INDIVIDUAL DEVELOPMENT AND ADJUSTMENT

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REPORT NO 66, 1986

PRENATAL AND PERINATAL FACTORS IN PSYCHOLOGICAL DEVELOPMENT A LITERATURE REVIEW

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A literature review

Report No 66 December 1986

ISSN 0281-8108

FOREWORD

This literature review was prepared within the longitudinal project 'Individual Development and Adjustment' at the Department of Psychology, the University of Stockholm. It was supported from funds from The Swedish Council for Social Research. It is a multiscience research program which started in 1965. The aim of the project is to study individual development as a process; how psychological and biological factors within the individual, and sociological and physical factors in the environment operate in the course of development.

This literature review, presented here by Monica Lagerström, will outline and summarize some results from longitudinal studies concerning prenatal and perinatal factors in psychological development.

We are grateful for the advices from professor Peter Eneroth, Karolinska Institutet, Stockholm, and docent Katarina Bremme, Karolinska Sjukhuset, Stockholm. The literature search has been performed in Medline.

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ABSTRACT

Lagerström, M. Prenatal and perinatal factors in psychological development. A literature review. Reports from the research program Individual Development and Adjustment, the Department of Psychology, the University of Stockholm, 1986, No. 66. - This literature review will attempt to outline and summarize some of the results of longitudinal studies concerning the relationship between, on the one hand, the pregnancy, delivery, prenatal period and, on the other hand, the development of the child. Here two different aspects of the development of the child will be discussed: behavioral disorders, specifically attention deficit disorders with or without hyperactivity and; cognitive development, specifically scholastic achievement and intelligence with the children subgrouped into those born pre-term, post-term, and full-term. Two main findings have emerged from this discussion of literature on prenatal and perinatal factors in development. The first is that the presence of prenatal and perinatal difficulties was not more important for later development than the absence or presence of environmental support. All children, including those with prenatal and perinatal problem, have a good chance to develop normally if they have stable, supportive homes. The second main finding is that children with prenatal and perinatal difficulties were disadvantaged in terms of long-term development and did not seem to 'catch up' compared to full-term children without these problems. In these studies, the effect of the environment was also analyzed but was not found to be the most important factor, as was the case with reproductive causalities. This paper also has shown that there exist many methodological problems with measuring children's development. Because of the methodological differences, the results are not always easily comparable.

CONTENT

INTRODUCTION

Is the development of a child affected over the long-term by the conditions surrounding pregnancy, delivery and the perinatal period?

This review will attempt to outline and summarize some of the results of longitudinal studies concerning the relationship between, on the one hand, the pregnancy, delivery, prenatal, and perinatal period and, on the other hand, the development of the child.

The development of a child can be judged in many ways. In this review two different aspects of the development will be discussed: behavioral disorders, specifically attention deficit disorders with or without hyperactivity and; cognitive development, specifically scholastic achievement and intelligence with the children subgrouped into those born pre-term, post-term and full-term.

Behavioral disorders

Attention deficit disorder with hyperactivity. In the Diagnostic and Statistical Manual of Mental Disorders (DSM.III, 1980) the disorders of infancy and childhood include five major groups. One of the major groups is 'behavioral disorders' with the subgroups 'attention deficit disorder' and 'conduct disorder'. Attention deficit disorder appears with or without hyperactivity. The essential features of attention deficit disorder with hyperactivity are signs of abnormal attention spans, impulsivity and restlessness.

The concept of hyperactivity has been the issue of much debate. In som reports, hyperactivity is related to socio-economic factors. Hyperactive children are found to be overrepresented among the lower socio-economic classes (Sandberg, 1977). In other reports hyperactivity is related to biological factors (Wender, 1971). In a recent retrospective study, Hartsough and Lambert (1985) described a change concerning the symptoms of the hyperactive children: "Back in 1974-1975, when the children in this project were first identified 'hyperactive' the term was commonly used to describe children with disorders of attention, impulsivity, a high activity level, and concomitant educational, social and behavioral difficulties. With the publication of DSM-III in 1980, the conditions formerly characterized by the label 'hyperactive' became diagnosable under the designation 'attention deficit disorder' with two subtypes: with 'hyperactivity' and 'without hyperactivity'."

Hartsough and Lambert studied six sample of children from 40 schools in the San Francisco Bay area. Data was obtained from three social systems: the home, the school and in a medical setting. The hyperactive children were divided into three groups for purposes of study: (a) Primary hyperactives - diagnosed by parents, teachers and physician, with no competing medical diagnosis; (b) Secondary hyperactives - diagnosed by parents, teachers and physician, with a competing medical explanation of their symptoms, e.g., epilepsy and; (c) Other hyperactives - who had not seen a physician or were only diagnosed by parents and teachers as hyperactive and not by the physician.

The researchers examined 492 pupils: 301 were rated as hyperactive by parents, school personnel and/or physicians with 193 primary, 56 secondary and 52 other hyperactives. Two control-groups were used: one 'behavior equivalent' (46 children) and one random control (145 children). Parents were asked for information concerning (1) Prenatal or perinatal complications, (2) Attainment of development milestones (e.g., age of walking, talking), (3) Frequency of illness or accidents, (4) Current health and physical status.

When interpreting the results, it should be noted that the mothers were interviewed several years after the events about which they were questioned had occurred.

Hartsough and Lambert found that the following prenatal and perinatal stressors were significant discriminators between hyperactive and control groups:

1. maternal health during pregnancy
2. toxemia or eclampsia during pregnancy
3. maternal age at birth of index child
4. parity of child
5. fetal postmaturity
6. duration of labor
7. fetal distress during labor or birth
8. presence of congenital problems
9. health problems during infancy.

The mothers of the hyperactive children were more apt to report (8%) that their children were born at gestational age of "ten months or later" than control mothers (2%). Twenty-five percent of the mothers with hyperactive children reported a labor that exceeded 13 hours, while only 16 % of the control mothers did so. Those prenatal and perinatal variables with no significant difference between hyperactives and controls were previous miscarriages, RH-factor incompability, prematurity, abnormal delivery and low birth weight. The most surprising factor was perhaps that prematurity did not influence hyperactivity.

