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To the Graduate Council:

I am submitting herewith a thesis written by Lynne McLamore Maddux entitled "Motor Development of Premature Infants." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Child Development and Family Relationships.

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# MOTOR DEVELOPMENT OF PREMATURE INFANTS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Lynne McLamore Maddux

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ABSTRACT

The current study involved 16 premature infants, a set of 8 who were 4-months-old and a different set of 8 who were 8-months-old. The purpose was to investigate the degree to which the prematures differed in terms of motor development from the norms established for full-term infants. The criterion for prematurity was a birth weight of 5 lbs., 8 oz. (2,500 grams) or less. The birth weight of all subjects tested fell within the range of 5 lbs., 8 oz., and 3 lbs., 4 oz.

The sample was drawn from the population of infants born at The University of Tennessee Memorial Research Center and Hospital and the Cookeville General Hospital between March 1, and November 1, 1972. The variables of race, social class, birth weight, and age were controlled by choosing a sample of Caucasian, lower socio-economic class premature infants of the same age. The sample was not randomly selected due to the small population of infants who met the above criteria.

Initial contact was made to the parents of the prematures through a xeroxed letter from the pediatrician at UTMRCH and the administrator at the Cookeville General Hospital. The letter explained the proposed research study and asked for parental cooperation. The researcher traveled to the home of each infant for the purpose of testing the subject in its natural environment as well as for the convenience of the parent. Generally, each child was tested within one week of its 4- and 8-month birthday.

The Bayley Scales of Infant Development: Motor Scale was used to measure the premature's current level of motor development. Before testing the premature infants the researcher practiced administering the motor test on 10 full-term infants. The test provided the researcher with a raw score which could then be used to determine the infant's Psychomotor Developmental Index (PDI) according to directions given in the test manual.

The premature 4-month-old infants were found to be significantly retarded in motor development at the .10 level for a one-tailed test when compared to the norms established by Bayley (1969). The 4-month-old premature infants had a mean raw score of 15.88 compared to the mean raw score of 17 for the norms. The observed t-value was equal to -2.04 which was greater than the -1.415 critical value of *t*, and the null hypothesis was rejected.

The premature 8-month-old infants were found to be retarded in motor development when compared to the norms, but the difference was not significant at the .10 level for a one-tailed test. The mean raw score for the premature infants was 33.75 compared to the mean raw score of 36 for the norms. The observed t-value was equal to -1.26 which was in the predicted direction, but not greater than the -1.415 critical value of *t*.

The Pearson r was computed to determine the degree of association between birth weight and motor scores. The Pearson r was found to be .01 for the sample of 4-month-old prematures and .02 for the sample of 8-month-old prematures. Neither r-value exceeded the critical value of r (.62) for a one-tailed test at the .10 level. Therefore, null

hypotheses (3) and (4) failed to be rejected. The low r-values indicated that in this study, no association existed between birth weight and motor scores.

Limitations of this study and suggestions for future research were also discussed.

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# CHAPTER I

## INTRODUCTION AND PROBLEM

The plight of the premature infant has been of interest to researchers in the United States since the early 1900's. Mental and motor development, physical growth, and behavioral characteristics of the premature infant have been the primary foci of concern for these researchers. The unfortunate fact is that many of their findings are contradictory, and many questions have been left unanswered. It is essential that further research regarding prematurity be initiated establishing proper controls for extraneous variables and refining testing procedures. By eliminating loopholes in research design, unnecessary contradictions in findings could be avoided, and a more meaningful, reliable wealth of knowledge concerning prematurity could be developed.

The current study arose out of a genuine interest in studying a specific aspect of prematurity in depth. It is designed to discover the effect of prematurity on motor development during the early months of life.

### Statement of the Problem

The purpose of this study was to compare the level of motor development of two groups of prematures, ages 4- and 8-months-old, with the norms for full-term infants of the same ages. In the course of the study the relationship between birth weight and motor scores was also

investigated. Each hypothesis was tested at the .10 level of significance for a one-tailed test. The four null and research hypotheses were as follows:

(1) $H_o$: There is no significant difference between the mean raw score for the 4-month-old premature infants and the norms established for full-term infants of the same age.

$H_1$: The mean raw score for the 4-month-old premature infants is less than the norms established for full-term infants of the same age.

(2) $H_o$: There is no significant difference between the mean raw score for the 8-month-old premature infants and the norms established for full-term infants of the same age.

$H_1$: The mean raw score for the 8-month-old premature infants is less than the norms established for full-term infants of the same age.

(3) $H_o$: There is no association between the motor scores and the birth weight of 4-month-old premature infants.

$H_1$: There is a positive association between the motor scores and the birth weight of the 4-month-old premature infants.

(4) $H_o$: There is no association between the motor scores and the birth weight of 8-month-old premature infants.

$H_1$: There is a positive association between the motor scores and the birth weight of the 8-month-old premature infants.

# CHAPTER II

## REVIEW OF THE LITERATURE

Investigating the effect of prematurity on motor development has required not only a review of the literature in this area, but also an examination of the nature of prematurity and motor development in their own right. The term prematurity has been critically examined in order to gain a fuller understanding of its implications and meaning. The derivation of the testing device used in the study has been explained and the recent findings concerning the specific use of the test for motor development have been presented. Studies which specifically investigated the relationship of prematurity to motor development have then been related. In addition, other factors which have been shown to affect motor development have been examined.

### The Concept of Prematurity

The term prematurity has been subjected over the years to a broad range of interpretations. Confusion has arisen as to whether prematurity is defined by a gestational age of less than 40 weeks, a birth weight of less than 2500 grams (5 lbs., 8 oz.), or a combination of a shortened gestational age and low birth weight. In 1948, according to Silverman (1961), for purposes of vital statistics, the World Health Assembly recommended the adoption by all countries, the following definition of prematurity:

> For the purpose of this classification, an immature infant is a live-born infant with a birth weight of 5 lbs. 8 oz. (2500 grams) or less, or specified as immature. In some countries, however, this criterion will not be applicable. If weight is not specified, a live born infant with a period of gestation less than 37 weeks or specified a "premature" may be considered as the equivalent of an immature infent for purposes of this classification. (p. 3)

Although most research on premature children has used low birth weight as the only criterion for prematurity, some studies have stressed the importance of using both gestational age and low birth weight to determine true prematurity. Wright (1971) revealed a study by Hodgman (1969) which found 50 per cent of the premature infants in a population of 12,000 live newborn infants weighed more than 2500 grams. These infants were classified as prematures on the basis of gestational age but not according to the birth weight factor. It was estimated that large premature infants account for 8 per cent of the total neonatal population.

The Committee on Maternal Nutrition of the National Research Council has illustrated the reverse situation; that is, even though some infants were born at full-term they still weighed less than 2500 grams. Full-term infants in this category have either been conceived small (a genetic cause), or developed into a "small-for-date" baby as a result of some growth retarding influence in utero.

The "heavy" premature (an infant weighing more than 2500 grams with a gestational age of less than 37 weeks) and the "small-for-date" (a full-term infant weighing less than 2500 grams) mentioned above exemplified the problems involved in assessing "true" pre-maturity based on birth weight only. However, according to the Committee on

Maternal Nutrition, birth weight has remained the most important single determinant of prematurity. The Committee explained that birth weight was a factor inherant in all infants regardless of maternal or environmental situational factors, and was readily and reliably measured. In contrast, the determination of the infant's gestational age at birth was dependent on both the mother's memory of the date of the last menstrual cycle, and the regularity of each menstrual cycle. For these reasons, the infant's gestational age was often either unknown by the mother and therefore unavailable to the researcher, or was unreliable due to the method of calculation. In the absence of a more sophisticated device for assessing "true" prematurity, most researchers, according to Wright (1971), have relied on the criterion of birth weight only.

Researchers investigating the effect of prematurity on mental and motor development have stressed the importance of establishing a corrected chronological age for the premature infant. The corrected chronological age was determined by subtracting the degree of prematurity by the nominal chronological age. By using the corrected chronological age the researcher was able to compare the development of the premature with that of the full-term infant of the same age from conception, rather than from birth. Due to the absence of information from mothers regarding gestational age at birth, researchers sought other means for determining gestational age. A regression curve for defining gestational age based on birth weight was the result.

