UNIVERSITY OF ALBERTA

Language Abilities in Five Through Seven Year Old Children Born at or under Twenty Eight Weeks Gestational Age

by

© A.M. Nancy Duncan

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Abstract

Although the presence of speech, language and hearing problems associated with disabling conditions in preterm children has been well established, there is scarcity of literature regarding the complex language abilities of nondisabled children of very low gestational age. This study examined language abilities in a group of 40 five through seven year old nondisabled children (without cerebral palsy, sensori-neural hearing impairment or visual impairment, epilepsy or IQ scores lower than one standard deviation below the mean) who were born ≤ 28 weeks gestational age with a mean birthweight of 970g. They were compared with 40 full-term children matched for age, gender and socio-economic status. All the children had normal hearing for speech and language and spoke English as a first language. A battery of language tests focusing on expressive syntax, narrative skills and memory was administered. Significant group differences were found in the language scores which remained when the effects of IQ scores were partialled out. Preterm sentence complexity and short-term memory for syntax were particularly weak. Multiple regression analyses with birthweight, intraventricular hemorrhage and Apgar scores at five minutes as the predictor variables revealed Apgar scores at five minutes to be the only significant predictor for four of the eight language scores.

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Chapter 1• Introduction

Prematurity is one of the world's major health concerns. Surviving very preterm babies are at risk for having problems in virtually all body systems (Halliday, 1992). Infants in the Extremely Low Birth Weight[1] (ELBW) category are especially at risk for acquiring neurological injury (Cooke, Dubowitz, Eyre, & Whitelaw, 1989).

There is great need for neonatal intensive care for babies of very low gestation particularly due to their inability to breathe spontaneously, immaturity of the respiratory system and the resulting effect on availability of oxygen and reduction of blood flow. Hemorrhaging in the brain, hypothermia, hypoxia and infection may occur. Disabilities such as cerebral palsy, vision and sensori-neural hearing impairment, epilepsy and mental retardation may be the outcomes of extreme prematurity. However, even in children who are not disabled in this way, communication skills may be affected as there is such potential for brain dysfunction or damage to occur in the fragile system of the pre-term baby of 28 weeks or less gestational age. Byers Brown, Bendersky, and Chapman (1986) noted that "communication skills appear to be particularly at risk since they depend upon the integrative functioning of motor, auditory and cognitive systems as well as a facilitative social environment" (p. 307).

Increasing numbers of preterm babies of lower gestational age are surviving due to better methods of neonatal care and, with each decade, the profiles of the children will change. In 1981, in a study of world literature of Very Low Birth Weight (VLBW) infants, Stewart, Reynolds and Lipscomb noted that since the 1960's, the chances of being a healthy infant had trebled while the rate

[1] ELBW ≤ 1000 g VLBW ≤ 1500 g

of disability had remained stable at 6-8%. One year survival of newborns weighing 500g through 1250g increased from 36% to 67% between 1979 and 1989, in a study of infants born in northern and central Alberta (Robertson, Hyrnchyshyn, Etches, & Pain, 1992). The authors found that the incidence, complexity and severity of disabilities did not increase during this time. However, although VLBW survivors may not have overt disabilities as delineated in this study, they may have subtle deficits which may not be recognized by society and the children may not reach their full potential. In some cases the deficits may remain hidden until the child enters the early elementary grades when learning disabilities are discovered.

The present study looked at the language abilities of 40 nondisabled preterm children, whose average birthweight was 970g when they were in their pre-kindergarten, kindergarten or early elementary school years. For the purposes of this study "disabled" is defined as having conditions such as cerebral palsy, epilepsy, vision or sensori-neural hearing impairment or IQ scores lower than one standard deviation below the norm. A comparison full-term group of 40 children matched for age, gender and socio-economic status was also studied. Comparisons between the groups and relationships among gestational age, birthweight, Apgar scores at five minutes (rating of the vital signs of infants) (Apgar, 1953) and degree of intraventricular hemorrhage (IVH)[2] (Papile, Burstein, Burstein, & Koffer, 1978) were explored.

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[2] Grade I IVH - subependemal hemorrhage
Grade II IVH - blood in ventricles without dilatation
Grade III IVH - ventricles dilated with IVH blood
Grade IV IVH - parenchymal hemorrhage

Chapter 2 • Literature Review

The literature review is presented in two sections. A review of medical complications that may result in later developmental problems establishes the rationale for studying language abilities in children who are born very prematurely. Then a review of studies of premature children's linguistic and cognitive abilities summarizes what is now known about this population as well as what remains to be learned.

Medical Complications

Newborn medical complications are inevitable consequences in the ELBW baby and they may suffer respiratory and neurological problems with recurrent illness in early childhood (Halliday, 1992). It has been reported that the lower the birthweight, the higher the incidence of disability or learning problems (Hack & Fanaroff, 1988; Escobedo, 1988; Veen et al., 1991). Eyre (1989) wrote that "the period from 24 weeks gestation to term is a critical time for maturation and organization of the cerebral cortex" (p. 250). The very premature infant is not prepared to meet the demands of the world outside the uterus and is at a level of development when much central nervous system maturation is occurring (Goldson, 1992). Processes which are genetically determined to occur at certain chronologically defined times may be prevented from doing so. This may be due to interruption or disorganization of neuroblast migration or proliferation, or to biochemical changes (Taylor, 1984).

Respiratory Distress Syndrome (RDS), leading to the need for inspired oxygen and artificial ventilation, occurs in the majority of the ELBW infants due to immaturity of the respiratory system (Morley, Brooke, Cole, Powell, & Lucas, 1990). Preterm babies, especially those who are mechanically ventilated, are more prone to middle ear problems which may continue into childhood. The preterm baby, therefore, may be at greater risk for developmental language-learning problems associated with recurrent otitis media (Pearce, Saunders, Creighton, & Sauve, 1988).

Asphyxia (impaired or absent exchange of oxygen or carbon dioxide) is often measured by a low Apgar score at birth or more accurately by the measure of blood gases themselves. Babies with low Apgar scores are less likely to survive and are more likely to have a higher incidence of gross abnormalities, although scores are generally considered to be a poor predictor of cognitive outcome. Roberton (1989) considered them a poor predictor of neurological outcome although McCarton, Vaughan, and Golden (1988) found an association between 5 minute Apgar scores and neurologic abnormality during the first three years. Infants with asphyxia are at great risk for major neurological damage, hearing loss and possibly developmental language disability (Gerber, 1990). There may also be seizures, abnormal muscle tone, difficulty with sucking and swallowing, poor facial movement and fasciculations of the tongue (Hill & Volpe, 1989).

The frequency of hemorrhaging in the brain in very premature infants may be increasing due to their increased survival. This may be diagnosed by computerized tomography (CT) or ultrasound scanning. The blood itself will be reabsorbed, but damage can occur from insufficient blood flow and oxygen deprivation, especially to the areas near the hemorrhage (Clark, 1989). Periventricular/intraventricular hemorrhage (PVH/IVH), especially co-occurring with lack of oxygen, may cause significant neurological injury (Hill & Volpe., 1989). However, infants with only mild perinatal brain injury may have "hidden" or minor deficits. Janowsky and Nass (1987) found early deficits in expressive language development in children reported to have IVH. Grunau, Kearney, & Whitfield, (1990) also found that language outcome was related to IVH. Infants with IVH showed significant delay and a wider range of performance than a control group in the study of Byers Brown et al. (1986).

Premature infants may also suffer from hypothermia due to inability to regulate temperature control (Morley, 1989) and from congenital and neonatal infection that may lead to hearing loss (Cohen & Taeusch, 1987). Pearce et al. (1988) found that "Preterm infants with a history of perinatal complications are at risk for language learning difficulties, and are more likely than full-term infants to show recurrent otitis media" (p. 346).

Babies may also be small for gestational age whether they are premature or full term and outcome varies depending upon the length and cause of the intra-uterine growth retardation (Roberton, 1986). In this study, with the highest gestational age (28 weeks) being a subject criterion, length of growth retardation may not be as high as, for example, in a study where limitation on birthweight rather than gestational age is required.

Hyperactivity, behavior problems and lack of attention/concentration in very preterm children have been reported (Lloyd, Wheldall, & Perks, 1988; Robertson, Etches, & Kyle, 1990; Saigal, Rosenbaum, Szatmari, & Campbell, 1991; The Scottish Low Birthweight Study Group, 1992; Weisglas-Kuperus, Koot, Fetter, & Sauer, 1993). In the study of Saigal et al., (1991), 18% of the variance in cognition and academic achievement scores in regression analysis was accounted for by attentional problems. Lloyd et al. (1988), in their study of 45 VLBW children, found that these children had more behavior problems than matched comparison children and several teachers reported that the VLBW children in their classrooms were very distractible. Parents of the children in the Scottish low birthweight study found that their preterm children had more behavior problems than their siblings and almost half reported that their premature children had poor attention spans.

