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ABSTRACT

This report presents a cumulative risk score system designed to identify high-risk infants through multiple assessments over an extended period of time. The system scores prenatal, natal, and neonatal biological events and neonatal behavioral performance in an additive fashion. Infants are assessed in the first month of life to distinguish those babies with transient brain insult from those with permanent brain injury. At 4 months and 8-9 months of age the infants are again tested, primarily on a behavioral basis. The researchers were concerned with the later adaptation of the infant to his environment regardless of any biological deficit. Therefore, a child with motor or sensory handicaps who progressively compensates sufficiently so that he does well cognitively and affectively removes himself from the risk category. Five examples of the use of this system were presented. The researchers expressed concern about labeling infants "high risk" too early in life because such a label can be very disruptive to caregiver-child attachment and interaction. However, intervention was advocated for those infants with persistent developmental problems which make them vulnerable to any adversity in their environment. (Author/BRT)

Selection of Developmental Assessment Techniques for Infants at Risk

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There are numerous biological and environmental factors that place an infant at risk for later developmental disability (Parmelee & Haber, 1973, Sameroff & Chandler, 1975, Hunt, 1975). It is almost impossible to study all aspects of this problem at once. Yet, in selecting variables to study it is helpful to remember the complexity of transactions between the infant and environment. We will not attempt to present a comprehensive review of all variables that place an infant at risk or all possible assessment techniques. Instead we will discuss how we addressed this problem and how we made our selection of assessment techniques. We realize that others might make entirely different selections based on the same information with equal justification.

In our study we decided to focus primarily on infants initially considered at risk because they had suffered hazardous biological events. This is of great interest to physicians who are hopeful of eliminating those biological events contributing most to developmental disability. Physicians are also likely to be concerned with later biological disabilities such as cerebral palsy, seizures, impaired hearing or vision, or severe retardation. In part this is because these outcomes are more definitive than those developmental disabilities that include milder degrees of retardation or affect disturbances. On the other hand, the latter are by far the most important social problems in terms of number of individuals and cost to society.

We are concerned with the total adaptation of the infant to his environment regardless of any biological deficit. A child with a motor or sensory handicap or seizure disorder who progressively compensates sufficiently so that he does well cognitively and affectively removes himself from the risk category. He no longer has a developmental disability in the cognitive or affective sense. On the other hand, an infant with no manifest motor or sensory handicap or sign of neurological disorder who persists in poor cognitive and/or affective performance is a child we consider continuing at high risk for later developmental disability. Thus, for us developmental disability is defined primarily by cognitive and affective performance.

This concept of developmental disability is best suited to the study of intervention procedures which are directed at helping the infant adapt to his environment successfully despite any biological deviance. It recognizes the fact that we will probably never be able to eliminate all biological defects, not only for lack of knowledge, but also because of lack of social application of available knowledge.

The next question is how early and how precisely can infants be identified for developmental risk. To classify all infants as at risk whose mothers had some unusual event occurring during pregnancy, labor or delivery or who suffered some neonatal problem results in as many as 60% of all newborn infants being placed in a risk category. However, most of these babies will do well without particular intervention. We need to be more precise in a definition of risk to avoid false labeling of infants and waste of manpower in needless surveillance and intervention (Rogers, 1968).

The concept of a continuum of pregnancy or a continuum of casualty implies that outcomes for a variety of pregnancy and perinatal events may have both lethal and sublethal outcomes (Lilienfeld & Parkhurst, 1951, Knobloch & Pasamanick, 1960). The sublethal outcomes include neonatal morbidity and later developmental disability. This suggests that we can isolate single prenatal, perinatal, or neonatal risk factors by identifying those associated with the highest mortality and morbidity in the neonatal period. However, there have been no, or very low, correlations between single obstetrical events and later outcome (Buck et al, 1969, Niswander et al, 1966, Nelson, 1968, Parmelee & Haber, 1973). The use of clusters of such events has been somewhat more successful for predicting outcome differences with groups of infants, but, not for individual infants. Even such global and clinically significant categories as neonatal hypoxia or prematurity are not strong predictors of developmental disability for individual infants though the incidence is somewhat greater in these groups than in the general population.

There are several reasons for these findings. One is that many prenatal, pregnancy, or perinatal risk events result in transient brain insult rather than permanent brain injury. Another is that environmental factors may have a stronger influence on behavioral outcome in some instances than these early biological events (Graham et al, 1962, Drillien, 1964, Braine et al, 1966, Wiener et al, 1968, Drage et al, 1969, Werner et al, 1971, Hunt, 1975).

In devising our risk score system we decided to consider multiple factors as cumulative in determining degree of risk. We also wanted to use a strategy of multiple short term predictions that take into account ongoing change, resulting from transactional processes between the individual and his environment. The risk score system considers the following clinical observations: 1. Many perinatal problems cause only transient insult, rather than permanent brain injury. Thus, in the newborn period, babies may appear equally ill upon examination but some will recover completely. 2. Some pregnancy and perinatal problems cause brain injury that is not manifest in obvious ways in the neonatal period, but, the deviance becomes more evident as complex behaviors unfold during infancy. 3. Some parents appear intuitively able to provide an optimal environment for an infant with mild neurological deviances thus allowing him to compensate.

With these points in mind we decided that a useful risk scoring system might be one that: Scores prenatal, natal, and neonatal biological events and neonatal behavioral performances in an additive fashion: assesses the infant in the first months of life to sort out those infants with transient brain insult from those with brain injury who remain deviant: assesses the infant again primarily on a behavioral basis later in the first year of life, providing time for environments to have an effect on developmental progress.

The risk score system is intended to be applicable to any population. However, in our study we have concentrated on infants born preterm in order to deal with a sample that might have a larger number of infants at high risk than the general newborn population (Parmelee et al, 1975[a], 1975[b]).

As soon as each family joins our project, they are assigned to a team composed of a public health nurse and pediatrician. There is frequent contact between the team and the family in the form of home visits, well-baby clinic appointments, and telephone calls. This type of support service is helpful to all the parents and their children, and facilitates our longitudinal evaluations.

Assessment Techniques

Having discussed our general strategy and the information on which we based it we will discuss the specific assessment techniques and the rationale for their selection. Our risk scoring system consists of five neonatal measures, four measures at 3 and 4 months, and five at 8 and 9 months. These are listed in Table 1.

