents subsequent to the assessments. The four parents felt that their children were not coping at school due to lack of confidence and emotional problems. Three of these four children were from the At-Risk group and one

was from the Normal group. None of these children had poor enough test results to warrant referral for treatment. Behaviour, as described by Scott and Spiker (1989), can influence how infants explore their environments, participate in learning opportunities, and interact with their parents. Hadders-Algra et al. (1988) found that distractability and clumsiness were both related to neurological findings. Thus, behavioural or emotional aspects may also influence a child's ability to perform at school.

Tausch and Yogman (1987), found in their review of the literature, that adverse social and biological conditions place children at risk for learning disabilities, and behavioural problems, especially by school age. They concluded that medical complications and social disadvantage place preterm infants at double jeopardy for developing behaviour problems, in particular.

TEACHING METHODS AND PREVIOUS THERAPY

All the children in this study were attending different schools at the time of assessment. Drillian et al. (1980), pointed out that comparisons of school performance of low birthweight children may be affected by the likelihood of there being much variety in teaching methods because of the large number of schools they were attending. As the author had contact with

several different teachers. teacher subjectivity could also affect results. As this research is part of a longterm follow-up, these children have had contact with the professionals in the medical field, and they have been recommended for therapy when it was thought to be appropriate. Thus, although this fact was taken into account when looking at incidence of learning problems, previous therapy could have been one of the reasons why no differences in learning problems were found between the At-Risk and Normal groups. This should possibly have been analysed further to determine the effect therapy would have had on the test results.

5.2. CONCLUSION

Neurological abnormalities in the first year of life, as assessed by Goodman (1987) using the Neurodevelopmental Assessment Scale (NDS), was predictive of the Developmental Quotient on the Griffiths Test at one year. Thus, the poorer developmental outcome of At-Risk infants on both the NDS and the Griffiths Test at one year appeared to validate the scoring system. Longterm follow-up was recommended by Goodman (1987) in order to test the NDS scoring system on later developmental outcome.

At the six year follow-up, 49 of the original 80 infants were assessed. Similar mean Developmental Quotients were found for At-Risk and Normal infants, using the Griffiths test, but the locomotor score of At-Risk infants was significantly below that of the Normal infants. Cerebral Palsy occurred in six of 24 At-Risk versus zero of 25 Normal infants. Remedial therapy was recommended in 17 of 24 At-Risk infants versus six of 25 Normals. These results confirmed that the NDS predicts a risk for Cerebral Palsy and soft neurological problems.

In this study, no significant difference was found in the incidence of learning problems between the At-Risk and Normal groups, as measured by the number of children who had had previous therapy and/or who were recommended therapy, or who had poor school performance and poor test results. There was, however, a trend towards significance in school performance. This suggests that the At-Risk group of children appear to do poorer at school than the Normal group. Also, more of the At-Risk group appear to have had previous treatment and more children from this group were recommended for treatment by the author.

In longitudinal studies there are many factors that can influence later developmental outcome. A more complete understanding of early learning and development in

preterm infants must take into account the complex and integrated nature of information-processing capabilities, behaviour style characteristics, and the social-environmental context. As discussed previously, the socio-economic status, number of hospital readmissions, behaviour and emotional status of the child, difference in teaching methods and previous therapy, could all influence developmental outcome.

In conclusion, in terms of learning problems and school performance, there was no significant difference between the At-Risk and Normal groups of children in this study. This suggests that the NDS is not predictive of developmental outcome. There is, however, some difference between the two groups which may be clinically significant. More children from the At-Risk group had had previous therapy and/or were recommended for treatment by the author, and these children had poorer school performance than the Normal group. Thus, those children diagnosed as At-Risk on the NDS in their first year of life should be carefully followed-up until school going age. This suggests that the NDS is predictive of which children need continued monitoring and which children do not.

5.3. RECOMMENDATIONS

This study confined itself to the assessment of learning problems and school performance. The At-Risk and Normal groups differed in school performance, but not in the incidence of learning problems. Therefore, it is felt that other factors such as behaviour and emotional status of the child may play a part in school performance. In future, more emphasis should be placed on behavioural and emotional aspects, including confidence and emotional maturity.

