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ABSTRACT

Are children intellectually impaired as a result of low birth weight and does relative impairment change as children grow older? Premature infants from a range of socioeconomic groups were studied in five rounds over 13 years to provide neurological, psychological, achievement, and sociological data on 582 children in three birth weight groups. A summary based on the final round makes these points: (1) Birth weight is related to reading and arithmetic achievement when social class and race are controlled, (2) Birth weight remains a significant correlate when an attempt is made to control for neurological status (estimated at age 40 weeks), (3) The correlation between indices of mental development and late adolescent intellectual behavior approaches zero, (4) Arithmetic is apparently more sensitive as an indicator of impairment due to birth weight than is reading, (5) None of the statistical interactions between race, social class, birth weight, and achievement were significant. (Tables make up one-half of the document.) (WY)

Long Term Study of Prematures: Summary of Published Findings

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The work reported here is concerned with a follow-up of about 12 years on a sample of resident infants born in Baltimore, Maryland, who were still living there when given a developmental examination at 40 weeks of age.[1] The sample included 500 single-born premature infants, consisting of all available survivors whose birth weight was 1,500 grams (3.3 lbs.) or less, with the remainder selected by a predetermined design from the weight group between 1,501 and 2,500 grams (3.3 to 5.5 lbs.) on the basis of hospital of birth and area of residence. The sample design assured inclusion of cases from the range of socioeconomic groups. Census tract data were used to control for social class between the premature and control infants.[2] The control infants were also matched to the premature infants on the basis of race, season of birth, parity of mother, and hospital of birth. The 992 infants examined at 40 weeks of age were 85% of the 1,170 infants who were given appointments. Of those who did not participate, 3.5% were refusals and 11.5% could not be located. Table 1 gives the race and weight distribution of the 992.

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1. This longitudinal study was an outgrowth of the evaluation of standards for the hospital care of premature infants which involved all 4,700 infants born in Maryland in 1952 (Rider, Harper, Knobloch, and Fetter, 1957). Retrolental Fibroplasia in the larger group was reported by Rothmund, Rider, & Harper, 1954.

2. Census tract data provide social class information, in that they are rated on the basis of median rental.

When approximately 40 weeks of age, [1] the 992 infants were examined. This survey was reported by Knobloch, Harper, and Rider (1956). Seventy-five percent of all children were seen between 39 and 41 weeks of age. For the most part, infants were seen without the examiner having knowledge regarding birth weight or other information about case history materials. The examination consisted of a Gesell developmental examination and a pediatric neurological evaluation, which was used to establish an "overall" diagnostic impression. In addition, history materials regarding infants' development and behavior were taken from hospital records and from information obtained from the infants' mothers. Table 2 and Table 3 represent the findings of these examinations.

Later in the course of the survey, it was felt desirable to return to the information obtained during, and prior to, 40 weeks, and to list the various perinatal and neurological factors that possibly differentiated premature from non-premature infants. Nineteen variables were found in these records, and these are listed in Table 4. These variables were used to construct

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1. Age refers to corrected age. Age is corrected for prematurity throughout the entire study in such a way that the prematurity time is subtracted from his actual age--thus, a child 6 years and 2 months of age who was born after 32 weeks gestation, was recorded as being 6 years and 0 months of age. Where gestation time was not known, it was estimated from the child's birth weight.

a scale (Table 5) which was used for multivariate statistical analysis at later rounds. This scale is felt to be an index of likely neurological impairment. A high score on the scale appearing in Table 5 is an addition of each of the "impairments" noted in Table 4. A "score" of 0 would imply that a child has none of the 19 noted factors, whereas, a higher score would represent the number of pathological factors noted. A higher score presumably reflects on the likelihood for a greater degree of neurological involvement. [1]

It is obvious from examinations of Tables 4 and 5, that the findings reported by Knobloch, Rider, and Harper (1956), as shown in Tables 2 and 3, are confirmed. Premature infants when examined at 40 weeks, have a case history and a neurologic status suggestive of neurologic impairment. Results of this first round, the examination at age 40 weeks, might be summarized by the statement that approximately 51% of the infants weighing less than 1500 grams have some intellectual or neurological abnormality. Of the infants weighing 1500 to 2500 grams, 25% demonstrate

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1. The inadequacies of this scale as an index of neurologic impairment are recognized; each of the 19 factors were given equal weights. Also, intensity of each factor was not considered, but only its presence. Reliability of case history materials and of neurologic examining procedures was not estimated.

some abnormality, whereas, those who would be classified as controls, only 13% demonstrate an abnormality. These results are independent of race and socio-economic status, as these were controlled by the design of this study.[1]

A second round of the survey was conducted when the children were 3-5 years of age in order to determine whether children in this (and successive rounds) were intellectually impaired[2] as a result of birth weight, and whether relative impairment changed as children grow older.[3]

When age 3-5, 900, or 91% of the original 992 cases, were seen. Ninety-two percent of infants were seen between 3 and 4½ years of age. Approximately 4% refused to be examined, 1% of infants had died, and 4% had left the Baltimore area. Less than 1% could not

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1. Later results will show that other estimates of socio-economic status confirm the original census tract estimates, and that comparisons between birth weight groups are free of this bias.

2. Throughout the various rounds of the study, information was obtained regarding physical and medical characteristics of children, as well as special data regarding enuresis. These data will not be summarized here.

3. The report prepared by Harper, Fischer, and Rider (1959) summarized the findings of the second round of examinations.

be located for follow-up. The attrition did not materially affect the population studied, in that cases not examined were not from a specific birth weight group.

The evaluation consisted of a home interview, designed to ascertain various characteristics of the child's family and environment, and an office interview which made use of the Gesell developmental scales and the Stanford Binet Intelligence Test, Form L. An estimation of neurological adequacy was made by reviewing intellectual and other types of behavior noted during the office evaluation.

Table 6 is an estimate of the neurological status noted at age 3-5. The proportion of infants termed "normal" increases with increasing birth weight. Although Table 6 does not present a control for race or social class factors, the original design of this study and later analyses imply that the results obtained are independent of such factors. The authors noted that when the results from the 40 week examination were compared with the results of the 3-5 year examination, the premature child's prognosis for intellectual improvement tended to increase with increasing birth weight. For example, 83% of the white prematures who were classified as average or low-average at 40 weeks were similarly classified at 3-5 years. This compares with 93% of the full term children. Similar results were obtained for non-whites.

A third round of evaluations were conducted when children were 6-7 years of age. [1] Eight hundred fifty-seven of the original 992 children were available for examination. Again, earlier data were examined to see whether the unexamined children represented a selected group. This was not the case here, or in later rounds of the survey. The children were administered a variety of psychological tests and measures. These included the Stanford Binet Intelligence Test, Form L, the Lincoln Oseretsky Test of Motor Development, [2] the Goodenough Draw-a-Person Test, and the Bender Gestalt Test of Visual-Motor Coordination. The Bender Gestalt examination requires children to copy nine geometric designs. Although there are many procedures available for scoring this examination, one of the authors (G.W.) devised a scoring scheme which, in his clinical experience, maximized the ability of the test to diagnose brain damage. Scoring of this test was dependent on the number of rotations, instances of perseveration, inability to produce an acute angle, crude reproductions of circles and dots, and gross distortions of gestalten. The Bender Gestalt was scored after all the children were examined. The raters had no way of knowing the race, sex, birth weight, or appearance of the children who produced the

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1. This round was reported in the paper by Wiener, Rider, Oppel, Fischer, and Harper (1965).