In conclusion, the very premature infant may have disabling conditions that result in cerebral palsy, vision and hearing loss, epilepsy and/or mental retardation. These are easy to diagnose, but Rapin (1982) noted that "damage affecting parts of the brain whose function is not fully developed may be silent until the age when the behavior dependent on the damaged part makes its appearance" (p. 28). This may be the case for the language/learning disabled children whose deficits remain hidden until first or second grade or later. Fitzhardinge (1980) wrote that "less severe forms of impairment are difficult to assess with accuracy even after a year or two of schooling" (p. 1). In many cases these impairments or deficits can be so subtle that they may be unrecognized by society and the child may not be helped to reach his or her full potential.

Studies of Cognitive and Linguistic abilities.

Academic Achievement and Intelligence

The impact of language on academic skills and the increasingly complex linguistic demands placed on students as they go through school are well documented (Stark & Tallal, 1988; Wallach & Miller, 1988; Wiig & Semel, 1980). Many studies of premature children that did not include language tests demonstrated that they were performing poorly at school. One may hypothesize that this poor school performance may be in part due to language difficulties which were not diagnosed.

The need for follow-up beyond the first few years may indeed be especially important for the ELBW and LBW child. Although catch-up may and often does occur in many areas, signs of potential academic problems or learning disabilities tend to predominate in studies despite "normal" neurological examination or IQ (Edmonds, Luther, Keith, Lennox, & Asztalos, 1992; Ross, Lipper, & Auld, 1991; The Scottish Low Birthweight Study Group, 1992).

Zubrick, Macartney and Stanley (1988) studied 371 West Australian children who had been considered to be medically at risk in the neonatal period and compared them with school classmates at age six. There were significantly more children with poor academic skills in the preterm low birthweight group. In another investigation, twenty five ELBW children born in the period 1960-1972 in Washington State were tested at varying ages from 6 to 18 years (Nickel, Bennett, & Lamson, 1982). Although full scale IQ's were normal, only seven of the 25 children were achieving at or above grade level, and three of these seven had been in special education programs.

Although only 32% of five to nine year old children in a Montreal study of ELBW children had neurological or developmental disability, 57% of them had educational problems (Lefebvre, Bard, Veilleux, & Martel, 1988). They needed special education, had failed or had difficulty in regular class. In the Ontario study of Edmonds et al. (1992), 52% of neurologically normal children who had weighed ≤ 800g at birth were experiencing academic difficulty at age eight. The authors stressed the need for dynamic assessment over time and for early identification of these ELBW children. In a New York study of the educational status of VLBW premature children, those who were neurologically normal with normal IQ scores had a higher proportion of low academic scores (29%) than the national prevalence rates (Ross et al., 1991).

Some studies report differences in IQ and language scores in preterm children compared to full-term children although no formal language tests, such as those normally administered by speech/language pathologists, were administered. However, despite this limitation, due to the strong relationship between language and intelligence, especially verbal intelligence, some studies that have reported differences using IQ test scores are still relevant to this study.

Auditory memory and verbal reasoning scores on the Stanford-Binet Intelligence Scale-fourth edition (Thorndike, Hagen, & Sattler, 1986) were significantly lower in a three-year-old group of children with birthweights of less than 1000g (Grunau et al., 1990).

An English study reported that ELBW five year old children had statistically significantly lower verbal scale scores on the McCarthy Scales of Children's Abilities (Portnoy, Callias, Wolke, & Gamsu, 1988). Abel Smith and Knight-Jones (1990) in England also reported significantly lower scores on the McCarthy Scales with particularly low verbal and memory sub-test scores for ELBW children. Lloyd et al., (1988) found that recall of digits and word reading were significantly lower for preterm children than term controls on the British Ability Scales.

Language Testing

Although the literature concerning general developmental follow-up of the preterm infant is extensive, recorded outcomes vary enormously. This can be due to lack of comparison groups, failure to test language abilities, inclusion of children with disabling conditions, limited time span (frequently covering the child only up to two years of age) and small sample sizes. In particular, there are few carefully controlled studies of language where discourse or complex language abilities have been assessed. Although IQ tests such as the Stanford-Binet Intelligence Scale, 4th Edition are heavily language based, the receptive and expressive language skills commonly tested by the speech/language pathologist, tend to look at language in a different way. Measurements of grammatic comprehension, ability to order words and combine sentences, sentence length and complexity, in-depth analyses of expressive vocabulary and semantics and tests of narrative ability and auditory memory are usual.

Failure to find significant differences in language abilities between preterm and full-term comparison children may be due to inclusion of language tests involving few complex receptive and expressive language skills. In the Ontario study of Saigal et al. (1991) of eight-year-old children who had been born between 1977 and 1981, only the Token Tests, the Peabody Picture Vocabulary Test-R (PPVT-R) and the Expressive One Word Picture Vocabulary Test (EOWPVT) were used to test language. Scores were not significantly different for preterm and full-term groups. The same group's 1990 study of children aged 5;6 without a comparison group had included only the PPVT-R and the EOWPVT. Scores were within the average range.

Aram, Hack, Hawkins, Weissman and Borawski-Clark (1991), in their study of eight year-old VLBW children born between 1977 and 1979 in the U.S.A., also pointed out that all the language measures they used were at the word or sentence level with no assessment of discourse and no measure of abstract language abilities. They used the PPVT-R, the Token IV and Token V, the Random Automatized Naming task and Recalling Sentences sub-test of the Clinical Evaluation of Language Fundamentals. There were significant differences between the preterm and full-term comparison children for all the tests except the PPVT-R but the authors did not consider the VLBW children's scores clinically significant when converted into standard scores. They defined clinical significance as "a greater occurrence of more extreme scores or a higher incidence of specific language impairment" (p.1179).

In the 1960's, a very large collaborative perinatal study of the National Institute of Neurological and Communication Disorders and Stroke (Lassman, Fisch, Vetter, & LaBenz, 1980) investigated the language development of 20,000 children. This group included 100 children at three and eight years with birthweights of under 1500g. At eight years, these VLBW children were found to have overall language comprehension, word identification, language production and concept development scores that were one-half standard deviation below the entire sample. Language production assessment included analysis of connected discourse in which the child's retelling of a story was scored for sequence, elaboration, relevance and grammar. Unfortunately, no tests of statistical significance were carried out presumably because of lack of time and money, and the fact that they were thought to be inappropriate due to possible lack of clinical significance.

Widely varying birthweights or gestational ages in premature children may also make interpretation of language testing results difficult and may lead to lack of significant differences in performances. For example, in a study of patterns of early lexical and cognitive development in premature and full-term infants over the first three years of life, no significant differences were found between the groups as they left the study at three years of age (Menyuk, Liebergott, Schultz, Chesnick, & Ferrier, 1991). The birthweights varied widely from 794g - 2240g in the premature group. In a Swiss study of language development during the first five years of life, gestational ages varied from 27 weeks to 36 weeks (Largo, Molinari, Comenale Pinto, Weber, & Duc, 1986). One hundred and fourteen preterm children were tested. These included 20 children with cerebral palsy to whom Largo et al. referred as neurologically impaired. Home protocols of language development were obtained from parents and frequent laboratory testing was conducted. A Swiss-German version of the Illinois Test of Psycholinguistic Abilities was given at age five, and sentence completion, digit repetition and grammar subtests were reported in the study. For the language protocols, the authors stated that "most stages were reached at slightly later ages by the neurologically unimpaired preterm children than by the term children" (p. 339). There were significant differences only in the sentence completion and grammar subtests between the premature (without cerebral palsy) and full-term girls on the ITPA. Using multiple regression analyses, the authors found that birthweight and gestational age were negatively correlated with language development.

De Hirsch, Jefferson, Jansky, and Langford (1964) studied 106 premature children aged five to six years who were born in 1955 and 1956 whose birthweights ranged from 1000-2239g. They were compared with 55 full-term children. Fifteen items of language were tested. All children had IQ's above 85 and none had neuromotor involvement or gross emotional disturbance. It was interesting that in contrast to the previous study and despite widely varying birthweights, significant differences were found on seven of the 15 tests: tapped patterns, language comprehension, word finding, number of words used during story telling, mean length of utterance, degree of sentence elaboration and word definitions. The remaining eight tests were auditory memory span for nonsense syllables, auditory discrimination, one word picture vocabulary, two articulation tests, overall story telling, number of grammatical errors, and categories. It was certainly very surprising to find a narrative test in an early 1960's study of premature children and to note that degree of sentence elaboration was evaluated since such analyses have only recently become common practice. Complexity of sentences was also investigated in the 1990 Vancouver study of Grunau et al. who reported that ELBW children used significantly fewer complex sentences.