Cutter, Heimer, Wortis, and Freedman (1965) formulated an Age Correction Curve for prematurity which was based on all the live,

Negro, single birth infants born in Kings County Hospital, Brooklyn, between 1952 and 1959. Males and females of the same birth weight (less than 2100 grams) were found to have an equal gestational age. The regression curve (p. 263) appeared as follows in Table I.

Gruenwald (1966) hypothesized that the fetal growth curve during most of the third trimester follows a straight-line course similar to the above findings. However, according to the Committee on Maternal Nutrition (1970) the age correction formulas have been cautioned against for the following reason:

> Assessment of growth that has occurred "in utero" involves the use of standards that describe the distribution of birth weights at a given gestational age. Some of the available standards are unsatisfactory, either because the sample on which they were based was atypical or because inaccuracies in the data gave rise to features that are likely to be "unbiological." More data are needed on weight in relation to gestational age in normal pregnancies, and care should be exercised in developing from such data statistically sound standards. (p. 129)

Mohr and Bartelme (1934), in a study of 250 Caucasian prematures of average socio-economic status and 152 full-term siblings of the prematures, compared the scores of the prematurely born children with normative scores for the test scales (The Gesell, Stanford-Binet, and Kuhlmann-Binet tests of intelligence). No reliable difference was found between the two groups when the degree of prematurity was taken into account. Mohr and Bartelme further found that the Gesell test scores indicated a tendency toward retarded mental development during the first two years for the prematurely born group, if the degree of prematurity was not taken into consideration.

TABLE I

AGE CORRECTION FOR PREMATURITY

| Birth Weight (in grams) | Number of Months Deducted |
|---|---|
| Less than 1000 | 3.0 |
| 1001 - 1220 | 2.5 |
| 1221 - 1550 | 2.0 |
| 1551 - 1880 | 1.5 |
| 1881 - 2100 | 1.0 |

The Bayley Scales of Infant Development

The Bayley Scales of Infant Development (BSID) have been developed to provide an improved means of measuring the developmental progress of infants (Bayley, 1969). Dr. Nancy Bayley has designed the scales to focus on three dimensions in infancy: mental development, motor development, and a behavior inventory. The Motor Scale, of primary concern in the present study, was described by Bayley in her test manual as follows:

> The Motor Scale is designed to provide a measure of the degree of control of the body, coordination of the large muscles and finer manipulatory skill of the hands and fingers. As the Motor Scale is specifically directed toward behaviors reflecting motor coordination and skills, it is not concerned with functions that are commonly thought of as "mental" or "intelligent" in nature. (p. 3)

According to Bayley (1969) the earliest versions of the Scales dated back to 1928 and 1933 when 1,250 administrations were given to 61 children. Since that time 4,500 infant examinations have contributed to the 1969 revised Scales. The Mental and Motor Scales have been developed on the basis of three California Scales which are no longer published: the California First-Year Mental Scale (Bayley, 1933), the California Preschool Mental Scale (Jaffa, 1934), and the California Infant Scale of Motor Development (Bayley, 1936). Preliminary efforts at scale revision resulted in an unpublished 1958 version covering infant development through the first fifteen months of life. Later Dr. Nancy Bayley extended and expanded the scales to include the fifteen to thirty month range in infant development. The 1958-1960 version was then administered to 1,409 infants aged one to fifteen months, and a pilot sample of 160 infants aged eighteen to 30 months. Subjects were

located through the assistance of twelve medical institutions in metropolitan areas throughout the United States. Based on the results of this testing the final revision of the scales was made. The revised form of the Mental and Motor Scales was essentially the same as the original scales (1933, 1935) with the primary difference being the addition of about 20 new items included at the younger ages.

Standardization of the Mental and Motor Scales was accomplished through the help of two institutes of the National Institutes of Health: the National Institute of Neurological Diseases and Blindness, and the National Institute of Mental Health. Included in the standardization sample were 1,262 children equally distributed in 14 age groups ranging from two to thirty months. The sample was selected to be representative of the United States population within this age range in terms of sex, race, geographical location, parent's education, occupation of the head of household, and urban-rural residence.

Bayley (1965) used the 1958-1960 version of the Mental and Motor Scales to test a nationwide sample of 1,400 full-term infants ages one to 15 months. The purpose was to investigate the effects of demographic and socio-economic variables on test scores. Subjects were located through hospital well-baby clinics whose patients were generally characterized, as belonging to the lower socio-economic stratum of the population. However, using the parent's education as an index of socio-economic status, the parents were slightly above the national average in number of years of education completed. For this reason, the sample was considered to be representative of the United States population.

Comparisons were made between Mental and Motor scores and sex, birth order, parental education, and geographic location. No differences were found on either scale between males and females, and there were no differences on test scores between urban or rural location of the subject. Thirty-six per cent of the sample was comprised of first-born infants. When the motor scores of the first-borns were compared with those of the later-born infants the means of the first-borns were higher at 11 of the 15 ages. Differences between the two groups were small but they reached significance at the .05 level in the seventh, twelfth, fourteenth, and fifteenth month. It was postulated that these differences existed due to a greater amount of parent-child interaction with first-borns, thus stimulating them to more rapid development. However, this explanation was questionable since there was no indication of a cumulative effect of such stimulation.

Bayley (1965) found no differences in either mental or motor scores on the basis of educational level of either mother or father. Bayley acknowledged the finding that the IQ of school age children consistently correlated with the education, occupation, and income level of the parents, but illustrated these correlations were zero to negative during the first 15 months of life.

The sample of 1,400 full-term infants was 55 per cent Caucasian and 42 per cent Negro. Bayley found no differences between the Negro and Caucasian populations on mental development, but the Negroes scored consistently above the Caucasians on motor development. The mean scores on the Motor Scale were higher for the Negroes at every age except 15 months. The differences were significant at the .01 level for months 3,

4, 5, and 9, and at the .05 level at months 7 and 12. After the 12th month the significant differences between the races in motor development disappeared. In conclusion, Bayley's findings indicated that motor and mental skills developing during the first 15 months of life were generally unrelated to sex, birth order, geographical location, and parental education. The variable of race, however, did affect motor development to some extent as the Negro infants tended to be superior during the first 12 months of life.

The Effects of Prematurity on Motor Development

Extensive literature reviews concerning prematurity written by Benton (1940), Alm (1953), and Wiener (1962) have emphasized the fact that the primary concern of research with prematures has been the area of mental development. Although motor development has been shown to correlate positively ($r = .50$ to $.60$) with mental development in infancy (Bayley, 1969), it is the author's opinion that findings related to mental development may not be accepted as indications of similar motor development.

Shirley (1938) studied a group of 63 prematures between the ages of six and thirty months, and a control group of 250 full-term infants. Using a modification by Cattell of the Yale Development Schedule, Shirley examined both the full-terms and prematures to determine their developmental status at three-month intervals. Through item-analysis the two groups were compared on each individual test aspect. Findings were that prematurity manifests itself more definitely in motor (manipulative development) than in non-motor (intellectual and social responsiveness)

developmental retardation. In addition, Shirley found that babies of birth weights under four pounds were retarded by a month or more through the eighteen-month period, whereas babies of birth weights four to five pounds overtook the normal group by nine months of age.

Benton (1940) has criticized Shirley's findings due to the fact that the socio-economic status of the full-term infants was higher than the status of the prematures, thus making the control group an unequal and inadequate basis of comparison. For this reason Shirley's findings were determined to be of questionable validity, and no clear-cut conclusions concerning the developmental status of the infant could be drawn from them.

Melcher (1937) administered the Buhler-Hetzer infant test to determine the developmental status of 42 premature infants in Vienna ranging from one month, fifteen days to eighteen months, twenty-five days. The range in birth weight was 830 to 2800 grams. Scores on the infant test were compared to the norms for the full-term infants as no control group was employed. Quantitative analysis of the tests showed that the premature infants lagged behind the average for full-terms through the fourth month, but thereafter scored within the limits of the norms. The infants under four months of age (seven cases) scored a mean D.Q. of 88, indicating retardation as the average D.Q. was 100. The infants aged five months and above scored a mean D.Q. of 111, indicating no retardation. The following breakdown in Table II of age categories was devised by the writer to summarize Melcher's findings. Melcher concluded that prematurely born children caught up with children born at term in a relatively short time. However, in evaluation of

TABLE II

AGE CATEGORIES

| Age in Months | Number of Subjects | Mean D.Q. |
|---|---|---|
| 1 - 4 | 7 | 88 |
| 5 - 8 | 8 | 104 |
| 9 - 10 | 6 | 111 |
| 12 - 15 | 13 | 114 |
| 16 - 18 | 8 | 112 |

Melcher's findings, Benton (1940) has questioned their validity. Benton suggested the apparent superior development of the prematures in the nine to eighteen month age range (mean D.Q. of 112) was highly improbable. The difficulty according to Benton was thought to be with the Buhler-Hetzer scale which had been criticized as being too easy when applied to American children from marginal and dependent homes. In the absence of a control group as a basis of comparison, Benton could not accept Melcher's conclusion that prematurely born infants did not show retardation in comparison with full-term infants.