2. This test contains items requiring children to maintain balance with eyes closed, touching the point of the nose alternately with the right and left hand, hop on one foot, etc.

drawings, nor did the rater of the Bender Gestalt have knowledge of the children's performance in other psychological tests. To this extent, the ratings of the Bender Gestalt results were truly "blind". They were independent of raters' knowledge of children's current behavior, as well as past history.

In addition to the above measures, ratings of speech maturity were made by noting articulation defects. Ratings were also made regarding perseveration trends and overly concrete thinking, as well as the ability to comprehend test instructions.

In addition to the previously listed information, children's guardians were interviewed by social workers, and information such as parental income, education, occupation, nature of residence, etc., was obtained. Also, children's mothers were rated on a variety of attitudes and practices such as intellectual interest, use of fear in training children, tendency to reject role as mother, etc. Social class and maternal attitudinal behavior were factor analyzed, and resulting factors were then used to provide each child with a social class and maternal attitude "score". Such scores were used as additional controls in eliminating the effects of environmental factors in assessing variance in intellectual functioning due to birth weight. The mean age of Ss was 6.52 years, and birth weight groups did not differ significantly with respect to age when examined.

Data from this third round of study were analyzed according to various multivariate statistical techniques which require that complete data be available for each child. Therefore, children who could not undertake the entire evaluation were not included in the final analysis. Also excluded were those who are blind, bedridden, grossly retarded (IQ less than 60), or emotionally disturbed. In effect, then, the analysis to follow is concerned with children who are above the moderately retarded range, and who are emotionally and physically capable of undertaking a complete office evaluation. Of those who were excluded from analysis, 46 were premature and 17 were control cases. [1]

Table 7 presents the basic data relevant to the analysis of the third round: The results of the psychological variables administered each child by birth weight, race, and sex. In addition, the score reflecting an index of the neurological damage (see Tables 4 and 5) and the maternal attitude and social class score are shown. Tests of significance for the scores of Table 7 are shown in Table 8. It can be noted in Table 8 that maternal attitudes and social class do not differentiate birth weight groups. This confirms that the initial matching using census tract data was highly efficient.

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1. This is an important consideration, in that those cases who are more than moderately retarded, or who suffer from severe physical disturbances, could by themselves radically change the mean score of birth weight groups. The result of this, and subsequent rounds, are not influenced by a small number of extremely devient cases.

The statistical significance of the neurological score is very large. Of the psychological measures, Stanford Binet IQ, Lincoln Oseretsky Test of Motor Development, Bender Gestalt, speech maturity, and "thinking mode", [1] each differentiated significantly between birth weight groups. Note that when the score used as an index of neurological damage is controlled, using the analysis of covariance technique, there is a tendency for significance of psychological measures between birth weight groups to drop. This has been a consistent finding through to the final study of scholastic achievement. Control for neurological defect reduces the effectiveness of birth weight as a predictor of psychologic performance. In some instances the effect of birth weight is entirely eliminated as a factor, but not completely so.

"Discriminant function analyses" [2] indicated that at age 6-8, the Bender Gestalt Test and "thinking mode"

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1. "Thinking mode" is a combined index of perseveration trends, concrete thinking, and comprehension difficulty noted during the examination.

2. The discriminant function statistic is used to estimate the difference between two (or more) groups when more than one variable is used to compare groups. Each of the variables are assigned weights. The weights are multiplied by the actual scores on the variables to produce a single score for each group, which maximizes the separation between groups.

evaluation proved to be the best discriminators between birth weight groups. This makes theoretic sense in that birth weight groups are also extremely different with regard to an estimate of neurological defect. Neurologists and psychologists commonly attribute to brain damage such defects as perceptual-motor incoordination, aphasia, perseveration, and concrete thinking.

Using a discriminant function score as an estimate of mental "efficiency" (based on the optimal weights ascribed to each of the six tests), the most mentally efficient 100 cases included 27% of the controls and 5% of the prematures (of those prematures who were less than 2000 grams at birth).

It is possible that the effect of low birth weight on mental test functioning is mediated by personality factors. For example, it is commonly thought that a brain damaged child is hyperactive and inattentive. Perhaps such a child does poorly because of this, rather than a deficit in his intellect, *per se*. Data as regards personality trait characteristics were obtained from psychologist's ratings during the 6-7 year examination. Psychologist's ratings were also obtained during the following round when children were 9-10 years of age, and from *Ss*' school teachers when *Ss* were 8-9 years of age. It should be noted that only one of the personality trait ratings obtained from the three sources discriminated premature from control children. Each of the three sets of personality ratings showed a small relationship for premature children to be more impulsive,

($p < .05$ for each of the three sources of data). Therefore, impulsivity was used as a control variable to see whether it, in fact, accounted for the low birth weight children's relative disadvantage. The relative mental impairment of prematures was not affected when ratings of impulsivity were controlled.

Previously, it was noted that catching up had not occurred through to age 3-5. Data from this third round of the study indicates that IQ differences have not disappeared by age 6-7. However, any attempt to analyze questions of prematures "catching up" would depend upon the use of identical measuring instruments, as well as the nature of the trait to be estimated. Children change remarkably within the span of time noted, therefore, the finding that "catching up" has not occurred is limited to the IQ measures used at various age levels.

The authors of the third round of the report concluded from their studies that low birth weight children were psychologically impaired when race, maternal attitudes and practices, and social class factors were simultaneously controlled. They also noted that such impairment was not secondary to personality trait disturbances. The degree of impairment increased with decreasing birth weight. It was concluded that low birth weight is a cause of poor performance, largely insofar as it is associated with an index suggestive of neurological damage. At age 6-7, perceptual motor disturbance, as measured by the Bender Gestalt test, flaws in comprehension and abstract reasoning and perseveration trends are most important discriminators between birth weight groups. Poor gross motor development, immature speech, and impaired IQ are also significantly identified with low birth weight children. There was no significant statistical interaction between low birth weight (or neurologic impairment) with race, socio-economic status or Ss' sex: The effect of birth weight is not potentiated by being from a lower socio-economic class group, or by being a Negro, or by being male. The effect of birth weight is apparently the same for each race, sex, or socio-economic group. Another conclusion is that personality trait data from several sources do not indicate that premature children differ from controls, with the exception of ratings of impulsivity. This conclusion is tempered by the known fact that personality trait estimates are of dubious reliability and validity.