In another early study, Kastein and Fowler (1959) found that with an increasing number of premature babies surviving, there were also increasing numbers of these children with communication disorders. From their studies of children at two years of age, they found that the development of language functions in the young child was a good indicator of the developmental profile and central nervous system deficit. However, these authors did not appear to follow these children into school and there was little data on what constituted "prematurity".

Michelsson, Lindahl, Parre and Helenius (1984) studied 116 children born between 1971-1974 in Finland with a BW of 1500g or less. At a later stage in development (nine years of age), 41 of these preterm children were compared with 39 comparison children. Included in the sample of 41 preterm children were one with slight hemiplegia, one with a convulsive disorder, one with vision and hearing problems and three with mild unilateral sensori-neural hearing loss. The authors reported that the children had a much higher incidence of speech defects and needed speech therapy. These children also performed at a significantly lower level than the controls on the Illinois Test of Psycholinguistic Abilities (ITPA), the total score and the visual reception, visual sequential memory, auditory association and auditory closure subtest scores being significantly different.

At a much earlier stage in development, larger group differences were also reported in a study of language development of two-year-old VLBW children in the New England region (Vohr, Garcia Coll, & Oh, 1988). Scores were significantly lower on the Mullen Scales of Early Learning (language subscales) for the preterm groups which included small for gestational age as well as appropriate for gestational age children. The Mullen Scales of Early Learning, which were developed and standardized in Rhode Island, were developed for use with children between 15 and 68 months of age. Language Receptive Organization and Language Expressive Organization scores are obtained but no information regarding the complexity of the language tested is available. Multiple regression analyses showed that gestational age, SES and neurological status together had a significant cumulative effect on language scores. In their 1989 study of 40 of these children at three years of age, gestational age and neurological status continued to predict language scores. Although the authors had hypothesized that neurological status at age eight months would not predict language scores at age three, they concluded "We may theorize, however, that although atypical tone and motor signs observed in the first year may resolve, neurological insults affecting the subtle processing and expression of language may persist" (p. 588).

Two recent studies of language abilities in preschool preterm children that used measures of more complex language than the studies previously described, showed interesting and significant differences for ELBW children.

The first of these studies, a Vancouver study of children who were born in 1986-1987 with birthweights below 1000g, compared the ELBW children with comparison subjects carefully matched for SES when the children were three years corrected for prematurity (Grunau et al., 1990). The Peabody Picture Vocabulary Test-Revised (PPVT-R) was administered and a 30 minute sample of language was audiotaped during free play and then analyzed. No other aspect of receptive or structured expressive language was tested. The preterm group used less complex expressive language in the spontaneous language sample and had lower scores on the PPVT-R. Perhaps these lower vocabulary scores, which were not reported in previous studies, were due to stringent matching using chronological age adjusted for prematurity, mother's education and gender. Language outcome was found to be related to IVH in this group of ELBW children. The authors noted that "average verbal intelligence in environmentally low risk, extremely low birth weight children is an insufficient indicator of complex language functioning" (p. 173).

In the second study assessing more complex language, The Scottish Low Birthweight Study Group (1992) assessed 611 four year, six month old children who had been born prematurely in Scotland during 1984. No comparison children were used. The Bus Story and the Action Picture Test were used to assess language and parents were asked to comment on their child's speech. Cognitive ability was tested by the British Ability Scales. Language ability was significantly related to birthweight, gestational age and social class and the effects were stronger for comprehension than expression. For example, significantly more of the ELBW children scored below the 25th percentile on the information portion of the Action Picture Test. Some sub-tests of the intelligence tests for children whose full-scale IQ scores were in the normal range were reported to have patterns of skill deficits. The possibility that these children had specific learning disabilities was raised. The authors stated, "This study highlights important deficits in the performance of low birthweight children, even among those whose overall psychometric scores fall within the normal range. These specific problems are likely to have implications for their success in learning to read and in acquiring numeracy." (p. 686).

Conclusion

The presence of speech, language and hearing problems associated with disabling conditions in the VLBW child is well established. However, there is evidence to suggest that a VLBW child may have a normal overall IQ but demonstrate specific deficits or delays in language development and academic progress. Scores on language tests of one word picture vocabulary (such as the PPVT-R) in preterm and full-term children are in almost all cases not significantly different. Tests of narrative abilities and more complex language structures are those in which significant differences have been found. Language deficits related to IVH have also been found. A greater frequency of attention and concentration, behavioral and learning problems are associated with low birthweight. There have been few studies of language abilities in ELBW children that involve complex language tasks, tests of narrative ability and some aspects of short term auditory memory and immediate auditory recall where the gestational age is controlled.

The current study differs from others by including tests of immediate recall of sentences and digits and delayed recall of sentences which may involve retention in short term memory (Northwestern Syntax Screening Test), as well as the more complex structures and narrative abilities similar to the Scottish low birth weight study (The Bus Story information and sentence length and the Action Picture Test). It also included scoring of sentence complexity (1991 version of The Bus Story Test). The degree of prematurity was controlled by including only those children who were born ≤ 28 weeks gestational age. This therefore differed from the Grunau et al. (1990) study and that of The Scottish Low Birth Weight Study Group (1992) which included preterm children based on weight rather than gestational age. Both of these studies were of pre-school children whereas the current study included children who are entering school or in the primary grades. Intelligence was also tested as it is generally believed to be related to language and therefore it was important to control for IQ.

Rationale for Study

There is a scarcity of literature regarding the language abilities of nondisabled children of ≤ 28 weeks gestational age, who were born at a time when survival rates of preterm newborns were escalating, and who are now ready to enter or are in their first few years of school. Thus a study examining the more complex language skills of these children was proposed. A group of 40 five-through-seven-year-old preterm children who have been periodically seen at the Glenrose Neonatal Follow-up Clinic were tested along with a comparison group of 40 full-term children matched for age, gender and SES.

Research Questions

1. (a) Will the language scores of the group of 40 preterm children be significantly lower than those of the group of 40 full-term children?
   (b) In which of the language tests will significant differences be found?

2. Will differences in language scores persist even when the effects of IQ scores are partialled out?

3. Will a significant portion of the variance in the language scores of the preterm children be predicted by birthweight, gestational age, degree of intraventricular hemorrhage and Apgar scores?

Chapter 3 • Methodology

Subjects

Preterm

The preterm subjects were 40 nondisabled children (no cerebral palsy, visual or sensori-neural hearing impairment or epilepsy and whose IQ at the time of testing was no lower than one standard deviation below the mean) who were born ≤ 28 weeks gestational age (GA) and were periodically examined at the Glenrose Hospital Neonatal Follow-Up Clinic. Information regarding the degree of IVH and the gestational age, birthweight and Apgar scores all of which were obtained from the Neonatal Follow-Up Clinic records, is provided in Table 1.

Table 1: Characteristics of preterm subjects

Characteristic	Mean	Standard Deviation	Range
Birthweight (g)	970.3	184.1	510-1320
Gestational Age (weeks)	26.8	1.1	24-28
Apgar (Five minutes)	6.6	1.4	3-9

Sixty percent of the children were female. Twenty-four were five years old, 12 were six years old and four were seven years old.

The distribution of gestational ages, Apgar scores at five minutes, birthweights, and IVH and are shown in Figures 1-4. Twenty-one children (53%) had experienced intraventricular hemorrhage: six had Grade I, nine had Grade II and six had Grade III using Papile's classification (Papile et al., 1978). Twenty percent had Apgar scores of 3-5,[3] 48% had scores of 6-7 and the remainder had

[3] Percentages may not add up to 100 due to rounding.

scores of 8-9. Five percent of the children had a gestational age of 24 weeks, 5% of 25 weeks, 28% of 26 weeks, 30% of 27 weeks and 33% of 28 weeks. Birthweights of 500-749g were obtained for 8% of the subjects, 55% had birthweights of 750-999g, 30% of 1000-1249g and 8% of 1250-1320g.