As a brief aspect of a study focused on the motor development in four-month-old infants, Solomons and Solomons (1964) examined the differences between the prematures and full-terms in their population. The 16 prematures had a mean score of 4.00 as compared to the 152 full-term infants with a mean score of 4.80. Differences between the two groups were significant at the .05 level. In examining the data further the researchers discovered a second phenomenon. Within the group of subsequent babies (all infants other than first-borns) motor scores of the premature infants were significantly lower than those made by full-term infants. However, no differences were found between premature and full-term first-born infants. The method of assessment used in this study was a combination of two techniques: (1) a developmental assessment was made using the research form of the Bayley Scales of Infant Development (Mental Form) revised, 1961, and (2) a pediatrician examined each infant for a neurological assessment of either Normal, Suspicious, or Abnormal.

Prematurity, defined by low birth weight, is often accompanied with neurological impairment and prenatal and maternal complications. Cutler, Heimer, Freedman, and Wortis (1965) have investigated the effects of prenatal and neonatal complications on the mental and motor development of prematures aged 30 months. Three tests were administered to the sample of Negro infants including a test for intelligence, perceptual-motor development, and gross-motor development. (Results of the gross-motor test are of primary concern for the present study.) The researchers developed a modified gross-motor test based on items taken from the Gesell Schedule and the Bayley Scale of Motor Development. Correction for prematurity of the subjects was made through the use of a regression curve previously described. The results of the research have been summarized by the writer as follows:

1. For the male prematures a positive correlation was found between gross-motor scores and birth weight and toxemia. Neither of these complications was associated with lower gross motor scores when neurological diagnosis was partialed out.
2. For the female prematures a significant relationship was found between gross motor performance and birth weight, infection, and hypoxia. When the neurological diagnosis was partialled out the correlations of the motor scores with birth weight and infection remained significant. However, the correlations of motor scores with hypoxia were not significant.

3. The mean gross-motor score for the prematures was 16.7 for the males and 16.9 for the females. These scores were significantly lower ($p < .005$) than the mean score of 19.6 for the full-term infants.

Braine, Heimer, Wortis, and Freedman (1966) found through their study of 351 Negro single birth prematures that prematures of both sexes scored significantly lower than the full-term infants on the standardized test of gross-motor development of thirteen and one-half months. The premature test scores tended to be linearly related to the birth weight ($r = .30$ and $.31$ for the males and females, respectively).

Other Factors Affecting Motor Development

In order to study the effects of prematurity on motor development, it is essential to be aware of other factors which may affect motor development. Braine, Heimer, Wortis, and Freedman (1966) investigated the effect of sex and social class on the motor development of prematures. The Gesell Gross Motor Schedule was administered to the 351 Negro, single-birth prematures, and the 50 full-term infants aged thirteen and one-half months. In regard to sex differences affecting the amount of motor impairment, the researchers found that weight for weight male prematures obtained consistently lower scores than the females on the motor test. However, the differences were small and insignificant.

A detailed analysis of the effect of socio-environmental variables on motor development was included in the research by Braine, Heimer, Wortis, and Freedman (1966). The sample of Negro premature and full-term infants was taken from a population of infants from low social class

parents. The prematures were tested for motor development at four days, six weeks, four months, seven and one-half months, and thirteen and one-half months. The socio-environmental rating was based on two variables: the mother's level of education and a rating of social status. The rating was obtained by a social worker through an interview, using a standard questionnaire, with the mother. In the prematures, there was no relation between the socio-economic variables and developmental scores in the examinations at four days, six weeks, and four months. For the female prematures the correlations showed no evidence of such a relation at any examination. The male prematures did evidence a positive correlation between the socio-environmental variables and motor development at the seven and one-half and thirteen and one-half month examination. These positive correlations did not reach significance.

The researchers explained these results by citing a study by Jones (1954), which found no relation between parental education or socio-economic status and mental or motor development in full-term infants of similar ages (four days to thirteen and one-half months). Jones further found that the correlation between socio-environmental variables and mental or motor development did not usually develop until the infant was approximately two years old. Braine, Heimer, Wortis, and Freedman (1966) indicated that this explanation was logical as the child must live in its environment for some spanse of time before the environment could have a postnatal effect on the child's mental or motor development. Thus, impairment due to socio-environmental variables would not become apparent until later testing--later than thirteen and one-half months.

The research by Solomons and Solomons (1964) on 152 full-term infants and 16 prematures (aged four months) has further illustrated the effects of race, sex, and birth order on motor development. The mean score on the motor test was 4.88 for the Negro infants and 4.68 for the Caucasian babies. These scores reflected a slightly higher score for the Negro infant but the differences in the scores did not approach statistical significance. In examining the differences in motor development related to race the researcher differentiated the effects of birth order by race. Negro first-borns scored slightly higher on the motor test (mean score 5.71) than did Negro subsequent babies (mean score 4.70), but the difference was not statistically significant. In contrast, Caucasian first-borns (mean score 5.50) scored significantly higher ($p < .001$) on the motor test than did Caucasian subsequent babies (mean score 4.17).

Regarding sex differences Solomons and Solomons found no differences in motor scores between male and female infants. (These findings were based on a population of which only 10 per cent was premature.) There appeared to be no sex differences in the entire population as well as within the subgroups of first-borns and subsequent infants.

Differences on motor tests were found between the 53 first-born and the 115 subsequent babies. The mean score for the first-borns was 5.53 which was significantly different ($p < .001$) from the 4.36 mean score of the subsequent children. The researchers found no relation between motor scores and ordinal positions two through twelve. As a possible explanation of the effects of birth order on motor development, Solomons and Solomons cited the research of two Japanese researchers.

"Tsumori and Inage (1958) state that with two-month and six-month-old infants motor development and development of manual skill were related to frequent body contact between mother and child, and mothers tended to have more frequent body contact and lenient attitudes toward their first-born, but this was not statistically significant" (p. 1292). This was the only study, according to Solomons and Solomons, which related birth order and infant motor behavior.

Some researchers have found that Negro infants experience a definite acceleration in gross-motor abilities compared to the Caucasian infant of the same age. In an effort to re-examine this apparent racial difference in motor development, Williams and Scott (1953) postulated that the differences in early motor development were not due to a racial factor, but were related to the manner in which the infant was handled and cared for. The population for the study was comprised of 104 Negro full-term infants ranging from four- to eighteen-months-old, and representing two contrasting socio-economic backgrounds. Group I (54 infants) was characterized as earning a weekly income of $80 or more, and by receiving medical care through a private physician. Group II (50 infants) was selected from a Well Baby Clinic or a Child Welfare Service Clinic, and was characterized as earning $45 or less per week. Each group was evenly divided as to sex. Family income level was defined as a fairly objective criterion of economic level, and the type of medical care a family received was both a reflection of the income level as well as a clue to the family's "self concept of status."

Although the subjects used in this research were all full-term infants, the knowledge gained through the findings can be applied (in

this writer's opinion) to the prematures as well. Williams and Scott found that the infants in the lower social class (Group II) scored significantly higher ($p < .02$) in motor development than the infants in the higher social class. The Gesell Developmental Schedule was used as the test for motor development. Group I and Group II scored a mean D.Q. of 107.57 and 114.32, respectively. When the groups were divided into two ages of less than 37 weeks and greater than 37 weeks, the researchers found that Group II was more advanced in motor development at both the younger and older levels.

These findings were explained through an intricate theory of how child rearing practices directly affect motor behavior. Through the interview technique the researchers questioned the parents of the infants concerning fifteen separate child-rearing practices. Information regarding all but one of these fifteen categories was expressed as a dichotomy. In order to determine if a relationship existed between the child-rearing practices and motor development, the subjects from both groups were combined and biserial correlations were computed between each child-rearing practice (dichotomy) and the developmental quotients from the motor test (continuous variable). Four of the fifteen child-rearing practices were found to have a significant relationship with motor development.