Particularly important as risk indicators were the presence of health problems in infancy: fetal postmaturity, poor maternal health during pregnancy, being first born, presence of toxemia or eclampsia in pregnancy, maternal youth and long labor. Here evidence suggested that *prenatal* factors rather than those occurring later in a child's medical history would be the most important antecedents of subsequent hyperactive status.

Hartsough and Lambert concluded that individual differences in the medical and psychological histories of the child as well as individual differences in family and school environments contribute to whether or not a child is hyperactive.

Pasamanick, Rogers, and Lilienfeld (1956) retrospectively studied 1151 children with behavior disorders and 902 controls matched for race, age and socio-economic background, all born in Baltimore after 1936. Unfortunately, there is no exact definition of the category 'behavior disorder' in the report. All the children had IQs over 79. Birth certificates gave information about prenatal and perinatal factors that made it possible to divide the children into three groups: (1) those who were exposed to one or more maternal complications; (2) those prematurely born without maternal complications; (3) neonatal abnormalities with no maternal complications or prematurity. It was found that significantly more children with disorders had been exposed to one or more of these three abnormal factors than their controls.

Concerning specific types of maternal complications, it appeared that nonmechanical difficulties such as toxemias and hypertensions of pregnancy are most highly associated with behavior disorder. These factors are more prone to produce fetal anoxia than the mechanical difficulties of delivery such as dystocia and serious surgical intervention. Hyperactive, confused and disorganized children had even more of these abnormalities in their background. Pasamanick et al. found that there exists a "continuum of reproductive causality" wherein the severity of birth complications is related to the severity of developmental disorders ranging from death to cerebral palsy, epilepsy, mental deficiency and behavior disorders.

In a longitudinal study of 95 hyperactive children, Minde, Webb, and Sykes (1968) examined birth records to relate prenatal and perinatal factors with hyperactivity. Hyperactivity was defined as a chronic, sustained and excessive level of activity that caused significant and continued complaint both at home and at school - i.e., it was defined in terms of socio-familial maladjustment. In an earlier report concerning the same subject, Werry, Weiss, and Douglas (1964) found that pregnancy disorders, such as bleeding, toxemia , high blood pressure during pregnancy, low birth weights, cerebral trauma, unconsciousness, and anoxia requiring active medical intervention, tended to occur more frequently for the hyperactives and their mothers ($p = .09$) than for controls.

Of the 95 subjects, only 56 birth records were available and birth records from 56 controls matched for sex, socio-economic status of the family at the time of the birth were used.

The variables which were measured were those possible to find in the records: background; history (age, illnesses etc), delivery (mode of prevention, duration, complications etc.) and infant characteristics (birth weight, infant diseases, resuscitation, etc.). The results for the two groups did *not* differ significantly with the exception of the fact that more hyperactive than normal children were born following an abnormally long labor which was further complicated by the use of forceps. The mothers of the hyperactive children tended to be younger than those of the controls. The most striking finding of the study was the great similarity in the incidence of severe prenatal and perinatal difficulties between the two groups.

Three factors must be noted when these results are interpreted. First, only 60% of the original sample of 95 children participated and no comparison was made between the drop-outs and those that remained subjects. Second, as noted by the authors, hospitals did not always have high standards of record keeping and information on several variables was therefore less than satisfactory. Third, the concept 'hyperactivity' was defined in the study but there was no information on the criteria used to choose the hyperactive children. Nevertheless, other researchers such as Frazer and Wilks (1959), Graham, Ernhart, Thurstone, and Croft (1962), have also failed to find any association between brain damage and hyperactivity.

Attention deficit disorder without hyperactivity. According to DSM-III, children with attention deficit disorder without hyperactivity can be diagnosed using inattention and impulsivity as criteria. Minimal brain damage and minimal brain dysfunction have been used as labels for this disorder in the past.

The diagnosis minimal brain damage was exchanged for minimal brain dysfunction in 1962 on the recommendation from the Oxford International Study Group on Child Neurology. This group of experts wanted to underscore that brain damage could not be diagnosed only from deviant conduct. By using 'dysfunction' of the central nervous system (CNS) the biological view was maintained while the origin was undefined (Sandberg, 1977).

The generally accepted definition of minimal brain dysfunction (MBD) given by Clements (1966) is as follows: "The diagnostic and descriptive categories included in the term, minimal brain dysfunction, refer to children of near-average or above-average general intelligence with learning or certain behavioral abnormalities, or both, ranging from mild to severe which are associated with subtle dysfunctioning of the central nervous system. These may be characterized by combinations of deficiencies in perception conceptualization, language, memory and control of attention, impulse or motor function. During the school years, a variety of special learning disabilities are the most predominant manifestation."

Herbert E. Rie (1980) in trying to find a definition to MDB quotes Clements (1966). Among the most troublesome aspects of the definition of minimal brain dysfunction is the relative vagueness with which the question of specificity of dysfunction is dealt. Reference is made to problems in "any of the areas of brain function", to "specific kinds of learning, thinking, and behavioral sequelae", and to the conviction that "these children are *different* in certain learning and behavioral pattern... . But it is not precisely clear in which ways they are different." (Clements,1966, pp 8-9)

Many different origins of MBD have been discussed; genetic, biochemical deviances, perinatal brain-injuries, different types of deprivations (food, human contact, etc.), low socio-economic class and/or familial-societal pathology (Sandberg, 1977). According to Lambert, Sandoval, and Sassone (1978) hyperactives are often characterized by low socio-economic class and alcoholism and sociopathia of the fathers.

Mark A. Stewart (1980) has reviewed studies of genetic perinatal and constitutional factors in MBD. He concluded:

1. There is a connection between hyperactivity in children and alcoholism, antisocial personality, and hysteria in their adult relatives.
2. Hyperactivity in childhood may predispose people to these psychiatric disorders in adult life.
3. Hyperactive children tend to have parents, uncles and aunts who were hyperactive themselves.
4. There is a direct evidence for genetic determinants of hyperactivity.

Kenny (1980) found an extensive body of literature dealing with the evaluation of MBD/hyperactive children, but found it difficult to sort out those papers which primarily focused on MBD from those that dealt with hyperactivity.