Figure 1: Distribution of gestational ages of preterm children

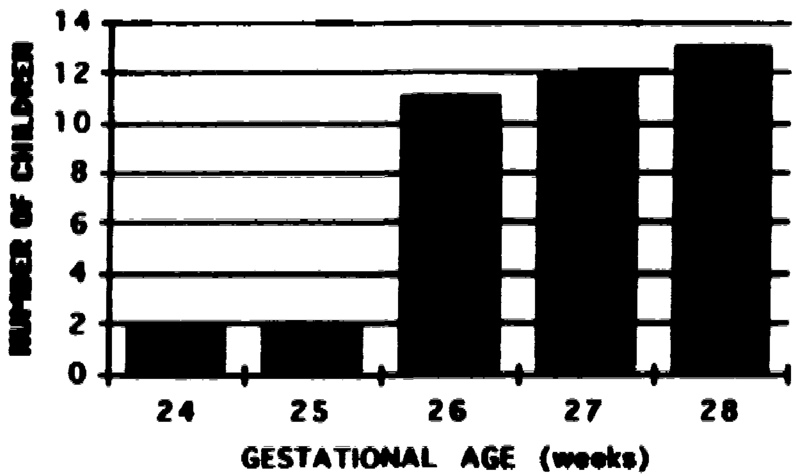

Figure 2: Distribution of Apgar scores

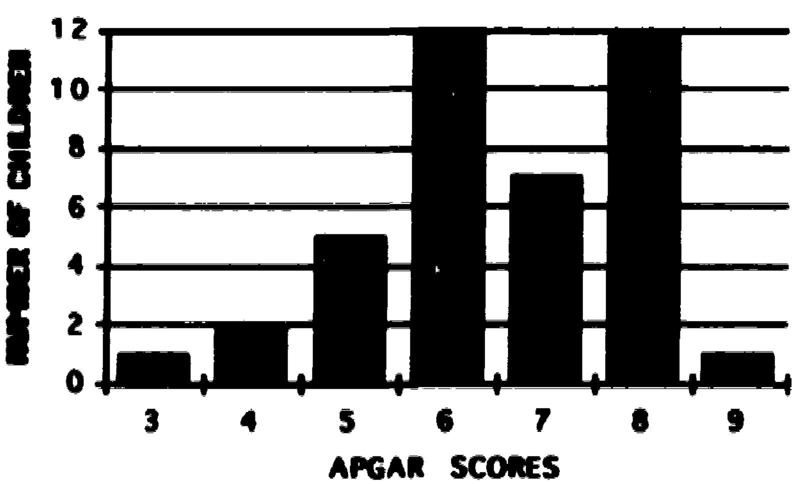

Figure 3: Distribution of birthweights

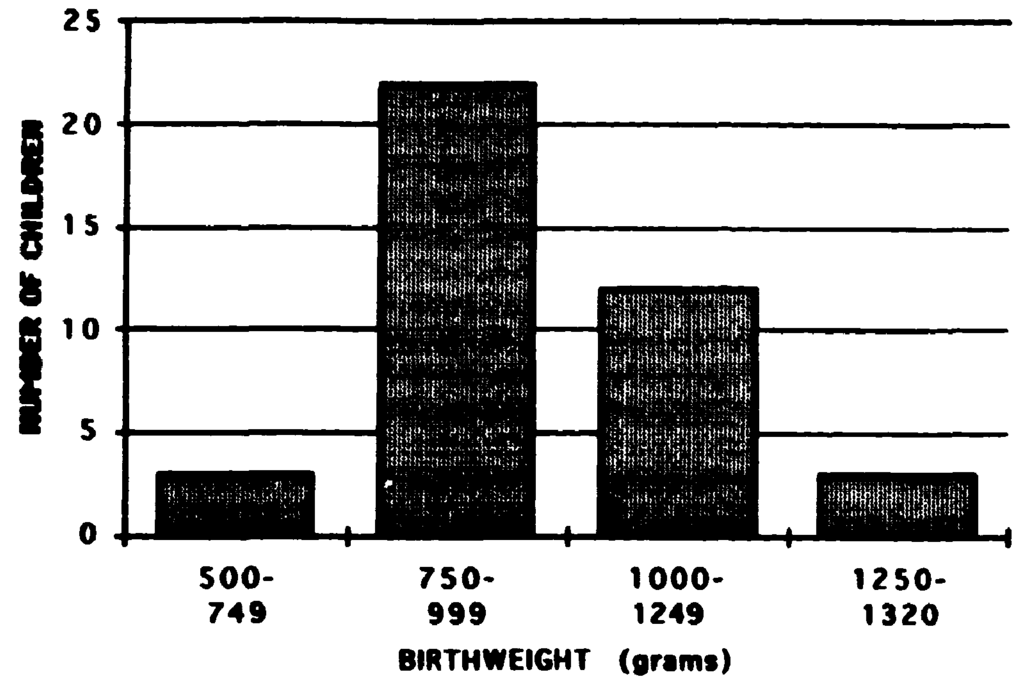

Figure 4: Distribution of degree of IVH

Comparison

The comparison children were 40 full-term healthy children (greater than 2800g and with gestational ages greater than 37 weeks) who had been cared for in well-baby nurseries and had no history of epilepsy or accident such as car or bicycle accident leading to concussion or hospitalization. Birthweight and medical information were obtained from the parents. Only nondisabled children were included the comparison group as in the preterm group. No additional exclusions such as referral for special services were made. The children attended after school care, daycare and school facilities in the Edmonton area.

Matching

Preterm and comparison subjects were matched for age, gender and socio-economic status. Matching varied by no more than six months in age and 10 points on the socioeconomic index of the Blishen scale (Blishen, Carroll, & Moore, 1987). This index, based on Canadian statistics, reflects equally weighted components of education and income level by occupation, indirectly reflecting occupational prestige. The scores of the Blishen index range from 17.81 (newspaper carriers and vendors) to 101.74 (dentists) with a mean of 42.74, a standard deviation of 13.28 and a median for men of 39.19 and women of 38.15. Mothers' educational level, categorized according to Statistics Canada (1972), was not used for matching but was recorded for comparison between the groups. All preterm and comparison subjects spoke English as a first language. Correction for chronological age was not considered appropriate for children of five and over. Although conclusions vary, it has been suggested that long term functioning may be overestimated if correction occurs as young as after 12 months (Portnoy et al., 1988; Siegel, 1983).

Materials and Instrumentation

Hearing

All preterm children had an audiological evaluation by a registered audiologist in a sound-proof booth or a hearing screening by the speech/language pathologist and were accepted as subjects if their hearing was judged by the audiologist to be within normal limits. In addition, if language testing took place on a different day from the audiological evaluation, preterm subjects' hearing was screened by the experimenter immediately before language testing as was the hearing of all the comparison subjects. A portable audiometer was used in a quiet room. The criterion to pass the audiometric screening was a response in both ears at the following frequencies: 1000 & 2000 Hz - at 20dB ; 4000 Hz - at 25dB (ASHA guidelines, 1975).

Language Tests

Five standardized language tests were administered. Each test is described below.

The Bus Story - a test of continuous speech - 2nd ed. (Renfrew, 1991), is a narrative test which involves the reading of a story (using 12 small pictures) by the examiner. The child then retells the story using the pictures but must rely on additional auditory memory to give full information. The test is scored in terms of information (the amount and accuracy of information), sentence length (the mean length of utterance of the five longest sentences) and complexity (total number of subordinate clauses).

In the *Action Picture Test - 3rd ed.* (Renfrew, 1988), samples of spoken language are scored in terms of grammar and information. The child is asked a standard question about each of 10 pictures, necessitating correct interpretation of questions and ability to reply accurately.

No strong reliability measures have been found for these tests and there are as yet no other standardized tests of narrative ability available. However, both the above tests have been found to have predictive validity in two important large scale studies. Bishop and Edmundson (1987), in their retrospective longitudinal study, found the tests to be highly predictive of persistent language problems. Howlin and Kendall (1991) also found that the Action Picture Test grammar sub-test and The Bus Story test items were particularly sensitive to difficulties in processing or expressing more complex information, and that The Bus Story was "a highly sensitive measure of disordered language functioning" (p. 365).

These are British tests and although they have been used in Canada, no North American norms are available. This study used norming information currently available.

The Recalling Sentences subtest of the *Clinical Evaluation of Language Fundamentals - Revised (CELF-R)* (Semel, Wiig, & Secord, 1987) involves immediate auditory recall of sentences which increase in syntactic complexity. As there is no visual content it should be possible to study auditory recall for language without the interfering effects of visual material. The manual reports that test-retest reliability coefficient to be .90 for six-year-old children. Miller (1985) considered the CELF-R a reliable measure, well constructed to detect language disorders.

The expressive portion of the *Northwestern Syntax Screening Test* (NSST) (Lee, 1971), a screening test, measures use of syntactic forms. As it requires delayed recall of pairs of sentences which are represented pictorially, short term memory is probably involved. Reliability information is not available but Aram, Ekelman and Nation (1984) found that the NSST was a strong predictor of adolescent language when they retested a group of 20 adolescent 10 years after they had originally been assessed as preschoolers.

The Auditory Sequential Memory subtest of the *Illinois Test of Psycholinguistic Abilities - Revised Edition* (Kirk, McCarthy and Kirk, 1968) tests digit span forward. Automatic, less meaningful but symbolic auditory recall can therefore be tested without the interference of syntax or visual material. Reported internal consistency coefficients were .90 at ages 5;7 to 6;1 and .92 at ages 7;7 to 8;1. Five month test-retest coefficients were .86 at 6 years and .89 at 8 years.

