THE RELATIONSHIP OF MEDICAL AND FAMILY CHARACTERISTICS TO LANGUAGE DEVELOPMENT SKILLS OF LOW BIRTHWEIGHT CHILDREN AT THREE YEARS OF AGE

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Submitted to the Faculty of
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Oklahoma State University
in partial fulfillment of
the requirements for
the degree of
DOCTOR OF PHILOSOPHY
December, 1994

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ACKNOWLEDGMENTS

I wish to extend my sincere thanks and appreciation to Dr. Barbara Wilkinson for her encouragement and guidance throughout my graduate program. My genuine thanks also go to Dr. Janice Williams, Dr. Diane Montgomery, Dr. Bob Davis, and Dr. Patricia Self for serving on my doctoral committee. Their suggestions and support have been very helpful throughout this project.

My deep appreciation goes to George Giacoia, M.D., Director of the hospital Perinatal Center, for his support and assistance during my internship and dissertation study conducted at the hospital. Many thanks to the parents and children who made this project successful by participating in this study.

I have been blessed with many wonderful friends and supporters throughout this endeavor. A special thanks to Dr. Lou Rossetti for lighting the candle that would see me through to the end of this venture. You have been a wonderful inspiration, mentor, and friend. To Suza VanTuyl and my many classmates and friends, I extend my thanks for your friendship and the experiences we have shared. To Jody Faulkner for being my colleague, my friend, and too often my sounding board. My best wishes to you in your similar pursuit. To Shirlee Davis, for always being there for me. To the many other friends who have been supportive during this time, I say, "Thank You".

My family has always been there to offer support and encouragement and to keep me on track. Tim and Phyllis Hershberger, Greg and Becky Pugmire, Ken and Bonita Shouse, and my sister, Lance and Tena Highfill have my deepest love and appreciation. A very special thanks to my mother and step-father, Harry and LaFaune Krampf, who have helped raise my children and keep my family on track during this long process. I sincerely could not have accomplished this without your help. Finally, my dear husband Phil, and my children, Justin and Amy, you are the light of my life. I appreciate your sacrifices and your allowing me the time to grow and learn as I have during this entire process. To all of the people close to me, I extend my love and a sincere thanks.

IN MEMORY OF:

KENNETH MITCHELL SHOUSE

and

MICHAEL JOSEPH DUBACH

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CHAPTER ONE

INTRODUCTION

The purpose of this investigation was to acquire additional information about low birthweight children, their families, and their developmental outcome at age three. Language development was used as the developmental outcome measure because language is accepted as one of the best early predictors of later cognitive functioning (Rossetti, 1990). The detecting of delayed early milestones of language development has been advanced as an extremely sensitive indicator of developmental disability, including later academic and social difficulties (Largo, Molinari, Comenale, Weber, & Duc, 1986). Another line of research in this investigation examined the correlation of mother's age at first birth to several family characteristics and compared the results to a study by Schraeder, Heverly, O'Brien, and McEvoy-Shields (1992). Three research questions were addressed in this study:

1. How do the family variables of 1) socio-economic status (SES), 2) use of public assistance, 3) mother's level of education, 4) family structure,

5) number of children in the family, and 6) the birth order of the child in this study correlate with the mother's age at first birth (MAFB)?

2. To what degree can we predict the multiple effects of receptive and expressive language skills by the medical variables of birthweight, gestation age, days in the hospital, and Neonatal Medical Risk (NMI) classification, and by the family characteristics of socio-economic status and mother's age at first birth?

3. How well do family characteristics and neonatal medical risk variables predict overall language ability of children 37 to 39 months of age?

Rationale for the Study

Recent studies with low birthweight (LBW) infants have shifted the emphasis from issues of survival to the complications seen as part of survival (Kopp, 1990; Wolke, 1991). Emphasis has shifted to the less severe disabilities and learning problems that are appearing in those children considered to have survived intact (Aylward, Pfeiffer, Wright, & Verhulst, 1989; Hunt, Cooper, & Tooley, 1988; McCormick, Gortmaker, & Sobol, 1990; Saigal, Szatmari, Rosenbaum, Campbell, & King, 1991).

The surviving premature, low birthweight, and critically ill children who have benefitted from the technological advances of the 1980's are now entering school. The incidence of severe handicapping conditions in this population has stabilized in recent years to a range of 4.5-10.1% (McCormick, 1989). Those children with severe handicapping conditions are often identified early and offered early intervention services. The less severe handicapping or disabling conditions that are associated with surviving a high risk neonatal course are manifested in a range of learning problems, which include language difficulties, perceptual-motor difficulties, and behavioral difficulties. The early identification and amelioration of these potential difficulties is critical to optimizing the child's development. This study provides important information to help identify those children who may be at risk for delayed language development.

Language Development

Language development and communication skills of children born premature appear to be particularly at risk since they depend on the integrative functioning of motor, auditory, and cognitive systems, as well as a facilitative environment (Brown, Bendersky, & Chapman, 1986).

Very low birthweight children have been observed to develop nonverbal communication skills such as visual and auditory tracking and social smiling around term or 40 weeks post conception. Expressive language development frequently lags behind receptive language (Hubatch, Johnson, & Kistler, 1985; Rossetti, 1986). At 18 to 24 months post-term, the very low birthweight child may display only a few words, when vocabulary size for the full-term healthy child is rapidly expanding. Although language skills within the range of normal were found for low birthweight children at 12 months of age (Byrne, Ellsworth, Bowering, and Vincer (1993), language deficits were present and not detected in these children until they were older when language measures were more sensitive to deficits.

The incidence of delayed speech and language development in very low birthweight children at 2 years of age ranges from 15 to 35 percent (Fitzhardinge and Ramsey, 1973). This high incidence of communication problems is seen in children without the confounding factors of mental retardation or severe hearing loss. Language delay among young children age 2 to 5 can be considered as a precursor of lower functioning in school. Language delayed children at age 3 have been shown to have a significantly higher prevalence of low IQ and reading difficulties at age 7 (Silva, 1980). Children who demonstrate early communicative delays or disorders tend not to outgrow these difficulties (Wilcox, 1989).

Similarly, prematurity places infants at increased risk for communication deficits due to the increased family stress and the decreased parent-child interaction (Jacobsen & Shubat, 1991). After a premature birth, parents deal with the stress of a lengthy hospitalization before the child is discharged home. Parents also deal with the financial stress of a lengthy hospitalization, plus certain medical necessities once the child comes home such as medications, special diets, supplemental oxygen, and monitors. Early parent-child interaction is based on reciprocal communicative intents between the infant and the caregiver. Parental stress and medical necessities translate into decreased enjoyment of the child and decreased communicative interaction with the child.

Age 3 was determined to be an important age to do follow-up studies because it is a critical period when language can be accurately assessed and used as a marker for screening later cognitive and academic difficulties. A London study (Stevenson & Richman, 1976) found the prevalence of language delay in very low birthweight (VLBW) 3 year-olds at 31%. Silva (1980) conducted a large study looking at the nature, prevalence, stability, and significance of language delays in 3 year olds. The incidence of very low language scores at age 5 among those who scored low at age 3 was significant. Seventy percent of those children scoring low in language at age 3 had low IQ scores at age 5, which are associated with increased difficulties with school learning.

Since it is impossible to evaluate all children in the 3 to 5 year age range for possible developmental delays, reliable screening procedures are the next most effective methods. Language assessment can be used as a screening tool for helping identify children who may have the potential for cognitive, and later, academic difficulties.

Definition and Incidence of Prematurity and Low Birthweight

Low birthweight (LBW) is defined as below 2500 grams, or 5.5 pounds, and includes both prematurely born infants and full term infants who are small for gestational age (SGA). Premature birth is defined as occurring before 38 weeks gestation. Very low birthweight (VLBW) is 1500 grams or below, and extremely low birthweight (ELBW) is 1000 grams or below (Saylor, Levkoff, & Elksnin, 1989). In the 1960's, only 10% of infants weighing less than 1000 grams survived. In the 1970's, 20% of these infants survived, but 50% of those were disabled. In 1985, babies weighing between 750 and 1000 grams had an 80% chance of survival (Donovan, 1992). The incidence of low birthweight in the United States is approximately 7% and has not changed in the past 25 years (Saylor, et al. 1989; Schwartz, 1989). Premature births have occurred in 1:12 live births in the United States for the past 35 years, compared with an 8% premature birth rate for other countries (Rayburn, 1992).

Family Characteristics

The likelihood of poor developmental and academic outcome is greater in the face of socioeconomic disadvantage, a risk factor for low birthweight and prematurity, placing many low birthweight infants at dual risk or "double hazard" for both biologic and environmental factors (Escalona, 1982; Infant Health and Development Program, 1990). Almost without exception, outcome studies that have considered social, familial, and environmental factors have found strong evidence for the influence of these factors on developmental outcome (Scott & Spiker, 1989).

It is well established that medical factors become less powerful predictors, especially of cognitive outcome, but that socioeconomic status and environmental factors increase in predictive power (Bozynski, et al. 1987). Research supported that the relationship of environmental factors to outcome is stronger for preterm infants than full-term infants (Grunau, Kearney, & Whitfield, 1990). In these doubly vulnerable situations, prematurity is likely to be highly predictive of school, development, and behavior problems (Escalona, 1982; Hunt, et al. 1988; McCormick,1989).

Socio-economic status (SES) is an important variable in predicting language development (Siegel, 1982) and a globally accepted predictor for school learning (Robertson, Etches, & Kyle, 1990). Among premature children, SES, birth order, and severity of illness in their perinatal period were found to be the most significant predictors of language comprehension and expression at age 3 (Siegel, 1982). This is supported by Largo, et al. (1986) who found that non-optimal perinatal conditions affect language development and articulation up to age 5. Hubatch, et al. (1985) matched preterm and full-term infants on single word level using the variables of SES, maternal education, race, birth order, number of siblings,and mother's work outside the home. They found the controls did significantly better than the preterms on both receptive and expressive language measures. At 3 years, 40% of the preterm children were considered language delayed, although their IQ's were in the low range of normal.

SES for this study was established through the Two Factor Index of Social Position (Hollingshead, 1957). This index was developed to provide an objective procedure to estimate the positions individuals occupy in our society. SES ratings are one through five on a Likert-type equal interval scale, with one being the highest based on education and occupation.

Mother's Age at First Birth

A related line of research has examined the maternal variable of mother's age in relation to developmental outcome. Furstenberg, Brooks-Gunn, and Chase-Lansdale (1989) observed that children of early childbearers (in their teen years) are at higher developmental risk throughout childhood than children of older childbearers (late twenties to early thirties). Early childbearing was found to be associated with lower SES, use of public assistance, lower maternal education, single parent status, and larger number of children. Schraeder, et al. (1992), in a study of low birthweight children at school age, found mother's age at first birth (MAFB) strongly associated with lower SES (r=.51), use of public assistance (r= -.48), education (r=.64), large number of children (r= -.52), single parent structure (r= -.31), and the study child being a later born child (r= -.30). Early childbearing was associated with a less emotionally and verbally responsive environment (r=.32). In the Schraeder, et al. (1992) study, mother's age at first birth accounted for over one third of the variance in children's school achievement after controlling for birthweight status.

Neonatal Medical Risk Factors

Neonatal medical risk factors are often overlooked by assessors when they are evaluating a toddler who appears to be functioning within the normal range. While it has been established that medical factors become less powerful predictors over time (Bozynski, et al. 1987), they can provide valuable information to the assessor to help explain and interpret a child's developmental functioning. The present study gathered the medical risk factors of birthweight (BW), measured in grams; gestation age (GA), measured in weeks; length of stay in the hospital (LOS), measured in days; and additional information from the child's medical records needed to assign the Neonatal Medical Index (NMI) classification including length of assisted ventilation, presence and grade of intraventricular hemorrhage, presence of apnea or bradycardia, major surgery, seizure activity, and meningitis. Developed by Korner, et al. (1993b), the NMI yields a one through five index as a measure of how ill the infant was during hospitalization.

Statement of the Problem

In general, the majority of surviving low birthweight infants have normal cognitive and motor development at 2 years (Bauchner, Brown, & Peskin, 1988). Outcomes continue to reveal a broad array of less severe educational difficulties such as learning disabilities, visual-motor integration problems, and language deficits (Kopp, 1990). Premature babies who have benefitted from the technological advances of the 1980's and survived are now in school and present a specific set of subtle learning difficulties which are of importance to both the regular and special education teacher.

