

TRACKING THE MOTOR BEHAVIOR

DEVELOPMENT OF MULTIHANDICAPPED INFANTS

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## ABSTRACT

Current strategies for measuring the effects of intervention with multihandicapped infants and the origins of these strategies are reviewed. Direct tracking of developing behaviors, primarily those related to postural control and precursors of ambulation, offers a useful measurement technique for describing the course of development, for curriculum building and for assessing intervention impact. Some of the results of such direct tracking of motor behavior development are presented.

Improving and evaluating the effectiveness of programs for multihandicapped infants rests on the development of an assessment methodology that is quantifiable, which will allow tracking of an individual child's course of development over time, and which is sensitive to the interventions. There is not yet a refined methodology which meets these criteria. This review makes three points about the development of an adequate assessment technology: first, that most infant intervention studies have focused on a "high risk" rather than an established risk population and thus have used an evaluation strategy which is not adequate for the multihandicapped; second, there is a need to add to the knowledge about the course of development in multihandicapped children; and third, there is growing recognition of the value of a quantitative assessment approach to infant development. We will additionally review some preliminary findings from the application of a quantitative methodology to a multihandicapped infant program.

#### Current State of Early Intervention

There are two major target populations of most infant intervention programs. The first are the high risk babies who, because of social disadvantage or compromising medical conditions are not expected to develop normally unless special procedures are added

to their early environment. Here the focus is on preventative programming, either in the home (Gutelius et al., 1972; Karnes, Teska & Hodgins, 1970) in day care (Caldwell, Wright & Honig, 1970; Caldwell & Smith, 1970) or residential settings (Lodge et al., 1970; Seyegh & Dennis, 1965). The review of infant programs by Horowitz and Paden (1973), which is characteristic of most infant intervention literature, centers almost entirely on the culturally different child.

The other target population includes children with single sensory impairments. Fraiberg's work with blind babies (Fraiberg, 1971; Fraiberg, Smith & Adelson, 1969) and the infant training programs for the deaf (Horton, 1968; Miller et al., 1972) are characteristic of this work.

Since, for these risk populations, the intervention outcome is expected to be normal functioning, the assessment strategies focus on cognitive development with the major issues being those of cognitive constancy and accurate prediction of eventual level of functioning, with little attention to the process or course of development (Erickson, 1968; Holden, 1972; Starr, 1971). The most frequent outcome measure among the intervention research reviewed by Horowitz and Paden (1973) was I.Q. gain. Unfortunately, this focus on cognitive development has predominated in assessment of intervention with physically multihandicapped infants. It is not unusual that pre and post test scores on a global infant intelligence scale serve as the measure of behavior change with these infants.

The population with which we are concerned are the "established

risk" infants of Tjossem (1973), those with early identifiable handicaps related to diagnosed medical disorders. For these infants the intervention goal is not to produce normal children but to help them function at the top of the range determined by the disability. For these infants the program must center on those gross and fine motor skills culminating in purposeful use of the hands, postural control and ambulation. For these goals an evaluation methodology relying on cognitive function is not useful. Tjossem's discussion of the rationale for intervention points out some of the questions that assessment procedures must address. For the established risk population he points out that we cannot as yet specify which of the many facets in a broad intervention program are the effective change agents, and that we do not know the best way to sequence these agents to maximize change. He concludes, "In short, we lack a refined, scientifically based technology of early intervention" (Tjossem, 1973).

#### Current Efforts at Tracking Infant Motor Development

Refinement of behavioral pinpoints. Currently available procedures for evaluating infant motor development have two features which diminish their value for the multihandicapped. First, many are designed for cross sectional assessment which places the child against a normative standard rather than for tracking the course of development; second, on most scales the behavioral sequences leading to the behavioral end product are not broken down into steps small enough for the multihandicapped. An additional characteristic of much of the research is that the data about

development have been plotted in terms of distributions of scores on scales rather than charting the behavior itself.