Prematurity can be a risk factor for MBD according to Wiener (1962), but Beskow (1949) found that the only premature children to become impaired were those who had associated obstetric complications. Douglas (1956) compared subjects with uncomplicated premature births with those born with toxemia, intracranial hemorrhage, delivery terminated by induction, etc. but did not find differences between these groups.

Several studies indicate that a large number of children with hyperactive/MBD do not have medical histories that would support the argument for physiological factors playing a role in behavioral impairment (Kenny, 1980). There is also evidence that the frequency of birth complications is no greater in the MBD group /'hyperactive children' than in the general population (Ross & Ross, 1976; Stewart & Olds, 1973). Gross and Wilson (1974), for example, analyzed over 1000 cases of diagnosed MBD children and found that obstetric complications were present in the great majority of these.

Some studies, on the other hand, indicate that brain injuries can accompany complications before or during delivery (Prechtl, 1960; Stewart, 1980) and that children with hyperactive diagnoses more frequently have prenatal or perinatal problems (Pasamanick & Knobloch, 1960).

Kaffman, Sivan-Sher and Carel (1981) made an extensive, retrospective study questioning the association between pregnancy and birth complications, on the one hand, and the subsequent appearance of MBD, on the other hand, using 70 children with MBD in a kibbutz. The control group consisted of 70 normal children from another kibbutz, matched for age and sex with the MBD group. The cases, 52 boys and 18 girls, had a mean age of 9.4 years, and were diagnosed as MBD by two of the authors. In diagnosing the following seven groups of symptoms including 50 symptoms (out of which a child had to have 38 to qualify for the MBD-group) were used:

1. hyperkinetic syndrome
2. motor and coordination problems
3. perceptual, cognitive and school difficulties
4. poor adjustment to new stimuli and social surroundings
5. emotional immaturity and reactive behavior problems
6. decreased capacity to experience and express pleasure
7. deviant early developmental history.

In a kibbutz, a number of environmental factors that may appear to be etiologically related to MBD in other social settings may be excluded. Economic, living and nutritional factors are controlled because the kibbutz offers support to all; there is equal and sufficient supply of food lodging, clothing, physical space, recreational outlets and medical care.

Physicians were interviewed for their medical records on the mothers in the kibbutz - both for the sample and control groups. In addition, developmental, family, clinical and school histories were obtained for all children.

The results showed a clear trend toward a higher prevalence of chronic physical illness among the mothers in the MBD group - the diseases antedating the pregnancy were both more frequent and more serious than those of the control mothers. The diseases of eight MBD-mothers were: hypertension, habitual abortion, congestive heart failure, polycytemia vera, hypothryoidism, and familial neurofibromatosis. Most of these diseases alter the mother's physiology and may affect the intrauterine environment and jeopardize the fetal oxygenation. This is compared to four control mothers who had chronic migraine, cervical spondylosis, obesity and bronchial asthma - none of which jeopardized the fetus.

The MBD group had a greater tendancy toward complications during pregnancy, labor and delivery with 43 abnormal conditions as compared to 17 complications in the control group. The severity of the complications was also greater among mothers of the MBD children. Toxemia of pregnancy, hypertension, and marked oedema were almost four times more prevalent. Likewise, acute infectious diseases appeared four times as often and were of a more serious nature. It is interesting to note that no significant differences were found in the prevalence of antepartum hemorrhage in the two groups and vaginal bleeding was evenly distributed among the three trimesters.

The occurrence of labor and delivery complications was also significantly higher in the MBD group. Abnormal events such as prolonged labor with fetal distress, use of forceps, vacuum-extraction, and Caesarian operation were found in 17 cases as contrasted to only two cases in the control group.

The proportion of infants with very low birth weights was higher, 7 to 1, in the MBD group. However, of the 15 children below 2500 g, only a few more belonged to the MBD group. On the other extreme, infants with high birth weight (over 4000 g) were also overrepresented, by 8 to 1, among the MBD children. When prematurity was calculated according to the length of gestation, it was found that the proportion of children with a gestation period of 32 weeks or less was about three times higher among the MBD children.

Seven of the MBD children had asphyxia at birth as compared to two from the control group. Two MBD children developed other types of neonatal complications (convulsions and sepsis).

The authors concluded that these findings definitely confirmed the existence of a significantly increased frequency of both complicated pregnancies and deliveries and chronic maternal illness in the MBD group (2.5 times higher than in the control group). These complications undoubtedly increased the risk of intrauterine or neonatal cerebral hypoxia with focal or diffused CNS damage. The clinical manifestation of the CNS lesion varies according to the type of risk factor to which the child has been exposed the developmental stage at which the damage occurred.

At the time of this writing the children had been studied for at least three years and the authors had not yet found evidence for the widely-held opinion that the MBD children outgrow their problems in adolescence or adulthood. Although they may have shown improvement of varying degrees following systematic training programs, guidance, psychotherapy and drug treatment, the vast majority of the kibbutz MBD children continue to exhibit unmistakable signs of impairment and difference from the 'normal'. In this respect, the MBD syndrome does not differ from other forms of organic CNS pathology in which detrimental effects tend to persist through the life stages.

Fianu (1976) has shown that obstetrical factors are related to MBD. One of Fianu's main interests was to study the relationship between symptoms of minimal brain damage and breech delivery. The parents and teachers of 556 children born in breech presentation and 550 children born in vertex presentation (controls) were asked questions concerning the deliveries and the development of the children, respectively.

The results indicated that one of the most relevant criteria of MBD concerns difficulties of various degrees in reading and writing. In all, children with reading and writing difficulties represented almost 45% of those delivered in breech presentation as compared to 26 % of children born in vertex presentation. Furthermore, it was noted that speech disorders and visual disturbances occurred more frequently among breech-delivered children than among vertex delivered ones. Several years earlier, Muller, Campbell, Graham, Brittain, Fitzgerald, Hogan, Muller and Rittenhouse (1971) had found breech deliveries to impair later development. Their retrospective study of 1698 nine year old children analysed delivery records. Of twelve developmental variables examined, significant relationships to obstetric parameters were obtained for six - two related to breech-deliveries were grade placement and arithmetic achievement. The results showed that 15.2 % of the low birth weight children and 24.5 % of the breech-delivered children had repeated one or more grades as compared to 8.3 % of the children with normal to high birth weights. In addition, there were more breech-delivered children with below normal arithmetic achievement and fewer above normal compared to the children delivered in other ways (spontanious or low forceps, mid-forceps, cesarean section).