The purpose of this study was to describe the relationship of family characteristics and neonatal medical risk variables to expressive and receptive language development of children from 37 to 39 months who were born at risk for developmental delay, and to compare the current results to the findings by Schraeder, et al. (1992) regarding the correlation of mother's age at first birth with family characteristics. This study involved three questions.

1. How do the family variables of: 1) socio-economic status (SES), 2) use of public assistance, 3) mother;s level of education, 4) family structure, 5) number of children in the family, and 6) the birth order of child in this study correlate with the mother's age at first birth (MAFB)?

2. To what degree can we predict the multiple effects of receptive and expressive language skills given neonatal medical risk variables and family characteristics related to a child's background?

3. How well do family characteristics and neonatal medical risk variables predict overall language ability of children 37 to 39 months of age?

Receptive and expressive language scores were determined by administering the Preschool Language Scale - 3. The neonatal medical risk factors included birthweight; gestational age; days in the hospital; and

Neonatal Medical Risk (NMI) classification. The family variables were socio-economic status (SES) and mother's age at first birth (MAFB).

Significance of the Study

Emphasis on assessing children during early childhood began with P.L. 94-142, the Education for All Handicapped Children Act (Federal Register, 1975), and it's amendments (Federal Register, 1986). These acts established a means to assist states in establishing comprehensive, community services to identify and serve infants and toddlers with disabilities before they reached school age. The amendments to this act provided continued services for 3 to 5 year-olds through Part B and extended services to eligible children, birth to age 3, and their families through Part H. Child find activities are extremely important to help identify developmentally delayed children as early as possible. Along with the federal money provided to identify and serve these children, the federal government required a program evaluation component that makes agencies accountable for the money they receive. This study helped identify the variables that best indicate which children may have potential difficulties developing language skills and might benefit from language stimulation and other developmental enhancement activities, thereby increasing the efficacy of the time, personnel, and money spent in early intervention efforts.

CHAPTER TWO

LITERATURE REVIEW

Introduction

Advances in neonatal-perinatal medicine have occurred during the past decade leading to a higher survival rate for very low birthweight infants (Bauchner, et al. 1988; Escobar, Littenberg, & Petitti, 1991; Resnick, et al. 1992; Shipps & Yonovitz, 1992). With this increased survival rate, there is growing concern about the subsequent health and long-term developmental outcomes of infants weighing less than 2500 grams (Bennett, 1990; Landry, Fletcher, Zarling, Chapieski, & Francis, 1984; Lawhon & Melzar, 1988). Literature reviewed as relevant to the present study centered on the developmental outcome of surviving low birthweight children ages 12 months to school age, as it relates to language development. Recent studies were necessarily most relevant since those babies have benefitted from the technological advances made in neonatal care in the last two decades. Relevant studies on language development and language testing with the Preschool Language Scale -III are outlined. Medical risk factors and their predictive value to later outcome were reviewed. Important family characteristics that have been studied with the low birthweight population were summarized.

Language Development

The overall development of premature children has been studied extensively by means of developmental and intelligence testing, but language development in this population has been under-investigated. Recognizing the critical link between language and cognition points to the importance of assessing language skills whenever developmental status is in question.

Preterm and full term children born in the mid 1970's were assessed using the Reynell Language Comprehension Scale (Reynell, 1969) in a study by Siegel (1982). Siegel found socio-economic status, birth order, and severity of illness in the perinatal period to be the most significant predictors of language comprehension and expression at age three.

Mother-infant pairs of full term and preterm babies at 12 months were studied by Crnic, Ragozin, Greenberg, Robinson, and Basham (1983). The premature group attained significantly lowered scores on 4 of 5 measures of cognitive and language performance and the premature infants vocalized much less than their full term peers. While this study did find significant differences, it is important to note that these babies were born in the early 1980's and that recent technological advances and better developmental care has tended to ameliorate these differences.

A study to describe language development during the first five years of life of premature children and to compare them with full term children was designed by Largo, et al. (1986). They began with 131 preterm infants and 111 term neonates and conducted neurological development assessments at 1, 3, 6, 9, 12, 18, and 24 months. Language development was charted through home protocols every 6 months to age five. This study found a significant negative relationship between the ages at which the various stages of language development were reached and the performance in language testing at age five. Term and preterm children who were slow in their language development during the first years of life tended to score lower on the language assessment at age five. This study provides support that language delays between ages two and five are a precursor of lower mental functioning at school age.

Language skills in low birthweight children at 8 months and 2 years were examined by Vohr, Garcia-Coll, and Oh (1988) using matched controls that were appropriate for gestational age (AGA, n=35) versus small for gestational age (SGA, n=15). A neurological assessment classified the children as normal, suspect, or abnormal. They did not exclude children with significant medical complications and those with gross neurological abnormalities, as did Kelsey and Barrie-Blackley (1976) and Greenberg & Crnic (1988). The Hollingshead Index (1957) was used to assign socio-economic status. Low birthweight AGA and SGA children were found to be significantly behind the term children in receptive and expressive language scores as measured by the Preschool Language Scale (Zimmerman, 1969). Both of the LBW groups scored lower than the term controls on the Bayley Scales of Infant Development Mental Development Index. A receptive or expressive language delay was present in 28% of the low birthweight children. This finding is in agreement with Byrne, et al. (1993) who found 28% of two year olds delayed in expressive language and 6% delayed in receptive language, and Stevenson & Richman (1976) who found a 31% delay present at three years. The percentage of language delay found in the general population ranges from 2-6% (Seidman, Allen, & Wasserman, 1986). The data analyses were continued by Vohr, et al. (1988) using multiple regression with gestational age, SES score, and eight-month neurological score as independent variables and the receptive and expressive language scores as dependent variables. Results indicated that the independent variables had a significant cumulative effect on language development, accounting for 42% of the variance in the receptive language scores and 41% of the variance in the expressive language scores. Gestational age and neurological status made significant independent contributions in the equation predicting receptive language scores. Gestational age was the only significant variable predicting expressive language scores. SES status had no independent significant effect on language performance at two years, although it contributed along with gestation age and neurological status to a significant percent of the variance in the language scores. These results confirm the importance of cumulative effects of variables on language development. Vohr, et al. (1988) concluded that suspect and abnormal neurological status at eight months correlates with poor language scores at two years, and that preterm SGA status does contribute significantly to language performance.

Comparing language at three years in a carefully defined groups of extremely low birthweight (ELBW) preterm children, with a sample of term children of comparable demographic status, was designed by Grunau, et al. (1990). They were concerned that previous studies evaluating language of preterm children usually involved samples with a wide range of birthweights and gestational ages, varying ethnicity, and limited evaluation of environmental factors. The sample selection included only children who were white, English speaking, singleton birth, and free of major neurological handicaps. The resulting subjects were 23 pairs of children matched for sex, corrected age due to prematurity, and mother's education. Test measures included the Stanford-Binet Intelligence Scale, fourth edition (Thorndike, Hagan & Sattler, 1986), the Peabody Picture Vocabulary Test, Revised (PPVT-R) - Form L (Dunn & Dunn, 1981), and a language sample of 50 utterances to establish mean length of utterance. Results indicated that ELBW children were significantly below the control group for receptive and expressive language, although within the normal range of the test measure. Regarding biologic risk, the neurological marker IVH (Intraventricular Hemorrhage) accounted for one-third of the variance in the Stanford-Binet vocabulary scores. Mother's education and IVH combined accounted for more than half the variance in short-term auditory memory for sentences. They concluded that children born below 1000 grams (ELBW), who show normal overall intellectual scores, appear to function linguistically less well than their full-term peers of comparable environmental background and do not appear to have overcome this language delay at three years.

The linguistic and cognitive development of preterm and full term infants was evaluated by Menyuk, Liebergott, Schultz, Chesnick, and Ferrier (1991) using frequent language sampling. They evaluated the children eight times during the first three years. The preterm group fell significantly below the full term group in cognitive development at 20,30, and 36 months. There were no significant differences in the age at which each group achieved various early language milestones. Overall, the preterm group was 3.5 months behind the full term group on all outcome measures, which were still in the normal range. The confounding problem with this study is that all subjects came from middle to upper SES families and the children overall were healthy. No subjects came from poverty families. The authors stated that the recurrent visits may have acted as an intervention and encouraged the parents to be aware of their child's language development.

A critical overview of neonatal follow-up studies from the past decade that followed children to school age was conducted by Ornstein, Ohlsson, Edmonds, and Asztalos (1991). They reviewed nine studies that examined extremely low birthweight infants (<1000 grams) at school age and 16 studies that involved very low birthweight infants (<1500 grams). Most of the children in the follow-up studies had age appropriate IQ scores, however, there was a greater variability of test scores. There was an increased need for special education services and remedial therapy. Behavioral difficulties, visual-motor integration deficits, and fine and gross motor incoordination were also reported. Low socioeconomic status was the most frequently reported predictor of poor outcome. Ornstein, et al. (1991) found speech and language delays reported in 28% of the studies, although 68% reported normal IQ's. In these studies, language delays and articulation deficits were reported in 14-55% of the children examined. Twenty-eight percent of VLBW infants were receiving speech therapy at follow-up compared to 4% of the control group in a study by Michelsson, Lindahl, Parre, and Helenius (1984).

An eight-year follow-up study of infants weighing between 500-1000 grams (ELBW) and who were born between 1977 and 1981 was conducted by Saigal, et al. (1991). The initial sample consisted of 143 ELBW infants and a control group of 145 children born at term who were matched for gender, age, and social class. Ninety percent (n=129) of the ELBW children were available for follow-up at 8 years as well as 100% (n=145) of the control children. The extra control children were not excluded so that the bias resulting from exclusion of some control children could be avoided. This resulted in 16 of the ELBW children having two matched control subjects each. Eight of the ELBW children were not testable, eight blind children received other tests, and 113 of the 129 completed the full test battery. The Wechsler Intelligence Scale for Children - Revised (Wechsler, 1974) revealed a mean Full Scale IQ of 91 +/- 16 for the ELBW children and 104 +/- 12 for the control children. Between 8% and 12% of the ELBW group scored in the abnormal range (<2 SD) compared with 1% to 2% of the control group. The Wechsler scores and achievement measures did not significantly improve when the 19 ELBW children with neurologic impairments or an IQ <70 or both were excluded. The motor performance and the visual-motor integration of the ELBW was also poorer than the control group. Saigal, et al. (1991) found significantly lower scores on both receptive and expressive language measures at eight years of age than those of matched controls. Teachers reported that 39% of the ELBW were below grade level and that 52% were receiving special education or remedial help, as compared to 17% and 16%, respectively, for the matched control group. Although approximately two thirds of the ELBW group were performing within the average range on intellectual measures, the ELBW children as a group were significantly disadvantaged on every measure tested.

Language abilities of three year olds who were born prematurely with low birthweight (<2500 grams), were measured for 30 subjects, along with neonatal risk information including degree of respiratory illness, length of hospitalization, birth weight, gestational age, SES, and gender (Craig, Evans, Meisels, & Plunkett, 1991). The Preschool Language Scale, Revised Edition (Zimmerman, Steiner, & Pond, 1979) was used to assess receptive and expressive language skills. Only 4 of the 30 children assessed demonstrated clinically significant language problems. The neonatal risk factors did not distinguish these four children (all boys) from their peers. This investigation had a small sample size but demonstrated that language developmental outcomes appear quite good for children born premature with low birthweight and are free of other major handicapping conditions. This study differs from the present study in that it only looked at one environmental factor, SES. The present study did not, as the Craig, et al. (1991) study did, exclude those with handicapping conditions, which are represented in higher numbers in the language delayed population.

In summary, language development is highly sensitive to a combination of variables both in the neonatal period and during the formative years of language development. Premature children were often found to have language development within the range of normal, but significantly lower than their full term counterparts. Additionally, preterm children with normal overall IQ scores appeared to function less well linguistically than their full term peers of similar environmental backgrounds. These children did not appear to overcome or outgrow this language delay at three years of age.