APPENDIX I

THE NEURODEVELOPMENTAL ASSESSMENT SCORE (NDS)

The 12 items used in the NDS are:

- 1) The Moro Reflex
- 2a) The Placing Reaction (of the foot)
- 2b) The Parachute Reaction
- 3) The Asymmetrical Tonic Neck Reflex
- 4) Eye Contact and Following
- 5) Head Control (head lag, pull to sit)
- 6) Development of Hand Function (fisting, hands to midline, reach, transfer)
- 7) Retraction of neck and shoulders
- 8) Prone Position Test (maintaining head control, weight bearing on arms)
- 9) Sit Position Test
- 10) Supine Rolling
- 11) Legs - Weight bearing and walking
- 12) Suspension - Horizontal and Oblique

APPENDIX II

FULL DESCRIPTION OF TESTS USED FOR THIS STUDY

Southern California Sensory Integration Tests -

Ayres, 1980.

A. VISUAL PERCEPTION:

1) Space Visualisation.

This test is intended to require perception of stimuli composed largely of spatial elements including, in the more advanced items, mental manipulation of space.

2) Figure-Ground Perception.

To assist in the determination of deficits in visual perception which require selection of a foreground figure from a rival background.

3) Position in Space.

To measure the perception of the same form in different orientations.

4) Design Copying.

To measure a combination of visual perception of a geometric design and the capacity of the brain to direct the hand in duplicating that design. Thus it is a visual-motor test tapping several neural systems.

B. SOMATOSENSORY PERCEPTION:

1) Kinaesthesia.

To measure the capacity to perceive joint position and movement.

2) Manual Form Perception.

This test is based on classical methods of testing stereognosis. The child identifies shapes by feeling them behind a screen.

3) Finger Identification.

The identification of fingers touched by the examiner, to test the sense of touch.

4) Graphaesthesia.

This test is a children's version of the clinically well-known procedure of drawing figures. In this case simple designs are drawn on the back of the hand, and the child repeats the drawing.

5) Localization of Tactile Stimuli.

In this test the child is expected to place a finger on a spot on his or her hand or arm previously touched by the examiner.

6) Double Tactile Stimuli Perception.

This test is based on clinical procedures of long usage, i.e. applying two tactile stimuli simultaneously to either or both the hand and cheek.

C. MOTOR PERFORMANCE:

1) Imitation of Postures.

This test requires the child to assume a series of positions or postures demonstrated by the examiner, a process that requires motor planning or programming a skilled or non-habitual motor act.

2) Bilateral Motor Co-ordination.

Performing the tasks of this test requires smoothly executed movements and an interaction between both upper extremities. Both motor planning and integration of function of the two sides of the body are involved.

3) Standing Balance.

The ability of the child to balance while standing on one foot with eyes open and with eyes closed, is measured by this test.

4) Motor Accuracy.

This test employs a motor response in connection with a visual stimulus, emphasizing the motor aspect. It is designed to measure with fine discrimination the accuracy of the visually directed hand use of a pen.

D. OTHER:

1) Crossing the Midline of Body.

The ability of the child to point to the ipsilateral or contralateral eye or ear.

2) Right-Left Discrimination.

This test measures the child's ability to discriminate right from left on self and on the examiner.

The Illinois Test of Psycholinguistic Abilities -Kirk, McCarthy, Kirk, 1968.

THE RECEPTIVE PROCESS:

1) Auditory Reception

This is essentially a vocabulary test, and measures the child's ability to derive meaning from verbally presented material.

2) Visual Reception

The ability of the child to gain meaning from visual symbols.

THE ORGANIZING PROCESS:

3) Auditory Association

This test taps the child's ability to relate concepts presented orally. The organizing process of manipulating linguistic symbols in a meaningful way is tested by verbal analogies of increasing difficulty.

4) Visual Association

The organizing process in this channel is tapped by a picture association test with which to assess the child's ability to relate concepts presented visually.

THE EXPRESSIVE PROCESS:

5) Verbal Expression

This test taps the child's ability to express concepts vocally. The child is required to describe given objects.

6) Manual Expression

This test taps the child's ability to express ideas manually. This ability is assessed by a gestural manipulation test.