When Ss were 8-10 years of age [1] they were seen for the fourth time. The purpose of this follow-up was primarily to describe the nature of the differences between groups, as well as note again whether low birth weight children compensate ("catch up"). Another purpose of this round was to replicate findings regarding the effects

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1. Wiener, G., R. V. Rider, W. C. Oppel and P. A. Harper. Correlates of Low Birth Weight. Psychological Status at Eight to Ten Years of Age, Pediat. Res., 2: 110-118, 1968.

of perinatal trauma and infant neurologic defects of the groups of children (shown in Tables 4 and 5), and to ascertain whether such phenomena are associated with psychological impairment of low birth weight children. Eight hundred forty-one children of the original 992 were located. Of these, 822 provided the data upon which this report is based. The other 19 subjects were excluded from this report because of severe sensory or gross motor disturbance, or they had an IQ of less than 50. Sixteen of these excluded cases were of low birth weight; three were control cases. Analysis of data indicated that the previous intelligence test scores of the non-located children were not significantly different from the 822 children who are the subject of this report.

Each child was administered ten subtests of the Wechsler Intelligence Test for Children, the Bender Gestalt Test, and the Wide Range Reading and Spelling Achievement Test. In addition, observations were recorded regarding speech articulation and complexity of grammar. The number of perseveration instances and indications of possible comprehension aphasia observed during the examinations were recorded. Children's guardians were again interviewed by social workers and rated for a variety of social class and attitudinal variables.

As with previous rounds of this study, the social worker and psychologist who collected data were unaware of the _Ss_' past history or prior test performances. After all children had been examined, raters again scored

Bender Gestalt reproductions as they were scored for the third round. Therefore, once again Bender Gestalt scores are independent of any influence from other test results, physical appearance, and knowledge of past history. Each Bender protocol was scored for instances of perseveration, separation of figures, inability to make acute angles or sine curves, crudeness of motor coordination, and gross distortions of Gestalt perception.

Sixteen of the 20 psychologic measures used indicated significant differences between birth weight groups. Data presented in Table 9 consider only the Wechsler Intelligence Test (WISC) and Bender Gestalt Test scores.

A significant relationship with birth weight was shown by the Verbal IQ, Performance IQ, and Full Scale IQ scores, as well as the independently obtained Bender Gestalt score. Increasing impairment was noted with decreasing birth weights. The noted significance was obtained for both Negro and white Ss. Negro children are not more impaired than white children as a function of birth weight. Although social class differences (as estimated from census tract data) were controlled by initial matching of Ss when the study began, further controls for such variables were provided by using additional data obtained when Ss were 8-10 years of age. These data, obtained by social workers, were factor analyzed and 10 resulting factors were scored.

These scores were simultaneously covaried. The F ratios of Table 9 are based on this control via analysis of covariance.

An examination of mean intelligence test scores provided in Table 9 indicates that the difference between birth weight groups is approximately five points. This is not a sufficient difference upon which to base a clinical or educational prediction. However, when the most impaired extreme of the distribution is examined (e.g., IQ 50-79), large differences exist between groups. Approximately twice as large a proportion of low birth weight as of control children fall into this IQ category, which is most frequently associated with special medical or educational needs.

To the extent that groups of children differ significantly on each of three psychological variables (e.g., Verbal IQ, Performance IQ, Bender Gestalt), it is likely that a better estimate of the true difference between birth weight groups would consist of a weighted combination of the three variables. The discriminant function statistic was again used to assign weights to each of the three variables and produced a new variable, so as to maximally separate groups.

In Table 10, Ss were grouped into sextiles which reflect this composite score of psychological efficiency, as estimated by this single "new" variable. Sextiles were prepared separately for each race. The lowest (6th) sextile, for example, may be interpreted as those children who have the most unfavorable scores on the three measures that maximally separate birth weight groups. [1]

Although the discrimination is significant, the most important implication of the difference between groups is noted in examining the extremes of the distributions. The lowest sextile contains 22.5% of the prematures, and 10.6% of the controls.

Once again, the question is considered whether the difference between birth weight groups changes as prematures grow older. Do prematures "catch up" as opportunities for compensation via learning experiences increase?

Changes between groups might be estimated by the changes in measure of significance if degrees of freedom remain constant. Table 11 presents some relevant data. At age 6-7, the Stanford Binet showed an IQ difference between the low birth weight and full sized groups of 3.4 points ($F = 7.77$, 3 and 810 df, $p < .001$).

The WISC at age 8-10 indicated an IQ difference of 4.9 points ($F = 10.87$, 3 and 810 df, $p < .001$) for the same children. These measures suggest that prematures have not caught up at age 8-10, if the measures used to assess this are in any sense appropriate.

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1. This maximizing procedure would not produce as wide a dispersion for subsequent samples. However, to the extent that separate groups of white and Negro low birth weight children are comparably impaired, the obtained dispersion is considered partially replicated.

Data in Table 12 are a further attempt to ascertain whether the mental impairment of low birth weight children is due to associated neurologic abnormalities shown in Tables 4 and 5. It can be noted that of the 20 psychological measures used to assess prematures' development, 16 were significant and 1 was nearly so, at .05 level of confidence (see Column 1 of Table 12). When the effect of neurologic scale scores were removed by analysis of covariance, the significance of the difference was reduced for each of the variables measured, and only 6 of the 20 remained significant, (Column 2 of Table 6). If the unreliability of the neurologic data was decreased, it would strengthen the conclusion that low birth weight leads to impaired performance in a wide variety of psychological measures only to the extent that a neurologic disturbance is present.

In summary, low birth weight is associated with impaired mental development in 8-10 year olds. This is in accordance with earlier findings from this study. The impairment is not secondary to correlated socio-economic factors or to the quality of "mothering". Such factors were controlled by the original design of the study and by the statistical techniques of analysis of covariance. Further data, previously noted, provide evidence that mental impairment is not secondary to behavioral disturbances such as impulsivity, frequently shown by brain damaged children. The data again suggest that the noted mental impairment is associated with an index of neurologic defect. Data presented here do not suggest specific psychologic diagnostic clues for clinical prediction of low birth weight and associated minimal brain damage. "Catching up" has not occurred, if one is to judge this by standard tests of intelligence. This does not deny that some children do compensate, whereas, others show increasing mental impairment. Rather, low birth weight children as a group do not appear to have caught up to full term children.

An earlier report from this longitudinal study indicated that the Stanford Binet Intelligence Test score was not as significant a predictor of low birth weight at age 6-8, as was the Bender Gestalt test or other psychological measures. However, the F ratios in Table 9 suggest that the WISC scores are a better predictor of the psychological status of birth weight groups at age 8-10, than is the Bender Gestalt at this age. Such seemingly discrepant findings may be due to the fact that the Stanford Binet and WISC are notably different tests, and demand different types of mental activity.

It was again found that children of the lower classes, or of the Negro race, are not relatively more impaired as a function of low birth weight. The effects of birth weight appear uniform in each social class group and in each race. (There is no evidence of a statistical interaction between low birth weight and social class or race).

Some clinical workers have suggested that brain damage can be diagnosed in part by "scatter" or by inconsistent performances. It follows that low birth weight groups should show more scatter on test scores than controls, since they have a greater risk of brain injury. In order to test this hypothesis, the variability of each child's scores on the 10 Wechsler subtests was estimated by computing a standard deviation; birth weight groups did not differ significantly with regard to this measure of variability. "Scatter" in itself is not a meaningful diagnostic device with respect to the minimal defect with which this report is concerned, and with regard to the age and measures used. A possible explanation of this finding is that those processes affected by minimal brain damage may be noted in any of the WISC subtests.