Language Testing

There are many widely accepted language assessment instruments available that assess both receptive and expressive language through norm-referenced and criterion-referenced means. Several different instruments have been used with low birthweight children. The subjects in this study are three years of age and able to be tested using a standardized instrument. The Preschool Language Scale - III (PLS-3) published in 1992 by Zimmerman, Steiner, and Pond was the normative instrument used in the current study. This study represents one of the first studies to use this recently published instrument on subjects born in the decade of the 1990's.

The Preschool Language Scale

Originally published in 1969, the Preschool Language Scale (PLS) (Zimmerman, 1969) was based on maturational and developmental aspects of language competence as identified by experts in speech pathology, human development, and psycholinguistics. The scale proved especially useful for measuring early language development because it featured both auditory and verbal sections and was easy to administer. The subscales could determine auditory comprehension ages (receptive language), verbal ability ages (expressive language), and a total language score for 1 year through 7 years. Each subscale contains four items at each six-month interval from twelve months to five years of age, and four items for each of the intervals from five to six and six to seven years of age. An age equivalency is derived for each subscale based on the number of items passed at each interval. The age equivalencies for the subscales are combined to compute a composite age equivalency for the total test. Rapid expansion of research in the areas of early language acquisition, including many studies using this scale, led to a need to revise the scale to reflect this progress.

Many concurrent validity studies used the PLS and the PLS-R, correlating them with other speech and language measures, composite tests that include a language section, and cognitive ability measures. The current form of this test, The Preschool Language Scale - III (PLS-3) was published in 1992 (Zimmerman, et al.).

The most frequent comparison of the PLS (Zimmerman, 1969) has been with the Peabody Picture Vocabulary Test (PPVT)(Dunn & Dunn, 1959), a measure of single word receptive language in which the subject points to one picture matching the stimulus word from a group of four pictures. Roston (1977) found correlations of the PPVT of r=.42 with the PLS auditory comprehension quotient, r=.66 with the verbal ability quotient, and r=.59 with the overall language quotient. Zimmerman and Steiner (1972) reported correlations of the PPVT of r=.65 with the PLS auditory comprehension and verbal ability quotients, and r=.67 with the PLS language quotient using normal preschoolers enrolled in Headstart programs.

Several studies have used the PLS-R with normally developing preschoolers. Goldstein, Smith and Waldrep

(1986) conducted a study using 40 normal three year old preschoolers. The correlation of the Kaufman Assessment Battery for Children (K-ABC) (Kaufman & Kaufman, 1983) standard scores with the PLS-R Auditory Comprehension Quotient was r=.55, and with the PLS-R Verbal Ability Quotient was r=.52.

The PLS-R, the Peabody Picture Vocabulary Test - Revised (PPVT-R)(Dunn & Dunn, 1981), and the Test of Early Language Development (TELD) (Hresko, Reid, & Hammill, 1981) were administered in counterbalanced order to 25 normal, white, middle-class preschool children (McLoughlin & Gullo, 1984). The purpose of the study was to compare the predictive efficacy of two instruments considered screening measures (PPVT-R and TELD) with one subskill diagnostic measure (PLS-R). The PLS-R was chosen because of its wide use and acceptance, and because it is one of the few instruments that compares both the child's receptive and expressive language performance. A stepwise multiple regression was conducted to assess the capacities of the PPVT-R and the TELD as predictors of the PLS-R total and subtests' scores. The PPVT-R was found to be the better overall predictor of the PLS total score (R^2=.529). The TELD accounted for less than 1% of the variance not already accounted for. Even combined (R^2=.536), these tests do not account for about 47% of the variance in the PLS-R, therefore only tapping a portion of the language components assessed by the PLS-R. The authors indicate that their sample was restricted and that further studies should include larger samples from a wider distribution range.

Five hundred twenty eight Nebraska 4 and 5 year old children were assessed to identify the possibility of cultural bias when using the Preschool Language Scale - Revised (PLS-R) to help determine future eligibility for kindergarten placement and possible need of remedial services (Hilton & Mumma, 1991). The study assessed 214 rural children and 214 suburban children in the same school district from the rural-suburban interface west of Omaha. Both groups scored above age level using the age equivalency tables for the PLS-R. A significantly higher percentage of rural children failed a wide range of both verbal and auditory ability items. The authors concluded that the PLS-R did not meet their criteria for a nonbiased, ecologically valid assessment when applied to two relatively large groups of rural and suburban populations. They do not recommend designating children eligible for special services based solely on the PLS-R performance.

The fact that most language studies to date have used other language instruments, it is important to know how the PLS-3 would perform in the current study as a valid measure of language ability. Two widely used instruments, the Clinical Evaluation of Language Fundamentals - Preschool (CELF-Preschool) (Wiig, Secord, & Semel, 1993) and the Wechsler Preschool and Primary Scale of Intelligence - Revised (WPPSI-R) (Wechsler, 1989) were used as criterion measures in several studies to assess the validity of the PLS-3.

A study of the relationship between the Clinical Evaluation of Language Fundamentals - Preschool (CELF-Preschool) (Wiig, et al. 1993) was conducted with 53 children. Twenty-five were ages 3 years to 3 years, 5 months, and 28 children were ages 4 years to 4 years, 5 months. The tests were administered in counterbalanced order and the between-test interval was one day to two weeks. The correlation between the CELF-Preschool Receptive Language Score and the PLS-3 Auditory Comprehension Score was .83. The CELF-Preschool Expressive Language score correlated with the PLS-3 Expressive Communication score at .81. The correlation between the total language scores for the CELF-Preschool and the PLS-3 was .90.

An analysis of the relationship between the PLS-3 and the Wechsler Preschool and Primary Scale of Intelligence - Revised (WPPSI-R) (Wechsler, 1989) was conducted with a sample of 40 normally functioning 4 year-old children. Testing was administered in counterbalanced order with a between-test interval of 1 to 14 days. The correlation between the PLS-3 Total Language Score and the WPPSI-R Full Scale IQ was .82. The variance shared by the two tests is .67, indicating a strong and significant relationship. These high correlations lead to the conclusion that the PLS-3 is a valid measure of language ability.

In summary, the PLS-3 appeared to be a well-standardized instrument for assessing the language skills of young children. The present study represented one of the first investigations to use the PLS-3. This test proved to be an important tool for diagnosing language disorders in high risk populations. Of interest to the present investigation was how well children who were born at lower birthweights than those in the standardization sample performed on this instrument.

Family Characteristics

Prenatal, birth, and perinatal factors alone are not effective in predicting developmental problems (Klein, 1985). The caretaking environment that the child lives in has a profound impact on the premature infant's long term development. The predictive ability of socio-economic status (SES) variables, as described by Escalona (1982) have been used in many studies with low birthweight children.

Language development at three years was assessed for infants weighing less than 1000 grams at birth and full term controls matched for socio-economic status (SES) by Grunau, et al. (1990). The extremely low birthweight group scored significantly below their matched peers in both receptive and expressive language skills. Bendersky and Lewis (1990) evaluating language skills at two years and Siegel (1982) evaluating language skills at three years both found lower SES significantly related to delayed expressive and receptive communication skills. A long term follow-up study by Resnick, et al. (1992) found that 95% of low birthweight intensive care nursery graduates had educational outcomes comparable with those graduates of the normal newborn nursery matched for similar SES backgrounds. Poverty status and race had the greatest impact on educational outcome. This study concluded that the consequences of neonatal risk factors and prematurity have a minor impact on development compared to SES risk factors.

Mother's education was found to be significantly related to overall verbal intellectual ability of both preterm and full term subjects (Grunau, et al. 1990).

A longitudinal study of very low birthweight children followed through school age focusing on SES variables found maternal education attainment to be a significant factor (McCormick, Brooks-Gunn, Workman-Daniels, Turner, & Peckham, 1992). For children with birthweights above 1000 grams, there was a 20 point difference in IQ between those children with the least educated and those with the most highly mducated mothers. More advanced maternal education eliminated the differences in IQ by birthweight groups for all but the tiniest babies.

Language development is dependent on a nurturing environment and a positive caregiver-child relationship. SES has a significant impact on outcome in terms of language development. Preterm and full term children from lower SES families score lower on verbal ability measures that do children from higher SES families. Maternal education level is a significant variable related to overall verbal ability of both preterm and full term children.

Mother's Age at First Birth

Several studies have examined the variable of mother's age at first birth in relation to developmental outcome. Children of teen childbearers were found to be at higher risk for developmental delays throughout childhood than children of women who were in their late twenties to early thirties when they began childbearing (Furstenberg, et al. 1989). The Furstenberg, et al. (1989) study found that early childbearing was associated with lower SES, use of public assistance, and lower maternal education.

Mother's age at first birth (MAFB) was found to have a large significant correlation with all aspects of achievement measured by Schraeder, et al. (1992) using the Kaufman Assessment Battery for Children (K-ABC) (Kaufman & Kaufman, 1983) and the Peabody Individual Achievement Test-Revised (PIAT-R) (Markwardt, 1989). The Schraeder, et al. (1992) study examined 71 children and their primary caregivers. Thirty-nine children were very low birthweight and 32 were normal birthweight. Children in both the VLBW and normal birthweight groups with lower achievement scores had mothers who were very young when they gave birth to their first child. Early childbearing was strongly associated with lower SES, use of public assistance, less education, larger numbers of children, single parent family structure, and the subject being a later child.

Medical Risk Factors

Children age 3 1/2 and 4 1/2 who were born premature and appropriate for gestational age (<2000 grams and <37 weeks), compared to children who were born small for gestational age (<2500 grams and 37-42 weeks), were studied by Kelsey and Barrie-Blackley (1976). There were no significant differences between the groups on measures of receptive and expressive language. Results of this study are in question, however, since children in this study were from middle and upper classes and those children with the poorest prognosis for normal development were excluded. Craig, et al. (1991) did not separate small for gestational age (SGA) from appropriate for gestational age (AGA) in their study and found few significant differences in the language skills of three year olds. They pointed out the need to control for the subject variable of AGA and SGA, as did Siegel (1982), in support of the earlier work of Kelsey and Barrie-Blackley (1976).

Intraventricular hemorrhage (IVH) is a rupture in the ventricles which causes pressure on the brain due to excessive pooling of blood. An IVH occurs in up to 45% of all preterm infants weighing less than 1500 grams (Blackman, McGuinness, Bale, & Smith, 1991) and is a major cause of long term neurologic disabilities

(Bauchner, et al., 1988). Lewis and Bendersky (1989) reported that low birthweight children who suffered an IVH in the neonatal period had significantly poorer performances on the mental and psychomotor scales of the Bayley Scales of Infant Development (Bayley, 1969). Janowsky and Nass (1987) and Landry, et al. (1984) studied 2 year old children who were preterm and had/had not suffered IVH. Results indicated the IVH groups were delayed in expressive, but not receptive language.

Follow-up studies into the school years, such as those by Gilbride, Kaplan, and Tallal (1983) and Bozynski, et al. (1987), found significant differences in auditory perception and language skills between premature children with a history of neonatal asphyxia, IVH, or chronic lung disease and normal term children. Interestingly, the Gilbride, et al. (1983) study did not find a significant difference in IQ scores between the premature and full term groups. Blackman, et al. (1991) cautioned that surviving IVH with normal cognitive functioning in the preschool years does not preclude certain learning disabilities from later emerging.

Mechanical ventilation is often a treatment for Respiratory Distress Syndrome, a common lung complication in premature infants. Prolonged mechanical ventilation is a powerful predictor of poor developmental progress during the first 18 months of life in infants weighing less that 1200 grams (Bozynski, et al. 1987). In a review of recent studies, the influence of respiratory distress on neurodevelopmental outcome was similar to that of prematurity in general (Bregman & Farrell, 1992). However, as the infant's stay in the hospital lengthened and the time on the ventilator increased, the risk for neurodevelopmental delay increased.

There are several neonatal medical complication scales available, but few include children below 1500 grams birthweight. The literature on perinatal risks scales as reviewed by Molfese, (1989) suggested that these scales hold promise and are generally valid in predicting later infant outcomes. The Neonatal Medical Index (NMI) classification developed by Korner, et al. (1993b) gives an index regarding the severity of the infant's medical condition as opposed to evaluating all of the complications and symptoms the infant experiences during the perinatal period. The medical information needed to assign an NMI classification, such as birthweight, length of time on a ventilator, presence and grade of IVH, major surgeries, or seizure activity, is readily available on an infant's discharge summary.