FUNCTIONS TESTED ON THE AUTOMATIC LEVEL:

7) Grammatical Closure

This tests the child's ability to make use of the redundancies of oral language in acquiring automatic habits of handling syntax and grammatical inflections.

8) Auditory Closure (Supplementary test)

This assesses the child's ability to fill in missing parts which were deleted in auditory presentation and to produce a complete word.

9) Sound Blending (Supplementary test)

The child must synthesize parts of a word spoken separately at half-second intervals. Thus he has to synthesize the separate parts of the word and produce an integrated whole.

10) Visual Closure

This involves figure-ground perception and requires completion of common objects, pictures of which are presented as incomplete.

11) Auditory Sequential Memory

This test assesses the child's ability to reproduce from memory sequences of digits increasing in length from two to eight digits.

12) Visual Sequential Memory

This requires the reproduction of sequences of nonmeaningful figures from memory.

APPENDIX III
LETTER OF CONSENT

Dear Parent and Child,

Much research has been done concerning the difficulties experienced by some children born prematurely. You have already been involved in one such study by Professor Goodman, shortly after your child was born. Professor Goodman's study was to evaluate the effectiveness of physiotherapy on the developmental outcome of preterm infants.

I am an Occupational Therapist, and I am involved in a study to determine whether children born prematurely, experience learning difficulties and school related problems. This study is a follow-up to Professor Goodman's research thesis.

I would like to do a full Occupational Therapy assessment on your child. This would take approximately 2 hours to administer, and will take place in your own home to prevent any inconvenience to yourselves. I will also be looking at school performance, and would therefore also like your permission to contact your child's teacher to get a list of grades for each subject.

If learning difficulties are found as a result of the assessments, I will spend time with you, giving a full report-back and making recommendations if necessary.

Participation is voluntary and no-one will be penalized in any way if they do not participate and you may withdraw from the study at any time. Confidentiality is assured.

If you are happy to participate in this study outlined above, please sign the relevant portion below.

Yours sincerely,

Kate Bailey (Tel: 465-2541)
OCCUPATIONAL THERAPIST
University of the Witwatersrand

.....

I agree to participate in the study outlined above.

PARENT:

Name.....Signature.....

CHILD:

Name.....Signature.....

APPENDIX IV

AFRIKAANS TRANSLATIONS FOR THE ITPA

OUDDITIEWE ONTVANGS:

DEMO I

- (a) Kan seuntjies speel?
- (b) Kan stoale speel?
- (c) Kan stoale eet?
- 1. Kan honde eet?
- 2. Kan honde vlieg?
- 3. Kan bone vlieg?
- 4. Kan babas drink?
- 5. Kan babas huil?
- 6. Kan fietsse eet?
- 7. Kan rokke sing?
- 8. Kan kinders klim?
- 9. Kan katte bief?
- 10. Kan bys steek?

DEMO II

- (a) Kan vliegstuie vlieg?
- (b) Kan perde hulleself skeer?
- 11. Kan mense trou?
- 12. Kan piesangs bal?
- 13. Kan miers krioel?
- 14. Kan arende verf?
- 15. Kan stene dryf?
- 16. Kan byle kap?
- 17. Kan horlosies gaap?
- 18. Kan stompe brand?
- 19. Kan sypaadjies sprinkel?
- 20. Kan pikkewyne waggel?
- 21. Kan speldekussings juig?
- 22. Kan worsies frons?
- 23. Kan blomme bot?
- 24. Kan valekerns vonkel?
- 25. Kan verkenners sien?
- 26. Kan hansworse tuimel?
- 27. Kan beuels vermoen?
- 28. Kan skoorstene ontapan?
- 29. Kan towenaars vermaak?
- 30. Kan barometers gelukwens?
- 31. Kan tandartse boor?
- 32. Kan mikroskope vergroot?
- 33. Kan Zebras grawe?
- 34. Kan bruide droom?
- 35. Kan skoonheidsmiddels feesvier?
- 36. Kan blare fladder?
- 37. Kan Katels koordineer?
- 38. Kan skrynwerkers kniel?
- 39. Kan sfinkse galop?