Cognitive development

Pre-term, low birth weight and small-for-gestational age children . The usual definition of prematurity is infants with a low (<2500g) or very low birth weight (<1500 g). The infants are small either because they were born after a short gestation (<38 weeks) i.e., preterm, or because they suffered retarded growth during the perinatal period i.e., small-for-gestational-age (SGA). An SGA infant is an infant whose weight is less than that of 90 % of his peers of comparable gestational age, for example, an infant born after a 38-week gestation with a birth weight of less than 2500 g (Holmes, Reich, & Pasternak, 1984). In early studies, prematurity was defined using only the criterion of birth weight. In recent studies, attempts have been made to determine differences in the developmental outcome of the two groups of newly borns. Holmes et al. (1984) state that the pre-term infants have more immature central nervous system at birth, compared to the SGA-infants who have more immature organs.

There are many different reasons for premature birth. In many cases, however, the cause remains unknown. Two common causes are maternal illness during pregnancy (especially hypertension) and multiple birth (Holmes et al.,1984).

It is often stated that prematurity is more frequent in low socio-economic groups than in other groups. Some important related factors here are the age and education of the mother, as well as nutrition and smoking during pregnancy (Holmes et al., 1984).

The cognitive development of children has been related to prenatal and perinatal problems. Many studies concern the development of prematurely born children. In a literature review, covering literature from 1940 - 1962 Wiener (1962) concluded the following:

1. Infants born prematurely tend to have slower developmental rates during the first years.
2. Prematures tend to be impaired on measures of intelligence at all ages of childhood.
3. The data suggest, albeit inconclusively, a correlation between increasing impairment and decreasing birth weight among premature children.
4. Premature children of all ages seem to be prone to a wide variety of personality aberrations.
5. Premature children apparently have impaired reading and writing abilities, which may reflect a perceptual disability. Negative or inconclusive findings were obtained concerning language development and speech disorder.
6. Whether prematurity is associated with impairment in the absence of other obstetric and neonatal complications has not yet been definitively studied.

Wiener (1962) criticized some of the studies for the failure to use factorial designs, as the interaction between birth weight and parental social and psychological characteristics might produce relatively extreme impairment.

Benton (1940) reviewed the literature before 1940. He found that prematurely-born children showed retarded development during the first two years of their lives. On the other hand, during the later development, the children were neither intellectually inferior nor less intelligent. The prematurely-born children were, however, more behaviorally disturbed than others. Benton criticized the studies he reviewed for failing to control socio-economic status. He found the measures concerning the intellectual functioning of the children lacking in objectivity and repeatability.

Wiener, Rider, Oppel and Harper (1968) studied 500 single-born premature infants and 492 full-term controls. The children lived in Baltimore and were studied until they were 12 - 13 years of age. There were five rounds of different examinations: at 40 weeks, 3 - 5, 6 - 7, 8 - 10 and finally 12 - 13 years of age.

The results from the different rounds confirmed many earlier findings that the intellects of the premature children were impaired. The first round examined both development and neurology and found that 51 % of the very low birth weight (<1500 g) and 25 % of the low birth weight (1500 g - 2500 g) infants showed some abnormality compared to 13 % of the full-term infants.

During the three subsequent rounds, a relationship between birth weight and different IQ-tests was found. Increasing impairment of IQ was noted with decreasing birth weights for the prematurely-born children. One of the most potent outcomes of low birth weight was comprehension difficulty at the ages of six and nine. This was associated with the neurological effects of premature birth. At age 9 - 10, grade placement was a significant discriminator between different birth-weights; 45 % of the very low birth weight, 57 % of the low birth weight and 72 % of the normal birth weight children were in appropriate grades.

During the final survey the scholastic performance of the 12 - 13 years old children was studied. The low birth weight children had impaired reading and arithmetic skills but, contrary to all expections, were more impaired on tests of arithmetic than on tests of reading and spelling. When the children were 8 - 10 years of age, reading and spelling were not significantly impaired as a result of low birth weight. The most impaired children, however, did not participate in the tests. The authors postulate that defects such as reading difficulties are caused by perinatal problems and might not be noticeable until relatively late in childhood.

In the final round, academic achievement, reading and arithmetic tests, and grade placement, were found to be significantly correlated with birth weight. There was no interaction effect between social class group, race and birth weight. The effect of birth weight as related to achievement was similar in each social class group and race.

In a later study, Wiener (1970) used the same sample as Wiener et al. (1968) to find out if differences in intellectual functioning were correlated to the length of the gestational period in children who were born with a low birth weight. The low birth weight children were subdivided into three weight groups (<1500 g, 1500 - 1999 g and 2000 - 2500 g). For each group, three subgroups concerning gestation were developed: short (<38 weeks), modal (38 - 40 weeks) or long (>40 weeks). No indication that gestational age resulted in differential impairment within the low weight groups was found, however. The purpose of the study was not to analyze the 'full-term' children, nevertheless the results from the testing of the controls were quite unexpected. The children with a birth weight of greater than 2500 g were also subgrouped according to the length of the gestation. Statistically significant results showed that lower IQ-tests scores were associated with short gestation. These results were obtained for tests of speech maturity, as well as reading and spelling, after controlling for race, birth weight and socio-economic status. In sum, the low birth weight and the high birth weight/short gestational age children were diagnosed as being unlikely to attain optimal IQ.

These results were reinterpreted by Neligan, Scott, Kolvin, and Garside (1976) in their seven-year follow-up study of children born too soon (short gestation) and born too small (light for date). They noticed that the children in four of the six main subgroups of Wiener's study had depressed IQ-scores. The four subgroups were all three gestational groups of the low birth weight and the high birth weight children with short gestational age.

Children with a high birth weight and modal or long gestation had higher IQ-scores. These results of Wiener's study were what could be expected according to Neligan et al., as the children with depressed scores were born either too soon, too small or both.