Area restriction, or the amount of freedom given the child in moving about the home, attitudes toward non-approved habits such as hair-pulling and thumb-sucking, and the way in which parents handled the child's outgoing motions toward objects and persons were significant with motor development at the .05 level. The degree to which motor functions such as sitting, creeping, standing and walking were

anticipated and encouraged by the parents was significant with motor development at the .01 level. It was found that those children who were not restricted as to area had a higher D.Q. in motor development than those children who were restricted in one place. The children in Group II, whose parents were found to be more permissive about non-approved habits, who were allowed greater freedom in interacting with their environment, and who were left to develop at their own rate without being pushed and encouraged, were found to be more advanced in motor development than the children in Group I.

Williams and Scott concluded that the environment of the subjects from the lower socio-economic group (Group II) was more active, free, and uninhibited than that of Group I. This environment allowed the infant a more direct and manipulating relationship with its surrounds. If the two groups had been matched more carefully as to birthweight and age, and the age range of the subjects had been less wide, the results may have been more meaningful. In any event, the researchers have questioned the presence of a racial difference in motor development by postulating that the difference is a function of socio-economic level.

In summary, although birth weight has been shown to be a crude index of prematurity, it is the single most reliable method. It has been generally found (Shirley, 1938; Melcher, 1937; Jones, 1954) that prematures experience a developmental lag in motor development as compared with the full-term infant. However, the research has been inconclusive as to when the premature begins to "catch up."

Braine, Heimer, Wortis, and Freedman (1966) have found a significant difference ($p < .05$) in motor development between male and

female prematures aged thirteen and one-half months. (Males obtained lower scores.) They found no sex differences on the motor test at four months or younger. It was suggested that the sex differences should be attributed to greater impairment in male prematures rather than female superiority. This study was the only one to find such a difference. It was found that no sex differences were apparent in full-term infants (Bayley, 1965; Solomons and Solomons, 1964; and Braine, Heimer, Wortis, and Freedman, 1966).

It was illustrated by Braine, Heimer, Wortis, and Freedman (1966) and Jones (1954) that socio-environmental variables (parental level of education, social status) were not related to the early motor development of the infants tested: four days to thirteen and one-half months. Based on this evidence there was reason to believe that social class differences did not affect the motor development of infants in the first year of life. However, in an earlier investigation of Negro families Williams and Scott (1953) found that the parents in the lower social class tended to allow the child a freer and less inhibited interaction with its environment. Children from this freer environment tended to achieve a higher D.Q. on the motor test than those from a higher social class. The age range for these subjects was four through eighteen months and no analysis of results was provided for the younger and older subjects.

The variable of race was found by Bayley (1965) to have an effect on motor development in full-term infants. Negroes were found to be more advanced in motor development than the Caucasian children. Williams and Scott (1953) questioned that finding by illustrating a

social class, rather than a racial difference, as the cause for the discrepancy between the classes in the Negro race. Solomons and Solomons (1964) found no significant differences in motor development by race.

Birth order was found by Bayley (1965) to have no generalizable effect on motor development in full-term infants. First-borns were found to have higher motor scores than subsequent children at some ages between one and fifteen months, but not all ages. Solomons and Solomons (1964) found no significant difference between the motor development of Negro first-borns and Negro subsequent children, but found that Caucasian first-borns scored significantly higher on the motor tests than did Caucasian subsequent children.

The contradictory findings related to prematurity and motor development were somewhat frustrating. The lack of information supporting the various findings indicated the need for validation studies in this area.

# CHAPTER III

# PROCEDURE

In order to investigate the effect of prematurity on motor development, a test for motor skills was administered to two groups of prematures ages four- and eight-months-old. The sample size was N = 8 for each group. The results of this testing were compared to the norms established for full-term infants of the same ages.

## Subjects

Subjects for this study were located through the Department of Pediatrics at The University of Tennessee Memorial Research Center and Hospital (UTMRCH), Knoxville, Tennessee, and the Cookeville General Hospital, Cookeville, Tennessee. All subjects were born at the hospital in 1972 or were admitted shortly after birth as a transfer. The majority of the subjects were residents of Knox County with the few exceptions living in Madisonville (1), Copperhill (1), Cookeville (1), and Sevierville (2).

The subjects living in Knox County were classified as "Service" patients at UTMRCH. This classification was assigned to their families by the Social Service Agency in Knoxville indicating their inability to pay for complete medical services. This classification was used to define these subjects as members of the lower socio-economic class. The four other subjects who were transferred to UTMRCH shortly after birth, and the one subject from Cookeville were not classified as service patients

because they were not residents of Knox County. However, the poor conditions of the home, the apparent low educational level of the parents, the lack of adequate furniture and space indicated the family was a part of the lower socio-economic stratum.

The criterion for prematurity was birth weight only, and all infants tested had a birth weight between 2500 and 1500 grams (5 lbs., 8 oz. to 3 lbs., 4 oz.). This weight range was chosen because the majority of prematures who survive have a birth weight of 3 lbs., 4 oz. or heavier. In addition, premature infants within this range generally experienced fewer complications in development. Infants tested represented a skewed distribution within the range of birth weight with most infants weighting 5 pounds or more.

All subjects tested were Caucasian. Those infants who had experienced serious birth injuries or neonatal complications were eliminated from this study in order to avoid the introduction of extraneous variables which could affect motor development. Selecting a sample characterized by homogeneity in race, socio-economic status, birth weight, and age allowed more meaningful interpretations of results. However, due to the small potential population which was narrowed by these variables, the sample was not randomly selected.

In the sample of four-month-old infants (N = 8) there was equal distribution between the sexes. The range in birth weight was 5 lbs., 8 oz. through 4 lbs., 5 oz., and the age range was three months, seventeen days to four months, seven days. Seven of the subjects lived in the Knoxville area and the eighth subject was a resident of Cookeville. Six of the eight infants were illegitimate, and six of the infants were

first-borns. The supposed gestational age of the infants ranged from 32 to 40 weeks.

The sample of eight-month-old infants (N = 8) consisted of three females and five males. The range in birth weight was 5 lbs., 10 oz. to 3 lbs., 7 oz. The infant weighing 5 lbs., 10 oz. was included in the sample because he lost weight to below 5 lbs. following birth and was transfered to the UTMRCH due to respiratory distress. The age range at the time of testing for this sample was seven months, twenty-one days to eight months, eleven days. The probable gestational age ranged from 30 to 36 weeks. Four of the subjects lived in the Knoxville area while the others lived in other parts of East Tennessee. One infant was illegitimate, and six of the infants were first-born children.

The potential population of four- and eight-month-old, Caucasian, lower-socio-economic class premature infants available from the UTMRCH and the Cookeville General Hospital consisted of 30 subjects. Letters were sent to the parents of each of these 30 subjects requesting their cooperation in this study. Of the 30 potential subjects, 14 were unable to be tested due to one of the following reasons:

(1) The letter was returned with the words, "addressee unknown" or "incorrect address" stamped on the envelope. According to the hospital Business Office, it was not uncommon for a patient to list an incorrect address in hope they would not be billed. (Two cases.)

(2) The letter was returned due to the fact that the family had moved and left no forwarding address. (Eight cases.)

(3) Due to an emergency the family had temporarily moved to another address. (One case.)

(4) Upon visiting the home of the premature it was learned that the family was Negro. (One case.)

(5) The researcher was unable to reach the family at home after many efforts to contact the family. (Two cases.)

Method

A typed letter was sent to the parents of the premature infants requesting their cooperation for the purposes of this study. The letter was written as if it were coming from the practicing pediatrician at UTMRCH or the administrator at the Cookeville General Hospital. The letter was signed by Dr. Henry S. Christian, Professor of Pediatrics at the Clinical Education Center of The University of Tennessee Memorial Research Center and Hospital, and by Michael J. Hurd, Administrator, Cookeville General Hospital for the Cookeville subject (see Appendix B for copy of letter). The letter was then xeroxed and sent to the parents. Included with the letter was a self-addressed post card on which the parent was asked to indicate: (1) their agreement or disagreement to cooperate with the research, and (2) the time most convenient for the test procedure when the feeding procedure would not be interrupted and when the baby would be most alert (see Appendix C for post card form).