All tests are administered at the same conceptional ages. Conceptual age is the age from the onset of the mother's last menstrual period to time of testing. It is equal to the gestational age plus age from birth. Thus, a pre-term infant of 34 weeks gestational age at its expected date of birth will have a conceptional age of 40 weeks, the same as a newborn full term infant of 40 weeks gestation. This concept makes it possible to administer tests to pre-term infants of varying gestational ages and full term infants at comparable biological conceptional ages (Parmelee and Schulte, 1970). In the following paragraphs we will discuss the assessment techniques in the chronological order in which they are administered.

Obstetric and Postnatal Complications

Our first formal evaluations are made in the neonatal period at term, but, we also wished to assess hazardous events that occurred in the prenatal, natal or postnatal periods. For this latter purpose we developed two measures that are closely related. The first measure, the Obstetric Complications Scale (OCS), covers events related to the prenatal and natal periods, including the onset of respiration and Apgar score. The second measure, the Postnatal Complications Scale, covers risk events occurring following the Apgar assessment through the first month of life. It is our impression from review of published studies that acute natal events may be highly associated with neonatal mortality, whereas maternal characteristics, prenatal, and neonatal events are more likely to be related to long term developmental outcome.

The OCS consists of a list of broad categories of items which can be defined as optimal or non-optimal. These include maternal characteristics, such as mother's age, health, and prior obstetrical history, pregnancy events such as illness, bleeding and hypertension; infant items relating to birth events, onset of respiration and the Apgar score. This system eliminates the problem of dealing with an almost infinite list of possible hazardous, isolated events. The assessment is self-weighting based on the assumption that if a non-optimal event is particularly hazardous a chain of associated non-optimal events will occur. For example, the loss of a point because the mother is above or below the specified age or because of a bleeding episode during the pregnancy will be of no consequence if no other events occur. On the other hand, a mother above the optimal age, with hypertension, might have bleeding due to abruptio placenta which necessitates an emergency Caesarean section. Her infant might have an Apgar score of 5. This chain of events, would result in the loss of a number of points and a deviant non-optimal score. This system is derived from the optimal scoring technique developed by Prechtl (1968). His method has the additional advantage of having been validated by neonatal behavioral measures rather than infant morbidity or mortality.

Other types of scoring systems also have been developed. For example, Nesbitt and Aubry (1969) examine maternal characteristics and prenatal problems in order to identify the pregnant woman at risk for delivery difficulty. Later Aubry and Pennington (1973) added a Labor Index for assessing intrapartum events. Another comprehensive technique is being used by Hobel and his associates (1973). This group used a scoring system covering three phases: prenatal, intrapartum and neonatal. It differs from ours in that the intrapartum phase ends with delivery and onset of breathing of the infant is included in the neonatal portion. The advantage of this system is that data from each phase can be used to make predictions regarding events in succeeding phases and the items can be weighted on this basis. However, the outcomes refer to medical complications rather than to infant behavior.

We also have a method for scoring hazardous events occurring in the first month of life but after the initial adaption to extrauterine life in the first minutes after birth which are included in our OCS. We call this our Postnatal Complications Scale. This is particularly important for infants born pre-term who commonly have many problems in the first weeks of life. It is also applicable to the full term infant. Again, as with prenatal and natal problems, listing all possible untoward events was unwieldy and insufficient data exist to select or weight specific items. We could not find a scoring system that met our needs and would also be applicable for medical records available in most hospitals. Most systems used today have used single items or clustered perinatal and neonatal events (Graham et al, 1957, Hrazik et al, 1965, Werner et al, 1971). The neonatal portion of the scoring system of Hobel et al (1973) would have been appropriate had we also used their prenatal and intrapartum scoring system. The optimal scoring technique seemed appropriate here too, and again, could be designed to be self weighting. For example, an infant might have respiratory distress but no other problems and lose only one point. However, if the respiratory distress was severe he might also have a metabolic disturbance and infection and lose a number of points resulting in a deviant non-optimal score.

Neonatal Assessments

The assessment of neonatal behavioral and neurophysiological integrity posed several difficult problems; particularly the question of when to do evaluations. While there are several assessment techniques that define maturational sequences in behavior, sensory cerebral evoked responses, electroencephalogram, and sleep states, none deal sufficiently with the range of normal and abnormal characteristics at the various gestational ages, so that deviance may be determined. They were designed for another purpose which is to determine maturity of the nervous system and define gestational age (Graziani et al, 1968, Parmelee et al, 1968[a], Amiel-Tison, 1968, Dubowitz & Dubowitz, 1970). By doing our behavioral and neurophysiological assessments at term conceptional age, 40 weeks, we can use norms established for full term newborn infants and compare the responses of the pre-term infants arrived at this age with the term born infants. This gives us a measure, of whether the neurological organization of the infant born pre-term is progressing as well as that of the infant carried to term.

Of the neonatal neurological and behavioral measures I will discuss the sleep polygraph first. It is the only available combined assessment of behavioral organization, electrical activity of the cortical neuropil, and the cybernetic coordinating mechanisms of the nervous system. It is also our most complicated measure from the standpoint of instrumentation, and is the most difficult for the parents to understand. The sleep polygraph consists of the simultaneous recording of electroencephalogram (EEG), respiration, eye movements and body movements. The recording extends over a two hour period after a feeding to ensure the possibility of including a complete cycle through active and quiet sleep as defined by the non-EEG parameters, eye movements, body movements and respiratory pattern. Quiet sleep is characterized by no body or eye movements and regular respiration and Active sleep by the presence of eye movements and body movements and irregular respiration.

Periods when these criteria are not met are considered as undifferentiated and are called transitional sleep because they usually occur at the onset of sleep and during shifts between states.

State organization as defined by these three parameters reflects the development of cybernetic controlling mechanisms of ascending and descending activating systems in both brain stem and higher centers. The EEG reflects activity in the cortical neuropil which varies depending on the degree of control by brain stem pace makers. We have defined four EEG patterns that occur in normal full term newborns and the frequency of occurrence of each pattern in each sleep state identified by non-EEG parameters. Thus with a sleep polygraph we can assess the level of development of sleep state cybernetic controlling mechanisms independent of EEG since sometimes these are well organized when the EEG is poorly organized. We can also determine whether or not the expected frequency of EEG patterns is present regardless of state and if these patterns change concommitant with state changes (Dreyfus-Brisac, 1966, Parmelee et al, 1967[a], 1967[b], 1968[a], 1968[b], Prechtl et al, 1968, 1969, Stern et al, 1969, Anders et al, 1971).