Data in Table 12 suggest, perhaps surprisingly, that reading and spelling achievement scores at best only slightly discriminate birth weight groups, whereas, many other measures (including arithmetic) are better. School achievement data were obtained from third and fourth grade children and from 12-13 year olds, and yielded somewhat similar findings.

The final section of this report is concerned with the last follow-up of this survey; the scholastic achievement of low birth weight children when age 12-13. Before these data are reported, it will be worthwhile to review findings regarding scholastic achievement obtained from the Baltimore City Public School System when children were age 9, and should have been in the fourth grade. [1] They are based on 582 children. Table 13 shows the average highest grade reached by birth weight, race and sex.

The ability to reach an appropriate grade level (a gross, but meaningful variable) varies significantly with birth weight. Another way of demonstrating this is to note that 45% of the smaller prematures, 57% of the larger prematures, and 72% of the children weighing more than 2501 grams at birth were in their age-appropriate grade when data were obtained.

Other data from the Baltimore City public shcool system confirm the IQ differences obtained from the office examinations. This is true for the Primary Mental Abilities Test administered during the first grade, and for the Kuhlman Anderson Test administered during the second grade. Descriptive data regarding these scores are shown in Tables 14 and 15.

Other data were obtained concerning reading and arithmetic achievement, as measured by the Metropolitan Achievement Test given in the third grade. It may be important to observe that 64 of 282 (23%) controls did

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1. These data were cited in a progress report previously submitted to the Children's Bureau as part of a request for the grant for which this summary has been prepared.

not have this data available, compared to 115 of 300 (38%) prematures. This, in itself, probably constitutes an index of premature children's impairment. Therefore, achievement data are available for those who were presumably relatively superior, i.e., were promoted to the third grade and were able to undertake the group-administered achievement tests. Such data indicate that prematures are not different from controls regarding reading ($F = 1.10$, 1 & 392 df), but are impaired on the arithmetic test ($F = 8.52$, 1 & 382 df, $p < .01$).

The interpretation of such data is not clear, but contrary to theoretical expectations, both school tests and office examinations given at age 8-10 (see Table 9) imply that arithmetic reasoning is a more sensitive discriminator of likely minimal brain damage than is a test of reading. Such an interpretation is tentative and is limited by the age of Ss examined, the nature of the tests used, and the fact that school data were not available for the more impaired children.

In summary, Baltimore City public school data and office examinations made at age 8-10 are in agreement regarding two major aspects of children's development:

1. Low birth weight is associated with relative impairment on a variety of tests purporting to measure intelligence.
2. Reading skills of low birth weight children may not be impaired at this age; arithmetic skills are.

Since the two sources of data are independent, and since both reports are blind as regards knowledge of children's histories,[1] the replication is of particular interest.

Data for the final (5th) round of this survey were collected in the spring of 1965.[2] These data concern the status of each of the studies' children when they were between 12 and 13 years of age. Table 16 provides information about the status of each of the original 992 cases, 848 (85%) of whom were available for statistical analysis. These 848 cases were in non-special community schools in Baltimore City, surrounding suburban counties, and in the Baltimore Diocese Catholic school system. Thus, the study will be concerned with those children who are not severely impaired, so as to require a special scholastic placement. These "special" schools (blind, severely retarded, physically impaired) had enrolled 26 of the premature and 4 of the control <u>Ss</u>. In effect, school placement information was available for 878 of the original 992 cases, but, as noted, 30 of these will be omitted from the analysis to be discussed below.

Earlier, it was noted that children were significantly impaired in their grade placement when age 9. This was shown in Table 13. The current follow-up indicates that relative grade retardation exists at age 12-13. For

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1. It is extremely unlikely that a teacher or group test administrator is aware of <u>Ss</u>' birth weight.

2. Wiener, Gerald. Scholastic Achievement at Age 12-13 of Prematurely Born Infants, <u>The Journal of Special Education</u>, Vol. 2, No. 3, Spring 1968.

both white and Negro children, relatively more prematures are in the 4th and 5th grades, or are in special education classes. Such data are presented in Table 17.

Along with grade placement, information was available for each of the children regarding relevant aspects of scholastic achievement. This consisted, primarily, of the most recent reading, arithmetic, and intelligence tests [1] listed in the school's records. Unfortunately, data for each of these items was not consistent. Each school system provides its particular grade scheduling of examinations and uses different group tests of intelligence and achievement. It may be assumed that the correlation between different types of group administered achievement tests is high. This assumption is reasonable in that the correlations (see Table 18) between reading, arithmetic and IQ is quite high, by psychological standards. Therefore, the correlation between two different types of group reading achievement tests should be equally high or higher. Assessment of achievement scores is difficult, because tests were given at different ages and grades in accordance with the school's policies, and in accordance with whether or not the child was referred for special testing because of intellectual impairment.

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1. School records at age 12-13 confirm many earlier findings that low birth weight children remain intellectually impaired. Therefore, this will not now be discussed.

This problem is avoided in IQ comparisons, in that each child's raw test score is considered to be a function of his age; and the score given him rules out the effects of age, by dividing the score by his age, or by resorting to use of standard scores based on the normal curve.

A similar device was used here to evaluate reading and arithmetic achievement scores. Each child's score was divided by the age he was when the test was given him. It is obvious that a child reading at the 3rd grade level, who is 12 years of age, is more impaired than a child reading at the 3rd grade level and was given this test when eight years of age. This impairment will be reflected by a lower score. However, this attempt to equate data is not fool proof, in that a 4th grade reading level impairment at age 13 does not provide the same ratio as a 3rd grade reading impairment at age 12 ($\frac{4}{13} \neq \frac{3}{12}$).

An additional research method to equate achievement scores would be by dividing the child's score by the grade placement at the time of test administration. In part, the distribution of these scores would resemble intelligence quotients. A child reading at the 6.5 grade level, and who is, in fact, given the test in January of his 6th year in school would obtain a reading "quotient" of 100. It is readily observed that a child who is reading below his current grade placement would obtain a low score, whereas, a child reading above his grade placement would obtain a high score. This method also has limitations, in that a 9 year old child in the 4th grade, reading at the 4th grade level obtains the same score as a 13 year old child who is in the 4th grade and reading at this grade level.

As a means of controlling for achievement, as a function of birth weight, the neurology score of Tables 4 and 5 will be used, as well as race and two estimates of social class status. The first estimate of social class consists of census tract data. This is available from the initial round of study. However, a later estimate of socio-economic status, as is indexed by residence, was obtained at age 6 to 8, the third round of this survey. The relationship of this variable with other relevant variables appears in the correlation matrix shown in Table 18. The second estimate of social class was established by a variable obtained by social workers during the 6-8 year survey, and the 8-10 year evaluation. Each of these variables fulfilled two criteria: They were highly reliable, and they correlated significantly with intelligence test scores.