40. Kan meteorite bots?
41. Kan woordesboeke eerskryf?
42. Kan muishonde brei?
43. Kan plofstowwe ontbrand?
44. Kan reptiele vervaardig?
45. Kan snoespeye versadig?
46. Kan duiwe koer?
47. Kan doeltreffende kompasse op 'n dwaalspoor bring?
48. Kan vierklose voels swawe?
49. Kan trekvoels deurkruis?
50. Kan stom musikante vokaliseer?

ODUITIEWE ASSOSIASIE:
DEMO I

- (a) 'n Pappa is groot; 'n baba is (klein).
- (b) 'n Baba is klein; 'n pappa is (groot).
1. 'n Katjie se "miaau"; 'n hondjie se (woef, enige blafgeluid).
2. 'n Voel vlieg in die lug; 'n vis swem in die (water, see, dam).
3. Brood is om te eet; 'n drank is om te (drink).
4. Rook gaan op; reën kom (af).
5. Ek sit op 'n stoel; ek slaap op 'n (bed, divan).
6. 'n Rooi lig se stop; 'n groen lig se (ry, gaan).
7. Jan is 'n seuntjie; Marie is 'n dogtertjie, meisie).
8. Ek eet uit 'n bord; ek drink uit 'n (beker, glas, koppie).
9. Ore is om mee te hoor; oe is om mee te (sien, kyk).
10. Ek bou met blokkies; ek teken met (kryt, potlood, verf).

DEMO II

- Gras is groen; suiker is (wit).
11. In die dag is ons wakker; in die nag (slaap ons).
 12. 'n Haas is vinnig; 'n skilpad is (stadig).
 13. Ek sny met 'n saag; ek slaan met 'n (hamer).
 14. Aan my hande het ek vingers; aan my voete het ek (tone).
 15. Watte is sag; klippe is (hard).
 16. 'n Seun hardloop; 'n ou man (loop, beweeg stadig).
 17. 'n Blokkie is vierkantig; 'n bal is (rond).
 18. 'n Ontploffing is hard; 'n fluistering is (sag).
 19. 'n Man kan 'n koning wees; 'n vrou kan 'n (konigin) wees.
 20. Berge is hoog; valleie is (laag, diep).
 21. 'n Ui is vat; 'n potlood is (dun, vaer).

22. Pistooolsakke het pistole; koeverte het (briewe).
23. Koffie is bitter; suiker is (soet).
24. 'n Tronk het gevangenis; 'n hospitaal het (siekas, pasiente).
25. Yster is swaar; vere is (lig).
26. 'n By het 'n kort; 'n man het 'n (huis).
27. Bome het bas; mensse het (vel).
28. Die parlamentsgebou het wandelgange; 'n dorp het (strate).
29. Skryftafels het laaie; langbroeke het (sakke).
30. 'n Has het 'n stert; 'n trein het 'n (kondukteurswa).
31. 'n Mens se nek kry 'n kraag; 'n mens se middellyf kry 'n (bel, gordel, saintuur).
32. Troeteldiere is mak; iesus is (wild).
33. 'n Meter het millimeters; 'n minuut het (sekondes).
34. 'n Brief het 'n seel; 'n passasier het 'n (kaartjie, pas).
35. 'n Vinger kry 'n ring; 'n arm kry 'n (armband).
36. 'n Oseaan is diep; 'n dammatjie is (vlak).
37. Ys is solied; water is (vloeibaar).
38. Bome het sap; diere het (bloed).
39. Toebroodjies het brood; boeke het (witeblaai).
40. 'n Hand het hare; 'n vis het (skubbe).
41. Huise het argitek; boeke het (skrywers, outeurs).
42. Jare het seisoene; gellings het (kwarte).

GRAMMATIKALE SLUITING:

Gebruik (1) vir demo, demc vir (1).

Demo is dan: Hier is 'n hond. Heir is twee (honde).