We have established an optimal expected score for the total polygraph and points are lost for each item not meeting our specified expectation. An infant could end up with a non-optimal total either because of poor sleep state organization independent of normal EEG patterns or normal sleep state organization without the expected EEG pattern changes or both. Of the latter, the most common deviant finding is the persistence of a single EEG pattern through all state changes. This EEG pattern may appear quite normal but seems to be locked to some unknown pacemaker independent of the other sleep state parameters.

Since a non-optimal sleep polygraph may be transitory as with any other deviant findings on our assessments it is done at two ages, 40 weeks conceptional age (term), and 3 months past term, 53 weeks conceptional age. Persisting deviance in the second record is considered to be of additional significance and will be reflected in the cumulative risk score by two non-optimal scores. As previously stated if the sleep polygraph has significance with respect to the behavior of the infant then the same baby would be expected to have some non-optimal scores on the behavioral measures.

In addition a clinical neonatal neurological examination was considered important since it could identify a different group of neurologically deviant infants, than those selected by the sleep polygraph. Such items as hypotonic or asymmetric responses of the extremities or deviant eye movements might be critical, but would not be noted in the sleep polygraph. There are several well designed newborn neurological examinations available, particularly those of Graham (1956), Prechtl & Beintema (1964), and Brazelton (1973). The most extensive neonatal and follow-up validation studies have been with the Graham and Prechtl examinations (Graham et al, 1962, Prechtl, 1968, Rosenblith, 1974). Any of these might have been selected. The Prechtl and Brazelton examinations take the longest to administer and do not result in a numerical summary score. Both factors were of some disadvantage to us. For several years one of us (Parmelee) has been developing a newborn neurological examination that is short, easily administered and not unduly stressful to sick infants. The examination assesses organized patterns of behavior, myotatic tonus, and states of arousal. We have norms for our newborn neurological examination for full term infants and have found that it is equally applicable to pre-term infants at 40 weeks conceptional age, which is their expected date of birth.

We also wanted to explore visual responses in early infancy. At term conceptional age, the infant's attention to a 2 x 2 black and white checkerboard and to the same checkerboard illuminated with flashing lights is observed and recorded. This test follows the newborn neurological examination, which is arousing for most infants, and a brief feeding period aimed at calming the child.

Rather than scoring best performance over a series of tests, we have chosen to measure performance following a standardized situation which appeared to maximize attentiveness during pilot testing (Sigman et al, 1973). The aim of this measure is to identify the balance that an individual infant is able to maintain between his responses to external and internal stimulation. In other words, the infant who is able to suppress internal cues in order to attend to the visual targets will show a longer duration of attention than an infant whose internal states are overwhelming or whose tie to the environment is weak. The ability to sustain attention during early infancy may be a precursor of curiosity in the child. Furthermore, interest in the environment and cognitive development seem closely linked. An infant with the capability and motivation to interact with his world may have additional advantages in his opportunities for learning.

As an alternative to studying attentiveness, one might examine visual preferences. Preference for novelty would not be a viable choice since the tendency to habituate seems limited among newborns. However, recent work by the group from Case Western Reserve University suggests that the absence of certain visual preferences may be diagnostic of poor development (Miranda this issue). One difficulty in examining visual preferences in newborns is that their attention span is limited and subject to state fluctuations. Any test of newborn preferences would require frequent retests and this is difficult to do with a large study population.

Four Month Assessments

As we moved to our studies of the older infant, the purposes and types of assessments changed. At four months, the evaluation of visual preferences is feasible within one test period and can be used with a large number of subjects. Most four-month-olds will spend considerable time looking at visual stimuli provided the experimenter uses attractive, salient stimuli. Furthermore, most studies indicate that four-month-olds show strong preferences for complex, novel, and face-like stimuli (Fantz, 1964, Haaf & Bell, 1964, Brennan et al, 1966, Karmel, 1969, Fagan, 1970). We chose to examine the presence or absence of these preferences in order to determine whether high-risk infants showed the same visual behaviors as normally developing infants (Sigman & Parmelee, 1974).

To some extent, the measure of visual attention at four months repeats the evaluation at term in that the infant's overall level of sustained interest can be assessed. However, the four-month-measure also evaluates early perceptual and cognitive processes. The ability to discriminate stimuli, to habituate to repeated presentation of the same stimulus, and to show differential preferences for novel stimuli, depends on perceptual and memory development. These types of functions cannot be examined with other methodologies before six months of age since the younger infant is not capable of complex motor responses. Thus, visual attention measures can, perhaps, identify delays in perception or memory at ages when other techniques are less useful.

In designing this measure, we decided to use simultaneous presentations of stimuli rather than successive presentations since a study comparing the two procedures found that the simultaneous technique was somewhat more sensitive (Greenberg & Weizmann, 1971). Furthermore, we focused on preference for novelty rather than the habituation paradigm as one study (Pancratz & Cohen, 1970) reported sex differences using the latter technique and we wished to avoid this kind of effect whenever possible. We also used fixed trial rather than infant-controlled trial length because most of the information derived from attention studies which we were using had been collected in experiments using the fixed-trial procedure. While infant control of trial length might lessen the incidence of distress, state fluctuations during testing have not proved to be a major problem. Most infants begin to cry at the start of testing if they show distress at all, and in these cases, retesting is necessary. Some infants do fuss during the habituation trials but this is usually intermittent and attention is maintained: in these instances, testing is continued.

The most important modification to be made in the procedure if it were redesigned with our present information would be to put more emphasis on preference for novelty and less on preference for complexity. We find that preference for complex stimuli is almost universal among our infants. At present, the data has not been analyzed in order to identify finer discriminations between stimuli and this may turn up differences. However, preference for novelty seems to be more strongly influenced by risk status.

Since all infants are subject to illnesses that have significant consequences for their behavioral development it is important to make some assessment of their ongoing physical development and the occurrence of illnesses, injuries, and surgical procedures. In devising such a Pediatric complications scale once more we used an optimal scoring technique that is self weighting. Deviance from an expected rate of weight gain, growth in length or head circumference causes a loss of a point as does any illness, injury, or surgery. An additional point is lost if there is hospitalization for the illness or injury. Points are also lost for severe feeding or sleep disturbance or excessive crying since these often occur in neurological disorders in infancy. Physical abnormalities also cause loss of points. Some of these though congenital in origin are not obvious at birth but are manifest later such as congenital heart murmurs, eye squint, or cerebral palsy and therefore are important items on this scale. If the physical problems have not interfered with the child's behavioral development then a non-optimal score on the Pediatrics Complications Scale will not have a major effect on the total cumulative score. On the other hand if the health problems are difficult for the child and parent to cope with, then some behavioral scores may be affected and this should be cumulative.