Neligan et al. (1976) studied 400 children from a representative sample of Newcastle Survey of Child Development to determine later effects of variations in the duration and rate of intra-uterine growth. Information concerning the prenatal and perinatal period was provided by the Newcastle Maternity Survey. The children were divided into three groups: born too soon, born too small and a control group. The infants born too small (light for date) had a gestation of more than 255 days (mean 281 days) and a mean birth weight of 2537 g, while the infants born too soon (short gestation) had a gestation of less than 255 days (mean 244) and a mean birth weight of 2415 g. The random control infants had a gestation of 281 days and a mean birth weight of 3508 g. The light for date infants were subdivided into rather-light for date and very-light for date according to birth-weight (2701 g and 2397 g, respectively). Their gestational age was the same.

The children were tested three times when they were five , six, and again when they were seven years old. There was an impressive array of tests: psychometric tests, behavioral and temperamental assessment by the mothers, teacher and psychologist assessment, neurological assessment by a psychiatrist and finally an assessment of physical growth.

The direct results, before an analysis of covariance and multiple regression, showed that being born too soon did not necessarily produce any harmful long-term effect in those surviving the neonatal period. However, those born too small as a result of impairment of intra-uterine growth were more likely to demonstrate impaired performance at school due to consequent organic effects during prenatal development. In general, the control group was found to have the best scores, followed by the short-gestation, rather light for date and finally the very light for date children. When biological, clinical, maternal and familial factors were taken into account a similar picture emerged.

The sex of the children was a strong determinant of several effects. In the control group, boys had higher IQ-scores than girls while the scores of boys and girls were similar in the abnormal groups, lending creedence to the arguement that boys are more vulnerable to adverse perinatal factors than girls (Bergman, 1981). Girls in the abnormal groups showed no behavioral abnormalities when compared to the control girls, as was the case with the boys. Mode of delivery and birth weight were important clinical and biological factors that affected the subsequent performance of the children of the two abnormal groups. Familial factors had the greatest impact on the control group, the most important factor being the mother's care of the child.

In a Norweigan longitudinal study, Rye (1981) followed 72 prematurely-born children. The children were physically examined at one and three years of age. Forty-eight children at the first stage and 66 at the second stage, had a medically normal development. At age three and seven the children had a psychological examination which showed that 21 of 72 and 28 of 63 children had deviant or retarded functions. Furthermore, those with deviant psychological examinations often had reading and/or writing difficulties and later in life chose manual professions. There was no correlation between emotional problems or socioeconomic factors and the psychological examination. No relationship between complications at pregnancy and/or delivery and later impairment of psychological functions was found, but a general tendency towards psychological deviancy was found in those children who had had neonatal comlications.

Post-term children. The postmaturity syndrome infants (born after 42 weeks gestation) may exhibit meconium staining, long fingernails, parchment-like skin and/or a long thin body. They have often experienced nutritional defiency and fetal distress due to placental insufficiencies. Developmental outcomes reported for the post-term postmaturity syndrome infant range from no problems to delayed social development, severe illness, sleep disturbances, reading disabilities, neurological handicaps and cerebral palsy.

In a study by Field, Dempsey and Shuman (1983) post-term postmaturity syndrome infants, children suffering from pre-term respiratory distress syndrome and healthy full-term children (control) were followed from birth over a five-year period. The original sample consisted of 194 infants. Unfortunately, no information exists on the drop-out rate over the five years. The neonatal problems of the postmature children were found to be more subtle than those of the pre-term group. Nonetheless, they showed delayed mental and social skills as late as five years of age, indicating that the effects of the post-term postmaturity syndrome are not only confined to the perinatal period. Field et al. summarized that not being born at term is not necessarily a risk factor, but when compounded by syndromes such as respiratory distress or postmaturity, the risk for developmental problems appears to be more pronounced.

Full-term children. The Rostock longitudinal study on two and six year olds (Meyer-Probst, Rösler & Teichmann,1983) found that social and biological factors interact to influence the development of the child. The sample of 294 children was divided into the two categories of 'risk child' and 'non-risk child' by those who delivered the child and by the pediatrician after birth (0 - 14 biological risk points). After the age of two, the non-risk children - the control group - had a mean developmental quotient (DQ) of 97.4 while the mean DQ of the risk group was 94.7. A birth-weight under 2500 g, long labor and hemorrhage during the second half of pregnancy were among the biological risks that emerged. While 27 biological risks were found to retard development, each biological risk factor (55 in all) was found to interact in a statistically significant way with an average of seven others.

Every child was also given psychosocial risk points (0 - 13 points). The mean DQ of the high-risk group was 97.0 while the mean DQ in the control group was 99.4. Types of psychosocial risks that resulted in risk points included: mother and/or father not successfully completing 8th grade, a large family, and a single-parent family. It was found that 25 psychosocial risks led to developmental retardation. Each of the 36 psychosocial factors studied were found to have a statistically significant interaction with an average of nine others. At the age of six, the rank orders showing the strength of the influences on DQ were:

None or only slight risk load	106	mean developmental quotients
Exclusively biological risk load	102	" " "
Exclusively psychosocial risk load	97	" " "
Double risk load	88	" " "

The compensatory influence of a favorable family milieu can be seen in the high biological risk children, whose DQ scores differ only slightly (106 versus 102) from the control. By contrast, children who grow up under unfavorable social conditions have a substantially different DQ score (97 to 88). The low DQ level shows that the development of a child is particularly endangered when biological and social risks interact. Thus, favorable psycho-social conditions reduce while unfavorable conditions increase the negative effects of biological risk loads.

A seven-year follow-up study of 1037 children using measures of language and intelligence was made by Silva, McGee and Williams (1980). They found that only two of 14 perinatal problems, e.g., being a twin or being small for gestational age, could be consistently associated with significantly lower cognitive factor scores. There was no significant association between perinatal problems and socio-economic status.

Kawi and Pasamanick (1959) correlated abnormalities of the prenatal, perinatal and neonatal periods with reading disorders. A comparison was made between 372 white males, 10 years of age or more who were diagnosed as having reading disabilities, and 372 white male control subjects. A reading disability was defined as a two year or more retardation of reading-grade for those children with an IQ of 85 or higher. For each individual selected with a reading disability, the birth certificate was collected. The controls consisted of the next reported births at the same hospital as the cases matched for race, sex and mother's age. This procedure ensured that the subjects were similarly distributed according to residence (social class) and age. The cases were obtained from reading clinics at the public schools in Baltimore, thus the lower socio-economic categories were over-represented.