These variables were:

1. Presence of a father in the home.
2. Home ownership.
3. Source of the family's income.
4. Condition of furnishings.
5. Condition of exterior of building.
6. Amount of income.
7. Number of persons per room in each dwelling unit.
8. Prestige of the job of the major wage earner.
9. Families' residence in house or apartment.

The scale was constructed in such a way that a high score would be indicative of higher social class status.

Data in Table 18 represents a correlation matrix of these variables. The sign of each of the significant correlations is "logical", and can be ignored. It can be seen that Ss' sex is not significantly correlated with any of the achievement measures and will not be considered further. It might also be observed that the correlation between census tract estimates of social class and the estimates obtained by social workers is very significant (.53, $p < .001$). However, the estimates based on social class status as a function of nine separate variables has consistently higher correlations with each of the four indices of achievement. For this reason, it was used to control for the effect of birth weight. Each of these four measures of achievement are significantly correlated to birth weight (Table 18), using the univariate Pearsonian r, and to the neurology score. The question arises now as to whether these relationships would maintain themselves when social class is controlled. It will also be critical to observe whether birth weight affects reading and arithmetic achievement, apart from an estimate of neurological status obtained during infancy.

In Table 19, mean scores are presented for each of the four measures of scholastic achievement, the neurologic score, the social class score, and pooled estimates of standard deviations. These scores are shown by race and three birth weight groups. Note that race and school system are "confounded". Negroes, with but few exceptions, are to be found in the Baltimore City public schools. Most white children are in suburban or parochial schools. However, since this study is not concerned with racial differences, this fact is not important, since within each racial group, birth weight is studied separately for each race. The mean scores of Table 19 and their F ratios shown in Table 20 indicate that each of the four measures of scholastic achievement are positively associated with birth weight. Variation in social class scores is not consistent, nor was it a statistically significant variable. As has previously been demonstrated, the neurologic score significantly varies with birth weight groups.

In Table 20 it will be noted that when social class and neurological scores are not controlled through an analysis of covariance, each of the four measures of achievement are significant ($p < .001$). However, when social class and neurological scores are covaried, the F ratios become smaller, but remain statistically significant. This finding differs from earlier reports when Ss were younger. Previously, it had consistently been found that low birth weight is a predictor of later development only when it is associated with an index of neurologic deficit. Currently, low birth weight, as such, appears to be a predictor of achievement, particularly arithmetic achievement, whether or not the low birth weight child possesses the neurological score shown in Table 4. Although this finding is different from previously reported, theoretical considerations imply that this finding ought be expected. Psychologists commonly accept that developmental measures (usually based upon neurologic indicators) made upon infants have a decreasing correlation with intellectual behavior as children grow older. In fact, this correlation approximates zero during late adolescence. Apparently, the skills measured in reading and arithmetic are based on a neurological substratum, but this is not adequately measured by the devices available when Ss are 40 weeks of age.

The data in Table 20, however, confirms a result found consistently earlier in this survey. The effect of birth weight (and whatever neurologic deficit this implies) apparently is greater for arithmetic achievement than for reading achievement. Although this result is not demonstrated statistically, note (Table 20) how the F ratios are larger for arithmetic scores than for reading scores.

Data in Table 21 contains a stepwise regression analysis regarding the predictability of reading achievement. Partial correlation coefficients (r_p) and multiple regression coefficients (R) are provided for three regression analyses as shown in Table 21. The purpose of a regression analysis is twofold: (1)To obtain an estimate of the overall predictability of achievement, as is provided by R. (2)To note the correlation between birth weight and the achievement when the environmental variables such as social class and race are controlled, and when the variance due to presumptive neurologic impairment is also partialled out. This is shown by r_p coefficients. The data in Table 21 confirms the analysis of variance with covariance shown in Table 20. Birth weight is a significant correlate of reading achievement at age 13. Removing the effect of the index of neurologic deficit reduces this effect, but it nevertheless remains significant.

In Table 22, an analysis of arithmetic achievement parallel to that of Table 21, is demonstrated and results are remarkably similar. Birth weight has an r_p of .12 ($p < .001$) when effects of social class, race and the neurological score is partialled out. [1]

The right hand column in Tables 21 and 22 show the relative efficiency of each of the four variables in predicting scholastic achievement. Consistently, social

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1. It is recognized that all correlational methods produce results which are dependent upon a continous normally distributed variable. In these analyses, race has scores only of 0 and 1, and the neurologic score is skewed such that most children have lower scores (are less likely to suffer from neurologic deficit). Therefore, results reported here suffer from unavoidable statistical distortions, but many mathematical statisticians believe these distortions are not great.

class, race, birth weight, and neurological score have meaningful independent prediction values (r_p) in the order listed. The overall predictability (R) of reading and arithmetic achievement is .49 and .54, respectively.

A summary of this final round of this survey might be made with the following points:

1. Birth weight is significantly related to reading and arithmetic achievement when social class and race are controlled by analysis of variance and covariance, or by partial correlation techniques.
2. Birth weight remains a significant correlate when an attempt is made to control for neurological status as estimated when age 40 weeks, and from perinatal history materials.
3. The previously listed finding is in contradiction with earlier reports from the study, but perhaps this should be expected. The correlation between indices of mental development in infants and late adolescent intellectual behavior approaches zero.
4. Findings from these data are consistent with earlier findings from other sources of information: Arithmetic is apparently more sensitive as an indicator of impairment due to birth weight than is reading.
5. None of the statistical interactions between race, social olass, birth weight, and

achievement [1] were significant. This is consistent with previously reported findings.

Although the correlation between birth weight and scholastic achievement is not huge, it nevertheless is a statistically important factor. Within our population of children who are of a relatively low IQ (90), there is a proportion whose educational defects is associated with birth weight, rather than with environmental variables such as social class and race. The epidemiology of low birth weight is of particular importance. In 1960, for example, approximately 15.9% of all Negro neonates in Baltimore weighed less than 2500 grams at birth, compared to 8.6% of white children. The question is raised, then, how much of the variation in scholastic performance correlated with racial or social class differences is due to presumably preventable constitutional factors, as well as the factors commonly assumed to be due to "cultural deprivation."

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1. Data for this are not presented.

TABLE 1

Weight Distribution, by Race, of Premature and Full-Term Control Infants

Weight Group (grams)	White %	Nonwhite %	Total %
1000 or less	0.9	0.5	0.7
1001-1500	3.2	6.5	5.0
1501-2000	6.7	9.9	8.5
2001-2500	37.9	34.8	36.2
Subtotal for premature infants	48.7	51.7	50.4
2501 or more (control)	51.3	48.3	49.6
Total	100.0	100.0	100.0

Note:--The non-white population was Negro, with the exception of one Japanese and one American Indian child. Later tables refer to the non-white group as "Negro".