Our Pediatric Complications Scale supplements our Obstetrics and Postnatal Complications Scales. The Pediatric scale is scored at 4 months and 9 months, post-term and covers the preceeding period. These time spans are selected to correlate with the battery of tests at 4 months, and 9 months. In this way if there is unexpectedly poor performance on some behavioral assessment at one age period we can see if any physical problems might account for this.

We use the Gesell developmental evaluation at 4 months as a global measure of behavioral development since it includes vocal and social behaviors as well as motor responses. It is also an excellent technique for the clinical neurological assessment of infants in that diverse sensory and motor behaviors are elicited bacause of the variety of situations presented to the infant. For examnle, mild hemiplegias are often more easily identified in this way than by classic deep tendon reflex examinations. At 4 months of age, the Gesell developmental exam is the counterpart of our newborn neurological examination (Knobloch & Pasamanick, 1974).

Eight and Nine Month Assessments

In the last phase of our evaluation period, when the infants are 8-9 months old, we introduce behavioral assessments that may tap different aspects of cognitive functioning. The aim of the first measure administered at eight months is a dual assessment of reach and grasp patterns and use of sensory-motor schemas demonstrated by infants. Observable individual differences are evident at this age prompting our interest in determining whether factors relating to fine motor coordination influence early learning (Kagan, 1971, Kopp, 1974). Might information intake be affected by the infant having to divert his attention from object exploration to attend to control of reach and grasp? At this age most infants approach a desired object quickly, with arm and hand prepositioned for accurate grasp (Halverson, 1932, Bruner, 1970, Bruner, 1973). However, a small group of full term infants and some preterm babies demonstrate difficulty in executing anticipatory motor adjustments of arm and hand prior to making contact with an object. We do not know whether such behavior represents a short period of immaturity and is of little consequence or if it is related to early cognitive development. Obtaining understanding of this issue has ramifications for diagnosis as well as modes of rehabilitation.

The procedure we use involves video taping the baby's initial approach and grasp of a cube. The infant sits on a crib with a platform tray placed in from of him. After the session, behaviors are coded for evidence of approach behaviors, prepositioning and accuracy.

The second part of this measure is an assessment of all sensory-motor schemas demonstrated by the infant when he is given another set of test objects. Infants usually show many similarities in their use of schemas although idiosyncratic behaviors are noted also. However, there are differences in the frequency of use of more mature types of object exp ations (Uzgiris & Hunt, 1966). Some infants may demonstrate a considerable amount of visual-manipulative exploration by looking at the object and turning it around in their hands, while other infants may do this briefly or not at all, and instead wave and bang the object. Such individual differences in style of interaction may foreshadow later variations in cognitive style with implications for attentional capabilities.

As in the previous phase of this test, the infant is video-taped as he plays with the test object. Two standardized objects are presented each for a duration of 60 seconds. Coding and evaluation of schemas are made at another time. Each schemas, defined by use of operational definitions, is coded for duration and frequency of demonstration.

Also at eight months, the infant's interest in objects, particularly novel objects, is assessed in a measure of exploratory behavior. The infant is presented with a single toy for six minutes and then this toy is paired with ten novel toys for ten one-minute trials. The infant's behavior is video-taped and later observed and recorded. Duration of play with each toy, attention to the experimenter and mother, and quality of play in terms of the integration of visual and motor behaviors are scored.

The eight-month exploratory behavior measure assesses intensity of interaction with objects as well as focusing on the infant's choice of novel and familiar toys. Thus, the eight-month measure follows up some of the variables recorded in the earlier visual attention measures. This particular technique was used since earlier studies had indicated that the measure was sensitive to environmental effects and might be predictive of later abilities (Yarrow et al, 1972, 1975). Furthermore, we wished to have a measure of attention and exploration at eight months, since state fluctuations are relatively less important at this age than at the earlier ages.

Finally, we come to the last of the evaluations, those given to the infant when he is nine months old. Sensorimotor series explore intellectual development by examining infant performance on tasks considered to be the foundation for later intellectual development (Piaget, 1952, Piaget, 1954). Since our target sample was derived from a population with a higher incidence of later intellectual problems it seemed important to include a sensorimotor series in our assessment battery.

There are several series, all developed from Piagetian theory, which have been designed to evaluate the course of intellectual growth during infancy (Uzgiris & Hunt, 1966, Casati & Lezine, 1968, Escalona & Corman, 1967, Gouin-Décarie, 1967, Corman & Escalona, 1969). In general all the series use tasks, similar to those described by Piaget, to elicit behaviors considered as representative of specific sensorimotor stages.

Some have suggested that sensorimotor series would be more sensitive to differences in environmental circumstances than traditional measures of infant development. Interestingly enough, the effect of milieu differences on sensorimotor performance are contradictory (Golden & Birns, 1968, 1971, Wachs et al, 1971). However, much of the research has focused on infants from different milieus and have ignored organismic differences such as pre-term versus full term birth. A consideration of both sets of variables may show differences in sensorimotor performance.

After reviewing all of the series we decided on the Casati and Lezine (1968) Sensory Motor Series. It is fairly comprehensive, appeared to be reasonably easy to administer and score, and could be administered in a relatively short period of time. We also liked the approach of the French authors; their series items were designed to be characteristic of the intellectual structures of Stages 4-6. After working with the series for a while we made a few procedural modifications although the series remains essentially as Casati and Lezine developed it (Kopp et al, 1974).

We chose nine months to administer their evaluation as we hoped that many of our infants would demonstrate the beginning of two important behaviors--that of actual search for the hidden object, and the beginning of intentionality as expressed in an understanding of means-ends relationships. These behaviors as well as those shown in exploration of a specific object are evaluated. In some situations the presentation is structured for the infant while in others his spontaneous actions with the presented object form the basis of his obtained score.