When studying the records of the cases and controls, it was found that mothers of the cases had experienced labor of more than 24 hours (8.1 %) compared with mothers of the controls (4.8 %). The mean birth weight for both the cases and the controls fell within the 3000 - 3499 g range. A significantly larger proportion of infants weighing under 2500 g occurred among the cases than among the controls ($p = < .05$).

Of the reading-disabled, 11.5 % had birth weights of less than 2500 g versus 4.6 % of the control group.

Abnormalities of the prenatal and perinatal period involving either mother or child occurred with significantly greater frequency among cases than among controls (p =<.05). The occurrence of preeclampsia, hypertensive disease, and bleeding during pregnancy were found to be significantly higher among the cases than among the controls (p = <.05). Furthermore, the higher incidence of complications in the cases could not have been accounted for by differences in socio-economic conditions, maternal age, or number of previous pregnancies.

The operative procedures at time of birth were similar for both cases and controls. Any difference was very small and not significant.

The prevalence of neonatal abnormalities was greater among the cases than among the controls, but again the difference was not statistically significant.

The incidence of complications of pregnancy and labor among severely retarded readers (reading quotient below 60) was higher than among the less retarded readers (reading quotient above 60) 56.9% in the former and 41.9% in the latter but the differences were not statistically significant.

E. E. Werner and collaborators (1985) have studied extensively all children born in 1955, and a selected sample born in 1956, on the island of Kauai, Hawaii. The children were of Japanese, Filipino, Hawaiian, Portugese, Puerto-Rican, Chinese, Korean and Anglo-Saxon/Caucasian descent and represented a wide range of socio-economic groups. The study began with an assessment of the physical and emotional status of the mothers from the fourth week of gestation to delivery (Werner & Smith, 1977).

The study continued with an evaluation of the cumulative effects of perinatal stress and quality of family environment on the physical, intellectual, and social development of the children at two and 10 years. A follow-up at age 18 assessed the long-term consequences of behavior and learning problems identified in childhood and evaluated the predictive validity of the multiple screening tools. Attrition rates throughout the study remained low: 96 % of the cohort participated in the two-year, 90 % in the 10 year, and 88 % in the 18-year follow-up.

The presence of conditions thought to have had a deleterious effect on the fetus or newborn was clinically rated for each child at the beginning of the study. A pediatrician scored the severity of approximately 60 complications occurring during the prenatal, labor, delivery, and neonatal periods, and assigned an overall rating of: 0 = not present; 1 = mild; 2 = moderate and; 3 = severe. Cases with overall scores of 2 and 3 were reviewed independently by a second pediatrician. In the 1955 cohort, 56 % had no perinatal complications, 31 % had mild perinatal complications, 10 % had moderate complications and 3 % experienced serious perinatal stress.

In the 10-year follow-up, wherein 750 of the 866 children participated, information was provided by records, teachers, and group tests as a screening device and in addition to diagnostic examinations by psychologists, neurologists, pediatricians, etc.

The quality of the childrens' environment was measured through interviews with the family - preferably the mother. Three dimensions were rated: socio-economic status; educational stimulation and; emotional support. The diagnosis of achievement, intellect, behavior, physical problems, and environmental ratings were made independently from each other and without knowledge of the childrens' perinatal scores.

The combined screening and diagnostic information was used to determine the presence or absence of the following types of problems: school achievement, intellectual, emotional, and physical problems.

At age 18, 698 youths participated in a record search, group tests plus questionnaires and in-depth interviews with clinicians. The youths were divided into five groups: those who had had learning disabilities at age 10 (n = 22), those who had been in need of short- or long-term mental health services (n = 85), those who had developed behavior problems after the age of 10 (n = 45) and two control groups (n = 45).

The greatest effects of perinatal stress on functioning at age 10 were found in those children who required placement in special classes or institutions, had IQs below 85 as well as significant physical health problems.

Among the 2 % (n = 14) who had suffered severe perinatal stress and survived to age 18, four of five had significant behavioral, learning, and/or physical problems. The incidence of *mental retardation, significant mental health problems, significant physical handicaps* were *ten, five* and *two* times that found in the total cohort, respectively.

There were no significant differences between the perinatal stress groups in the percentage of poor grades received in reading, writing, and arithmetic and in the percentage of children who had language or perceptual problems, with the exception of those who were placed in institutions. Twice as many boys as girls were among the 3 % of the cohort considered in need of placement in a learning disability (LD) class due to serious reading problems (despite normal intelligence), perceptual-motor problems, hyperactivity and difficulties in attention and concentration. None of the LD cases had suffered from severe perinatal stress but children who were diagnosed as LD by age 10 and later at age 18 had higher proportions of moderate perinatal complications, chronic conditions judged by pediatricians as "possibly leading to MBD" at birth, low birth weight and congenital defects than controls. There was a higher tendency toward living in chronic poverty in the 18-year old case group than the controls.

Socio-economic status showed a significant correlation with achievement, intellectual, and emotional problems (persistent aggressiveness) among the 10-year-olds on Kauai. Educational stimulation received in the home had more of an impact than other environmental dimensions on achievement problems, IQs below 85, language, and perceptual problems. Emotional support in the home had more of an impact than the other environmental dimensions on behavior problems. The majority of children with emotional problems grew up in an unfavorable environment.

Only 10 of the 231 children with emotional problems came from the group with the most serious perinatal complications. When looking at the

PMA IQ distribution by both degree of perinatal stress and amount of educational stimulation, it is quite apparent that the differences in mean IQs between children born into and growing up in the most and least favorable home environments are much larger than those between children from the most and the least severely stressed perinatal groups.

At age 10, perinatal stress accounts for much less of the variance in MPA IQ scores than the quality of the environment. The effect of environmental deprivation is much more powerful than was apparent at 20 months, even for those children who had no perinatal complications.