TABLE 2

Intellectual Potential at Forty Weeks of Age of Premature and Full-Term Control Infants

Weight Group (grams)	No.	% in Each Diagnostic Category								Total
		Superior	High Average	Average	Low Average	Dull-Normal	Borderline Defective	Defective	Defect Type Unclassified	
1500 or less	57	---	5.3	57.8	14.0	5.3	5.3	8.8	3.5	100.0
1501-2500	443	1.8	14.5	69.7	9.5	2.7	0.5	1.1	0.2	100.0
Subtotal for premature infants, adjusted for weight distribution		1.7	14.0	69.1	9.7	2.8	0.7	1.5	0.4	99.9
2501 or more (controls)	492	6.3	15.5	67.5	8.1	1.0	0.4	1.0	0.2	100.0
Total	992	3.9	14.4	68.0	9.1	2.0	0.7	1.5	0.4	100.0

Note:--Intellectual potential was estimated from Gesell test data.

TABLE 3

Neurological Status at Forty Weeks of Age of Premature and Full-Term Control Infants

Weight Group (grams)	No.	% in Each Diagnostic Category					
		Normal	Indeterminate	Minimal Damage	Possible Cerebral Palsy	Overt Neurological Defect	Total
1500 or less	57	29.9	21.0	22.8	14.0	12.3	100.0
1501-2500	443	63.6	13.1	16.0	5.6	1.6	99.9
Subtotal for premature infants, adjusted for weight distribution		62.0	13.5	16.3	6.1	2.1	100.0
2501 or more (controls)	492	78.0	10.4	10.0	1.0	0.6	100.0
Total	992	68.9	12.2	13.4	3.8	1.7	100.0

Note:--Neurological status was based on a diagnostic impression made as a result of a standard pediatric neurological evaluation.

TABLE 4

Incidence of Perinatal and Neurologic Abnormalities by Birth Weight

Variable	Birth Weight (grams) < 2000 No.	%	2000-2500 No.	%	> 2500 No.	%	x^2 (4 df)	p
Total number of subjects	115		302		405			
Maternal Disorders and Perinatal Pathology								
1. Clinical correlates (hypertensive disorders, pre-eclampsia, eclampsia)	29	25.2	35	11.6	65	16.1	24.9	$<.001$
2. Lues in mother	13	11.3	10	3.31	25	6.2	8.2	$<.10$
3. Bleeding during pregnancy	36	31.3	40	13.3	55	13.6	22.3	$<.001$
4. Possible mechanical trauma as indicated by mid or high forceps, breech delivery, caesarean section	35	30.4	60	19.9	68	16.8	10.9	$<.05$
5. Oxygen deprivation as indicated by cyanosis or gasping	21	18.3	13	4.3	4	1.0	73.6	$<.001$
6. Abnormal muscle tone (hyper or hypotonic)	14	12.2	10	3.3	4	1.0	42.4	$<.001$
7. Illnesses such as erythroblastosis and severe diarrhea (excluding jaundice)	27	23.5	14	4.6	12	3.0	68.0	$<.001$
8. Jaundice	50	43.5	103	34.1	106	26.2	14.0	$<.01$
9. Convulsive Disorders	17	14.8	29	9.6	45	11.1	3.2	n.s.

(cont'd.)

TABLE 4 (cont'd.)

Neurologic Abnormailities Noted During the 40 Week Examination								
10. Head (e.g., tilting, sagging)	7	6.1	8	2.7	2	.5	15.0	< .005
11. Arms and hands (adduction, abduction)	96	33.5	226	74.8	235	58.0	41.2	< .001
12. Strabismus	18	15.7	27	8.9	19	4.7	17.4	< .005
13. Other eye disorders	4	3.5	3	1.0	0	0	12.5	< .025
14. Legs and feet (scissoring, withdrawal in standing)	53	46.1	110	36.4	110	27.2	19.0	< .001
15. Postural Disturbances (abnormal t-n-r, rounded back in sitting)	20	17.4	32	10.6	30	7.4	10.3	< .05
16. Abnormal locomotion (dragging leg in crawling)	13	11.3	28	9.3	32	7.9	5.7	n.s.
17. Abnormal muscle tone (tremor, rigidity)	25	21.7	34	11.3	26	6.4	22.2	< .001
18. Substitutive patterns	12	20.4	50	16.6	41	10.1	8.5	< .10
19. Reflex disturbance (usual clinical scoring)	59	51.3	139	46.0	119	29.4	28.9	< .001

Note:--X^2 tests were made separately for Negro and white subjects. X^2 scores were then added along with degrees of freedom. N = 822. This represents the number of cases who were evaluated during the 4th round of this survey, when Ss were 8-10. Maternal disorders and perinatal pathology are based on a note by either doctor or nurse, or on a laboratory report in hospital record concerning infant or mother. All neurological examinations at 40 weeks of age were done by one examiner, Dr. Hilda Knobloch, now Professor of Pediatrics, University of Ohio.

TABLE 5

Mean Number of Perinatal and Neurologic Abnormalities (Noted in Table 4) by Race and Birth Weight

	>2500 grams		2000-2500 grams		<2000 grams	
	Mean	No. of Ss	Mean	No. of Ss	Mean	No. of Ss
White	3.32	167	4.69	125	6.59	32
Negro	3.33	238	4.40	177	6.92	83

Note:-- N = 822 cases evaluated at age 9-10. F (for birth weight) = 55.72, 2 & 816 df, $p < .001$. Pooled standard deviation is 3.19. F ratio between racial groups is not significant.

TABLE 6

Neurological Status by Birth Weight at 3 to 5 Years

Weight Group (grams)	No. (1)	% in Each Diagnostic Category Normal (2)	Question-able Signs of Minimal Damage (3)	Signs of Minimal Damage (4)	Overt Abnor-mality (5)	Unknown (6)	Total (7)
1500 or less	54	51.9	24.1	7.4	13.0	3.7	100.1
1501 - 2000	76	72.4	18.4	5.3	0	3.9	100.1
2001 - 2500	330	81.8	11 5	1.5	1.2	3.9	99.9
Subtotal for premature infants, adjusted for weight distribution		78.6	13.4	2.5	1.6	3.9	100.0
2501 or more (controls)	440	87.3	7.5	1.6	0.7	3.0	100.1
Total	900						

TABLE 7

Mean Scores on Measures of Psychological Development at Age 6-7 and Associated Variables by Birth Weight, Race, and Sex

	Birth Weight (gm)												Pooled Standard Deviation
	>2,500				2,000-2,500				<2,000				
	White		Negro		White		Negro		White		Negro		
	M	F	M	F	M	F	M	F	M	F	M	F	
Number	85	84	114	116	54	67	69	98	10	20	35	42	(782 df)
Associated variables													
Index of neurological damage	3.78	3.43	4.85	5.08	5.26	4.15	6.00	5.55	6.80	6.50	8.60	7.31	2.73
Maternal attitudes	6.38	6.46	7.96	7.91	7.04	6.85	8.25	8.22	7.50	6.80	7.80	8.10	3.40
Social Class	20.18	20.52	29.17	28.86	21.65	21.33	29.12	29.66	22.10	23.05	28.62	28.43	5.56
Psychological variables													
IQ	102.55	100.81	90.08	91.92	100.87	99.40	90.65	88.42	100.80	96.85	85.89	88.45	11.36
Motor Development	1.49	1.55	1.32	1.51	1.26	1.52	1.29	1.26	.90	1.65	.94	1.05	.96
Draw-A-Person	2.73	3.24	2.63	3.15	2.43	3.24	2.49	2.98	2.60	3.10	2.49	2.93	1.14

(continued)

TABLE 7 (continued)

Bender Gestalt	4.14	4.15	5.25	4.88	5.09	4.37	5.91	5.22	6.00	4.85	5.97	5.90	1.77
Speech Maturity	.36	.24	.47	.27	.43	.25	.62	.36	.70	.40	.60	.36	.59
"Thinking Mode"	.09	.11	.39	.17	.20	0.7	.33	.37	.30	.10	.80	.52	.52

Note:--Total N = 794. For the index of neurological damage, maternal attitudes, and social class scales, higher scores indicate deleterious situations. High scores on the IQ, Motor Development, and Draw-A-Person tests are indicative of favorable mental development. High scores on the Bender Gestalt test and scales of speech maturity and "Thinking Mode" indicate a greater degree of mental impairment.