The Gesell developmental examination is used as the standard development tool at this age. We have chosen this measure because it provides not only an overall score of the infant's developmental level, but also allows us to examine intra-infant variability in relation to gross and fine motor behaviors, adaptive, language, and personal-social development. This type of analysis can be used to infer behavioral integrity and therefore these measures are independent. The other reason for choosing the Gesell is that its test items do not overlap with those found in sensorimotor series (Knobloch & Pasamanick, 1974).

The preceeding introduced our measures and now we will describe how they are used. Pilot studies were conducted on all new measures to determine the range and distribution of scores. A range of performance scores from normal to abnormal was established for each test and the raw scores were converted to standardized scores with means of 100 and standard deviations of 20. In this way, the scores could be treated as equivalent and all tests summed and averaged to obtain a cumulative risk score at nine months. We arbitrarily determined that infants having an average cumulative score of 100 or less at nine months would be designated as high risk, and those with scores greater than 100 as low risk. The first battery of outcome measures or dependent variables to determine the validity of our risk score will be obtained at two years of age.

EXAMPLES

To give an example of the use of this system we will present risk scores obtained for five project infants. These cases illustrate the porblems of identifying the infant at high risk for later developmental disability whatever technique one wishes to use (Table 2). Baby 1 was very small at birth having been born 14 weeks pre-term; on this basis alone she was fortunate to survive. In addition, she suffered a significant number of non-optimal obstetric and postnatal complications. However, of her neonatal behavioral measures only her visual attention performance was very deviant. After the first month of life her physical development was normal and she did very well on the performance measures at 3-4 months, with the exception of the 3 months sleep polygraph. This reflected some deviancy. At eight and nine months her behavioral performances on all measures except the hand precision and schema assessment were reasonable. We were encouraged by her developmental progress despite scattered poor performances on some assessments at each age level. Her cumulative risk score is below the mean of 100 so she remains at high risk by our definition but we are nevertheless, optimistic about her future.

The social circumstances of this baby are very complex. Her mother is an alcoholic and an epileptic and is seldom able to care for the baby. Currently the parents seem to be permanently separated. The father has managed well in caring for the baby with the help of neighbors. They baby sit for him when he is working, although at present he is unemployed. Our public health nurse was able to be of considerable help to the father in organizing care for the baby. Given this adverse environment and the very hazardous beginning of life of this child it is amazing she is doing so well.

Baby 2 illustrates the problems of a small for gestational age infant. He was born only five weeks pre-term but weighted only 1130 grams, the average size of a baby born 10 weeks before term. This sometimes occurs with babies born of mothers with severe toxemia. This mother had severe seizures at the time she went into labor and an emergency Caesarean section was necessary. She remained in critical condition for a few days. The baby had some respiratory distress at first but then he improved. His term sleep polygraph was very deviant but the other measures were normal. His general health remained good, after the initial problems, as indicated by the Pediatric Complication scores. His sleep polygraph score was again deviant at 3 months and this caused us continuing concern. His visual attention performance was also poor at 4 months, but his Gesell test performance was adequate. We were very concerned about this baby, fearing he might manifest more problems with maturation, however, we were encouraged by his performance on the Gesell test. At 8 months his hand precision and schema performance was poor but his visual and manual exploration of objects was good and at nine months his cognitive and Gesell test performances were quite adequate. The parents were pleased with his developmental progress and did not identify any particular areas of concern. His total cumulative score is below 100 and places him at high risk as might have been expected. However, the areas of good performance and steady progress are encouraging.

The family of this baby are middleclass. The primary complication here was the threat to the mother's life at the time the baby was born.

For this reason the family has been advised by the obstetrician not to have anymore children. Thus all their attention and concerns are focused on this baby. This is potentially a hazardous emotional situation which the parents have managed well so far.

Baby 3 was born 7 weeks pre-term and was average size for this length of gestation. There were significant complications during pregnancy and delivery and in the neonatal period. His sleep polygraph was somewhat deviant but his other behaviors were normal. His sleep polygraph continued to be deviant at 3 months. His 4 months Gesell test performance was lowered primarily because of some motor difficulties, however, his social and visual awareness was good as evident in the visual attention score. During the next few months, before he was 8 months past term, it was apparent that the motor difficulties seen on the 4 month Gesell test were early manifestations of cerebral palsy involving his arms and legs. This was very mild at first but became more pronounced with maturation. His motor handicap influenced all of his eight and nine months scores adversely. In this child there was a progressive deterioration of performance rather than the steady progress noted in the previous cases. His cumulative risk score is below 100 and places him at high risk. Clinically, we feel this boy has good intellectual potential which was manifest in complex social interactions. His good 4 months visual attention performance may also be an indication that he can use visual mechanisms to sustain his cognitive growth.

The parents of baby 3 are both professionals who had had considerable experience with handicapped children. They also knew of the hazards of preterm birth and were fearing their child might be handicapped.

Unfortunately their fears became reality. They have coped well with his cerebral palsy but with almost too much effort to provide a compensating environment resulting at times in what appeared to be an over stimulating environment.

Baby 4 represents the relatively benign course of many infants born only five weeks pre-term and of normal weight for this gestation. Except for some neonatal medical problems indicated in his postnatal complications score his other scores are all good like those of baby 5, a normal full term infant. The cumulative risk score is above 100 so he is no longer considered at risk in our system.

The parents of this baby are high school graduates and the father is a labor foreman. They have two older girls and hadn't planned on another child. However, they have been very pleased with their baby boy and have never been concerned about him. They placed few demands on the nurse or doctor.

Although baby 5 represents a normal full term infant with good performance at all ages with a good cumulative risk score still there are scattered poor performances on isolated tests. We expect that normal infants may do poorly on some tests often for extraneous reasons that we cannot control. However, the cumulative score concept should prevent a sporadic poor performance on any test from producing a deviant risk score.

The mother of baby 5 is a skillful mother and very knowledgeable about child development. She has made maximal use of all the help the doctor and nurse could give her in furthering her knowledge about babies, but we feel she would have done very well on her own.

These cases provide an example of how the risk score system is derived from the infant's history, and performance.

Discussion

We have two primary purposes for our assessment system: one is to identify infants at high risk for later developmental disability with greater accuracy than has been possible in the past, and the other is to define the areas of deficit with greater specificity.