The children with severe perinatal stress who grow up in homes rated 'high' in educational stimulation with the exception of the institutionalized, did not differ from children without perinatal stress who were raised in homes with a favorable educational stimulation. At age 10, both groups achieved mean PMA IQ scores well above the average. The mean difference in PMA IQ between children with severe perinatal stress coming from homes rated 'high' and from homes rated 'low' in educational stimulation was much larger. Of the 750 10-year old children, more than 10 times as many were affected by deprived environment as those by severe perinatal stress. It was therefore concluded that perinatal complications could only be consistently related to later impaired physical and psychological development when combined with persistently poor environmental circumstances.

Werner and Smith (1977) found that the best single predictor of learning disability of girls at age 10 was a Cattell IQ score below 80 at age two. For the boys, the best single predictor was the mother's rating of the baby's high activity level at one-year old. Predictions increased slightly for children from poor homes. A combination of Cattell IQ below 80, presence of congenital defects and chronic conditions judged by physicians to lead to minimal brain dysfunction, difficult labor, birth weight below 2500 g, a low standard of living, and a low level of maternal education were the most powerful predictors for the girls in this group. A combination of moderate to severe perinatal stress, ratings of high activity levels, high social responsiveness at one year, and a home rated low in family stability at age two were the most effective predictors for boys.

In sum, a combination of biological insults to the central nervous system around birth and an early home environment low in stability led to problems for both sexes. Infant temperamental traits nonrewarding for the mother appeared more frequently in boys with later learning disabilities than in girls.

METHODOLOGICAL COMMENTS

Many methodological problems emerge when studying the development of children. To find the cause of deviant behavior or learning disabilities it would be necessary to expose the children to experiments during pregnancy, delivery or the perinatal period. Naturally this is not possible as it would be highly unethetical. The methods at hand are therefore retrospective or prospective.

It is without question necessary to use a longitudinal perspective when studying developmental outcomes. In numerous studies, children with different perinatal complications have been studied at intervals following their birth up to five years of age. A longer time-span may be necessary depending on the problem. Wiener (1970), for example, found a marked reading disability at age 12 - 13 but not at age 9 - 10 for premature children. Evidently some defects can take a long time before they develop.

One of the difficulties concerning longitudinal prospective studies is the risk of high attrition in the follow-ups. It is often advisable to compare the dropouts with the participants on some variables. Werner's (1985) longitudinal study of children in Kauai had very low attrition rates. Very few people seemed to move away from the island. In the final follow-up, the children reached an age of 18-years old and yet 88 % of the sample participated. In the Isle of Wight study, Schachar, Rutter and Smith (1981) investigated the 585 children excluded from the study of 2121 (72.45 % participated after four years). They found that the excluded children were similar in age and sex to the 1536 in the study. They were more often of lower social class, however, and more often rated by their teachers as disturbed and hyperactive compared to the participants. This example demonstrates the importance of comparing the children who remained in the sample with the dropouts.

There is no uniform method for selecting a sample. In some studies all newborns who fill the existing criteria are included. In other studies, the heavily retarded with low IQs or the severely physically handicapped children are excluded. Harper and Wiener (1965) compared their longitudinal Baltimore study (Wiener et al., 1968; Wiener, 1970) with those of McDonald (1964) and Drillien (1964). They found that each study used different methodologies and that conflicting findings might have been the result. Drillien's study included, unlike the other studies, subjects with gross mental or physical abnormalities. This might be one reason for the large variation in intelligence as a function of birth weight which was not found in the other three studies.

As mentioned in the discussion of the cognitive development of premature infants, attention has been given to the fact that newborns differ not only concerning birth weight and gestational age but also concerning the concordance between the two factors. The overall morbidity and mortality rates are affected substantially dependent on whether the low birth weight subjects have a weight of <1500 g or <2500 g. The lower the birth weight, the higher the mortality and morbidity rates. The same situation exists for children born after a short gestation: the shorter the gestation, the higher the rates. Infants who are not born at an appropriate size for their gestational age also are at a higher medical risk. It is therefore important to divide the children into subgroups so as to evaluate the developmental outcomes of different conditions. Other conditions that might be of interest to evaluate separately are maternal illness during pregnancy or medical complications in the infant.

The identification of an appropriate control can be a difficult problem. If newborns with specific hospitalized disease are studied, the control ought to consist of children hospitalized for another disease, according to Meisels & Plunkett (1986). They also suggest that low-risk, full-term infants be used as controls for social and environmental factors or to provide a normative baseline for dependent variables used with high-risk infants.

One of the most probable explanations for the many divergent findings in this field is the way 'development' and 'behavior disorders' have been conceptualized. Every study has different dependent variables that measure different aspects of cognitive development, ranging from general IQ, to schoolastic achievement, to mental retardation. Given that neurological damage is associated with the long-term effects of development it would be advisable to use specific tests that measure for verbal, spatial and arithmetic skills in addition to a general IQ-test. The use of school reports as a single measure of development has obvious shortcomings as several schools, both public and private, are involved as well as different teachers with varying demands on the children. If school reports are to be used they should be analyzed in conjunction with other measures.

The general view is that neurological damage generally impairs perceptual processes such as those involved in reading and spelling. There is one exception, however, Wiener (1968) found the 12- to 13-year old prematurely born children were most impaired on tests of arithmetic achievement. Holmes et al. (1984) had several objections to the methodologies in general such as the lack of control groups and the fact that if control groups were used, they were not matched based on social class. The third and most serious failing, however, was the way development was assessed. Very few studies made any attempt to use objective tests instead meaternal reports, school reports and clinical impressions of the researcher were used, according to Holmes et al.

Minde, Webbs and Sykes (1968) tested the validity of prenatal and perinatal data given by the mothers to a psychiatrist in their study of hyperactive children. The reports by the mothers were given years after the events had taken place - the children were enrolled in school at the time of the study. The concordance of the reports given by the mothers and the hospital reports was not very impressive, although the authors were satisfied with the concordance of the first two of the five variables tested ('birt weight of child' and 'mother's age at the birth of the child') the overall result was rather negative. Concerning the three questions 'birth weight', 'mother's age at the birth of the child' and and 'previous miscarriages', 29, 20 and 32 answers (of a total of 56), respectively, showed agreement with the hospital records, while the rest were in disagreement (6, 12, and 18 had missing values). For the question 'use of forceps', five of 24 agreed to the use of forceps, while two of 29 agreed to not using forceps (49 missing values). For the last question 'presence of antenatal and perinatal abnormalities in mother and child', only one of 14 cases agreed as to the type of abnormality, three mentioned different types and 10 agreed to the absence of abnormalities (29 missing values).