As mentioned above, measurement of cognitive change has been used in the evaluation of programs for multihandicapped infants even when the intervention is directed at motor rather than intellectual development. Global development scales such as the Bayley and the Denver Developmental Screening Test are commonly used. Although these are useful in assigning a developmental level to the child's current repertoire, they are not responsive enough to behavior change to provide immediate feedback to the therapist or teacher about how the child is progressing toward the training goals. Knowing how a child compares to normal children is useful but it is not sufficient information. Adelson and Freiberg (1974) in their study of motor development of blind babies point out the need for several kinds of data on children with developmental peculiarities. In order to characterize the effects of blindness on mobility they compared blind and normal babies on motor items from standard infant scales; in order to demonstrate the effects of their intervention programs they had to compare the motor skills of infants in their program with those of a larger sample of blind babies who had not received similar intervention.

The greatest limitation of developmental scales as a sensitive tracking system for multihandicapped infants relates to the size of the steps between skills which are geared to the pace of behavioral emergence in the rapidly developing normal child. These scales include only a limited number of developmental

pinpoints in the major areas of head and postural control, mobility and development of reach and grasp. For example, on the Bayley Motor Scale there are only four items measuring postural control prior to the competence level of maintaining the head erect and steady; there is only one item before the skill of reaching for and grasping a cube on a surface before him.

There is a growing recognition of the need for greater precision and quantification of motor development among children whose development is deviant. One expression of this is the appearance of a number of fine grained check lists breaking motor skills into smaller steps appropriate to the multihandicapped. Reimers (1972) constructed a hierarchical list allowing assignment of a numerical figure to the ambulation skills of cerebral palsied children based on the amount of support the child required. Wright and Nicholson (1973) present a scale for assessing effects of physical therapy with young spastic children. On their scale the examiner rates the child's performance on a scale of zero to three, four, five, or six, depending on the item, on a series of activities related to head control, rolling, sitting, and walking. Grant, Boelsche and Zin (1973) refined the measurement of two early motor skills (finger to thumb apposition and rapid alternating supination and pronation of the forearms and hands) and set up performance norms at the lower age levels.

The work of Kopp and associates at UCLA represents one of the major national efforts to carry out fine grained analyses of the components of the major classes of behavior. They are studying the longitudinal development of normal infants including the

differential rates of acquisition of behaviors (Kopp, Sigman, & Parmelee, 1974) and the analysis of reach and grasp patterns among eight month old infants (Kopp, 1974).

Cohen, Gross & Haring (1975) recognized that teachers of the multihandicapped needed information about behavioral development sequences and that any single developmental scale did not provide either sufficient behaviors following a single skill or behaviors stated in terms relevant to the classroom. As a response to this need they have prepared a curriculum, the Developmental Pinpoints, which is a compilation of sequenced skills adapted from over a dozen child development scales. The value of their lists is that they have many more pinpoints than any single scale, and by sandwiching all items related to a single skill they have a large number of sequenced behaviors. The limitation of this curriculum is that the sequences are made up of landmark behaviors that observers of normal children felt were useful for tracking normal development; they do not represent observations of children with impairments to determine which pinpoints are most relevant to their rehabilitation and most sensitive to their development.

Infant training programs themselves have been a source of sequential check lists of motor behavior. One example is the Portage Project, a home teaching program for preschool children with any degree of disability (Shearer, et al., 1974). The program's initial assessment of the child is provided by a check list covering several areas including motor. The child's status with respect to these serial items provides the starting point

for the training program. The motor section of the list includes 45 items of which 21 relate to the broad classes of postural control and development of reach and grasp. For example, there are nine items related to various skill levels in achieving head control. Another example of a small step check list is the Behavioral Development Profile of the Marshalltown Project (Keisler, et al., 1974). This instrument is designed to monitor behavior in communication, social and motor areas. Each of the items which are grouped into one month age categories for the first year refer to "incremental" behavioral objectives. The items are based on general information on patterns of normal child development.

Sequential check lists of motor development pinpoints represent the starting point from which to develop a tracking system for the multihandicapped infant; they provide suggestions for the small behavioral steps that are necessary. As a monitoring system, however, they are not sufficient in themselves, since they were designed to provide a cross sectional baseline of the child's level of attainment prior to intervention, and to suggest a starting point for treatment. Also, check list comparisons do not provide information about rate of acquisition and how the emergence of one skill is influenced by acquisition of other behaviors.