TABLE 8

Correlates of Birth Weight: Analysis of Variance and Covariance of Mean Scores Presented in Table 7

Variables Examined for Differences Among Three Birth Weight Groups	Analysis of Variance		Analysis of Covariance of Variables 1,2,& 3	
	F Ratio 2 & 782 df	p	F Ratio 2 & 779 df	p
1. Index of neurological damage	51.35	<.001	--	--
2. Maternal attitudes	1.11	n.s.	--	--
3. Social class	2.10	n.s.	--	--
4. I.Q.	4.77	<.01	.95	n.s.
5. Motor development	5.56	<.01	1.34	n.s.
6. Draw-A-Person	1.84	n.s.	.55	n.s.
7. Bender Gestalt	15.42	<.001	7.07	<.01
8. Speech maturity	3.05	<.05	.88	n.s.
9. "Thinking Mode"	12.28	<.001	4.95	<.01

Note:--None of the F ratios for the interaction of birth weight with race or sex (or both) were significant at the .05 level for any of the variables, before or after covariance. As expected, significant sex and race differences appeared, but these are beyond the scope of this report.

TABLE 9

Psychological Test Scores by Birth Weight and Race at 8 - 10 Years

	Birth Weight (grams)						F for Birth Weight (2 & 800 df)	Pooled Standard Deviation
	<2000		2000-2500		>2500			
	White	Negro	White	Negro	White	Negro		
WISC Mean Score								
Verbal I.Q.	95.9	83.7	97.8	85.9	102.0	89.6	17.70	13.14
Performance I.Q.	92.3	85.5	100.8	87.9	106.0	92.3	19.54	14.68
Full Scale I.Q.	96.9	83.1	99.3	85.5	105.0	89.9	22.94	13.65
Bender Gestalt Mean Score	14.4	19.3	14.1	17.6	11.9	17.0	16.21	5.23
Total Cases	32	83	125	177	167	238		
WISC Full Scale I.Q. 50-79								
Number of cases	4	32	12	61	8	46		
Percent of total	12.5	38.6	9.5	34.5	4.8	19.3		
Mean Corrected Age	8.9	8.8	8.8	8.8	8.8	8.8	1.00	.39

Note:--All F values shown for psychological measures are significant ($p < .001$). Mean age is not significantly different. Higher scores indicate a greater degree of impairment for the Bender Gestalt test.

TABLE 10

Number and Percentage of Cases by Sextiles of Psychological Efficiency and Birth Weight Using a Weighted Combination of Three Psychological Test Scores at 8 - 10 Years

Composite Psychological Efficiency Sextile	White				Negro				Total			
	<2501 g		>2500 g		<2501 g		>2500 g		<2501 g		>2500 g	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1st (high)	13	8.3	41	24.6	37	14.2	46	19.3	50	12.0	87	21.5
2nd	27	17.2	27	16.2	35	13.5	48	20.2	62	14.9	75	18.5
3rd	25	15.9	29	17.4	38	14.6	45	18.9	63	15.1	74	18.3
4th	31	19.7	23	13.8	44	16.9	39	16.4	75	18.0	62	15.3
5th	25	15.9	29	17.4	48	18.5	35	14.7	73	17.5	64	15.8
6th (low)	36	22.9	18	10.8	58	22.3	25	10.5	94	22.5	43	10.6
Total	157	99.9	167	100.2	260	100.0	238	100.0	417	100.0	405	100.0

Note.--The WISC Verbal and Performance I.Q. and the Bender Gestalt constituted the three variables combined to form a single index. The significance of the separation between birth weight groups may be expressed as follows:

1. White Ss - $X^2 = 16.40$, 1 df, $p < .001$.
2. Negro Ss - $X^2 = 20.70$, 1 df, $p < .001$.
3. Both groups - $X^2 = 37.10$, 2 df, $p < .001$.

TABLE 11

Intelligence Test Scores at Ages 6-7 and 8-10 by Birth Weight

	Birth Weight Groups (grams)						
	Low Birth Weight			All Subjects			
Examination	<1500	1500-1999	2000-2500	<2501	>2500	Difference	F (3 & 810df)
WISC, Age 8-10	84.7	88.5	90.8	89.8	94.7	4.9	10.84
Number	41	74	302	417	405		(p <.001)
Stanford-Binet, Form L, Age 6-7	88.9	90.6	93.0	92.2	95.6	3.4	7.77
Number	44	68	301	413	409		(p <.001)

Note:--This analysis controlled for three levels of social class as determined by an index consisting of parental education, income, housing, and employment. F ratios for the interaction of three levels of social class with four levels of birth weight were 1.34 and .60 (6 and 810 df) for the Stanford-Binet and WISC, respectively. These are not significant.

TABLE 12

F Ratios for Twenty Psychological Measures Comparing the Three Birth Weight Groups Shown in Table 5 at Age 8 - 10

Psychological Measure	F Ratio Controlling for Social Class and Maternal Attitudes (2 & 808 df)	F Ratio Controlling for "Neurologic" Scale, Social Class, Maternal Attitudes (2 & 807 df)
WISC Subtests		
1. Information	6.36	3.40
2. Comprehension	4.56	1.27
3. Arithmetic	5.86	4.83
4. Similarities	3.64	.63
5. Digit Span	4.11	1.11
6. Vocabulary	4.74	3.55
7. Picture Completion	3.65	2.20
8. Block Design	5.57	2.16
9. Object Assembly	6.93	1.90
10. Digit Symbol	5.97	2.24
Observations		
1. Comprehension Difficulty	7.33	4.82
2. Perseveration Trends	.94	1.16
3. Concrete Thinking	6.66	2.29
4. Speech Distortions	4.05	3.87
5. Speech Substitutions	3.12	1.83
6. Speech Omissions	4.35	3.87
7. Sentence Structure: complexity	1.65	1.56
8. Tenses: complexity	.61	.38
WRAT Achievement Test		
1. Reading	3.46	2.11
2. Spelling	2.98	2.01

Note:--N = 822. Design of factorial analysis controlled for Race and Sex. For 2 and 800 df, F ratios of 3.00 and 4.62 are significant at the .05 and .01 level of confidence.