To do this we have designed a cumulative risk system that features the use of multiple measures. We expect that the most valid predictions will be made using clusters of these measures. The strength of the approach used is that it will make possible the identification of the contributions made by the various measures independently and in combination. With this information it may be possible to design a more effective system either by eliminating certain measures or utilizing a weighting system. In addition, the strength of the various components of each measure can be evaluated in relation to risk score and later performance so the individual measures can be evaluated in relation to risk score and later performance so the individual measures can be improved. We anticipate that the risk score system will be applicable for infants identified as at risk for developmental disabilities due to environmental and/or biological factors.

Our research goals are complex and the fulfillment of the goals is demanding. The task is made easier by having a strong clinical services team who provides a program of medical and supportive care to the project families. Every family is assigned to a team of a pediatrician and a public nurse and consulting social worker. The doctors, nurses, and social worker have all been trained in infant development, well baby care, and family counseling. Contact is made in the nursery by the doctor or nurse with a follow-up call made 24 to 48 hours after the baby has gone home, a home visit by the nurse one week later, and clinic visit starting at two weeks of age. From then on the frequency of phone calls, home visits and clinic visits depend on family needs but are never more than a month apart, in the first year and every 2 to 3 months in the second year. Spanish speaking families are assigned to a Spanish speaking nurse or a Spanish speaking Social Work assistant who translates for the nurse and doctor. We feel this form of non-specific intervention is established as helpful and should be standard care available to families everywhere.

We recognize that despite this help there will be some infants with persisting developmental problems. These infants are likely to be those with biological problems, which even though mild, make them very vulnerable to any adversity in their environment. We believe that a special intervention program is necessary for them. Therefore, we have established a program that is individualized for each infant, and focuses on the mother as the major mediator of change. This educational intervention extends from the time that the child is ten months until he reaches two years of age (Kass et al, 1975).

We are pointing out these two kinds of intervention because some people have the impression that we are opposed to any type of intervention before 9 months of age. We feel that there is a great need for the kind of parent counseling and assistance that is provided by public health nurses and pediatricians, but for all infants and parents, not just those considered at risk.

We are concerned about labeling infants "high risk" very early in life, particularly in the first months of life. Such a label can be very disruptive to caregiver--child attachment and interaction. Considerable damage can be done by unwarranted labeling of many infants considered at biological risk in the neonatal period who will do well without a "specialized" intervention program. We have found that in the early months of life parents of infants at risk are primarily concerned with the survival of the infant and the reorganization of their lives to accommodate the infant. It is in the latter half of the first year that they become concerned about specific details of developmental deviance. They are also more receptive to discussion of these problems and more amenable to our specific education intervention. Infants with obvious congenital anomalies or chromosomal abnormalities such as Down's syndrome and severe neurological damage are exceptions and can be recognized at birth or soon after but they are only a small proportion of children ultimately identified as developmentally disabled.

In addition to the problems associated with "labels" we also suggest that early, very specific intervention programs directed at a young, sick infant do not take into account several factors. For example, they may overlook individual differences in terms of the infant's physiological needs and his early preferred modes of information intake and processing. Furthermore, such programs increase parental anxieties and ignore the problem of early diagnosis that we discussed previously.

The critical questions about our research, the risk score system and the specialized intervention, cannot be addressed until the infants are evaluated at two years of age. Significant questions concern the validity of our diagnostic system and the effectiveness of intervention. Our outcome measures consist of standard developmental assessments (Bayley and Gesell) as well as evaluation of the following competencies: Cognitive, expressive and receptive language, persistence, and social-affective behaviors. The infant's overall ability will be determined by his performance on all these measures as well as separate estimates based on the individual standardized developmental examinations.

Table I. Assessments and age of administration.

1. Obstetric Complications
2. Postnatal Complications
3. Sleep Polygraph - Term*
4. Newborn Neurological - Term
5. Visual Attention - Term
6. Sleep Polygraph - 3 months*
7. Pediatric Complications - 4 months*
8. Gesell Test - 4 months
9. Visual Attention - 4 months
10. Hand Precision and Sensory Motor Schema - 8 months*
11. Exploratory Behavior - 8 months*
12. Gesell Test - 9 months
13. Cognitive-Cesati, Lezine Test - 9 months*
14. Pediatric Complications - 9 months*

* Term = 40 weeks conceptual age which is gestational age plus a from birth.

3,4,8,9, months are calculated from term.

Table 2
Case Fxamples

		1	2	3	4	5
	Gestation (wks)	26	35	33	35	40
	Birth Weight (gms)	920	1130	1940	2360	3955
	Sex	F	M	M	M	M
TERM:	Obstetric Comp.	63	57	76	92	112
	Postnatal Comp.	67	77	77	81	160
	Sleep Polygraph	96	50	83	104	94
	Newborn Neurological	98	103	107	103	132
	Visual Attention	80	108	116	108	160
4 MONTHS:	Pediatric Comp.	100	121	121	160	121
	Sleep Polygraph	85	50	82	109	98
	Gesell Test	111	94	89	112	117
	Visual Attention	130	63	105	160	105
8-9 MONTHS:	Pediatric Comp.	90	90	90	128	128
	Hand Prec. & S.M. Schema	80	80	63	160	80
	Exploration	126	92	50	117	126
	Cognitive	97	86	78	140	119
	Gesell Test	102	95	78	98	108
TOTAL CUMULATIVE RISK SCORE:		95	83	87	120	119

Standard Score
+ 1SD 120
M 100
- 1SD 80

References

Amiel-Tison, C. Neurological evaluation of the maturity of newborn infants. Archives of Disease in Childhood. 1968. Vol. 43, 89-93.

Anders, T., Emde, R., & Parmelee, A. (Eds.) A manual of standardized terminology, techniques and criteria for scoring of states of sleep and wakefulness in newborn infants. UCLA Brain Information Service, NINDS Neurological Information Network, 1971.

Aubry, R.H. & Pennington, J.C. Indentification and evaluation of high-risk pregnancy: the perinatla concept. Clinical Obstetrics and Gynecology. 1973. Vol. 16, 3-27.

Beckwith, L. Caregiver-infant interaction and the development of the risk infant. In T. Tjossem (Ed.) Intervention strategies for high risk infants and young children. Baltimore: University Park Press, 1975. in press.

Braine, M.D.S., Heimer, C.B., Wortis, H. & Freedman, A.M. Factors associated with impairment of the early development of prematures. Monographs of the Society for Research in Child Development. 1966. Vol. 31, Whole No. 106.

Brazelton, T.B. Neonatal behavioral assessment scale. Clinics in Developmental Medicine No. 50. Spastics International Medical Publications. Philadelphia: J.B. Lippincott, 1973.