Scoring of Tests

The raw scores for the language tests were converted into standard scores with a mean (M) of 100 and a standard deviation (SD) of 15 with the exception of The Bus Story complexity sub-test (number of subordinate clauses in each story) for which standard deviations were not available. According to the test author this was due to small differences across ages. This implies that the use of a standardization technique could not be justified statistically and could distort the results. There were three levels for the ages of the study children. At 5;0 years, for example, the mean was two, at 5;1 to 6;6 years the mean was three and from 6;7 to 7;6 years the mean was four.

For data analysis, which included multiple analysis of variance (MANOVA), the children were matched and therefore the age differences between the groups at the above three levels were extremely small. In order to make interpretation of the results easier, the total number of subordinate clauses in each Bus Story was used. For the multiple regression analyses which were also used in the data analysis, allowances for age differences in the preterm group were made by subtracting the raw score from the published mean score expected at a given age. For example, a child of 5;1 with a raw score of 4 (mean score =3) would be given a score of 1. A child of 5;1 with a raw score of 0 would be given a score of -3.

Scoring Reliability

All the tests were administered and scored by the primary investigator. A random sample of 20% of the individual administration audiotapes (8 from each group) was scored by one other speech/language pathologist who was blind to subjects' group membership. In addition, the Action Picture Test and The Bus Story were transcribed before scoring by the other speech/language pathologist. Overall point-to-point agreement was 97% and ranged from 92% to 100%.

Psychological Evaluation

A chartered psychologist or experienced psychometrician (under the supervision of a chartered psychologist) tested the preterm children and a chartered psychologist tested all the comparison children using the Stanford-Binet Intelligence Scale, fourth edition (Thorndike et al., 1986). Eight subtests were administered overall in the Verbal Reasoning (vocabulary, comprehension and absurdities), Abstract/Visual Reasoning (pattern analysis and copying), Quantitative Reasoning (quantitative) and Short-term Memory (bead memory and memory for sentences) areas to give a composite score.

Procedures

A consent form was signed by the parent and child (Appendices A to E). The child was tested in a well-lighted room with minimized background noise. Hearing was screened as described previously.

The language tests were then administered. The order in which the tests were given was kept constant. The Action Picture Test was given first, followed by The Bus Story, the NSST, the Recalling Sentences subtest of the CELF and the Auditory Sequential Memory subtest of the ITPA. This was due to the relatively free, less structured type of response needed for The Bus Story and the Action Picture Test. The other tests were administered in ascending order of structure with those involving only auditory memory administered at the end of the session. The Action Picture Test, which has short questions with pictures, was given first to interest the child before administration of the lengthier Bus Story. Language test administration and psychological evaluation each lasted approximately one hour for the preterm and comparison subjects .

Audio recordings of all the tests were made using either a Sony Walkman Professional or a Califone tape recorder with an external stereo omnidirectional microphone.

Six of the potential comparison children were not suitable for the study. Of these one had an IQ below 85, one was untestable and four repeatedly failed hearing screenings. Five of the preterm children who were tested were subsequently not used for the study. One had a mild to moderate sensori-neural hearing loss, one had hearing loss combined with low IQ, and three had IQ's below 85.

Data Analysis

To answer the research questions, the following data analyses were used:

1. To make comparisons between the language scores in the matched preterm and full-term groups, repeated measures multiple analysis of variance (MANOVA) with post-hoc univariate tests were used.

2. To determine whether the difference in language scores persisted when the effects of IQ were partialled out, multiple analysis of covariance (MANCOVA) with IQ as a covariate, and post-hoc univariate tests were used.

3. To examine the variance predicted by birthweight, gestational age, degree of intraventricular hemorrhage and five minute Apgar scores, multiple regression analyses using each language score as a dependent variable were used.

Chapter 4 • Results

Preliminary Analyses

Paired two sample t-tests were used to ensure that groups did not differ in age or socio-economic status. There were no significant differences between age and socio-economic status as shown in Table 2.

Table 2: Preterm and comparison groups' characteristics

	Preterm		Comparison		*p* values
	M	SD	M	SD	
Age (months)	71.3	(8.5)	70.9	(7.6)	.575
Blishen SES	51.3	(13.9)	51.0	(14.9)	.733

Mothers' education levels were not significantly different (p =.818). The mean for the preterm group was 8.1 (SD 1.8) and that of the comparison group was 8.1 (SD 2.3). This mean educational level for both groups is equivalent to some university with no additional training.

Group Comparisons

Results of the MANOVA show a significant overall effect (Hotellings = 1.06; F[8, 32] = 4.26, p <.001) indicating significant group differences between the language scores of the preterm and the comparison subjects. Follow-up univariate analyses were then conducted to examine differences in language scores between the preterm and comparison subjects (Table 3). Significant differences were obtained for all eight dependent variables. Figure 5 illustrates group differences for the seven of the language scores which were standardized.

Figure 5: Group differences in language scores

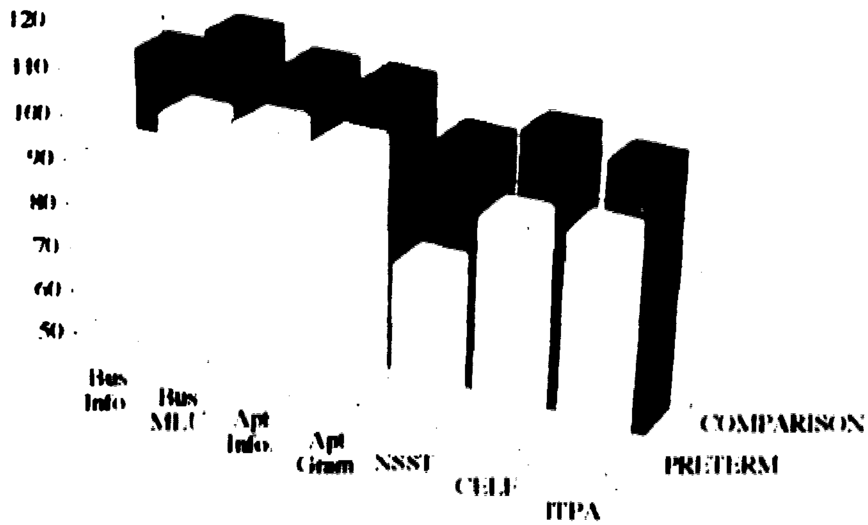

Table 3: MANOVA - Group means and standard deviations for language variables

Variables	Preterm M	Preterm SD	Comparison M	Comparison SD	*p*
Bus Story					
Information	93.6	(19.5)	108.2	(13.7)	<.001
MLU[a]					
(standardized score)	103.7	(13.7)	115.1	(12.8)	<.002
Complexity					
(subordinate clauses)[b]	2.0	(2.1)	3.4	(1.8)	<.003
Action Picture Test					
Information	105.4	(10.2)	110.9	(6.7)	<.007
Grammar	105.1	(12.6)	110.9	(8.2)	<.011
NSST-expressive	83.4	(20.9)	102.5	(12.9)	<.0001
CELF-sentence repetition	97.6	(12.7)	107.9	(11.5)	<.0001
ITPA-digit repetition	98.7	(12.9)	105.6	(13.5)	<.041

[a] Actual MLU scores (average number of words in 5 longest sentences) : Preterm = 10.4 (SD 3.0) Comparison = 12.1 (SD 2.0)

[b] Actual number of subordinate clauses. Scores not standardized (see p.23).

Composite IQ scores and scores for the four IQ areas (verbal reasoning, auditory/visual reasoning, quantitative reasoning and short-term memory) of the two groups were compared using paired t-tests with Bonferroni's correction (Table 4). With an alpha level of .01, the results indicated no group differences for composite IQ, auditory/visual reasoning, quantitative reasoning and short-term memory. There were significant differences in the verbal reasoning area ($p < .01$).

Table 4: Group means and standard deviations for Stanford-Binet scores

Area	Preterm		Comparison		*p*
	M	SD	M	SD	
Composite IQ	103.9	(8.3)	105.6	(9.0)	.367
Verbal Reasoning	104.8	(7.0)	109.9	(11.0)	<.010
Auditory/Visual Reasoning	98.8	(9.6)	99.1	(12.0)	.897
Quantitative Reasoning	108.2	(8.5)	110.3	(11.5)	.325
Short-Term Memory	101.3	(11.3)	102.0	(14.9)	.824

As planned, the effects of IQ were partialled out using MANCOVA. The language scores of the groups remained significantly different (Hotellings = 1.69; $F[8,31] = 6.57$, $p < .0001$). Follow-up univariate analyses indicated differences in all but the ITPA auditory sequential memory sub-test (Table 5).