The author traveled to the home of each of the infants in order to administer the test in the home environment. It was felt that parents would be more willing to cooperate with the study under these

circumstances, rather than if they were asked to bring the infant to the hospital for testing. There was less likelihood of the subjects missing a scheduled examination by testing the infants in this manner.

Through informal conversation prior to testing, the author tried to establish a rapport with the mother in order to develop a relaxed environment for testing. It was through this means that valuable information regarding the infant's prematurity was acquired. Of particular relevance to prematurity was determining the mother's physical stature (and that of the father, too, if possible), inquiring as to the approximate gestational age of the child, and requesting information as to the infant's history of illness since birth. If the mother were found to be 5 ft., 2 in. or less or weighed less than 110 pounds, and if the father were found to be 5 ft, 6 in. or less or weighed less than 140 pounds, there would have been reason to believe that the low birth weight was a result of genetic smallness rather than prematurity per se. In this event the subjects would have been eliminated from the study, but this did not occur. Information concerning the gestational age of the infant was used to interpret the results of the study. Those infants whose life since birth had been accompanied with severe illnesses or further complications which may have affected motor development would have been eliminated from the study. None of the infants tested were eliminated from the study.

A card table, with a disposable cover for sanitation purposes, was used by the researcher for purposes of testing. This was used also in an attempt to control for variations in the testing situation. Extra toys were taken to the home in order to occupy the infant's attention

during the interview with the mother, and to allow the infant time for free play while adjusting to the presence of the researcher. All extra toys and test stimuli were cleaned thoroughly before testing the next infant.

In an effort to thank the parents for their cooperation and helpfulness in this study, the researcher offered to take a picture of the infant or family and send it to the parents. At the completion of the testing situation a color picture was taken. When the film was developed, the picture along with a thank you note was sent to the parents.

Testing Device

The Bayley Scales of Infant Development, specifically the Motor Scale, was used to measure motor skills in the two groups of prematures. The Bayley Scales of Infant Development was chosen because norms had been developed for full-term infants, ages two to thirty months. Ordinarily the complete Bayley examination, including the Mental and Motor Scales and the Behavior Inventory, require a qualified tester for administration. In lieu of the fact that the author used strictly the Motor Scale and that the purpose of the test was not diagnostic for the infant, Dr. Kenneth Newton of the Psychological Clinic at The University of Tennessee, suggested that the author would be a qualified tester following a practicum of testing infants. Therefore, before testing the premature infants, the author practiced administering the test for motor development on 10 full-term infants in the three to five month and seven to nine month range. Testing an infant within the four to

eight month range was deemed by the author to be less complicated than testing an older child.

# CHAPTER IV

## RESULTS

Each premature infant tested was assigned a raw score based on the number of motor skills passed. The Psychomotor Developmental Index (PDI) was derived from the motor scale chart in the test manual by using the raw score. The two scores determined for each infant have been listed below in Tables III and IV.

The motor test scores of the premature infants were then compared to the norms established for full-term infants of the same age. The manual for the Bayley Scales of Infant Development (Bayley, 1969) provided a Motor Scale which contained all possible raw scores and their assigned Psychomotor Developmental Indices (PDI) for infants ranging in age from two to thirty months. Information presented in the manual indicated that a PDI of 100 was considered to be the mean of each age group. Thus, the mean raw scores for the four-month and eight-month-age categories were able to be determined by locating the raw scores associated with a PDI equal to 100 on the Motor Scale. The mean raw score for the four- and eight-month-old full-term infants was 17 and 36, respectively. The age range established on the Motor Scale for four-month-old infants was three months, twenty-three days through four months, seven days, and for the eight-month-olds the range was seven months, sixteen days through eight months, fifteen days.

Analysis of the data collected revealed an $\bar{X}$ of 15.88 and an $\bar{X}$ of 33.75 for the sample of four- and eight-month-old premature infants,

TABLE III

FOUR-MONTH-OLD INFANTS (a)

| Infant | Sex | Raw Score | PDI | Birth Weight |
|---|---|---|---|---|
| 1a | M | 14 | 85 | 5 lbs., 5-1/2 oz. |
| 2a | F | 14 | 85 | 4 lbs., 5-1/2 oz. |
| 3a | M | 15 | 90 | 5 lbs., 8 oz. |
| 4a | F | 16 | 96 | 5 lbs., 5 oz. |
| 5a | F | 16 | 96 | 5 lbs., 1-1/2 oz. |
| 6a | F | 17 | 110 | 4 lbs., 5 oz. |
| 7a | M | 17 | 100 | 5 lbs., 8 oz. |
| 8a | M | 18 | 108 | 5 lbs., 5 oz. |

TABLE IV

EIGHT-MONTH-OLD INFANTS (b)

| Infant | Sex | Raw | PDI | Birth Weight |
|---|---|---|---|---|
| 1b | F | 26 | 64 | 4 lbs., 11 oz. |
| 2b | F | 30 | 77 | 3 lbs., 7 oz. |
| 3b | M | 31 | 81 | 4 lbs., 15-1/2 oz. |
| 4b | M | 34 | 94 | 5 lbs., 10 oz. |
| 5b | F | 35 | 97 | 4 lbs., 9 oz. |
| 6b | M | 35 | 97 | 5 lbs., 5 oz. |
| 7b | M | 38 | 106 | 5 lbs., 3 oz. |
| 8b | M | 41 | 119 | 5 lbs., 8 oz. |

respectively. $H_1$ was suported in the sample of four-month-old prematures but was not supported in the sample of eight-month-old premature infants.*

In order to investigate the degree of association between the raw scores for motor development and the birth weight of the premature infants tested, a Pearson r was computed for each of the two independent samples. The Pearson r was .01 for the four-month-old prematures, and .02 for the eight-month-old prematures. These r-values indicated no significant association between the motor scores and birth weight.**

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*In order to reject null hypotheses (1) and (2) in favor of the research hypothese at the .10 level for a one-tailed test, the critical value of $\underline{t}$ had to be equal to or greater than -1.415. Statistical computations revealed t = -2.04 and t = -1.26 for the sample of four- and eight-month-old prematures, respectively.

**The observed r-values did not exceed the critical value of r (.62) for a one-tailed test at the .10 level of significance. Therefore, research hypotheses (3) and (4) were not supported.

# CHAPTER V

## DISCUSSION

The four-month-old premature infants in this research experienced significantly slower motor development than the norms for full-term infants of the same age. These findings support the work of Solomons and Solomons (1964) which revealed a significant difference ($p < .05$) existed between four-month-old prematures and full-term infants in motor development. Cutler, Heimer, Freedman, and Wortis (1965) and Braine, Heimer, Wortis, and Freedman (1966) also found that premature infants scored significantly lower on motor development than did full-term infants, but in these studies the prematures were thirty months and thirteen and one-half months, respectively.

Additional information on each subject gained through the interview and testing situation was used to further explain the test results. Infant 1a was noticeably slower in development than the other infants tested. For example, when elevating himself by his arms in a prone position (a task accomplished by the average child at 2.1 months according to the Motor Scale) the infant elicited a wobbly, jerky, uncontrolled movement. He was unable to sit with support as he was unable to tense his back muscles, and fell passively to one side. His hands were tightly fisted whereas the average child's hands were predominantly open by 2.7 months. The child's caretakers explained that the infant experienced no significant weight gain during the first six weeks of life as a result of complications with his formula. Improper nourishment could

have been an important influence on development during that period. The writer felt the intervening variable of physical health could have partially explained the low motor scores of subjects 2a and 3a. Both appeared very unhealthy, undernourished, small for their age, weak, and unresponsive. The home environment of each child was dirty, corroded, cramped, and deteriorated. Both mothers were approximately 16 years old and appeared ignorant as to the proper care of their child. The unwed mother of 2a appeared unstable, immature, and disinterested in the welfare of her child. Infant 2a apparently was left with wet diapers most of the time, suffered a flaky infection on the right eye which was unattended, and acted lethargic through the duration of the testing situation. In summary, both subjects probably experienced poor motor development as a result of inadequate nutrition, improper attention to their physical needs, and the lack of physical stimulation.