Brennan, W.N., Ames, E.W., & Moore, R.W. Age differences in infant's attention to patterns of different complexities. Science. 1966. Vol. 151, 354-356.

Bruner, J.S. Growth and structure of skill. In K.J. Connolly (Ed.) Mechanisms of motor skill development. New York: Academic Press, 1970.

Bruner. J.S. Organization of early skilled action. 1973. Child Development. Vol. 44, 1-11.

Buck, C., Gregg, R., Stavraky, K., et al. The effect of single prenatal and natal complications upon the development of children of mature birthweight. Pediatrics. 1969. Vol. 43, 942-955.

Casati, I. & Lézine, I. Les etapes de l'intelligence sensori-motrice. Les Edition du Centre de Psychologie Appliquee, Paris, 1968. (English translation, E. Ristow. Unpublished manuscript)

Corman, H. and Escalona, S. Stages of sensorimotor development: A replication study. Merrill-Palmer Quarterly. 1969. Vol. 15, 351-361.

Drage, J.S., Berendes, H.W., & Fisher, P.D. The Apgar scores and four-year psychological examination performance. In Perinatal factors affecting human development. Pan American Health Organization Scientific Publication No. 185, 1969.

Dreyfus-Brisac, C. The bioelectric development of the central nervous system during early life. In F. Falkner (Ed.). Human development. Philadelphia and London: W.B. Saunders Co., 1966.

Drillien, C.M. The growth and development of the prematurely born infant. Baltimore: The Williams and Wilkins Co., 1964.

Dubowitz, L.M.S., Dubowitz, V., & Goldberg, C. Clinical assessment of gestational age in the newborn infant. The Journal of Pediatrics. 1970. Vol. 77, 1-10.

Escalona, S. & Corman, H. The validation of Piaget's hypothesis concerning the development of sensori-motor intelligence: Methodological issues. Paper presented at the biennial meeting of the Society for Research in Child Development, New York City, March, 1967.

Fagan, J.F. Memory in the infant. Journal of Experimental Child Psychology. 1970. Vol. 9, 217-226.

Fantz, R.L. Visual experience in infants: decreased attention to familiar patterns relative to novel ones. Science. 1964, Vol. 146, 668-670.

Golden, M. & Birns, B. Social class and cognitive development in infancy. Merrill-Palmer Quarterly. 1968. Vol. 14, 139-149.

Golden, M. & Birns, B. Social class, intelligence, and cognitive style in infancy. Child Development. 1971. Vol. 42, 2114-2116.

Gouin-Décarie, T. Intelligence and affectivity in early childhood. New York: International Universities Press, 1967.

Graham, F.K. Behavioral differences between normal and traumatized newborns. I. The test procedures. Psychological Monographs. 1956. Vol. 70, Whole No. 20.

Graham, F.K., Pennoyer, M.M., Caldwell, B.M., Greenman, M., & Hartman, A.F. Relationship between clinical status and behavior test performance in a newborn group with histories suggesting anoxia. The Journal of Pediatrics. 1957. Vol. 50, 177-189.

Graham, F.K., Ernhard, C.B., Thurston, D. & Craft, M. Development three years after perinatal anoxia and other potentially damaging newborn experiences. Psychological Monographs, 1962, Vol. 76. Whole No. 522.

Graziani, L.J., Weitzman, E.D., & Velasco, M.S.A. Neurologic maturation and auditory evoked responses in low birth weight infants. Pediatrics. 1968. Vol. 41, 483-494.

Greenberg, D.J. & Weizmann, F. The measurement of visual attention in infants: A comparison of two methodologies. Journal of Experimental

Child Psychology. 1971. Vol. 11, 234-243.

Haaf, R.A. & Bell, R.O. A facial dimension in visual discrimination by human infants. Child Development. 1964. Vol. 38, 893-899.

Halverson, H.M. An experimental study of prehension in infants by means of systematic cinema records. Genetic Psychology Monographs. 1932. Vol. 10, 110-286.

Hobel, C.J., Hyvarinen, M., Okada, D.M., & Oh, W. Prenatal and intrapartum high risk screening. 1. Prediction of the high risk neonate. American Journal of Obstetrics and Gynecology. 1973. Vol. 117, 1-9.

Honzik, M.P., Hutchings, J.J., & Burnip, S.R. Birth record assessments and test performance at eight months. American Journal of Diseases of Children. 1965. Vol. 109, 416-426.

Hunt, J.V. Environmental risk in fetal and neonatal life and measured infant intelligence. In M. Lewis (Ed.). Infant intelligence. New York: Plenum Press, 1975., in press.

Kagan, J. Change and continuity in infancy. New York: Wiley, 1971.

Karmel, B. The effect of age, complexity, and amount of contour on pattern preferences in human infants. Journal of Experimental Child Psychology. 1969. Vol. 7, 339-354.

Kass, M.A., Sigman, M., Bromwich, R., Parmelee, A.H. Educational intervention with high risk infants. In T. Tjossem (Ed.) Intervention strategies for high risk infants and young children. Baltimore: University Park Press, 1975. in press.

Knobloch, H. & Pasamanick, B. Environmental factors affecting human development, before and after birth. Pediatrics. 1960. Vol. 26, 210-218.

Knobloch, H. & Pasamanick, B. Gesell and Amatruda's Developmental diagnosis. 3rd Edition. Hagerstown, Maryland: Harper & Row, 1974.

Kopp, C.B. Fine motor abilities of infants. Developmental Medicine and Child Neurology. 1974. Vol. 16, 629-636.

Kopp, C.B., Sigman, M. & Parmelee, A.H. Longitudinal study of sensorimotor development. Developmental Psychology. 1974, Vol. 10, 687-695.

Lilienfeld, A.M. & Parkhurst, E. A study of the association of factors of pregnancy and parturition with the development of cerebral palsy. A preliminary report. American Journal of Hygiene. 1951. Vol. 53, 262-282.

Nelson, K.B. The 'continuum of reproductive casualty'. In R. MacKeith & M. Bax (Eds.) Studies in infancy. Clinics in Developmental Medicine No. 27. Lavenham, England: Spastics International Medical Publications in Association with William Heinemann Medical Books Ltd., 1968.