Table 5: MANCOVA - Significance of language variables

Language variables	*p*
Bus Story	
Information	<.0001
MLU	<.003
Complexity	<.005
Action Picture Test	
Information	<.012
Grammar	<.018
NSST-expressive	<.0001
CELF-sentence repetition	<.0001
ITPA-digit repetition	.068

Regression Analyses

Within the preterm group, relationships between birth variables and language scores were examined using multiple regression analyses. Correlations between perinatal variables were calculated (Table 6). Gestational age, which had a lower correlation with the language scores, was excluded as the correlation between birthweight and gestational age was statistically significant at the .01 level.

Table 6: Correlations of perinatal variables for preterm subjects

	Birthweight	Gestation	IVH
Birthweight	1.00		
Gestation	.57**	1.00	
IVH	.07	-.01	1.00
Apgar - 5 min.	.31	.27	.03

** p <.01

As shown in Table 7, the only significant correlations between perinatal variables and language scores were the five minute Apgar scores with each of the three Bus Story sub-tests ($p < .05$) and the Action Picture Grammar sub-test ($p < .01$).

Table 7: Correlations of language variables with perinatal variables for preterm subjects

	Birthweight	Gestation	IVH	5 min. Apgar
Bus Story Information	.12	.02	.17	.32*
Bus Story MLU	.11	.05	-.04	.36*
Bus Story Complexity	.05	.07	.17	.37*
Action Picture Test Information	.12	.10	-.05	.15
Action Picture Test Grammar	.08	.13	.02	.43**
NSST-expressive	.14	.12	.09	.12
CELF- sentence repetition	.04	-.02	.03	.24
ITPA- auditory sequential memory	-.07	.08	-.20	-.18

*p <.05 **p <.01

Multiple Regression Analyses using a stepwise method with birthweight, degree of intraventricular hemorrhage and five minute Apgar scores as independent variables were carried out (Table 8). The five minute Apgar scores were significant in predicting The Bus Story Information, Bus Story MLU, Bus

Story Complexity and Action Picture Grammar scores.

Table 8: Multiple regression analyses for preterm subjects

Dependent variable	Significant predictors	Adj. R^2	p
Bus Story			
Information	Apgar	.08	.05
MLU	Apgar	.11	.02
Complexity	Apgar	.11	.02
Action Picture Test			
Information	None		
Grammar	Apgar	.16	.01
NSST	None		
CELF	None		
ITPA	None		

Chapter 5 • Discussion

Group Comparisons

The first research question posed in this study was specifically concerned with overall group differences in the language scores of the 40 preterm and 40 comparison children who were matched for age, gender and socio-economic status and all of whom spoke English as a first language. Results of the MANOVA showed that the scores of the comparison children as a group were significantly higher than those of the preterm children. When individual test differences were investigated, the scores of the three sub-tests of The Bus Story, the two sub-tests of the Action Picture Test, the expressive portion of the NSST and sentence and digit recall were all significantly different.

Group differences in the information and complexity (number of subordinate clauses) scores of The Bus Story had been expected. The amount of information given and presumably remembered was less for the preterm children although it was still within the average range with a mean of 93.6. The number of subordinate clauses used by each child ranged from zero to nine in the preterm group and from one to nine in the comparison group. In fact 35% of the preterm children used no complex sentences at all, the average number of subordinate clauses in the group being two (with a standard deviation of 2.1). One would have expected an average for a group of children of this age to have been just over 3 according to the norms. This must be interpreted with caution, however, as only means and not standard deviations were available. The comparison children used an average of 3.4 subordinate clauses in their stories and the variance was less. These findings regarding the number of complex sentences are similar to those of Grunau et al., (1990) and to those regarding sentence elaboration reported in the de Hirsch et al. study (1964).

Large group differences in mean length of utterance (MLU) were not anticipated as previous studies have shown that for language samples MLU did not differ from the comparison group or varied little within ELBW, VLBW and LBW groups of preterm children (Grunau et al., 1990; The Scottish Low Birthweight Study Group, 1992). In this study, the MLU of the preterm group was also average but the comparison group used longer sentences.

The preterm children used sentences which were grammatically less complex than the comparison children when replying to the questions of the Action Picture Test and the quality of information given was also lower. This type of complex task, which involves comprehension plus ability to give pertinent information in a well constructed sentence, becomes more important for the child in the kindergarten or early primary years when reading and writing are being taught and listening and comprehension skills are valued. Once again, however, both syntax and information were in the average range for the preterm group.

The expressive portion of the Northwestern Syntax Screening Test was particularly difficult for many of the preterm children. In this test, delayed recall of sentences presented orally along with pictures is necessary, thus probably involving short-term auditory memory rather than just immediate recall of sentences. The expressive syntax skills of this preterm group of children as tested by the NSST, were below average and considerably below those of the comparison group. Given that the NSST expressive sub-test was found to be a strong predictor of adolescent language by Aram et al. (1984), continued evaluation of this preterm group of children into the high school years seems to be warranted.

As part of the language evaluation, the speech/language pathologist noted difficulties with attention/concentration which could potentially have affected the test results. A greater proportion of preterm children were observed to have concentration problems which seemed to affect performance on the NSST and to a lesser degree sentence imitation of the CELF. Given the nature of the IQ test where the child has to concentrate for shorter periods of time as with the Action Picture Test, lack of concentration/attention would probably not have affected the results to the same extent on these latter tests. Difficulty with ability to concentrate/pay attention was noted by the speech/language pathologist in 16 of the 40 preterm children and to a much lesser extent in an additional four. In contrast to those of the preterm children, the speech/language pathologist's observations revealed concentration difficulties in only six of the full-term children, four of them having very mild difficulties. The Child Behavior Checklist for ages 4-18 (Achenbach, 1991) was completed by the parents of the preterm children as part of the Neonatal Follow-up Clinic. The protocols were available for 33 of the preterm children. Parents of the other 7 children had discussed their children's attention with the speech/language pathologist. "Can't concentrate, can't pay attention for long" was a concern for 18 of the parents. Nineteen parents also agreed with the description of the child as "Can't sit still, restless, or hyperactive". Unfortunately the checklist was not available for the comparison children. Forty seven percent of the parents in the Scottish low birthweight study (1992) also considered that their children had a poor attention span. One must therefore take into account the compounding effects of distractibility/concentration difficulties or hyperactivity on the language and learning skills of the preterm child. These in turn may have been affected by social and biological conditions surrounding preterm birth with lack of bonding due to lengthy hospital stays, possible overprotection and parental concern with the fragility of their baby and disruption of sleeping and crying patterns more common in the full-term baby (Yogman, Wilson, & Kindon, 1987).

Recall of sentences, which become both longer and progressively more syntactically complex in the CELF sub-test, was also significantly lower for the preterm group although, once again, the mean was within average according to the given norms. As noted above, lack of ability to concentrate may also have affected the scores of this test.

The composite IQ scores of the groups did not differ significantly although, as would be expected given the differences in language scores of the groups, the verbal reasoning area of the Stanford -Binet Intelligence Scale was significantly lower in the preterm group. Partialling out of the composite IQ scores, therefore, was not expected to decrease the significance of group differences in the language scores in MANCOVA and in fact it increased. However, there were no longer significant differences in the digit repetition scores. The lack of differences in the groups' ability to perform an automatic, less meaningful task, which often appeared to be enjoyed by those children who had difficulty concentrating or whose syntax skills were particularly poor, possibly serves to highlight the differences in more complex language and expressive syntax. Inclusion of recall of digits forward, therefore, may not be useful in a battery of tests used for comparing language differences in ELBW and full-term children.

Although information on middle-ear problems was not collected in the current study, the higher incidence of middle ear problems commonly found among preterm infants may have contributed to group differences in language (Pearce et al., 1988).

Regression Analyses

Birthweight, IVH and 5 minute Apgar scores were used in the stepwise Multiple Regression Analyses for the preterm children. Apgar scores were significantly correlated with the language scores and when entered in the analyses, accounted for the variance in 8% of The Bus Story Information, 11% of MLU, 11% of Complexity and 16% of Action Picture Test Grammar scores. Perhaps low Apgar scores, which indicate higher degrees of distress in the newborn infant representing overall lowering of vital functions, serve to reflect brain damage or dysfunction and ensuing complex language difficulties. There is conflicting information about the predictive value of Apgar scores, and their use in predicting complex language scores for this age group does not appear to have been explored in any detail previously. Scores at one and five minutes were found to very minimally predict comprehension but not expression in two Australian studies of children at 3 years and preschool age (McAllister, Masel, Tudehope, O'Callaghan, Mohay, & Rogers, 1993a, 1993b). However, their subjects' gestational ages and birthweights varied greatly and were higher than in the present study. This area merits further investigation with varied groups of preterm children at different ages.