Neonatal medical risk factors have been shown to affect outcome. The importance of gathering medical data such as birthweight, gestation age, IVH, length of ventilation and stay in the hospital have been outlined. Although the influence of medical risk factors on development decreases over time, the subtle difficulties in learning that can result from surviving medical complications may not emerge and be identified until later years.

Summary

What emerged from the literature was a clear description of developmental performance that differentiates many high-risk infants from the healthy full term infant. Although these children appear more resilient than formerly supposed and though the incidence of major handicapping conditions has been decreasing, more subtle cognitive and socioemotional problems continue to characterize this population. These differences extend into school age and can be represented in a growing number of children with learning problems as the number of infants surviving at low birthweights and younger gestational ages increases (Rossetti, 1986). Within this context, it seems imperative to identify which groups of infants born premature with low birthweight are at risk for specific long-term difficulties, including language delay.

CHAPTER THREE

METHOD

Introduction

This chapter describes the subjects, instruments, procedures, and data analyses used to investigate the three research questions. The subjects consisted of a low birthweight birth cohort from late 1990 and early 1991.

Subjects

The participants for this study (N=51) were babies born at low birthweight (<2500g) admitted to a Neonatal Intensive Care Nursery between July, 1990, and March, 1991. Their mean birthweight was 1720.66 grams with a range of 680 grams to 2470 grams. This study focused on the 38-month-old child, plus or minus 4 weeks. The mean age was 37 months, 3 weeks with a range of 37 months to 39 months. The age range of 37 to 39 months of age was chosen for this study because it is an age not previously used in studies of language skills using medical risk factors and family characteristics. Three years of age is a critical period for screening later academic or cognitive problems and it is the age at which children with mild disabilities are eligible for school services through Part B of P.L. 99-457. These children represented babies born at the beginning of the decade of the 1990's which have benefitted from the technology developed during the late 1980's.

The Institutional Review Board of the hospital where the subjects were obtained and the Institutional Review Board at Oklahoma State University reviewed the treatment of human subjects and approval was granted from both boards (see Appendix A).

Procedure

The admissions records of the hospital were reviewed and a list was compiled of 152 children born below 2500 grams from July, 1990 to March, 1991. The parents' names and addresses for all children identified were obtained from hospital admission records.

All eligible families (subjects' birthweight <2500g) were contacted by letter (see Appendix B) and invited to participate in this study. The purpose of the study was explained in the letter, as well as the procedures and information that were to be gathered.

Included with the letter was a stamped, addressed post card (see Appendix B) for the parents to fill out and return. Information requested on the post card included parent and child's name, address, phone, and child's birthdate. The parent then checked one of the following categories on the post card: 1) Yes, I would like for my child to participate in this study and receive a free language assessment. Contact me to schedule an appointment; 2) Yes, I am interested but unable to come to the testing site. Contact me to discuss an additional testing site; or 3) No, I decline to participate at this time. A phone number was provided so that parents could call the examiner to discuss any additional questions they may have. Parents were asked to return the stamped post card they received with the letter regardless of whether or not they wanted to participate. Forty-nine (49) of those letters were returned due to wrong addresses and were lost to follow-up.

A second letter was mailed 2-4 weeks later to the valid addresses of parents not responding to the first letter. A third letter was sent two to three weeks later to those still not responding. The third letter was sent registered return receipt mail. After 3 contacts with no response, the subject was considered in the "no response" category. There were 45 potential subjects eliminated due to lack of response, leaving 58 potential subjects. Seven (7) parents responded but declined to participate, leaving 51 respondents who agreed to participate and became the study subjects.

When the post card was returned, the parent was contacted by phone to schedule an assessment visit with the examiner. Every effort was made to make participation in the study as convenient for the family as possible. For example, parents who lived outside the urban area were offered a closer, more convenient testing site, such as a local library. There was no charge to the family for this assessment, which would cost them $100.00 or more in a private clinic setting. All testing was completed solely by the examiner.

The children were brought to the hospital or other mutually agreed upon testing site for evaluation. All but four subjects were tested at the hospital. Those four subjects were tested at their local public library. Test conditions were duplicated between the hospital and the library with the parent/caregiver present and the child sitting on the floor with the examiner.

Each evaluation session lasted approximately one hour. The consent form for the study was reviewed and signed by the parent/guardian. (See Appendix C). The Demographic Information Form (See Appendix D) was filled out by the mother, or the information was supplied by a legal guardian. This time spent with the caregiver allowed the child to have a warm-up period and become familiar with the surroundings and the examiner. The testing portion took approximately 30-40 minutes and included administration of the Preschool Language Scale - III. The child was encouraged to sit at a small table, but testing was sometimes accomplished on the floor. The mother/parents of all subjects stayed in the room during testing.

After the testing session, the language test was scored while the child was in free play, and the results shared immediately with the parent. Questions were answered, and referrals for other services such as preschool, Head Start, or speech therapy, were made as necessary.

The demographic information form was reviewed for missing data or unclear answers before the end of the session. All parents filled out the information form completely. The parent and child were thanked for their participation as they left the testing room.

After the assessment visit, the child's medical record was reviewed by the examiner to obtain the needed information on the Medical Records Review Form (see Appendix D). The medical information was then used to assign a Neonatal Medical Index (NMI) classification. A master list provided the subject name and code number, so that the medical records reviewed could be coded without using the subject's name on the form.

Instruments

The instruments used in this study consisted of the Preschool Language Scale - III, and two data collection forms developed by the researcher. A demographic information form was designed to obtain information regarding the child's mother and family characteristics. The medical records review form was used to document medical risk variables and to obtain information needed to assign an NMI classification.

Preschool Language Scale - III

Content and Scope. The subjects were assessed using the Preschool Language Scale - III (PLS-3) (Zimmerman, et al. 1992), which has recently been normed and published. The PLS-3 was organized similarly to the original and revised editions of the PLS with two standardized subscales: Auditory Comprehension, which measures receptive language; Expressive Communication, which measures expressive language; and a Total Language Score. Evaluating infants and toddlers requires different skills and procedures from those used to test older children. Taking these differences into account, the developers of the PLS-3 established criteria for designing tasks that would be age appropriate. In constructing tasks for children 3 years to 6 years, 11 months, the following criteria were applied: 1) tasks should engage the child in a variety of behaviors, such as responding to questions, manipulating objects, and pointing to pictures; 2) to the maximum extent possible, tasks within an age level must reflect a variety of linguistic parameters, so that a single age level would not consist of all grammar tasks or all vocabulary tasks; 3) on the Auditory Comprehension subscale, tasks should include multiple foils, including picture foils; 4) the colors and sizes of the illustrations presented as stimuli must be balanced so that no single illustration is significantly more salient than others on the page; and 5) a variety of ethnic groups must be represented in the picture manual.

The Auditory Comprehension subscale is used to evaluate a child's receptive language skills in the areas of attention, semantics (content), vocabulary and concepts, structure (form), morphology and syntax, and integrative thinking skills. The Expressive Communication subscale uses tasks to evaluate expressive language skills in the areas of vocal development, social communication, semantics (content), vocabulary and concepts, structure (form), morphology and syntax, and integrative thinking skills.

<u>Description and Components of the Scale.</u> The *PLS-3* was standardized and can be used with children ages 2 weeks through 6 years, 11 months. The authors feel this test should not be used with adult clients and is not appropriate for determining whether or not a child is gifted.

The materials consist of an easel-backed picture manual with full-color pictures, a spiral bound examiner's manual, and a 16-page record form. Addition materials needed to administer the scale to three year olds include: a teddy bear, tennis ball, shoe box, three metal keys on a standard key ring, three heavyweight plastic spoons, three plastic cups, a child's white sock, and eight one-inch blocks in assorted colors. The average testing time is 30-40 minutes for 3 year olds.

Each 6-month age section has 4 tasks for each subscale from birth through 4 years 11 months. Passing criteria is included on the scoring form for each task. An example is Auditory Comprehension task number 32 in the 3-6 to 3-11 age bracket. The task states, "Indicates body parts on self" and has seven items. The examiner asks, "Show me your a) head, b) arm, C) knee, d) elbow, e) thumb, f) chin, g) eyebrow. Passing criteria is 6 correct. Individual items within each task are scored with a "check" for a correct response, "minus" for an incorrect response, and "NR" if the child has no response. An example of an Expressive Communication task is number 26 in the 3-0 to 3-5 age range. The task examines the child's ability to answer questions logically and has three items. The examiner states, "What do you do when a) you're sleepy, b) your hands are dirty, c) you're cold." Passing criteria is two of the three items correct. For each of the four tasks per age bracket, the overall task is scored as "1" if the passing criteria for the task is met, or "0" if the passing criteria is not met. The starting point generally was in the 2 year, 6 month to 2 year, 11 month age section. A basal is achieved when a child passes three consecutive tasks. The child is given credit for all tasks below the basal. Testing is discontinued when a ceiling of 5 consecutive task errors is reached. Some tasks can be scored if the child is observed to spontaneously perform the target behavior. No credit is given for a task that is not observed.

The raw scores consist of the total number of correctly passed tasks for each subscale. Raw scores were then converted to standard scores using the tables provided. The two subscale standard scores were added and converted to a total language standard score using the tables provided.

__Standardization of the PLS-3.__ The standardization study began in June, 1991. The following children were excluded from participation in the standardization testing: children previously identified as language-disordered through formal assessment; those receiving language remediation services following a diagnosis of a language disorder; and children less than two weeks of age, born at less than 35 weeks gestation, or who had "difficulties at birth" as reported by the parent on the parent consent form. Included in this category were: children who did not go home from the hospital with their mothers, those with a significant birth defect (e.g., cerebral palsy, spina bifida), or those who had a genetic defect (e.g., Down's syndrome).

More than 1900 children in 40 states and the District of Columbia participated in the standardization and related reliability and validity studies. Twelve hundred children, ages 2 weeks to 6 years 11 months, were included in the standardization sample. The standardization sample for the age interval of interest in this study was 3 years to 3 years 5 months, consisting of 101 subjects. A representative sampling based on the 1980 Census of Population, 1986 update, was stratified on the basis of parent education level, race, and geographic region. The northeastern, north central, southern, and western geographic regions were represented in the sample within 2% of the U.S. population. The southern region represented 33.0% of the U.S. population and was represented in the PLS-3 sample at 34.8%.

Race and Ethnic origin are exceptionally well represented in the standardization sample. Whites (n=828) comprise 69.0% of the sample as compared to 69.6% of the population. African-Americans (n=179) were represented at 14.9%, which is the exact representation in the U.S. Population. Hispanics (n=143) comprise 11.9% of the sample (11.5% in the population), and Others (n=50) are represented at 4.2% in the sample, compared with 4.0% in the population.

Mother's education level was also used to stratify the PLS-3 sample. For each child tested, the child's parent checked one of the following categories to indicate the years of education completed by the mother and father: a) 11th grade or less, b) high school graduate or GED equivalent, c) 1-3 years college or technical school, or d) 4 years of college or more. The mother's years of education were also closely matched for the sample and the U.S. population. For example, high school graduates represented 37.0% of the sample compared to 36.8% of the population, and 1-3 years college comprised 26.5% of the sample compared to 25.8% of the population. The selection of the Preschool Language Scale - III was made due its well defined standardization sample.

Validity of the PLS-3 - Construct Validity. A discriminant analysis was performed to determine how well the test differentiated between language-disordered and non-language-disordered children (Zimmerman, et al. 1992). Language-disordered children, defined as having a diagnosed language disorder, were matched with non-language-disordered children from the standardization sample on the basis of age, gender, race, and parent education level. Of the 28 language-disordered 3-year-olds, the PLS-3 classified 10 correctly (hits) and 18 as non-language-disordered (misses). Of the 28 non-language disordered, the PLS-3 incorrectly classified one child as language disordered (false positive) but correctly classified the other 27 as non-language-disordered (correct rejections). The "hits" plus "correct rejections" divided by the total results in the PLS-3, correctly identified children as language disordered or non-language disordered 66% of the time.