Analysis of the personal and environmental characteristics of the remaining five subjects revealed no noticeable differences among the infants. All subjects attained a raw score of 16, 17, or 18, departing negligibly from the mean of 17 for full-term infants as defined by Bayley. All subjects, seemed to live in an environment characterized by warmth, affection, interest, and a positive attitude toward the child. Each infant appeared to be in good health, well nourished, and well cared for. In the case of the two highest scoring subjects (8a and 6a) the higher level of motor development (PDI 108 and 110, respectively), could be attributed to more physical handling and cuddling in the home environment. The unwed mother of 8a was judged by the writer to be an affectionate and devoted mother. She viewed the testing situation with

interest and empathy, and held and caressed the infant tenderly and lovingly. The married parents of 6a cuddled, rocked, hugged, kissed and fondled the infant to the extent that she became irritable. The abundance of physical stimulation perceived by the researcher to be given to subjects 8a and 6a could explain their more advanced motor scores.

The study by Braine, Heimer, Wortis, and Freedman (1966) based on a population of lower class, Negro, premature infants concluded that there was no relation between the socio-economic variables and motor development at four months. They also found a positive but insignificant relationship for male prematures at seven and one-half months and thirteen and one-half months. Jones (1954) found similar results on full-term infants, and further determined that the correlation between socio-environmental variables and motor development did not develop until the infant was approximately two years old. In the sample of four-month-old premature infants tested in this study socio-environmental variables seemed to have affected the motor scores of at least two of the subjects: 2a and 3a. In the case of these two infants poor nutrition and improper physical care, variables more frequently associated with lower social class, appeared to be the cause of poor physical health which directly affected their motor development. In contrast, the low motor score of subject 1a was associated with less adequate nourishment due to the doctor's inability to prescribe the correct formula for the child, rather than the mother's ignorance in caring for the infant. In this sample the physical health of the child seemed to the writer to have an important effect on motor development.

Other than the above observations there appeared to be no additional factors among the four-month-old infants which could have explained their motor scores. It was assumed that the subjects experienced retarded motor development in comparison to the full-term infant due, in part, to the infant's low birth weight and probable shortened gestation.

In the sample of eight-month-old premature infants the observed t-value was equal to -1.26. Although the t-value was in the predicted direction, it did not exceed the critical value of $t$ and the null hypothesis could not be rejected.

To the writer's knowledge little information has been found concerning the point at which the premature infant begins to "catch-up" with the full-term infant. Interpretation of the data in this study suggested a "catching-up" process may begin by the time the infant is eight months old. The difference between the norms and the four-month-old prematures was significant with an observed t-value equal to -2.04, whereas the difference between the norms and the eight-month-old prematures was insignificant ($p < .10$) with an observed t-value equal to -1.26. Thus, the difference between the norms and the four-month-old infants was greater than the difference between the norms and the eight-month-old prematures. However, since the study consisted of two independent samples where one sample consisted of four-month-olds and the other was composed of a different set of eight-month-olds, the results could not be interpreted as supportive evidence that a "catching-up" process existed.

Additional information on each subject in the eight-month-old sample was used to explain the test results. Subject 1b whose raw score of 26 greatly reduced the mean, was far heavier than any of the other eight-month-olds tested. Her parents appeared over-concerned about their child and may have reacted to the infant's low birth weight by over-feeding the child. The infant's large size seemed to explain her poor motor performance as her weight restricted her free and easy movement. She was more content to rest comfortably on her back and watch objects, rather than pull herself to a sitting position, crawl, or sit. In addition to her large size she was one of the youngest infants tested, based on corrected chronological age, as she was considered to be six weeks premature.

The second lowest score of 30 was received by the smallest infant in the sample, 2b, who weighed 3 lbs., 7 oz. at birth. Her gestational age was 28 weeks according to the mother and 32 weeks according to the hospital approximation. The fact that the infant was premature in terms of birth weight and gestational age suggested a possible explanation for her low motor score.

Evaluation of the personal and environmental characteristics of subjects 8b, 7b, and 6b, revealed certain basic similarities. All subjects lived in a home consisting of family members supplementing the presence of the mother. The presence of several family members provided an environment characterized as verbally and physically stimulating for the child. All families appeared interested in the child and concerned over its proper growth and development. All of the infants appeared healthy, happy, and well-nourished. It could be said infants 8b, 7b,

and 6b probably attained higher motor scores as a result of heavier birth weight, adequate nutrition and physical health, and plentiful physical stimulation.

Examination of the individual characteristics of subjects 3b, 4b, and 5b, further explained the results of this study. Infant 3b was unable to pass the motor skills related to sitting. The parents provided a variety of toys and a playpen for the infant. The mother's attitude toward the infant and his three-year-old brother was interpreted as cold, harsh, and passive. The mother used a belt to discipline the three-year-old child, appeared unusually negative, and never affectionate. Although the infant's low motor score could be attributed in part to low birth weight, it could also be concluded that the mother spent a minimal amount of time handling and physically stimulating the infant due to the demands placed upon her by an extremely active three-year-old.

The environment of infant 4b illustrated conflicting forces which could have affected his motor development. On one hand, the mother's attitude toward the child may have enhanced his motor development. The mother was permissive concerning where he played, what he played with, or how messy he became. In essence, she was not protective and allowed him to learn through his mistakes and experiences. For example, the mother said the infant would not crawl because he had fallen off the couch so many times. The mother was young and seemed very interested in the child and affectionate toward him. However, she seemed unaware of the proper way in which to care for the infant. The child appeared physically miserable. His body was pale and he had dirty ears, face, arms, and legs. His legs were severely chapped and raw from the wet,

rough diapers. The house was old, deteriorated, and filthy; few stimulative toys or objects were present. The infant moaned and whined with a pained expression on his face during the entire testing situation. It was apparent to the author that the child was weak and sickly, probably due to improper nutrition and care. Normally, in an unrestrained and encouraging environment, a child would be expected to experience a more rapid motor development. However, in this situation, the constricting influence of the child's unhealthy physical state seemed to have a negative effect on motor development.

Infant 5b was judged by the author to be one of the two smallest babies in the sample at the time of testing. The infant stayed with a couple in a comfortable trailer all day while the parents worked away from home. She appeared happy and content, but was very inactive and did not elicit many of the motor functions tested such as crawling, rolling over from stomach to back, or raising herself to a sitting position. The mother of the child reported inactivity or laziness to be a factor noticed earlier in the child's development. The hospital records indicated the baby suffered from anemia after birth. Anemic conditions still present in the child could have explained the infant's apparent laziness at the time of testing.

In summary, this study illustrated, perhaps most importantly, the many variables which affect motor development among infants. It emphasized the impossibility found in isolating one variable, prematurity, and determining its inter-relationship with motor development. The variables associated with home environment probably had the single most powerful effect on motor development. The amount of stimulation

(physical, verbal, and visual) given to the child seemed to have been a crucial factor in the development of motor skills. This variable imposed a tremendous variation in the backgrounds of the premature infants tested.

The measure of association between motor scores and birth weight was determined to be a $r = .01$ for four-month-old infants and an $r = .02$ for the eight-month-old infants. Neither of these r-values exceeded the critical value of r (.62) which indicated no correlation existed between motor scores and birth weight in this study. Even by simply examining the birth weight and motor score of each infant in the sample, it was apparent that no consistent, predictable relationship existed between the variables. Considering the extraneous variables which affected the subject's test performance such as physical health, nutrition, and physical stimulation, and the small sample size, it was understandable why no correlation was found between birth weight and motor scores. Braine, Heimer, Wortis, and Freedman (1966) tested a population of 351 Negro premature infants and found the motor test scores to be linearly related to birth weight with $r = .30$ and .31 for the males and females, respectively. In a large sample where the effects of extraneous variables and individual differences would be partially eliminated, a correlation between motor scores and birth weight may have existed.

In conclusion, the shortcomings of this study as well as suggestions for future research have been considered. The results of the present study relied to a large extent on the subjective evaluations of the researcher. Each infant was tested by the researcher herself which introduced a series of weaknesses into the validity of the data:

(1) The tester was, for the most part, inexperienced in administration of the motor test. (2) The tester was aware of the characteristics of the population tested which could have introduced experimenter bias. (3) The actual motor test relied on the subjective appraisal of the tester to determine whether or not the subject passed each test item. The subjective nature of the test administration coupled with the fact that the researcher did her own testing may have made the results of this study less valid.