Neither birthweight nor IVH were significant predictors for this group of children. Low birthweight was found to minimally predict language outcome in the same two Australian studies (McAllister et al., 1993a, 1993b). The IVH results are different from those of Janowsky & Nass (1987), for example, who found delays in expressive language (using the Early Language Milestone Scale) in infants who had experienced Grades I and II IVH in contrast to preterm infants without IVH. Byers Brown et al. (1986) found differences in speech-sound variables in infants with varying degrees of IVH the majority of whom, unlike this study, had a higher frequency of Grades III and IV IVH. Both studies were of much younger children (whose language tends to vary greatly) who had higher gestational ages and birthweights than those in the present study With older studies one also has to take into account the less advanced medical technology and the probability of poorer prognosis for the preterm infant. Although IVH had predicted language ability as tested by the Stanford-Binet Intelligence Scale and one word receptive vocabulary (PPVT-R) in a group of 3 year old ELBW children (Grunau et al., 1990), it did not predict sentence complexity. Thus, although some studies have found statistically significant relationships between IVH and measures of less complex language, in no study has IVH predicted measures of complex language.

Chapter 6 • Conclusion

The language scores of the group of preterm children were statistically significantly lower than those of a comparison group even when the effects of the composite IQ scores were removed. Multiple regression analyses revealed that Apgar scores only accounted for a small part of the variance in some of the language scores and that degree of birthweight and IVH did not account for any. Thus, preterm status itself may be more relevant than the independent variables chosen. Composite IQ scores were not significantly different for the two groups. Therefore, if one had predicted outcome differences with the preterm and comparison groups solely on the basis of overall cognitive abilities, a very different picture with no hint of differences in complex language would have emerged. However, looking at the four areas which made up the composite score, verbal reasoning was found to be significantly lower for the preterm group.

Group differences in all of the individual language scores except for digit span were found when the effects of IQ were partialled out. Nevertheless, five of the remaining seven scores were in the average range for the preterm children. The group means for the number of subordinate clauses in The Bus Story and the expressive syntax score of the NSST were below average. One must consider the possibility that the language potential may have been above average or superior for a preterm child but may now be normal or average due to perinatal insults. Similarly it may be below average for some of those with potentially average ability.

The negative effects of an increased risk of middle-ear infections in infancy and the much higher percentage of concentration and attentional difficulties among children in the preterm group may have contributed to language score differences. Attentional capacity at 5 years of age was one of the areas predicted by Als and Duffy (1989) in their electrophysiologic studies (brain electrical activity mapping) in the newborn period using healthy preterm and full-term babies, with the children of lower gestational age showing more difficulties in this area. They noted that "It appears that programs of environmental structure and care must be geared to the individual infant's sensory thresholds" (p.148). Yogman et al. (1987) also stressed the need to help parents of very preterm children understand individual needs of their children and to organize the environment in such a way as to minimize potential for later behavior/attentional disturbances.

Differences in language abilities between the preterm and full-term children may also be accounted for when one looks at development of the brain. Rapid growth of the brain actually takes place in the second half of gestation after most of the neurons which make up the adult brain have developed (Dobbing & Sands, 1973; Taylor, 1992). The preterm study children would have been born during this second half when dendritic complexity increases, synaptic connectivity is established, glial cells multiply and myelination occurs. Much of the growth of the cerebral hemispheres would have been established by the time the very preterm children were born but growth of the cortex continues to be very important for language development as integration of the neural structures necessary for its function is located there. IVH may cause some neurons to be unable to migrate to the cortex and therefore the timetable of genetic processes in utero and after birth may be disrupted. Myelination, which facilitates rapid transmission of neural information and continues after birth, may be critical in the language areas and disturbance in its maturation may be a cause of developmental language delays (Love & Webb, 1992). One may hypothesize that the very preterm child may be more at risk for language delay due to arrest in development during the normal gestational period. If there is interference with neuronal migration, for example, to the left hemisphere (most often associated with dominance for speech and language) the ensuing deficit, if any, may be in complex language functioning. There also may be damage to the subcortical pathways with resultant lack of stimulation to the cortex and therefore some restriction in development of language. Studies involving brain electrical activity mapping, magnetic resonance imaging (MRI) scans and positron emission tomography (PET) scans will be important in our understanding of language as it relates to brain functioning in the very preterm child.

Limitations

Several limitations of the study must be taken into account.

Internal Validity

The first threat to internal validity was that the speech/language pathologist was not blind to the children's group membership. However, although she conceivably could have been influenced by this knowledge, there was careful attention to consistency in test administration, use of instruments and scoring for the eighty children. In addition, a second speech/language pathologist, who was blind to the subjects' group membership, independently transcribed and scored a random sample of 20% of the language test administration tapes and 97% agreement was reached. The psychologist and psychometrician who tested the preterm children were not blind to group membership but were both experienced testing preterm children and all the comparison children were tested by a different experienced psychologist who was familiar with a wide range of types of children. Apart from being employed to independently test the children, or testing them as part of the Glenrose Neonatal Follow-up Clinic, the psychologists were not involved in this study in any way. Thus it does not appear that experimenter bias was a factor in this study.

The second threat to internal validity was that the settings in which the children were tested were different. However, with the exception of one comparison child who was tested in a university setting, the settings were familiar to all the children: schools, daycares and after school cares for the comparison children and the Glenrose Hospital and homes for the preterm children.

The data were controlled for experimentwise error for the group comparisons by using MANOVA. In the multiple regression analyses, there is a slight possibility that, given the number of variables, significance could have occurred by chance. However, the analyses were considered appropriate due to their exploratory nature and the fact that only one independent variable accounted for variance in four of the eight dependent variables.

External Validity

The Bus Story and the Action Picture Test are British tests and were not standardized using North American children unlike the other tests used. Although they were considered appropriate for and appeared to be enjoyed by the study children, the results may not be fully generalizable.

The preterm children came from Northern and Central Alberta and the study children were recruited in or near Edmonton. However, with the exception of three preterm children who came from rural areas, one of whom was matched with another farm child who lived near Edmonton, all the preterm children were from metropolitan areas and therefore would have had similar backgrounds and schooling.

With continuous advances in medical technology, for example, the use of surfactant therapy to combat Respiratory Distress Syndrome, there are constant changes in medical outcome of very preterm children. Therefore, results from this particular group of children may not be entirely generalizable to children who were born after 1986 or who will be born in the future. However, any problems due to immature nervous systems would still be generalizable to more recently born preterms.

The high mothers' educational level of the children in this study was not necessarily typical of that of many VLBW children, although very similar to that found in a recent Finnish study (Herrgård, Luoma, Tuppurainen, Karjalainen, & Martikainen, 1993). This is probably because they were older, of a higher SES and with a higher antepartum risk (e.g. many previous miscarriages and low fertility) than many of the mothers whose babies are in the VLBW range. They were, in many cases, women who had complicated pregnancies and were at the time under care of highly qualified obstetricians.

Implications for Clinical Practice

As a group, the preterm children gave less information, had lower grammatic complexity, sentence length and syntax/memory skills and more attentional/concentration difficulties than the comparison children. However, with the exception of the NSST and complexity sub-test of The Bus Story, language scores were in the average range. The communication problems of some of the children were serious whereas some others were more subtle. Therefore, there is need for in-depth language assessment for the very preterm infant as he or she may benefit from some type of speech/language therapy or counseling. Given the potential for neurological problems in the infant of very low gestation, there is the possibility of hidden deficits which cannot be "cured". Language therapy may help to remediate some of the language problems while others may be permanent. The need to teach compensatory strategies to some of the children will therefore be important. Ideally the speech/language pathologist should be part of the team at neonatal follow-up clinics and can refer children for or administer appropriate speech/language therapy. Alternatively, for parents who are not able to bring their children to a clinic, the need for assessment at a local facility should be stressed.

An integrative team approach (e.g. pediatrician, nurse, speech/language pathologist, psychologist, learning disabilities specialist and occupational /physical therapist) will be important for assessment as studies have shown that despite normal intellectual ability, VLBW children are at more risk for learning disabilities and utilize more special resources in schools (Saigal, Szatmari, Rosenbaum, Campbell, & King, 1990; Saigal et al., 1991; The Scottish Low Birthweight Study Group, 1992). As oral language deficits such as those found in some of these preterm children often underlie reading, writing and spelling problems, early intervention and remediation for some preterm children may be warranted. Some children may need direct speech/language therapy but many of the parents just need ideas for development of vocabulary and oral language and the importance of talking and reading to their child should be stressed. Some language problems of preschool children, including the very preterm, may be developmental. However, especially as it may be unwise to correct for chronological age for the very preterm child after 12 months, it may be appropriate to err on the side of caution and to offer language therapy or ongoing advice as a preventative measure for the child with what appears to developmental delay rather than wait until he or she is considerably behind his or her peers. Given the high incidence of attentional difficulties, there is need for help for management of very preterm infants. Ideally this would be given in the home environment, at least initially, with additional counseling provided if difficulties persist. This may ensure that the child will be able to concentrate as well as possible at school entry.