Validity of the PLS-3 - Concurrent Validity. Most language studies to date have used other language instruments. Therefore, it was important to explore how the PLS-3 would perform in the current study as a valid measure of language ability. Two widely used instruments, the Clinical Evaluation of Language Fundamentals - Preschool (CELF-Preschool) (Wiig, et al. 1993) and the Wechsler Preschool and Primary Scale of Intelligence - Revised (WPPSI-Revised) (Wechsler, 1989) were used as criterion measures to assess the validity of the PLS-3.

A study of the relationship between the PLS-3 and the CELF-Preschool (Wiig, et al. 1993) was conducted with 53 children. Twenty-five were ages 3 years to 3 years, 5 months, and 28 children were ages 4 years to 4 years, 5 months. The tests were administered in counterbalanced order and the between-test interval was one day to two weeks. The correlation between the CELF-Preschool receptive language score and the PLS-3 receptive language score was .83. The CELF-Preschool expressive language score correlated with the PLS-3 expressive language score at .81. The correlation between the total language scores for the CELF-Preschool and the PLS-3 was .90.

An analysis of the relationship between the PLS-3 and the Wechsler Preschool and Primary Scale of Intelligence - Revised (WPPSI-Revised) (Wechsler, 1989) was conducted with a sample of 40 normally functioning 4-year-old children. Testing was administered in counterbalanced order with a between-test interval of 1 to 14 days. The correlation between the PLS-3 Total language score and the WPPSI-R Full Scale IQ was .82. The variance shared by the two tests was .67, indicating a strong and significant relationship. These high correlations lead to the conclusion that the PLS-3 was a valid measure of language ability.

Test-Retest Reliability. The stability of the PLS-3 scores over time was conducted using a sample of 85 children randomly selected from the standardization sample (Zimmerman, et al. 1993). The sample included children in three age intervals: 3-0 to 3-5, 4-0 to 4-5, and 5-0 to 5-11. The between test time averaged 4.7 days between the two testings. For the 3-0 to 3-5 age group, the initial Auditory Comprehension mean was 100.0 with a standard deviation (SD) of 14.9, and the retest mean was 101.5 with a SD of 15.3. The initial Expressive Communication mean was 98.4, SD of 10.0, and the retest mean was 100.9, with a SD of 14.0. The initial Total Language mean was 99.2, SD of 13.2, and the retest mean was 101.5, SD of 14.9. The PLS-3 stability coefficients for the 3-0 to 3-5 age range were: AC = .89, EC = .82, and Total Language = .91. These high correlations indicate that this test will consistently measure language skills over time and one can reliably conclude that scores on this test will be consistent over time. In summary, the PLS-3 appeared to be a well-standardized instrument for assessing the language skills of young children and was a reliable instrument for assessing language with this sample.

Demographic Information Form

The demographic information form (see Appendix D) was designed for this study to obtain information about the child's mother and family to be used as family characteristics. The form contained instructions and a statement that the mother's name or other identifying information is not listed or requested anywhere on the form. The only identifying mark was a place for the subject code number. Information obtained from the child's mother included: current age, race, mother's age at birth of her first child, the birth order of the child in this study, number of children in the home, mother's highest level of education, current marital status, head of household, education level and occupation of head of household, mother's current occupation (if not head of household), use of public assistance, and annual income.

The demographic information was used for two purposes. One, to answer the research question regarding the correlation of mother's age at first birth with other important variables such as number of children, level of education, occupation, and annual income. Two, to assign a socio-economic status rating (SES) according to the Two Factor Index of Social Position (Hollingshead, 1957).

Medical Records Review and Neonatal Medical Index Classification

The Medical Records Review Form (see Appendix D) was designed specifically for this study and was completed by the examiner from the child's medical records. Importantly, the sole identifying information on the form was a subject code number. The only medical information reviewed in the child's medical chart included the labor and birth history, plus the child's course in the hospital. Additional hospitalizations were only reviewed from the standpoint of length of stay and number of rehospitalizations. Clearly, the information gathered was archival in nature, as the subjects are now approximately three years old. Information gathered included birthweight, gestational age, and a determination if the child was small, large or appropriate for gestational age. The total days in the hospital, any rehospitalizations, plus the number of days on a ventilator were obtained from the medical records. Other archival medical information collected was the presence of intraventricular hemorrhage, congenital abnormalities or syndromes, and the mother's para/gravida status. The birth records were examined for any indication of maternal substance abuse evidenced by a report of a positive maternal/infant drug screen, abstinence symptomatology, or reported history of maternal substance abuse. Since this information was obtained through a medical records review of archival data, it was not germane to be responsible for reporting suspected illegal drug use which may have occurred several years ago.

The majority of the information obtained through the medical records review was obtained from the discharge summary. This summary, which outlines the infant's course in the hospital, is often released to physicians, schools, or other intervention agencies. Thus, it is not uncommon for agencies working with high risk children to have access to this medical information.

The medical information gathered was used to assign a Neonatal Medical Index (NMI) classification. This classification system was developed by Stevenson and the other attending neonatologists at the Stanford University Neonatal Intensive Care Unit in the context of a study that evaluated the clinical validity of the Neurobehavioral Assessment of the Preterm Infant (NAPI) (Korner, Stevenson, & Forrest, 1993a). This system was developed as a means of measuring how ill the infants were during their hospitalization rather than to represent a complete inventory of all the different complications and symptoms the infants had experienced during and after birth. The index classifications range from one to five with one describing preterm infants free of significant medical problems and five characterizing those infants with the most severe complications.

The scoring is based on two overarching principles: 1) Infants with birthweights more than 1000 grams would be assigned an NMI classification of I or II, depending on their oxygen requirements. Infants born at less than 1000 grams or heavier babies who had experienced major medical complications would receive a III, IV, or V; and 2) The need for and duration of mechanically assisted ventilation required. The choice of the assisted ventilation classification principle was based on the rationale that, with a few exceptions, the duration of assisted ventilation would be dictated by the length and severity of illness and/or complications.

Korner, et al. (1993a) used the NMI with low birthweight infants to show good concurrent validity of the NMI in discriminating between the neurobehavioral performance of infants, as measured by the NAPI, who had experienced different degrees of illness.

The NMI showed good predictive ability of later development in infants weighing less than 1500 grams at birth in a validation study by Korner, et al. (1993b). Their study used 512 low birthweight children that were part of the eight site Infant Health and Development Program control group. The study found that socioeconomic status was the most predictive of development in preterm infants born at higher weights, but that the NMI was as good as SES in predicting the development of infants born at less than 1500 grams.

Data Analysis

The data collected were analyzed with correlational and multiple regression techniques. Research question one (1) looked at the pattern of correlations and compared the results of the current study to those of Schraeder, et al. (1992) correlating mother's age at first birth (MAFB) with: 1) socio-economic status (SES), 2) use of public assistance, 3) mother's education level, 4) family structure, 5) number of children in the family, and 6) the birth order of the child in this study.

SES was derived from Hollingshead (1957) Two Factor Index of Social Position. SES ratings are one through five on a Likert-type equal interval scale. Occupation and education are the two factors utilized to determine social status. The Occupation Scale is presumed to reflect the skill and power individuals possess as they perform many functions in our society. Education is believed to reflect not only knowledge, but also cultural tastes. Occupation is scaled from one through seven, with one representing major professionals and seven representing unskilled laborers. The Educational Scale is based on the assumption that men and women who possess similar educations will tend to have similar tastes, similar attitudes, and will tend to exhibit similar behavior patterns. The scale ranges from one (graduate professional training) to seven (less that seven years of school). Weights for each factor are provided and multiplied by the scale score. The scores are totaled and ranges of scores are provided for the social class ratings one through five.

Use of public assistance was coded as a dichotomous variable with one indicating use of public assistance and zero indicating no use of public assistance. Education was coded one through seven as listed on the demographic information form with one indicating less than 7th grade and seven being a graduate degree. Number of children in the family and birth order of the child in this study were listed as 1 for first, 2 for second, etc. Family structure was also coded dichotomously with one indicating single parent structure and zero indicating two parents. For this study, two dichotomous variables, use of public assistance and family structure, were considered to be measured along an underlying binary scale. Therefore, these variables were treated as continuous as opposed to discrete.

Pearson Product-Moment Correlation Coefficients were generated between MAFB and SES, use of public assistance, mother's education, family structure, number of children in the family, and birth order of the study child. These correlation coefficients were compared to the correlations found in the Schraeder, et al. (1992) study. Fisher's (Fisher, 1936) r to z transformations were used to directly compare the correlation coefficients across the samples. It was anticipated that strong correlations would be obtained with this sample, which would indicate that the MAFB variable contained information that may be valuable to obtain during the course of a competent evaluation.

Predicting the multiple effects of receptive and expressive language skills given neonatal medical risk variables and family characteristics was of interest in research question two. Canonical correlation analysis is a multivariate statistical technique that can assess the relationship among the set of criterion variables (receptive and expressive language) and the set of predictor variables. Predictor variables analyzed were: 1) birthweight (BW), 2) gestation age (GA), 3) length of stay in the hospital (LOS), 4) SES Index, 5) mother's age at first birth (MAFB), and 6) Neonatal Medical Index (NMI) classification.

Multiple regression was used to answer research question three: How well do family characteristics and neonatal medical risk variables predict overall language ability of children 37 to 39 months of age. The single criterion variable was the Total Language Score on the PLS-3. The predictor variables were birthweight, gestation age, length of stay, socio-economic status, NMI classification, and MAFB.

CHAPTER FOUR

RESULTS

Introduction

This chapter outlines the demographic information and results of the data analyses. The first question dealt with the correlations between mother's age at first birth (MAFB) and the family variables of: socioeconomic status (SES), use of public assistance, mother's education level, family structure, number of children in the family, and the birth order of the child in this study to compare results to those found by Schraeder, et al. (1992). The second question dealt with the relationship between the multiple effects of receptive and expressive language skills and the neonatal medical risk variables and family characteristics related to the child's background. Canonical correlation analysis results are presented. The third question regarded the prediction of overall language ability of children 37 to 39 months of age from family characteristics and neonatal medical risk variables. Multiple regression analyses are presented regarding these findings.

Demographic and Descriptive Information

The demographic, medical risk factors, Mother's age at first birth (MAFB), and language test scores' means, standard deviations, and ranges are presented in Table 1. The mean birthweight for the 51 children was 1720.66 grams and the mean gestational age was 32.4 weeks. There were 35 boys and 16 girls in the study translating to 68.6% and 31.4% respectively. The original subject pool of 152 consisted of 61% boys and 39% girls, closely matching the 2:1 ratio used in this study. Seventy-eight percent of the subjects were White, 6% were African-American, 12% were American Indian, 2% were Other such as Oriental, and there were no Hispanics in the study.

Table I

Infant and Family Data

	Mean	SD	Range
Birthweight (grams)	1720.66	540.5	680-2470
Gestation Age (weeks)	32.4	3.2	24-38
Length of Stay (days)	42.9	33.8	4-119
MAFB (years)	23.1	5.2	16-41
NMI classification	2.68	1.4	1-5
Preschool Language Scale			
Receptive Language	98.08	13.58	60-118
Expressive Language	98.96	14.60	62-129
Total Language	98.24	15.48	51-123

The mean age of mothers at first birth was 23.1 years. The median age of 21 years represents a more accurate average of mother's age at first birth, since one mother in the study was age 41 when she had her first baby. The average educational level of the mother and the head of household (if different) was a high school degree with some college or technical training. Thirty-five percent of the participants indicated using some type of public assistance, leaving 65% who do not use public assistance. Forty-four subjects, or 86.3%, were from two parent families. The mean number of children per family was 2.569 with a standard deviation of 1.472. The range of children was from one child to eight children. The subjects in this study, on average, were the second child (mean 2.196, standard deviation 1.358). The range was the subject child being the first through the seventh child.

The mean Neonatal Medical Index (NMI) classification was 2.68 on a scale of one to five, one being the fewest medical complications and five being the most critical babies. This meant the average baby was on assisted ventilation for 3-14 days and had some additional cardio-respiratory distress requiring additional treatment. There were 14 children with an NMI classification of 1, nine with class 2, fifteen with class 3, six with class 4, and seven with class 5.