The small sample size (N = 8 for each sample) severely limited the generalizability of the test results. With a small N it was critical to eliminate as many variables as possible before beginning the research. For this reason the subjects of this study were all Caucasian, from the lower socio-economic class, single-births, the same age, and had a birth weight within the range of 5 lbs., 8 oz. to 3 lbs., 4 oz. Due to the limited base population of prematures it was impossible to control for first-born vs subsequent children, or for sex. Even in a sample where extraneous variables were eliminated as well as possible, the effects of individual differences among the subjects in terms of home environment, nutrition, stimulation, and health could not be avoided with a small sample size. Because of the small sample size the results of this study can not be interpreted as conclusive evidence that all premature infants with characteristics similar to those of this sample will function below the norms. However, the results do support the theory that premature infants tend to develop slower in terms of motor skills than the full-term infant during the first year of life.

The conflicting data on prematurity currently available is indicative of the need for more thorough, detailed, and comprehensive research in this field. At this point there is little research on sex differences of premature infants. Bayley (1969) has found no sex differences among her population of full-term infants. Braine, Heimer, Wortis, and Freedman (1966) found a significant difference in motor development between male and female prematures at thirteen and one-half months, but the difference was thought to be attributed to greater neurological impairment in male prematures rather than female superiority. This is the type of scant information on sex differences that exists in the field at the present time. There is a need to know more about sex differences among premature infants at all levels of development, not just thirteen and one-half months. In order to do this a large population of premature infants must be studied at each month of development.

More information is also needed concerning first-born vs subsequent prematures and how this variable affects motor development. Of particular concern to parents, doctors, child development experts, and researchers is the developmental lag experienced by premature infants. If they are retarded in motor development compared to the full-term infant, at what point, if ever, do they begin to catch-up? Do premature infants with a birth weight between 5 lbs., 8 oz. and 3 lbs., 4 oz. experience more rapid development than those infants born weighing less than 3 lbs., 4 oz.? Differences among premature infants of varying birth weights must be studied. To answer some of these questions researchers must study a large population of premature infants

together with a matched population of full-term infants. Strict controls must be placed on each population in order to derive generalizable results.

# CHAPTER VI

## SUMMARY AND CONCLUSIONS

The current study involved 16 premature infants, a set of 8 who were four months old and a different set of 8 who were eight months old. The purpose was to investigate the degree to which the prematures differed in terms of motor development from the norms established for full-term infants. The criterion for prematurity was a birth weight of 5 lbs., 8 oz. (2500 grams) or less. The birth weight of all subjects tested fell within the range of 5 lbs., 8 oz. and 3 lbs., 4 oz.

The sample was drawn from the population of infants born at The University of Tennessee Memorial Research Center and Hospital and the Cookeville General Hospital between March 1, and November 1, 1972. The variables of race, social class, birth weight, and age were controlled by choosing a sample of Caucasian, lower socio-economic class premature infants of the same age. The sample was not randomly selected due to the small population of infants who met the above criteria.

Initial contact was made to the parents of the prematures through a xeroxed letter from the pediatrician at UTMRCH and the administrator at the Cookeville General Hospital. The letter explained the proposed research study and asked for parental cooperation. The researcher traveled to the home of each infant for the purpose of testing the subject in its natural environment as well as for the convenience of the parent. Generally, each child was tested within one week of its four- and eight-month birthday.

The Bayley Scales of Infant Development: Motor Scale was used to measure the premature's current level of motor development. Before testing the premature infants the researcher practiced administering the motor test on 10 full-term infants. The test provided the researcher with a raw score which could then be used to determine the infant's Psychomotor Developmental Index (PDI) according to directions given in the test manual.

The premature four-month-old infants were found to be significantly retarded in motor development at the .10 level for a one-tailed test when compared to the norms established by Bayley (1969). The four-month-old premature infants had a mean raw score of 15.88 compared to the mean raw score of 17 for the norms. The observed t-value was equal to -2.04 which was greater than the -1.415 critical value of $t$, and the null hypothesis was rejected.

The premature eight-month-old infants were found to be retarded in motor development when compared to the norms, but the difference was not significant at the .10 level for a one-tailed test. The mean raw score for the premature infants was 33.75 compared to the mean raw score of 36 for the norms. The observed t-value was equal to -1.26 which was in the predicted direction, but not greater than the -1.415 critical value of $t$.

The Pearson r was computed to determine the degree of association between birth weight and motor scores. The Pearson r was found to be .01 for the sample of four-month-old prematures and .02 for the sample of eight-month-old prematures. Neither r-value exceeded the critical value of r (.62) for a one-tailed test at the .10 level of significance.

Therefore, hypotheses (3) and (4) failed to be rejected. The low r-values indicated that in this study, no association existed between birth weight and motor scores.

Limitations of this study and suggestions for future research were also discussed.

# BIBLIOGRAPHY

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# APPENDICES

## APPENDIX A

Interview Schedule

1. Do you have any other children? What are their ages?

2. Do you notice a difference in the development of the low birth weight infant and your other children?

3. Has your son/daughter had any serious illnesses since the time of birth?

4. How would you describe the physical size of the father of your son/daughter? (Weight _____ Height _____)

5. How long do you think you carried your child: 9 months, 8 months, 7 months, or 6 months?

APPENDIX B

The University of Tennessee
MEMORIAL RESEARCH CENTER
AND HOSPITAL
Knoxville, Tennessee 37920

Dear Parent:

I am writing to you to ask for your cooperation in a study involving low birth weight babies born in 1972. It has generally been found that those babies born weighing 5 lbs., 10 oz. or less experience a slower development in some ways than heavier babies. Mrs. Lynne Maddux, a graduate student at The University of Tennessee in the Department of Child Development, is concerned with studying specifically the motor development of low birth weight infants. Motor functions include such skills as rolling over from stomach to back, sitting, crawling, standing, walking, and reaching for an object. With your permission I would like for Lynne to have the privilege of coming to your home to meet you and to determine your infant's current level of motor development.

Let me further explain Lynne's study. She would be coming to your home at a time suitable to you. During her visit she would administer a motor test, a device consisting of certain toys which your infant can manipulate while she observes his behavior. The test is very short and informal; it is fun both for the parent and the infant, and there is no stress placed upon the infant. The experience should be very educational to you as you would be informed of how your child was progressing in terms of motor development.

Enclosed is a post card addressed to Mrs. Maddux on which you are asked to state whether or not you will cooperate with this project. As one of the doctors concerned with the development of low birth weight infants, I would like to encourage you to assist Mrs. Maddux with her worthwhile study. We have much to learn about low birth weight babies, and your efforts would help us to understand similar babies of low birth weight in the future. Your assistance in this study will be greatly appreciated.

Sincerely,

Dr. Henry S. Christian
Department of Pediatrics
UT MEMORIAL RESEARCH CENTER
AND HOSPITAL

COOKEVILLE GENERAL HOSPITAL
142 West Fifth Street
Cookeville, Tennessee 38501

Dear Parent:

I am writing to you to ask for your cooperation in a study involving low birth weight infants born in 1972. It has generally been found that those babies born weighing 5 lbs., 8 oz. or less experience a slower development in some ways than heavier babies. Mrs. Lynne Maddux, a graduate student at The University of Tennessee in the Department of Child Development, is concerned with studying specifically the motor development of low birth weight infants. Motor functions include such skills as rolling over from stomach to back, sitting, crawling, standing, walking, and reaching for an object. With your permission I would like for Lynne to have the privilege of coming to your home to meet you and to determine your infant's current level of motor development.

Let me further explain Lynne's study. She would be coming to your home at a time suitable to you. During her visit she would administer a motor test, a device consisting of certain toys which your infant can manipulate while she observes his behavior. The test is very short and informal; it is fun both for the parent and the infant, and there is no stress placed upon the infant. The experience should be very educational to you as you would be informed of how your child was progressing in terms of motor development.

Enclosed is a post card addressed to Mrs. Maddux on which you are asked to state whether or not you will cooperate with this project. I would like to encourage you to assist Mrs. Maddux with her worthwhile study. We have much to learn about low birth weight babies, and your efforts would help us to understand similar babies of low birth weight in the future. Your assistance in this study will be greatly appreciated.

Sincerely,

Michael J. Hurd
Administrator
COOKEVILLE GENERAL HOSPITAL

## APPENDIX C

Sample post card to be included in each letter:

I (will ___, will not ___) give my permission for Mrs. Maddux to come into my home to observe my low birth weight infant.

_____, is a convenient date for Mrs. Maddux to observe my child. (Yes___ No___)

If no, what date during the same week is acceptable?
DATE: _____

What time on the above date do you wish for Mrs. Maddux to observe your child? TIME: _____
(Please suggest a time when the baby is usually awake and alert.)