1. Hier is 'n bed. Hier is twee (beddens).
2. Hierdie kat is onder die stoel. Waar is hierdie kat? Sy is (op die stoel).
3. Elke kind het 'n bal. Dit is Hare in die is (byne).
4. Hierdie hond blaf graag. Hier is hy besig (om te blaf).
5. Hier is 'n rok. Hier is twee (rokke).
6. Hier is die sauntjie besig om die hek op te maak. Hier het hy die hek klaar (opgemaak).
7. Daar is melk in die glas. Hier is nou 'n glas (melk).
8. Hierdie fiets behoort aan Jan. Wie se fiets is dit? Dit is (Jan se'n).
9. Die saun skryf iets. Dit is wat hy (geskryf het).
10. Dit is die man se huis, en dit is waar hy werk. Hier gaan hy werk toe, hier gaan hy (huis toe).
11. Hier is dit aand, en hier is dit oggend. Hy gaan soggens werk en wanneer kom hy huis toe?

- (saans, in die aand).
12. Hierdie man is besig om te verf. Hy is 'n (verwer).
 13. Die seuntjie gaan al die koekies opeet. Nou het hy al die koekies (opgeëet).
 14. Hy wou nog 'n koekie gehad het, maar daar was nie (meer nie).
 15. Hierdie perd is nie groot nie. Hierdie perd is groot. Hierdie perd is nog (groter).
 16. En hierdie perd is die heel (grootste).
 17. Hier is 'n man. Hier is twee (mans).
 18. Die man is besig om 'n boom te plant. Hier is die boom (geplant).
 19. Dit is seep en dit is (seep).
 20. Hierdie kind het baie blokkies. Die kind het nog (meer).
 21. En hierdie kind het die (meeste)
 22. Hier is 'n voet. Hier is twee (voete).
 23. Hier is 'n lam. Hier is 'n klomp (lammers).
 24. Hierdie koekie lyk nie so goed nie en hierdie koekie lyk goed. Hierdie koekie lyk nog (beter).
 25. En hierdie koekie lyk die heel (beste).
 26. Die man hang die prent op. Hier is die prant (opgehang).
 27. Die dief steel die krale. Hy steel die groot krale en die klein (kraletjies).
 28. Hier is 'n vrou. Hier is twee (vrouens).
 29. Die seun het twee piesangs. Hy gee een weg en hy hou een vir (ho,).
 30. Hier is 'n blaas. Hier is twee (blase).
 31. Hier is 'n kind. Hier is drie (kinders).
 32. Hier is 'n muis. Hier is twee (muis).
 33. Hierdie kinders het almal geval. Hulle het almal bloukollie; hy het 'n bloukol op hom en sy het 'n bloukol op (haar).

OUITIEWE SLUITING

DEMO: bo/al (bottel)

- | | |
|--------------------------|---------------------------|
| 1. vlieg/tui/
sonskyn | - vliegtuig 2. sonsky/- |
| 3. lampa/
telefoon | - lampen(s) 4. tale/corn- |
| 5. was/asjien | - wasmasjien |
| 6. /amatia | - tamatie |
| 7. driewie/ | - driewiel |
| 8. /ingernaal | - fingernaal |
| 9. oli/ant | - olifant |
| 10. grondboontjie/otter | - botter |
| 11. /oetbal | - voetbal |
| 12. ko/iakan | - koffiakan |
| 13. sjo/laad | - sjokolade |
| 14. sy/aadjie | - sypaadjie |

15. /uffel
16. mo/or/ar
17. /oante/inkel
18. kan/jas
19. /isser/an
20. /aat/a/oen
21. /ers/eas/eskenk
te/agra/
23. /ilm/ter
24. on/hoorsaashei
25. skoo/bos/e
26. ho/pitaa/
27. ka/outer/ie
28. aps/aai
30. /ik/asjian

- buffel
- motorkar
- groentewinkel
- kamerjas
- visserman
- waatlomper
- kersteesgeskenk 22.
- telegram
- filwater
- ongehoorsaamheid
- skoolboeke
- hospitaal
- kaboufertjie
- papagaaï
- tikaasjian

APPENDIX V

MEANS AND STANDARD DEVIATIONS OF ALL RAW SCORES

VARIABLE	GROUPING	MEAN	SD
Special School	At-Risk	1.762	0.436
	Normal	1.895	0.315
Previous Treatment	At-Risk	1.476	0.512
	Normal	1.632	0.496
Recommended Treatment	At-Risk	1.714	0.463
	Normal	1.547	0.229

For the above variables a score of "1" or "2" was given. 1 = Yes the child does attend a special school, or has had previous treatment, or has been recommended for treatment. 2 = No the child has not received any of the above.