The mean Receptive language score on the Preschool Language Scale -III was 98.08 with a range of 60-118. The mean Expressive language score was 98.96 with a range of 62-129. The Total language scores ranged from 51-123 with a mean of 98.24. The standardized mean for both subscales and total language score on the PLS-3 is 100 with a standard deviation of 15. These results indicate that the subjects mean scores were within the range of normal.

Question One - Correlations with Mother's Age at First Birth

The first research question looked at the pattern of correlations and compared the results of the current study to the findings of Schraeder, et al. (1992). Their data supported a younger mother's age at first birth (MAFB) as being strongly associated with lower SES, use of public assistance, lower maternal education, single parent structure, large numbers of children, and the subject being a later child.

Fisher's (Fisher, 1936) _r_ to _z_ transformation was used to directly compare the correlation coefficients across the samples. The _z_ adjusted _r_ values (obtained from Table H, Guilford & Fruchter, 1973) ranged from -.234 to .633 for the current study and -.310 to .758 for the Schraeder study. Due to the difference in the range of _z_'s, t tests (Goulden, 1939) using the transformed _r_'s were conducted. Table Two presents the Pearson Product Moment Correlation Coefficients, the _z_ adjusted _r_ values and the exact probability of their significance. Table Three presents the t-ratios for the _z_ adjusted _r_ values for the six variables examined with their exact probabilities.

TABLE II

CORRELATIONS WITH MOTHER'S AGE AT FIRST BIRTH

Variable	Current Study			Schraeder, et al. (1992)		
	r	*z*	*p*	*r*	*z*	*p*
SES	.56	.633	.0009	.51	.563	.0012
Use of Public Asst.	-.47	-.510	.0008	-.48	-.523	.0023
Education	.40	.424	.0039	.64	.758	.0006
Family Struct.	-.29	-.299	.0367	-.31	.321	.0052
Number of Children	-.23	-.234	.1006	-.52	-.576	.0010
Birth Order	-.23	-.234	.1006	-.30	-.310	.0060
df = 84		N=51			N=39	

In the Schraeder et al. study, all variables were significantly correlated with MAFB (see exact probabilities in Table II). In the present study, MAFB correlated significantly with SES, use of public assistance, family structure, and mother's education. The correlations between MAFB and two variables, number of children in the family and the birth order of the child, were not significant. Although MAFB did not correlate significantly with all six variables assessed in the current study, MAFB can be considered a valuable variable for obtaining an overall idea of the family's social situation.

TABLE III

t-ratios for Current Study and Schraeder, et al. (1992)

Variable	Current Study <u>z</u>	Schraeder, et al. (1992) Study <u>z</u>	t	p
SES	.633	.563	0.3175	.9999
Use of Public Asst.	-.510	-.523	-0.0589	.9999
Education	.424	.758	-1.5149	.1296
Family Struct.	-.299	-.321	-0.0998	.9999
Number of Children	-.234	-.576	1.5512	.1207
Birth Order	-.234	-.310	0.3447	.9999

The t-ratios were examined to assess the pattern of the correlations between the two studies. There were no significant differences between the two studies on all six variables. The <u>z</u> scores for the variables of Education and Number of Children varied slightly, but not significantly. There was virtually no difference between the two studies on the variables of

SES, Use of Public Assistance, Family Structure, and Birth Order.

Question Two - Multiple Effects of Receptive and Expressive Language Scores

For the second research question, canonical correlation analysis was used to study the relationship between two sets of variables. The scores of the 51 children in the study were subjected to a canonical correlation analysis in which the quantitative Preschool Language Scale - III Receptive and Expressive language scores were related to the six quantitative variables: mother's age at first birth (MAFB), socio-economic status (SES), birthweight (BW), gestation age (GA), length of stay in the hospital (LOS), and Neonatal Medical Risk Index (NMI). A canonical correlation was used to analyze the relationship between the two sets of variables and to eliminate the potential of losing important information from the receptive and expressive language scores by combining them through use of the Total Language Score. This technique was used to state the interrelationships among the variables more concisely, recognizing that there is are correlations between the variables, as is often the case in a behavioral study. The two language scores represented the left set variables and the medical risk factors and family characteristics represented the right set variables.

Matrices of the intercorrelations among the variables were determined. The correlation between the receptive language scores and the expressive language scores (the left set) was .906247. The correlations between the right set (medical risk factors and family characteristics) and the left set (language scores) are presented in Table IV.

TABLE IV

Matrix of Intercorrelations Among the Variables

Variable	Receptive Language	Expressive Language
MAFB	.061370	-.048688
SES	-.387879	-.344969
BW	.253681	.199564
GA	.295682	.212803
LOS	-.342379	-.206500
NMI	-.499065	-.359972

The overall results of the canonical analysis are presented in Table V.

TABLE V

Canonical Analysis Results

Canonical R: .6013796

Chi-Square:30.72645 df=12 p=.0021758

	No. of Variables	Variance	Total Redundancy given the other set
Left set	2	100.000000000	30.815693661%
Right set	6	42.347871831	14.39180014%

The overall canonical R represents the correlation between the first and most significant canonical variates in each set. This correlation is significant (Chi Square = 30.72645; p=.0021758). The variance extracted and the total redundancy values give an indication of the magnitude of the overall correlations between the two sets of variables relative to the variance of the variables. The variance extracted is the average amount of variance extracted from the variables in the respective set by all canonical roots. Thus, as expected, the 2 roots extract 100% of the variance from the left set (receptive and expressive language scores) and 42% of the variance in the right set (medical risk factors and family characteristics). The total redundancy values are interpreted based on all canonical roots. These values tell us that, given the right set of variables (medical risk and family characteristics), we can account for 30.8% of the variance, on average, in the left set (language scores). These results also show we can account for 14.30% of the medical risk and family characteristics given the language scores.

Canonical weights are determined so that the structure of the variables in the two sets are reflected in the weights. Canonical correlation produces weighted sums that are maximally correlated with each other. These weighted sums define a canonical root or variate. When extracting more than one root, each root explains a unique additional proportion of variability in the two sets of variables. The number of roots extracted by the canonical correlation analysis program is equal to the minimum number of variables in either set. For the current study, there were two variables in one set, receptive and expressive language scores. Two canonical roots were thus extracted in this study.

Eigenvalues can be interpreted as the proportion of variance accounted for by the correlation between the respective canonical variates. The first weight computed maximizes the correlation of the two sum scores. After the first weight is extracted, the weights that produced the next largest correlation between sum scores was computed. Eigenvalues will be the same as the canonical R squared. Eigenvalues for the current study were:

Root 1 .361657

Root 2: .202622

Correlation coefficients were determined by taking the square root of the eigenvalues. Because the correlations pertain to the canonical variates, they are called canonical correlation coefficients. Like eigenvalues, the correlations between successively extracted canonical variates are smaller and smaller. The canonical correlation coefficients for the current study were:

Root 1: .601380

Root 2: .450136

Each root represents two weighted sums and the first root maximizes the correlation between the two sums. In this study, the right and left sets shared a common root as evidenced by the canonical correlation coefficient of .60, indicating a shared variance of 60%. This root, which symbolizes a child's language vulnerability, represents the effect of medical and family characteristics in relation to receptive and expressive language scores.

The significance test for the canonical correlations begins with the largest correlation and tests the different canonical correlations one by one. Only the statistically significant roots are reported and retained for interpretation. Initially, the program looked at all the canonical variates together with none of the roots removed, then with the first root removed. Table VI presents the results of the test of significance of the Canonical roots:

TABLE VI

Test of Significance of Canonical Roots

Roots Removed	Canonical R	Canonical R-sqr.	Chi-Square	df	p
0	.601380	.361657	30.72645	12	.002176
1	.450136	.202622	10.30241	5	.067136

In the current study, when zero roots were removed, the results were significant (Chi-square = 30.72645, p=.002176). After the first root was removed, the remaining root was not significant (Chi square = 10.30241, p=.067136). Therefore, only the first root was statistically significant and was retained for further examination.

After determining the number of significant canonical roots, the issue changed to how to interpret this significant root. Since each root actually represents the two weighted sums, one way to interpret the meaning of each canonical root would be to look at the weights for each set. In general, the larger the weight, the greater is the respective variables unique positive or negative contribution to the sum. To facilitate comparisons between the weights, the canonical weights are presented for the _z_ transformed variables with a mean of zero and a standard deviation of one. The canonical weights allow us to understand the make-up of each canonical root, that is, let us see how each variable in each set uniquely contributes to the respective weighted sum (canonical variate). Table VII presents the Canonical weights.

TABLE VII

Canonical Weights

Variable	Root 1
Receptive Language	-1.72780
Expressive Language	.88283
Mother's Age at First Birth (MAFB)	.037762
Socio-economic status (SES)	.379323
Birthweight (BW)	.021497
Gestation Age (GA)	.497665
Length of Stay (LOS)	.333783
Neonatal Medical Risk Index (NMI)	.873425

The canonical roots can also be interpreted by examining the simple correlations between the canonical variates (or factors) and the variables in each set. These correlations are also called canonical factor loadings or structure coefficients. These values provide information for interpretation. Generally, variables that are highly correlated with a canonical variate have more in common with it. The redundancy measure tells us how much of the actual variability in one set of variables is explained by the other. The average amount of variance accounted for in each item by the first root was computed. Presented in Table VIII are the factor structure coefficients and variances extracted for the first root.

TABLE VIII

Factor Structure and Variance Extracted

Variable	Factor Structure	Variance Extracted	Redundancy
Receptive Language	-.927745		
Expressive Language	-.682991		
Left Set		.663594	.239994
MAFB	-.247794		
SES	.607987		
BW	-.435883		
GA	-.537120		
LOS	.680534		
NMI	.905406		
Right Set		.365405	.132151

Again, only the results from the first root are provided in Table VII since it was the only root that was significant. Both language variables show substantial loadings on the first canonical factor with receptive language correlating higher than expressive language. The variance extracted and redundancy measure indicate that the first root extracted about 66% of the variance from the language items. The redundancy value tells us that given the medical risk variables and the family characteristics, we can account for about 24% of the variance in language scores based on the first canonical root. The factor structures for the right set indicated very high loadings for the NMI classification (.905406). It is recognized that the NMI is based on medical data. Therefore, the variables of NMI, BW, GA, and LOS are highly correlated, as is most behavioral data. Moderate loadings were reported on LOS (.680534), SES (.607987), and GA (.537120). Lower loadings were reported for BW (-.435883) and MAFB (-.247794). The significant canonical correlation based on these loadings, provided an index of the child's language vulnerability. These results indicated that the significant canonical correlation between the variables in the two sets based on the first root, is probably a result of a strong relationship between language scores and NMI classification, and a moderate relationship between language scores and LOS, SES, and GA, and less affected by BW and MAFB.

The results of this portion of the study confirm those of Siegel (1982), Vohr, et al. (1988), and Grunau, et al. (1990) that medical risk factors, whether one uses the NMI or specific medical variables such as birthweight or gestational age, and socio-economic status are the two variables that are highly correlated with outcome as measured by language scores.

Question Three - Prediction of Language Scores

The third research question examined how family characteristics and neonatal medical risk factors predicted overall language ability of children born at low birthweight who are now 37 to 39 months old. The Total Language Score from the Preschool Language Scale - III was used as the criterion variable in a multiple regression analysis. Predictor variables entered into the full model were: Mother's age at first birth (MAFB), socio-economic status (SES), birthweight (BW), gestation age (GA), length of stay (LOS), and neonatal medical index (NMI) classification. The O.S.U. Statpak Multiple Regression Program was used to analyze the data.

Table IX presents the Betas (B), b-weights, Y intercept, standard errors, and t-ratios with their exact probabilities, for the full model.

TABLE IX

Betas, b-Weights, Standard Errors, and t-Ratios

Variable	Beta (B)	b-Weights	S.E.	t	p
MAFB	-0.2398	-0.709	0.47	-1.512	.1340
SES	-0.4087	-6.916	2.97	-2.332*	.0229
BW	-0.1455	0.004	0.01	0.551	.8515
GA	-0.2032	-0.974	1.47	-0.663	.4525
LOS	0.1082	0.046	0.11	0.414	.9999
NMI	-0.4310	-4.840	2.31	-2.099*	.0392
Y intercept - 173.924					

df=44

The standardized regression coefficients (Betas) were used to assess the strength of the individual predictors. The strongest predictors were SES and NMI, holding all other variables constant. The unstandardized regression coefficients (b-weights) were used in this study to generate an equation to determine how much change in the criterion variable (language skill) is associated with a change in each predictor. The prediction equation for the full model was:

$Y' = 173.924 + -0.709\ (MAFB) + -6.916\ (SES) + 0.004\ (BW) + -0.974\ (GA) + 0.046\ (LOS) + -4.840\ (NMI)$.