There is also a confusion, mentioned earlier, in evaluating children with behavioral disorders in different reports. Some reports focus on MBD and some on hyperacitivity. MBD and hyperactivity seem to be used synonymously as if they represent the same disorder. This overlap is one cause of confusion. The evaluation in both cases included a medical history, a neurologic examination, an electroencephalogram, psychological assessment and an educational assessment. It has been shown that any medical examinations and EEG are of little or no use in diagnosing MBD/hyperactivity or differentiating between them.

Kaffman et al. (1981), in their study of MBD children in a kibbutz, had two ideas of why there are divergent outcomes in studies concerning MBD and birth complications:

(1) The lack of a clear and uniform diagnostic criterion for the specific identification of the syndromes of MBD. Confusion in this area is so great that many clinicians maintain that MBD does not exist as a medical entity at all.

(2) The lack of a detailed and reliable obstetric history, since in most cases the diagnosis of MBD is made several years after the child's birth.

CONCLUSIONS

This paper has shown that there exist many methodological problems with measuring children's development. Because of the methodological differences, the results are not always easily comparable. A table of nine major studies described at length in this report has been compiled (Table 1) so as to provide a comprehensive view of the methods and results.

Table 1. Summary of some major studies concerning long-term effects of prenatal and paranatal factors on the development of the child.

Authors	Prospective or retrospective (P/R)	Age at follow-up of the study	The study group	Representative or clinical (R/C)	Controls matched for	Data	More pre/peri-natal compl. in study group
Hartsough, Lambert (1985)	R	Kindergarten grades 1-5 1 sample for each	301 hyper-actives	R	Grade Sex	Self-reports from parents	Yes
Minde, Webb, Sykes (1968)	R	10 years	56 hyper-actives	C	Next born at the same hos-pital; sex, soc.econ.status	Birth records	No
Pasamanick, Rogers, Lilienfeld (1956)	R	In school Born in Baltimore after 1939	1151 behavior-disturbed	C	Sex, race, age - next in alphabet in class	Birth certificates	Yes
Kaffman, Sivan-Sher, Carel (1981	R	9 years	70 with MBD, living in a kibbutz	C	sex, age living in kibbutz	Questionnaires to kibbutz physicians	Yes
Wiener (1968)	P	40 weeks 3-5 yrs 6-7 yrs 8-10 yrs 12-13 yrs	500 lowbirth weight and very low birth weight	C	Race census tract season of birth, parity of mother, hospital of birth	Neurol.exam., home interviews, psychometric, achievement, several school tests, grade placement, school marks	Yes
Neligan, Kolvin, Scott, Garside (1976)	P	5 yrs 6 yrs 7 yrs	141 born light for date, 59 born after a short gestation from Newcastle Survey of Child Dev.	R	Random sample from NSCD	Psychometric-, behavioral-, temperamental-, neurological-assessment, physical growth	Yes
Kawi, Pasamanick (1959)	P	10 yrs or more	372 reading-disabled	C	Race Sex	Birth certificates	Yes
Meyer-Probst, Rösler, Teichmann (1983)	P	2 yrs 6 yrs	294 with biological and/or psychosocial risk load	R	Age-attend same day nursery	Perinatal exam., psychomteric test, medical exam., questions of home, school marks	No
Werner (1985)	P	20 months 2 yrs 10 yrs 18 yrs	Some 700 born on the Isle of Kauai 1955 and 1956	R	A whole cohort	Prenatal and peri-natal records, medical exam., psychometr. tests, register data, school and other data, interviews from home	No

Two main findings have emerged from this discussion of literature on prenatal and perinatal factors in development. The Rostock study (Meyer-Probst et al., 1983) and the Kauai study (Werner, 1985) found that the presence of prenatal and perinatal difficulties was not more important for later development than the absence or presence of environmental support. All children, including those with prenatal and perinatal problems, have a good chance to develop normally if they have stable, supportive homes.

The 'neurological' studies of Wiener (1968, 1970), Kawi and Pasamanick (1959), Neligan et al. (1976) and Kauffman et al. (1981) found that children with prenatal and perinatal difficulties were disadvantaged in terms of long-term development and did not seem to 'catch up' compared to full-term children without these problems. In these studies, the effect of the environment was also analyzed but was not found to be the most important factor, as was the case with reproductive causalities.

These findings are in accordance with the theories that Wiener (1962) stated, and could possibly explain the results of different studies. The first group of theories are the environmental theories. In this group there are different subgroups: environmental deprivation, parental response and membership in a particular social class. The second group of theories are the neurological theories. According to these theories, the infants with prenatal and perinatal problems are in danger of recieving minimal brain damage. The third group of theories state that a combination of neurologic and psychosocial factors is necessary to produce significant impairment. Pasamanick et al. (1956) have stated the theory within the "neurological view" of the "continuum of reproductive causalty." This theory suggests that there exists a linear relationship between the severity of the risk and the extent of the developmental delay. Complications during pregnancy and delivery, as well as prematurity, can lead to brain damage - the more severe the complication and the lower the birth weight, the worse the brain damage. The continuum of reproductive causalty might have death as a worst case and descend in severity to cerebral palsy, epilepsy, mental deficiency, learning disability and perhaps even behavior disorder.

Are there long-term effects of the conditions during pregnancy, delivery and the perinatal period on the development of the child? As has been shown in the studies reviewed here, despite all scientific knowledge, there exists no congensus concerning those matters. As some deviances show up later in life, the most fruitful way to find answers to these complex questions must be to follow the subjects over time - from birth to adulthood. Furthermore, the subjects should form a representative sample so that generalizations can be made. Thus, it can be stated that longitudinal studies that follow a representative sample over a long period of time - perhaps a life-time - are needed. This research including theoretical modeling and empirical studies, is necessary to properly predict the psychosocial developmental outcomes of children born with prenatal and perinatal problems.

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