The variables below were scored using Z-scores, where scores below -0.9 were considered below average, and those above -0.9 considered average or above average.

Space Visualisation	At-Risk	-0.419	1.056
	Normal	-0.300	1.026
Figure Ground	At-Risk	0.305	1.141
	Normal	0.274	1.074
Position in Space	At-Risk	0.162	0.966
	Normal	0.337	0.823
Design Copy	At-Risk	0.010	1.111
	Normal	0.116	1.076
Visual Motor Integration	At-Risk	-0.051	0.841
	Normal	0.300	0.923
Kinesthesia	At-Risk	-0.024	1.149
	Normal	0.232	0.817
Manual Form Perception	At-Risk	0.148	1.014
	Normal	0.221	0.851
Finger Identification	At-Risk	-0.633	1.365
	Normal	0.032	0.906

Graphesthesia	At-Risk	-0.433	0.962
	Normal	-0.547	1.167
Localisation of Tactile Stimuli	At-Risk	0.300	1.492
	Normal	0.368	1.605
Double Tactile Stimuli	At-Risk	0.324	0.126
	Normal	0.195	0.409
Imitation of Postures	At-Risk	0.400	0.982
	Normal	0.237	0.718
Standing Balance Open	At-Risk	-0.771	1.454
	Normal	0.163	0.547
Standing Balance Closed	At-Risk	-0.133	1.205
	Normal	0.216	1.133
Motor Accuracy Right hand	At-Risk	-2.048	0.831
	Normal	-1.711	1.232
Motor Accuracy Left hand	At-Risk	-1.657	0.668
	Normal	-1.456	0.954
Crossing the Midline	At-Risk	-0.710	1.435
	Normal	-0.753	1.355
Crossing the Midline crossed	At-Risk	-0.700	1.559
	Normal	-0.921	1.185
Bilateral Motor Co-ordination	At-Risk	-0.400	0.837
	Normal	-0.826	0.937
Right - Left Difference	At-Risk	0.229	0.876
	Normal	-0.211	1.195
ITPA Composite Score	At-Risk	-0.076	0.801
	Normal	-0.184	0.594
Visual Reception	At-Risk	-0.029	1.251
	Normal	-0.237	1.153
Visual Association	At-Risk	-0.386	0.963
	Normal	-0.105	1.063
Visual Memory	At-Risk	0.457	1.629
	Normal	-0.432	0.643
Visual Closure	At-Risk	-0.519	0.833
	Normal	-0.537	0.909
Auditory Reception	At-Risk	-0.343	1.203
	Normal	-0.416	0.900

Auditory Association	At-Risk	-0.210	1.471
	Normal	0.079	1.292
Auditory Memory	At-Risk	0.143	1.295
	Normal	0.032	0.999
Verbal Expression	At-Risk	-0.233	0.694
	Normal	-0.379	0.804
Manual Expression	At-Risk	0.186	1.017
	Normal	-0.095	0.719
Grammatical Closure	At-Risk	0.067	1.443
	Normal	0.268	1.138

As described in the study method, the following school subjects were scored according to a scale from 1 to 5. "1" = Good; "2" = Above Average; "3" = Average; "4" = Below Average; "5" = Fail.

Maths	At-Risk	3.000	1.000
	Normal	2.526	0.697
English	At-Risk	2.310	0.928
	Normal	2.632	0.831
Afrikaans	At-Risk	2.762	0.889
	Normal	2.526	0.841
Writing	At-Risk	2.857	0.910
	Normal	2.211	0.855
Reading	At-Risk	2.667	1.017
	Normal	2.263	0.806
Spelling	At-Risk	2.952	0.973
	Normal	2.421	0.769
Neatness	At-Risk	3.048	0.805
	Normal	2.737	0.933
Concentration	At-Risk	2.857	1.062
	Normal	2.737	0.991