Parents of preterm children may naturally be more anxious about their child's progress and many may in fact provide a very supportive atmosphere and devote more time to their preterm child than they would to a full-term child. Although many of the parents of children who performed well wanted to have periodic testing to ensure knowledge of continued progress, those whose children performed poorly on language tasks and/or who probably were at risk for learning difficulties, had genuine cause to be concerned. Counseling may also be needed for parents of preterm children who may not have reached their full potential and are performing at an average level in homes where there are siblings who are above average.

Implications for Future Research

Large comparative studies which include more comprehensive tests of complex language abilities than the present study and which include preterm children who are carefully controlled for gestational age and/or birthweight and disabling conditions are needed. Longitudinal studies of preterm children from birth onwards are needed in order to establish the predictive value of neonatal variables and tests of complex language abilities.

Single case and comparative language remediation studies of VLBW children with varying degrees of language problems are warranted. These would help us discover what type of remediation or compensatory strategy teaching would benefit the preterm child and also lead us to understand the nature of the language problem.

Follow-up studies of communication and academic skills for the present preterm study children are recommended at the time of entry into the intermediate grades at elementary school when complexity of language involving reading skills increases and more independent work skills are necessary, and again in the adolescent years. One would then be able to compare performance in the present and future language tests for predictive purposes and to assess language skills in conjunction with academic performance.

It is often difficult to assess language development of very young children, due to the wide range of what can be considered normal performance. New tests, which would more easily identify children such as the very preterm who are at risk for later language problems, are needed. Standardized systems of data collection and of interviewing parents about their concerns and perceptions of their child's development may be of value. They may provide a bank of information about the development of speech and language and of behavior and attention difficulties in the very young child for future generations.

Studies involving neuropsychological combined with language testing and MRI, brain mapping and PET scans will be important for the future. These could help our understanding of language and brain functioning and help establish the predictive value of some neonatal variables. They could, for example, help discover the reason for the language deficits found in the present study.

A British test of narrative ability (The Bus Story) was used for this study due to its predictive validity found in two large scale studies (Bishop & Edmundson, 1987; Howlin & Kendall, 1991). Feagans and Appelbaum (1986) in their study of language subtypes in learning disabled children, stated that "the ability to understand and paraphrase narratives appears to be a critically important skill for academic functioning for LD children, and it may be much more important than the traditional building blocks of language skills, such as vocabulary and syntax" (p. 364). It is suggested that new standardized tests of narrative ability and/or standardization of The Bus Story using North American children would be a valuable contribution to addressing language and learning abilities of learning disabled children.

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APPENDIX A
Information form for preterm children
INFORMATION FORM

PROJECT TITLE: Language abilities in 5 through 7 year old nondisabled children born ≤ 28 weeks gestational age.

PRINCIPAL INVESTIGATOR: Nancy Duncan
CO-INVESTIGATORS: Dr. C. Robertson and Dr. P. Schneider

The Neonatal Follow - Up Clinic has been involved with evaluation of neonatal care for many years. One of the aspects of our evaluation has been the long term outcome of babies who were very premature. At this time we wish to study their language and memory. To do this, we will use the results of the standardized tests which will be given to your child along with the results from other very preterm children. Therefore, we are asking you to give us consent to use the information obtained.

If your child has not already been seen by a psychologist at the clinic, a psychologist will test your child's intelligence. This will last for about one hour.

The speech/language pathologist will test hearing, memory, and how well your child can talk and understand what is said. The session will last about one hour and part of it will be audiotaped. Snack and bathroom breaks will be given. Additional breaks may be requested by you or your child.

If you wish, the results of the tests will be discussed with you briefly after the test session. A summary of the test results will be sent to you and if you wish to have more details, an appointment may be made for a later date. Recommendations for any necessary further testing and/or treatment will be made. The details of the test results will be kept strictly confidential by number, not name, in research files and not placed in your child's clinic file, and not released, unless requested by you.

We will be pleased to answer any questions concerning the assessment at any time.
The contact person is Nancy Duncan who may be reached at 471-2262, extension 2521.

The alternative contact person is Dr. C. Robertson, Director, Neonatal Follow-Up Clinic at 471-7924.

APPENDIX B

Consent form for preterm children

CONSENT FORM

PROJECT TITLE: Language abilities in 5 through 7 year old nondisabled children born ≤ 28 weeks gestational age.

PRINCIPAL INVESTIGATOR: Nancy Duncan
CO-INVESTIGATORS: Dr. C. Robertson and Dr. P. Schneider

CHILD'S NAME ______________________________

I acknowledge that the research procedures described on the attached form and of which I have a copy , have been explained to me and to my child as far as he/she can understand. Questions that we have, have been answered to my satisfaction and that of my child. I understand the benefits (if any) of joining the study. I may ask now, or in the future, any questions I have about this study or the research procedures. I understand that there are no known risks to these procedures.

I have been assured that personal records and audiotapes relating to these research protocols will be kept confidential and that no information will be released or printed that would disclose personal identity without my permission.

I understand that I am free to withdraw my child from the study at any time. I further understand that if my child does not join the study, or there is withdrawal from it at any time, the quality of medical care will not be affected.

I give permission for the researchers to have access to my child's medical records.

THIS IS TO CERTIFY THAT I, ______________________________, have given consent

for my daughter/son ______________________________, to participate in the above research project.
Any further inquiries concerning the study may be obtained by contacting Nancy Duncan at 471-2262, extension 2521.

____

Signature of parent/ Guardian   Relationship to Subject   Date

____

Signature of child   Date

____

Signature of Principal Investigator

____

Name of witness

____

Signature of witness

APPENDIX C

Information letter to parents of children in schools, daycare and after school care facilities.

LANGUAGE ABILITIES RESEARCH STUDY

INFORMATION LETTER TO PARENTS

I am a Speech/Language Pathologist presently studying at the University of Alberta and am particularly interested in language abilities in five, six and seven year old children. I am testing a group of children who were born very prematurely. I also wish to test a group of healthy children who were born at full-term and to compare them with the preterm group.

I am writing to ask if you would permit your child to be involved in the study. At this time we will be testing children who were healthy full-term babies. Your child will be seen privately at the school (daycare or after school care)[4]. Hearing, memory and how well your child can talk and understand will be tested. This will last about one hour and part of it will be audiotaped. A psychologist will evaluate your child's cognitive development. This will also last about one hour. Rest breaks will be provided.

If you wish, I will talk to you about the results. You will be contacted if they indicate that any follow-up or further testing is necessary. The details of the test results will be kept strictly confidential by number, not name, in research files in a locked cabinet, and not released, unless requested by you.

As I am matching each child in the preterm group with a child in the full-term group, I will need to contact you to ask some questions. I can then let you know if your child is suitable for the study. Can you please return the Language Study Return Form in the enclosed envelope?

Please feel free to contact me if you have questions.

Principal Investigator: Nancy Duncan. Tel. 432-9195

Co-Investigator: Dr. P. Schneider, Department of Speech Pathology and Audiology, Corbett Hall, University of Alberta.

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[4] Name of appropriate facility will be inserted here.

APPENDIX D

Language Study Return Form for Parents of Comparison Subjects.

LANGUAGE STUDY RETURN FORM

YES I would like my child ______________________________ to be
(Name)

considered for the study.

Telephone number ______________________________

Most suitable time for phoning ______________________

Name of parent/parents______________________________________

Age of child ________years ______months.

NO. I would not like my child ____________________________ to be
(Name)

considered for the study.

APPENDIX E

Consent form for comparison children

CONSENT FORM

PROJECT TITLE: Language abilities in 5 through 7 year old nondisabled children born ≤ 28 gestational age.

PRINCIPAL INVESTIGATOR: Nancy Duncan
CO-INVESTIGATORS: Dr. C. Robertson and Dr. P. Schneider

CHILD'S NAME ______________________________

I acknowledge that the research procedures described on the attached form and of which I have a copy , have been explained to me and to my child as far as he/she can understand. Questions that we have, have been answered to my satisfaction and that of my child. I understand the benefits (if any) of joining the study. I may ask now, or in the future, any questions I have about this study or the research procedures. I understand that there are no known risks to these procedures.

I have been assured that personal records and audiotapes relating to these research protocols will be kept confidential and that no information will be released or printed that would disclose personal identity without my permission.

I understand that I am free to withdraw my child from the study at any time. I further understand that if my child does not join the study, or there is withdrawal from it at any time, there will be no adverse consequences.

THIS IS TO CERTIFY THAT I, ______________________________, have given consent for

my daughter/son ______________________________, to participate in the above research project.

____

Signature of parent / Guardian   Relationship to Subject   Date

____

Signature of child   Date

____

Signature of Principal Investigator

____

Name of witness

____

Signature of witness