Name of Family _____

## APPENDIX D

## INFORMATION ON SUBJECTS TESTED

Four-Month-Old Infants (a)

(1a) BIRTH WEIGHT: 5 lbs., 5-1/2 oz.
RAW SCORE: 14
PDI: 85
GESTATION: 32 weeks
MALE: first-born, illegitimate
AGE: 3 months, 23 days

COMMENTS: The infant experienced no significant weight gain during the first six weeks of life due to a difficulty with the formula. The real mother was not living in the home. The child lived with his grandparents and their seven children.

(2a) BIRTH WEIGHT: 4 lbs., 5-1/2 oz.
RAW SCORE: 14
PDI: 85
GESTATION: 7 months according to the mother
less than 36 weeks reported by hospital
FEMALE: first-born, illegitimate
AGE: 4 months, 7 days

COMMENTS: The household was composed of the mother, the mother's mother, and the mother's brother. The conditions of the home were particularly depressing and dirty, and there was complete absense of personal cleanliness among the family members. The grandmother was the primary caretaker. The infant was noticeably lethargic and unresponsive during the testing situation.

(3a) BIRTH WEIGHT: 5 lbs., 8 oz.
RAW SCORE: 15
PDI: 90
GESTATION: 36 weeks
MALE: subsequent child
AGE: 4 months

COMMENTS: The mother was 16 years old and had a daughter 16 months. The infant had problems with initial weight gain and weighed only 9 pounds at 2 months. The mother appeared interested in her children, but ignorant as to the proper way to care for them. She reported a difficulty in getting the child to eat solid foods and fed him only milk and cereal through the infant feeder. The home was very dirty and corroded, the family's clothes were badly soiled, and the children were unkept and messy.

(4a) BIRTH WEIGHT: 5 lbs., 5 oz.
RAW SCORE: 16
PDI: 96
GESTATION: 40 weeks
FEMALE: first-born, illegitimate
AGE: 3 months, 24 days

COMMENTS: The infant lived with her unwed mother who was 17 years old, and her mother's family which included mother, father, two brothers and two sisters. The grandmother was the primary caretaker. The mother appeared very immature and disinterested in her child. All family members seemed very affectionate toward the infant.

(5a) BIRTH WEIGHT: 5 lbs., 1-1/2 oz.
RAW SCORE: 16
PDI: 96
GESTATION: 32 weeks
FEMALE: first-born, illegitimate
AGE: 3 months, 28 days

COMMENTS: The infant lived with her mother and her family. Much affection and attention was shown toward the infant.

(6a) BIRTH WEIGHT: 4 lbs., 5 oz.
RAW SCORE: 17
PDI: 110
GESTATION: 32 weeks
FEMALE: first-born
AGE: 3 months, 17 days

COMMENTS: The parents provided much stimulation for the child primarily verbally and physically. There was much touching, holding, loving and talking directed toward the child.

(7a) BIRTH WEIGHT: 5 lbs., 8 oz.
RAW SCORE: 17
PDI: 100
GESTATION: 36 weeks
MALE: subsequent child, illegitimate
AGE: 4 months

COMMENTS: Surprised the infant scored so high as he elicited a blank stare at each object that was presented to him. The T.V. was blasting loudly, and the grandmother reported that the child watched T.V. all day long. The infant was given much attention by its mother and grandmother. A second child, a boy of three years was also present in the family.

(8a) BIRTH WEIGHT: 5 lbs., 5 oz.
RAW SCORE: 18
PDI: 108
GESTATION: 36 weeks
MALE: first-born, illegitimate
AGE: 3 months, 24 days

COMMENTS: The mother lived alone in a small house near a factory where she was employed. She provided a clean, well-kept, comfortable environment for the child. The child appeared to be well-fed, healthy, and the happiest child tested.

Eight-Month-Old Infants (b)

(1b) BIRTH WEIGHT: 4 lbs., 11 oz.
RAW SCORE: 26
PDI: 64
GESTATION: 30 weeks
FEMALE: subsequent child
AGE: 7 months, 21 days

COMMENTS: The infant lived with her mother, father, and seven-year-old sister. The child was very large and heavy. She seemed content to lie on her back and observe her surrounds rather than actively move around and manipulate her environment.

(2b) BIRTH WEIGHT: 3 lbs., 7 oz.
RAW SCORE: 30
PDI: 77
GESTATION: mother reported 28 weeks
hospital estimated 32 weeks
FEMALE: first-born
AGE: 7 months, 26 days

COMMENTS: The infant was a very active child who was interested in her surroundings. She was able to scoot herself around the home in her walker, but was unable to sit steadily or crawl. The child lived with her mother and father only.

(3b) BIRTH WEIGHT: 4 lbs., 15-1/2 oz.
RAW SCORE: 31
PDI: 81
MALE: subsequent child
AGE: 8 months, 7 days

COMMENTS: The child lived with his mother, father, and three-year-old brother. The home environment was filthy and the children and their clothes were badly soiled. The mother used a belt in disciplining her older son. The infant appeared afraid of the examiner and generally unhappy.

(4b) BIRTH WEIGHT: 5 lbs., 10 oz.
RAW SCORE: 34
PDI: 94
GESTATION: 32 weeks
MALE: first-born
AGE: 8 months

COMMENTS: Although the infant had a birth weight of 5 lbs., 10 oz., it was included in the study because it lost weight to below 5 pounds after birth and was taken to the UT hospital due to respiratory distress. The mother appeared interested in her child, but evidently did not attend to his physical needs. The infant was dirty, his diapers were wet, and his legs were red, chapped, and scaly from wet diaper irritation. The child acted physically uncomfortable throughout the test situation by moaning, fretting, frowning, and whimpering. The home was old, dilapidated, unkept, and filthy. There were few stimulative toys or objects present in the home.

(5b) BIRTH WEIGHT: 4 lbs., 9 oz.
RAW SCORE: 35
PDI: 97
FEMALE: first-born
AGE: 7 months, 27 days

COMMENTS: Hospital records indicated the infant had respiratory distress and anemia at birth. The child was well dressed, clean, and seemed happy and content. She stayed with a couple in a comfortable trailer during the day when the parents worked. The trailer was where the testing took place. The infant appeared lazy and therefore did not carry out many of the test items. Her mother reported laziness to be a factor noticed earlier.

(6b) BIRTH WEIGHT: 5 lbs., 5 oz.
RAW SCORE: 35
PDI: 97
GESTATION: 32 weeks
MALE: first-born
AGE: 8 months

COMMENTS: The mother appeared very concerned about the child's proper growth and development. She was kind, interested, and affectionate toward the child. The infant had a playpen full of toys, but seemed content to sit and watch rather than actively move around the home. The infant's grandmother was present in the home along with the infant's mother and father.

(7b) BIRTH WEIGHT: 5 lbs., 3 oz.
RAW SCORE: 38
PDI: 106
GESTATION: 36 weeks
MALE: first-born, illegitimate
AGE: 8 months, 11 days

COMMENTS: The home environment was crowded, unkept, and in deplorable physical condition. The infant lived with its mother and her family, including her mother, father, sister, and brother. When the examiner entered the home at 11 a.m. everyone was hovering under their blankets in bed trying to stay warm. The infant's pajamas were too tight and seemed to restrict the movement of his legs. The child appeared to be a happy and responsive child and received much affection and attention from the mother as well as other family members.

(8b) BIRTH WEIGHT: 5 lbs., 8 oz.
RAW SCORE: 41
PDI: 119
MALE: first-born
AGE: 8 months

COMMENTS: The child appeared healthy, happy, and radiant. He lived with his parents, maternal grandparents, and the sister and cousin of his mother. All of the family members were very supportive of the young infant, and provided him with a variety of physical and verbal stimulation. There was much laughter and happiness seen among family members. The infant had a walker and several small toys. The family lived in a local housing project, and the living conditions were dirty and unkept.

# VITA

Lynne McLamore Maddux was born in Wilmington, Delaware, on September 16, 1949. She attended public school in Miami, Florida, where she graduated from high school in 1967. She received a B.A. degree in Psychology from Miami University, Ohio, in August of 1971. In September of the same year she entered graduate school at The University of Tennessee and completed her Master of Science degree in Child Development and Family Relationships in March, 1973. She is married to John Jared Maddux of Cookeville, Tennessee, and planned to settle permanently in Cookeville upon graduation.