APPENDIX VI

NUMBER OF BELOW AVERAGE SUBTEST SCORES, PER CHILD, IN
THE NORMAL AND AT-RISK GROUPS

01 500 63 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99

**NUMBER OF SCHOOL PERFORMANCE ITEMS BELOW AVERAGE,
PER CHILD, IN THE NORMAL AND AT-RISK GROUPS**

→ Number 4 or 5's

00-00-0000-0000-0000

01 00-00-0000-0000-0000-0000-0000-0000

02 00-00-0000-0000-0000-0000-0000-0000

03 00-00-0000-0000-0000-0000-0000-0000

04 00-00-0000-0000-0000-0000-0000-0000

05 00-00-0000-0000-0000-0000-0000-0000

06 00-00-0000-0000-0000-0000-0000-0000

07 00-00-0000-0000-0000-0000-0000-0000

08 00-00-0000-0000-0000-0000-0000-0000

09 00-00-0000-0000-0000-0000-0000-0000

10 00-00-0000-0000-0000-0000-0000-0000

11 00-00-0000-0000-0000-0000-0000-0000

[REDACTED]

00-00-0000-0000-0000-0000-0000-0000

01 00-00-0000-0000-0000-0000-0000-0000

02 00-00-0000-0000-0000-0000-0000-0000

03 00-00-0000-0000-0000-0000-0000-0000

04 00-00-0000-0000-0000-0000-0000-0000

05 00-00-0000-0000-0000-0000-0000-0000

06 00-00-0000-0000-0000-0000-0000-0000

07 00-00-0000-0000-0000-0000-0000-0000

08 00-00-0000-0000-0000-0000-0000-0000

09 00-00-0000-0000-0000-0000-0000-0000

10 00-00-0000-0000-0000-0000-0000-0000

11 00-00-0000-0000-0000-0000-0000-0000

590

APPENDIX VII

GROUPING OF SUBTESTS INTO 5 CATEGORIES

CATEGORY I - VISUAL PERCEPTION- Space Visualisation

- Figure Ground
- Position in Space
- Design Copy
- Visual Motor Integration

CATEGORY II - SOMATOSENSORY PERCEPTION

- Kinesthesia
- Manual Form Perception
- Finger Identification
- Graphesthesia
- Localisation of Tactile Stimuli
- Double Tactile Stimuli

CATEGORY III - MOTOR PERFORMANCE

- Imitation of Postures
- Standing Balance with Eyes Closed
- Standing Balance with Eyes Open
- Motor Accuracy with Right Hand
- Motor Accuracy with Left Hand

CATEGORY IV - BILATERAL INTEGRATION

- Crossing the Body Midline
- Crossing the Body Midline, Crossed Items Only
- Bilateral Motor Co-ordination

CATEGORY V - LANGUAGE

The ITPA was used as a test of language as the test items are predominantly language related, but it must be noted that some of the test items are visual perceptual tests.

- ITPA composite score
- Visual Reception
- Visual Association
- Visual Memory
- Visual Closure
- Auditory Reception
- Auditory Association
- Auditory Memory
- Verbal Expression
- Manual Expression
- Grammatical Closure

APPENDIX VIII

DIFFERENCES BETWEEN ^N AT-RISK AND NORMAL GROUPS, AT
SIX YEARS, AS DETERMINED BY GOODMAN (1987)

	AT-RISK (n=24)	NORMAL (n=24)
SCHOOL READINESS:		
Language	7	3
Motor	1	0
Socio-emotional	1	0
CEREBRAL PALSY	6	0
CLUMSY/INCOORDINATED	8	7
VISUAL PROBLEMS	3	2
HEARING PROBLEMS	0	1
REMEDIAL THERAPY between 1 & 5 yrs	4	2
REMEDIAL THERAPY RECOMMENDED at 6 yr assessment	17	6

APPENDIX IX

GRIFFITHS SCORES FOR NORMAL AND AT-RISK GROUPS AT **SIX YEARS**

	NORMAL (n = 25)	AT-RISK (n = 24)	P - VALUE
GRIFFITHS MENTAL DEVELOPMENT SCALE			
Development Quotient	107 + 8	105 + 11	NS*
Sub-scales:			
Locomotor	112 + 7	103 + 21	<.05
Personal/social	109 + 14	110 + 17	NS
Hearing/speech	115 + 12	116 + 15	NS
Eye/hand	106 + 9	107 + 16	NS*
Performance	123 + 10	101 + 12	NS*

Results expressed as mean + SD

* = had been significantly different at 1 year.

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