Nesbitt, R.E.L., Jr. & Aubry, R.H. High-risk obstetrics. II. Value of semiobjective grading system in identifying the vulnerable group. American Journal of Obstetrics and Gynecology. 1969. Vol. 103, 972-985.

Niswander, K.R., Friedman, E.A., Hoover, D.B., et al. Fetal morbidity following potentially anoxigenic obstetric conditions. I. Abruptio placentae. II. Placenta previa. III. Prolapse of the umbilical cord. American Journal of Obstetrics and Gynecology. 1966. Vol. 95, 838-845.

Pancratz, C.N. & Cohen, L.B. Recovery of habituation in infants. Journal of Experimental Child Psychology. 1970. Vol. 9, 208-216.

Parmelee, A.H., Jr., Wenner, W.H., Akiyama, Y., Schultz, M., & Stern, E. Sleep states in premature infants. Developmental Medicine and Child Neurology. 1967[a]. Vol. 9, 70-77.

Parmelee, A.H., Jr., Wenner, W.H., Akiyama, Y., Stern, E., & Flescher, J. Electroencephalography and brain maturation. In A. Minkowski (Ed.). Regional development of the brain in early life. Oxford: Blackwell Scientific Publications, 1967[b].

Parmelee, A.H., Jr., Schulte, F.J., Akiyama, Y., Wenner, W.H., Schultz, M.A. & Stern, E. Maturation of EEG activity during sleep in premature infants. Electroencephalography and Clinical Neurophysiology. 1968[a]. Vol. 24, 319-329.

Parmelee, A.H., Jr., Akiyama, Y., Schultz, M.A., Wenner, W.H., Schulte, F.J., & Stern, E. The electroencephalogram in active and quiet sleep in infants. In P. Kellaway & I. Petersen (Eds.). Clinical Electroencephalography of Children. New York: Grune & Stratton, 1968[b].

Parmelee, A.H., Jr. & Schulte, F.J. Developmental testing of pre-term and small-for-date infants. Pediatrics. 1970. Vol. 45, 21-28.

Parmelee, A.H. & Haber, A. Who is the "risk infant"? Clinical Obstetrics and Gynecology. 1973. Vol. 16, 376-387.

Parmelee, A.H., Sigman, M., Kopp, C.B., & Haber, A. The concept of a cumulative risk score for infants. In N.R. Ellis (Ed.). Aberrant development in infancy. Human and animal studies. 1975[a]. in press.

Parmelee, A.H., Sigman, M., Kopp, C.B., Haber, A. Diagnosis of the infant at high risk for mental, motor, or sensory handicap. In T. Tjossem (Ed.). Intervention strategies for high risk infants and young children. Baltimore: University Park Press, 1975[b]. in press.

Piaget, J. The origins of intelligence in children. New York: International Universities Press, 1952.

Piaget, J. The construction of reality in the child. New York: Basic Books, 1954.

Prechtl, H.F.R. Prognostic value of neurological signs in the newborn infant. Proceedings of the Royal Society of Medicine. 1965. Vol. 58, 1991-1994.

Prechtl, H.F.R. Neurological findings in newborn infants after pre- and paranatal complications. In Aspects of prematurity and dysmaturity. Nutricia Symposium, Groningen 10-12 May 1967. Leiden: H.E. Stenfert Kroese NV, 1968.

Prechtl, H. & Beintema, D. The neurological examination of the full-term newborn infant. Little Club Clinics in Developmental Medicine No. 12. London: William Heinemann Medical Books Ltd., 1964.

Prechtl, H.F.R., Akiyama, Y., Zinkin, P., & Grant, D.K. Polygraphic studies of the full-term newborn: 1. Technical aspects and qualitative analysis. In R. MacKeith & M. Bax (Eds.). Studies in infancy. Clinics in Developmental Medicine No. 27. Lavenham, England: Spastics International Medical Publications in Association with William Heinemann Medical Books Ltd., 1968.

Prechtl, H.F.R., Weinmann, H., & Akiyama, Y. Organization of physiological parameters in normal and neurologically abnormal infants. Neuropaediatrie. 1969. Vol. 1, 101-129.

Rogers, M.G.H. Risk registers and early detection of handicaps. Developmental Medicine and Child Neurology. 1968. Vol. 10, 651-661.

Rosenblith, J.F. Relations between neonatal behaviors and those at eight months. Developmental Psychology. 1974. Vol. 10, 779-792.

Sameroff, A.J. & Chandler, M.J. Reproductive risk and the continuum of caretaking casualty. In F.D. Horowitz, M. Hetherington, S. Scarr-Salapatek, & G. Siegel (Eds.). Review of child development research. 1975. in press.

Sigman, M., Kopp, C.B., Parmelee, A.H., & Jeffrey, W.E. Visual attention and neurological organization in neonates. Child Development. 1973, Vol. 44, 461-466.

Sigman, M. & Parmelee, A.H. Visual preferences of four-month-old premature and full-term infants. Child Development. 1974. Vol. 45, 959-965.

Stern, E., Parmelee, A.H., Jr., Akiyama, Y., Schultz, M.A., & Wenner, W.H. Sleep cycle characteristics in infants. Pediatrics. 1969. Vol. 43, 65-70.

Uzgiris, I. & Hunt, J. McV. An instrument for assessing infant psychological development. Mimeographed paper, Psychological Development Laboratory, University of Illinois, 1966.

Wachs, T., Uzgiris, I., & Hunt, J. McV. Cognitive development in infants of different age levels and from different environment backgrounds: An explanatory investigation. Merrill-Palmer Quarterly. 1971. Vol. 17, 283-317.

Werner, E.E., Bierman, J.M. & French, F.E. The children of Kauai. Honolulu: University of Hawaii Press, 1971.

Wiener, G., Rider, R.V., Oppel, W.C., & Harper, P.A. Correlates of low birth weight. Psychological status at 8 to 10 years of age.

Pediatric Research. 1968. Vol. 2, 110-118.

Yarrow, L.J., Rubinstein, J.L., Pedersen, F.A., & Jankowski, J.J. Dimensions of early stimulation and their differential effects on infant development. Merrill-Palmer Quarterly. 1972. Vol. 18, 205-218.

Yarrow, L.J., Klein, R.P., Lamonaco, S., & Morgan, G.A. Cognitive and motivational development in early childhood. In B.Z. Friedlander, G.M. Sterritt, & G. Kirk (Eds.). The exceptional infant. Vol. 3. New York: Bruner/Mazel, 1975. in press.