TABLE 13

Baltimore City Public School Data: Average Highest Grade Obtained at Age 9 by Birth Weight, Race and Sex

	Birth Weight (grams)					
	> 2500		2000-2500		< 2000	
	Male	Female	Male	Female	Male	Female
White	3.71	3.71	3.50	3.67	3.13	3.12
No. Ss	35	38	32	31	6	8
Negro	3.58	3.73	3.40	3.53	3.12	3.54
No. Ss	110	99	65	88	31	39

Note:--F = 10.60, 2 and 567 df, $p < .001$. F ratio is independent of Ss' race, sex according to the design of the analysis. Number of changes of school, number of changes of home address, and the number of days absent from school were covaried and do not affect the F ratio.

TABLE 14

Baltimore City Public School Data: First Grade IQ's (Primary Mental Abilities Test) by Birth Weight

Birth Weight (grams)	Total Number	"IQ" under 70	
		No.	%
< 2000	84	30	43
2000-2500	216	48	28
> 2500	282	33	13
Total: 582			

TABLE 15

Baltimore City Public School Data: Second Grade IQ's (Kuhlman-Anderson Test) by Birth Weight

Birth Weight (grams)	Total Number	"IQ" under 90	
		No.	%
< 2000	84	28	37
2000-2500	216	62	30
> 2500	282	61	22
Total: 582			

TABLE 16

Status of Study of Premature Children in June, 1965

	White		Negro		
	Prematures	Controls	Prematures	Controls	Total
1.Baltimore City Public Schools	76	71	248	231	626
2.Baltimore Diocese Catholic Schools	45	65	5	7	122
3.Local Suburban and Private	44	52	1	3	100
4.Various "Special" Schools	12	0	14	4	30
5.Deceased	1	0	6	2	9
6.Data Unavailable, left area	27	26	12	19	84
7.Non-locatable, Refusals	7	9	2	3	21
Total original cases	212	223	288	269	992
Total of cases for whom data will be analyzed	165	188	254	241	848
% of original sample	78	84	87	89	85

Note:--Data were analyzed (as shown in later tables) for categories 1-3. Data in category 4 either were not collected or not analyzed. This category is indicative of severe impairment (blind, severe retardation, crippled).

TABLE 17

Grade Placement for Children in Community Schools
When Age 12-13

	White				Negro			
	Prematures		Controls		Prematures		Controls	
Grade Placement	No.	%	No.	%	No.	%	No.	%
4th, 5th grades (or special education)	32	19.4	18	9.6	91	35.8	54	22.4
6th grade	33	20.0	41	21.8	71	28.0	75	31.1
7th grade	100	60.6	129	68.6	92	36.2	112	46.4
Total	165	100.0	188	100.0	254	100.0	241	99.9

Note:--N = 848. $X^2 = 18.06$, 4 df, $p < .01$. (Computed for each race and pooled).

TABLE 18

Correlation Matrix of Variables Used to Analyze
School Achievement Data at Age 12-13

Variable	1	2	3	4	5	6	7	8	9	10	11
1. Grade	-										
2. Reading/Grade	-.12	-									
3. Reading/Age	-.14	.95									
4. Arithmetic/Grade	-.15	.74	.71	-							
5. Arithmetic/Age	-.18	.75	.84	.89	-						
6. I.Q. (School Record)	-.16	.78	.85	.67	.81	-					
7. Census Tract	-.14	.33	.31	.34	.32	.30	-				
8. Birth Weight	-.05	.14	.15	.19	.19	.14	.06	-			
9. Neurologic Score	.00	-.10	-.12	-.09	-.11	-.12	-.00	-.32	-		
10. Social Class	-.15	.44	.45	.47	.49	.44	.53	.11	-.04	-	
11. Race	.18	.42	.38	.48	-.42	-.40	-.48	-.12	.03	-.56	-
12. Sex	.04	.03	.06	-.01	.04	.05	-.05	-.13	-.06	-.03	.02

Note:--N = 848, σ_r = .034. In this and subsequent tables, neurologic score is that described by Tables 4 and 5. Social class data were those obtained when Ss were 8-10. Census tract data were obtained during the 6-8 year analysis.

TABLE 19

Scholastic Achievement, Neurological Status and Social Class by Race and Birth Weight at Age 12-13

	White			Negro			Pooled Standard Deviation
Birth Weight (grams)	<2000	2000-2500	>2500	<2000	2000-2500	>2500	
Reading/Grade	91.0	98.9	102.3	73.0	73.2	78.6	25.9
Reading/Age	48.3	53.0	55.3	36.8	37.0	41.7	17.4
Arithmetic/Grade	93.5	99.2	104.0	76.5	78.7	83.0	18.8
Arithmetic/Age	49.4	52.5	56.0	38.4	39.5	43.4	13.5
Neurologic Score	3.3	4.6	6.2	3.3	4.4	6.8	3.1
Social Class Score	6.9	6.6	6.6	4.1	3.7	4.2	2.1
No. Ss	34	131	188	77	177	241	

TABLE 20

Effect of Birth Weight: Analysis of Variance and Covariance of Mean Scores Shown in Table 18

	No Covariance		Social Class Covariance		Neurological Score Covariance	
	F (2 & 842 df)	P	F (2 & 841 df)	P	F (2 & 841 df)	P
Reading/Grade	8.24	<.001	6.08	<.01	5.01	<.01
Reading/Age	9.42	<.001	6.80	<.01	5.63	<.01
Arithmetic/Grade	15.60	<.001	12.76	<.001	11.91	<.001
Arithmetic/Age	15.62	<.001	12.22	<.001	11.92	<.001

Note:--F ratios between races on each of the achievement measures were highly significant. None of the F ratios referring to the interaction between race and birth weight were significant.

TABLE 21

Stepwise Regression Analysis: Prediction of Reading Achievement (Reading/Age)

Variable Included	r_p	Variable Included	r_p	Variable Included	r_p
Social Class	.31	Social Class	.30	Social Class	.30
Race	-.17	Race	-.17	Race	-.17
		Birth Weight	.10	Birth Weight	-.08
				Neurological Score	.07
R = .47, F = 122.1, 2 & 845 df		R = .48, F = 85.0, 3 & 844 df		R = .49, F = 65.6, 4 & 843 df	

Note:--N = 848. σ_{r_p} = .034. It is estimated that r_p values of .07, .09, and .11 are significant at the .05, .01, and .001 levels, respectively.

TABLE 22

Stepwise Regression Analysis: Prediction of Arithmetic Achievement (Arithmetic/Age)

Variable Included	r_p	Variable Included	r_p	Variable Included	r_p
Social Class	.34	Social Class	.33	Social Class	.33
Race	-.20	Race	-.20	Race	-.20
		Birth Weight	.15	Birth Weight	.12
				Neurological Score	.07
R = .52, F = 156.3, 2 & 845 df		R = .53, F = 112.5, 3 & 844 df		R = .54, F = 85.60, 4 & 843 df	

Note:--Data regarding interpretation of above regression analysis appear in note at bottom of Table 21.

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