The standard error is used to set up confidence intervals around the predicted score. The smaller the standard error of estimate, the smaller the standard error of the predicted score. The t test of the regression coefficient addresses the relationship between any given predictor and the criterion when the other predictors have been taken into account.

The full model was significant F=2.892 (.05; 6,44). The squared multiple correlation (R2) was .283, indicating 28% of the variability in language scores was accounted for by the linear combination of the predictor variables. In the full model, the variables of SES and NMI were significant.

Based on the full model results, a reduced model was run with three variables, MAFB, SES and NMI. The F value (F=5.663) was significant (.05; 3,47) and these three variables continued to account for 26.55% of the variability in language scores, as compared with 28% with the full model.

SES and NMI were the two significant predictor variables from the full model, so they were included in the reduced model. MAFB was included in the reduced model, even though it was not a significant predictor, because the results from research question one tell us that MAFB can be a useful variable to represents the family's social status and current situation. In addition, this reduced model eliminates gathering and entering redundant data, as the variables of birthweight, gestation age, and length of stay in the hospital are reflected in the NMI score. Thus theory and statistics were combined to produce a parsimonious prediction equation. The Betas, b-weights, Standard Error, and t-ratios and their exact probabilities, for the reduced model are presented in Table X. The prediction equation for the reduced model was :

$Y' = 146.977 + -0.727\ (MAFB) + -6.535\ (SES) + -3.449\ (NMI)$.

Table X

Reduced Model

Variable	Betas	b-Weights	S.E.	t	p
MAFB	-0.2456	-0.727	0.45	-1.608	.1107
SES	-0.3862	-6.535	2.75	-2.379*	.0203
NMI	-0.3072	-3.449	1.51	-2.282*	.0255
Y intercept = 146.977					

df=47

The adjusted R2 indicates the amount of variability that would be accounted for if this equation were used on a different population. The variability accounted for will decrease from 26% when this equation is used on another additional subjects. The adjusted R2, or shrinkage, for the reduced model was 0.2186, indicating that approximately 22% of the variability in language scores could be accounted for if this equation was applied to another sample.

The results of this portion of the study indicated that gathering data on SES and the child's NMI classification, along with mother's age at first birth, could provide an examiner with information to predict which children may potentially be at risk for language problems around age three.

Summary

Descriptive and demographic information from this study were presented as well as the results from the analyses designed to answer the three research questions. Fifty-one low birthweight children ages 37 to 39 months and their families participated in this study. Correlations between family characteristic variables and Mother's Age at First Birth (MAFB) were presented to answer research question one. In this study, MAFB correlated significantly with socio-economic status, use of public assistance, family structure, and mother's education. The correlations between MAFB and number of children in the family and the birth order of the child were not significant.

Canonical correlation analyses were presented to answer research question two. Two roots were extracted, but only the first root was statistically significant and retained. The structure coefficients presented indicated that both language variables show substantial loadings on the first canonical variate. The redundancy value indicates that given the medical risk variables and family characteristics, we can account for about 24% of the variability in language scores based on the first canonical root.

The analyses for research question three yielded similar results to those found in the canonical correlation analysis. The Total Language Score was used as the dependent variable for purposes of multiple regression analyses. The full model produced an R2 of .2829, indicating that 28% of the variability in the total language score can be accounted for by a combination of the predictor variables. A reduced model with three variables (MAFB, SES, and NMI) produced an R2 of .2655, indicating 26.5% of the variability can be accounted for by these three variables.

CHAPTER FIVE

DISCUSSION, SUMMARY, AND CONCLUSIONS

Discussion

Research Question One

The first research question examined the correlation between mother's age at first birth (MAFB) and various family characteristics (socio-economic status (SES), use of public assistance, maternal education, family structure, number of children in the family, and the birth order of the study child). These variables were used in a similar study by Schraeder, et al. (1992). The purpose of the question was to compare results from the current study to the Schraeder, et al. study and to establish whether or not MAFB would be a valuable piece of information that should be gathered on case histories as part of a child's developmental evaluation.

There were no significant differences between the correlations found in the two studies on all six variables. In the current study, MAFB correlated significantly with SES, use of public assistance, education, and family structure. The correlations between MAFB and the two variables, number of children and birth order, were not significant.

Interestingly, there were only 7 out of the 51 participants in the current study from a single parent family. This low percentage could be attributed to the fact that two parent families often allow some flexibility to enable one parent to bring the child back to the hospital for testing. Since participation in this study was voluntary, perhaps many of the families choosing not to participate would have had difficulty bringing the child back to the hospital for testing due to such things as work obligations, transportation, child care for other children, and other reasons.

In the current study, ten of the families had one child in the family, representing 20% of the participants. Twenty-two families had two children (43%), ten families had 3 children (20%), and nine families had from 4 to 8 children (17%). Thirty-seven percent of the children in this study were first born in their family. Thirty-five percent were the second born child, and 27% were the third or later child in their family. It is difficult to compare these findings with the Schraeder, et al. (1992) study, because it is unclear from the Schraeder study what the mean number of children per family was and the ranges were not given. The Schraeder, et al. (1992) study identifies birth order in their demographics table as either first born, middle, or last child.

In the current study, 32 of the families had only one or two children representing 63% of the participants. Thirty-seven of the study subjects were either the first or second born child in their family, representing 73% of the participants. This suggests that the participants who volunteered for this study tended to be from two-parent families (86%) who did not use public assistance (65%), and tended to have higher educational attainment, more than a high school degree with some college or technical training.

Perhaps many of the potential subjects who failed to respond were from families with larger numbers of children, single parent families, and lower educational levels making it more difficult to make arrangements to participate in this study.

The high correlation between MAFB and SES found in this study is not surprising. Mother's who begin their childbearing early tend to have lower educational attainment and lower paying jobs (Furstenberg, et al. 1989), and that observation appears to hold for this study population. SES is a well documented variable for predicting language development (Siegel, 1982) and school learning (Robertson, et al. 1990).

This study supports using MAFB as an indicator of family characteristics and general educational and occupational attainment when time or other constraints preclude obtaining indepth case history information. It, in no way, indicates the self-fulfilling prophecy that children born to young mothers are more at risk for failure. The only information that MAFB provides is as a risk factor, that is closely tied to the well-documented risk factor of SES, and indicates that those children may have potential difficulties that could benefit from early intervention services. MAFB should be viewed as only one piece of information gathered as part of a child's developmental evaluation.

Research Question Two

Predicting the multiple effects of receptive and expressive language skills given neonatal medical risk variables and family characteristics was the subject of research question two. A canonical correlation analysis was conducted where the receptive and expressive language scores were related to the six predictor variables: mother's age at first birth (MAFB). socio-economic status (SES), birthweight (BW), gestation age (GA), length of stay in the hospital (LOS), and neonatal medical risk index classification (NMI). Although receptive and expressive language scores were shown to be highly correlated, they were retained as separate variables in the left set so as to not lose important information or to destroy the relationship between the variables.

In the right set, the first canonical root, or child's language vulnerability, was marked by high loadings on NMI indicating a high correlation between medical risk index classification and the canonical variate. The NMI represents birthweight, length of stay, and seriousness of medical complications in the neonatal period, and this is highly correlated with the first canonical variate. There were moderate loadings for the variables LOS, SES, and GA. Although LOS and GA are represented to a degree within the NMI classification, this indicated that they were moderate markers in and of themselves. MAFB and BW have lower correlations. This study indicated that SES is more valuable in the information it provides than MAFB.

A surprising finding was the low correlation of BW with the canonical variate since the NMI correlates so highly and birthweight is the deciding principle in assigning an NMI classification. The BW was expected to correlate closer to GA and LOS. One possible explanation is that for the present study, all low birthweight (<2500 grams) subjects were eligible and the mean birthweight was 1720 grams. If the potential subjects had been limited to very low birthweight (<1500g) or extremely low birthweight (<1000g), the results would likely have indicated a stronger correlation of birthweight with the canonical variate.

The child's language vulnerability, symbolized by the significant correlation between the variables in the two sets, is probably the result of a strong relationship between receptive and expressive language scores and NMI, a moderate relationship between language and SES, LOS, and GA, and less affected by BW and MAFB.

This study indicates that both receptive and expressive language skills are affected highly by the child's medical complications during the neonatal period, including length of stay in the hospital, in addition to the child's socio-economic status. The application of this information is that children with potential for problems with language can be identified. Both receptive and expressive language skills should be evaluated when children have had lengthy hospitalizations and medical complications at birth, or when the child is in a less than optimal environmental situation. However, an NMI score or medical complications in general, and a lower SES do not automatically indicate deficit language. They only serve as markers for further examination.

This information is also useful when dealing with families and when making programming decisions. Three year old children may present with a wide range of language skills. Those children with less than optimal medical risk factors and environmental factors may benefit from early language stimulation to overcome the possible effects of those risk factors. Teachers should exercise caution when identifying risk factors to parents. The benefits of early language stimulation to avoid potential difficulties later should be emphasized to parents, instead of the fact that their child may have had a significant medical or social history.

Research Question Three

The third research question examined how family characteristics and neonatal medical risk factors predict overall language ability of children born at low birthweight who are now 37 to 39 months old. Multiple regression analyses were performed using the Total Language Score from the Preschool Language Scale III as the criterion variable and the predictor variables were: birthweight (BW), gestation age (GA), length of stay (LOS), socio-economic status (SES), mother's age at first birth (MAFB), and neonatal medical index (NMI) classification. In the full model, these variables accounted for 28% of the variability in language scores. The only two significant predictors were SES and NMI. When the reduced model was applied using the variables of MAFB, SES and NMI, these three predictors accounted to 26.5% of the variability in the language scores, and SES and NMI continued to be significant predictors. The adjusted R2 indicates that when this prediction equation is used again by either teachers or clinicians attempting to identify children with potential for language delays, the amount of variance in the language scores accounted for will go down to 22%.

Although this model accounted for approximately one-fourth of the variability in the language scores, almost three-fourths of the variability can be accounted for by other variables not measured in this study. There are potentially a number of other variables that affect language development.

These results are similar and support those of research question two that medical complications and environmental status continue to emerge as significant indicators regarding those children who are at risk for language development problems. The application of these results is to provide markers for identifying which children need further evaluation and monitoring of their language development.

Summary

These results indicate that language skill is affected by the combination of neonatal medical risk factors and socio-economic status, and to a lesser degree by the factors of GA, LOS, BW and MAFB. These results confirm the "double hazard" described by Escalona (1982) and others, when biologic and environmental factors combine to place children at risk for poor developmental and academic outcome.

It is interesting to note that for the current study, the mean receptive language score (98.08) and expressive language score (98.96) were within the range of normal. Detecting delayed early milestones of language development is an extremely sensitive indicator of developmental disability and later academic and social difficulties. If the results of this one language assessment instrument are the only pieces of data used to detect language delayed children, very few children in this particular study would be identified as language delayed. It is anticipated that many more of these children whose scores on this particular language instrument were within the range of normal, will display language and other learning difficulties as they progress through their school years. This points to the importance of serial assessment, early intervention for those at risk of language and developmental delay, and ongoing monitoring of their academic and behavioral characteristics.

Being able to predict which children are at risk for language delays has implications for special education and regular education teachers for programming, assessment, child find, and intervention. This study supports the need for the inclusion of medical information on all case histories. The results of this study indicate that a medical risk classification such as the NMI can be successfully used as a high risk marker variable. As stated previously, the medical information needed to assign an NMI is often found on the hospital discharge summary, which is a document often available to schools and other early intervention agencies. The use of classification systems also allow for changes in medical technology which are occurring at a rapid rate. A clinician does not have to have a child's entire medical chart to obtain the historical medical information needed. In other words, it is not necessary to examine all of the child's medical information to be able to assign a NMI. Clearly, this study supports the inclusion of birthweight, gestation age, length of stay, days on a ventilator, and other serious medical complications as basic information required on all case histories dealing with young children.

Limitations

One limitation of this study is the small sample size. It is recommended that this study be replicated with a larger population to ensure that the canonical factor structure that led to the interpretation of the first canonical root is reliable and to decrease the amount of shrinkage of the adjusted R2 for the multiple regression analysis.

This study limited its participants to one hospital to eliminate the confounding variables from different medical and nursing protocols and technology available. A multi-site, randomized trial would be an excellent way of verifying and replicating the results of this study with a more representative sample. These results are felt to be sample specific and generalizing these results to other samples is cautioned.

It is felt that many potential participants declined to participate due to the distance they live from the hospital. Since this hospital is a regional center, many babies were transported from a wide region. Parents were given the option of an alternate testing site, but only four parents chose that option.

Another factor that contributed to parents not responding was that phone numbers were not available for all potential subjects. The only information initially available was the child's address. It is felt that more parents would have agreed to participate if they had been contacted by phone. A phone number was included with all parent contacts so that parents could contact the researcher for more information. Only four parents called requesting additional information.

Another limitation is the fact that the PLS-3 was normed on a wider range of ethnic backgrounds. The current study involved 78% white, as compared to 69% of the norming sample. African-Americans were represented at 6% in the current study and 14.9% in the norming sample. American Indians represented 12% of the current sample and Indian, Oriental, and others were represented in the norming sample at just 4.2%. This study sample represents the demographics of the area which includes a moderate native American population. Replication of this study in different geographical regions of the country would add support to these findings.

It is speculated that many of the potential subjects who declined to participate were from minority groups. Seventy-eight percent of the participants were white. Perhaps a study using subjects that more closely matched the norming sample would provide interesting results in terms of the language scores obtained and the predictability of the variables. This study should also be replicated using different language assessment instruments to assess the validity of these results.

Finally, evaluating all children with birthweights under 2500 grams as a single group was a limitation. Advanced technology has allowed children to survive at earlier gestation ages and lower birthweights. Additional studies need to be conducted evaluating children below 1500 grams, below 1000 grams, and below 750 grams to assess their unique developmental complications and abilities.

Conclusions

Normal language development is critical for optimizing later academic success. Assessing and monitoring communication skills as well as other pre-academic skills, and the early identification and amelioration of potential developmental problems, has been and will continue to be one of the main goals of our early intervention and preschool programs.

Children continue to be born and survive at earlier gestation ages and at lower birthweights, and go home to a variety of family structures and environments. Prematurity places infants at increased risk for communication deficits.

This study identified mother's age at first birth as a variable that can provide general information regarding the family's social structure, education and occupation. This variable can be used when complete case history information is not available to give a general picture of the child's environment.

Neonatal medical risk variables and family characteristics have been shown to be helpful in predicting which children will be at risk for language delay. Although the mean language scores for the low birthweight children in this study were within normal limits, it is anticipated that these children will be at continued risk throughout their preschool and early elementary years for subtle learning difficulties that can range from needing tutorial help to special education programming. These children will need ongoing monitoring to identify any areas of delay that may develop. The information gained from this study and related studies with similar samples of this population will be useful to clinicians and educators who continue to serve children at younger and younger ages with a wide range of medical and socio-environmental challenges.

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APPENDIXES

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
FOR HUMAN SUBJECTS RESEARCH

Date: 10-04-93 **IRB#:** ED-94-002

Proposal Title: THE RELATIONSHIP OF MEDICAL RISK FACTORS AND PSYCHOSOCIAL FACTORS TO LANGUAGE DEVELOPMENT SKILLS AT THREE YEARS OF AGE

Principal Investigator(s): Barbara Wilkinson, Patricia Hershberger

Reviewed and Processed as: Modification

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL. ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Modifications received and approved.

Signature: John H. Wycoff Date: October 4, 1993
Chair of Institutional Review Board

Hospital

INSTITUTIONAL REVIEW BOARD

August 5, 1993

George Giacoia, MD

Dear Dr. Giacoia:

The study {987-93} The Relationship of Medical Risk Factors and Psychosocial Factors to Language Development Skills at Three Years of Age was approved this date following review of the information you submitted based on 45 CFR 46.110(b)(1) and 21 CFR 56.110(b)(1) Federal Policy for the Protection of Human Subjects (Final Rule of 6/18/91) - Expedited Review and Approval. The following conditions are applicable for research conducted at Saint Francis Hospital:

1) The Board must be notified of any changes to the research project prior to implementation except where hazards exist to human subjects;

2) A report of your project will be requested on a timely basis as determined by the Board;

3) Adverse reactions, life-threatening or lethal, must be reported to the Board immediately.

Sincerely,

Ronald C. Passmore, MD, Chairman
Institutional Review Board

APPENDIX B

PARENT CONTACTS

October 7, 1993

Parents of:

Dear Parent,

I am currently a doctoral student at Oklahoma State University and am doing an internship at . You and your child are invited to participate in a research study entitled "The Relationship of Medical and Family Characteristics to Language Development Skills of Low Birthweight Children at Three Years of Age". The purpose is to examine the language skills of children who were of low birthweight and were in the Neonatal Intensive Care Nursery after birth.

Your participation in the study would be greatly appreciated. If you agree to participate, an assessment visit will be scheduled with you at your convenience. You will be asked to bring your child to St. Francis for an assessment visit. The visit will last approximately one hour. The Preschool Language Scale will be administered to your child and demographic information regarding the child and the family will be gathered at that time. You will be asked to provide information such as the mother's age at the birth of her first child, number of children in the home, plus information on marital status, education, income, and occupation. Medical information such as the child's birthweight, gestational age, and other neonatal complications will be obtained from the child's medical records. The research study will look at the medical variables and family variables to predict the child's language scores.

All information will be held confidential and a subject code number will be assigned so that there will be no names or other identifying information on the information form or the child's test form. Again, participation in the study is voluntary and there is no penalty for refusal to participate. The benefits of participation include receiving a free language assessment for your child, being able to return to and visit the unit, plus receiving help with any referrals you might need for assistance in meeting your child's developmental needs. Finally, being a part of this study will help researchers understand the effects of being born at low birthweight, and how these children are doing as they reach the preschool years.

I would personally appreciate your help with this study. Please return the enclosed post card as soon as possible.

Sincerely,

Patty Hershberger
(918)224-1416

HERSHBERGER
16 WOODLAND ROAD
SAPULPA, OK 74066

Parent Name:______________________________
Child's Name:______________________________
Child's Birthdate:__________________________
Address:__________________________________
______________________Phone:(   )__________

PLEASE CHECK ONE OF THE FOLLOWING AND RETURN CARD

___Yes, I would like for my child to participate in this study and receive a free language assessment. Contact me to schedule an appointment.

___Yes, I am interested but unable to come to Tulsa. Contact me to discuss an additional testing site.

___No, I decline to participate at this time.

Parents-Call me (collect if long distance) for more information. Patty Hershberger (918) 224-1416

APPENDIX C

RESEARCH CONSENT FORM

RESEARCH CONSENT FORM

I_____________________________________(parent/guardian) hereby authorize participation of my child ____________________________in a research investigation entitled "The Relationship of Medical Risk Factors and Psychosocial Factors to Language Development skills at Three Years of Age". The purpose of this study will be to gather data on language skills of high risk children for the doctoral dissertation of Patty Hershberger through Oklahoma State University.

The procedure will include:

1. Parent/guardian providing demographic data on the child, the child's mother, and the child's family to the researcher.

2. Parent/guardian bringing the child to the Developmental Follow-Up Clinic office at St. Francis Hospital, Tulsa, Oklahoma, for administration of the Preschool Language Scale - III.

3. Obtaining archival data regarding the child's birth history from the child's medical records.

4. Testing Procedure:

   a. The testing session will last approximately 1 hour and be conducted by the researcher.

   b. The test results will be interpreted and discussed with the parent.

   c. There will be no charge to the family for this assessment.

5. Conditions of the Research

   a. The child's language test, medical and demographic information will be coded to assure anonymity of the child and family. There will be no names or other identifying information on the test forms. Code sheets will remain in the possession of the researcher.

   b. All information will be held confidential and cannot be released without the parent's signature. Data will be stored in the possession of the researcher.

5. Conditions of the Research (continued)

c. The subjects will not encounter any stress or risks which are greater than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

d. The subjects and their families will not be deceived or misled in any way.

e. The benefits of participation include gaining information about the child's language development. This study will help determine which children may be at risk for language delays.

f. The St. Francis Hospital Institutional Review Board has approved this project and will be cooperating by providing a testing location and access to medical records.

"I understand that participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time without penalty after notifying the project director.

I may contact Patty Hershberger (918) 224-1416, or Barbara Wilkinson (405) 744-6036, should I wish further information about the research. I may also contact Beth McTernan, University Research Services, 001 Life Sciences East, Oklahoma State University, Stillwater, Oklahoma 74078: Telephone: (405) 744-5700.

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me."

Name of Subject:______________________________
A minor child

Date:____________________Time:__________(am/pm)

Signed:______________________________________

Relationship To Subject:________________________

"I certify that I have personally explained all elements of this form to the subject or his/her representative before requesting the subject or his/her representative to sign it."

Signed:______________________________________

APPENDIX D

INSTRUMENTATION

SUBJECT
CODE:________

MEDICAL RECORDS REVIEW

1) Birthweight:________________________________

2) Gestational Age:______________3) (EDC)______

4) SGA:_____AGA:_____LGA:______

5) Days in hospital:_______________

6) Number of Rehospitalizations/Days:__________________

7) Hours/Days on Ventilator:______________________

8) IVH:(Grade 1-4)_________________

9) Congenital Abnormalities or Syndrome:_____________

10) Mother: P____G_____AB______

11) Past maternal substance abuse:___________________

NMI classification:___________

RESEARCH ON LANGUAGE SKILLS
DEMOGRAPHIC INFORMATION

SUBJECT CODE:______

Below is information requested to assist with the completion of this study. Nota that your name or other identifying information is not requested and does not appear on this form. Please answer all questions to the best of your ability. If you have any questions or concerns about any of the items, please feel free to discuss these with the examiner.

Information from the child's mother:

13) Mother's current age: ____________

14) Race: (Choose One) White_____African-American___ Hispanic_____American Indian_____Other_____

15) Mother's age at birth of her first child:_______________

16) The child in this study is #_______(1st, 2nd, 3rd child, etc)

17) Number of children in the home:___________(including foster children, stepchildren, etc.)

18) Mother's education:(Circle One) less than 7th grade, some high school, high school diploma, some college, college degree, some graduate work, graduate degree

19) Current marital status: (choose one) single, divorced, widowed, married, separated

20) Head of Household: (First Name)___________________

21) Occupation of head of household:___________________

22) Education of head of household:__________________

23) Mother's current occupation:_______________________

24) Use of public assistance: (Circle all that apply) AFDC, Medicaid, Food Stamps, SSI, Other__________

25) Annual Income:

_____Below $15,000

_____$15,001 to $20,000

_____$20,001 to $25,000

_____$25,001 to $30,000

_____$30,001 to $40,000

_____$40,001 to $60,000

_____above $60,001

VITA

Patricia Anne Shouse Hershberger

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE RELATIONSHIP OF MEDICAL AND FAMILY CHARACTERISTICS TO LANGUAGE DEVELOPMENT SKILLS OF LOW BIRTHWEIGHT CHILDREN AT THREE YEARS OF AGE

Major Field: Applied Behavioral Studies

Biographical:

Personal Date: Born in Oklahoma City, Oklahoma, October 9, 1954. Currently residing in Sapulpa, Oklahoma. Married to Philip M. Hershberger. Children: Justin Philip and Amy Anne.

Education: John Marshall High School graduate May, 1972; Bachelor of Science Degree in Speech Pathology from Oklahoma State University in December, 1975; Masters of Arts Degree from Wichita State University in December, 1977; Doctor of Philosophy Degree from Oklahoma State University in December, 1994.

Professional: Oklahoma Speech-Language Pathology License #253; American Speech-Language-Hearing Association member and holder of Certificate of Clinical Competence (C.C.C.); Oklahoma Teaching Certificate; member Oklahoma Speech-Language-Hearing Association; member Council for Exceptional Children; member C.E.C. Division for Early Childhood.