Development of a quantitative assessment strategy. Accurate assessment of intervention with multihandicapped infants requires an evaluation technology which is quantitative in nature, and which allows longitudinal study of systematic changes in a single child, comparison of development of several behaviors in one child, and

comparisons across children, both normal and handicapped. Most data on infant motor development was compiled for different purposes.

The major efforts to study emerging motor behavior occurred in the first half of this century. The primary strategy was to observe large numbers of children to obtain normative information about age-related behaviors with the aim of constructing developmental test items. Since motor behaviors all share two features - universal appearance in all normal infants and an increased probability of occurrence as a function of age, the data obtained was expressed in group fashion and no attention was given to the quantitative assessment of the course of development in an individual child (Bayley, 1935; Halvorson, 1933; McGraw, 1941). Shirley (1931) made some preliminary attempts to directly and quantitatively measure emerging motor behavior, using duration measures for sitting and number of steps to quantify the development of walking.

Shapiro (1962), studying the development of walking in one child, used the average daily frequency of consecutive steps before falling as his measure. His data demonstrated a non-linear exponential mode of development of this skill and a periodicity or four day cycle effect in growth. Although his findings provided new information about the course of a systematically changing behavior, his measurement tactic was evidently never followed up.

Seth (1973) made a recent effort to develop an "analytic/quantitative" approach to behavior development. His strategy

was not to develop norms for infant behavior but to quantify some of the prominent features of visual-motor performance in order to define trends in development. Using filmed records of nine infants he charted frequency over weeks and median percent of total weekly observation time during which a child engaged in the behavior being studied. He obtained quantitative measures of several components of visual-motor skills such as duration of gaze at an object, frequency of gaze shifts, of reaching toward an object, and of gaze and reach directed toward same object. This approach was valuable in studying the developing organization of behavior and allowed him to see trends, not apparent by previous methods, in concentration of attention and its relation to movement. His data reveal some relations between eye-hand activity and nature of the object presented not before noted. His measure also details changes over time in handedness. Although his data is presented as grouped data for nine children his technology, including fine grained analysis of individual behaviors and direct measures over time of frequency and duration would be useful for studying the systematic changes in other emerging skills in individual children.

Significant for the quantification of motor development is the preliminary work in measurement of infant motor, social and language behaviors of the Edwards'. They demonstrate that direct and daily recording of the frequency of such behaviors as sits, supported and free steps, and creeps provided precise quantified measures sensitive to systematic developmental changes in behavior allowing within and across child comparisons (Edwards &

Edwards, 1969 a; Edwards & Edwards, 1970). They also directly measured behavior frequencies of normal and handicapped children for a variety of postural and mobility skills. They validated the sensitivity of directly recorded frequency to (a) individual differences in behaviors within and across children, (b) differential rates of change in development, (c) effects of illness, (d) effects of prosthetic devices, and (e) differences between normal and birth defect children in motor development (Edwards & Edwards, 1969 b).

Cairns and colleagues have conducted a series of research projects on the quantitative changes over time in vocal behavior of normal and at-risk infants recorded in terms of behavior frequencies (Cairns, Weaver, & Wehr, 1974; Cairns & Karchmer, 1975). Their methodology and preliminary findings are relevant to the study of infant motor behavior.

First, they confirmed that grouped data, which is the form in which much developmental information is presented, does not allow for the extraction of developmental trends for individual children, which is necessary for rapid feedback about intervention with deviant infants. Second, they found that a direct quantitative technology of observation provides highly reliable data, which can be collected inexpensively by parents. Third, that quantitative tracking of infant vocal behavior development expressed in frequency data allows the visualization of differential developmental patterns and in the sample studied so far, suggests that deviant patterns related to sensory and environmental deficits can be identified and tracked early.

Koenig (1972) presents a strategically oriented discussion of the value of behavior frequencies as a measurement technology for human behavior, specifically for developing behavior. Some of the positive features of frequency include (a) improvements in behavior independent of their absolute frequencies can be visualized, which is necessary when studying children whose actual movement potentials are extremely diverse, and (b) the charts of behavior frequencies may be projected reliably to allow for prediction of future frequencies which, when compared to obtained frequencies will provide indications of treatment effects.

Application of Direct Behavioral Measurement to  
Multihandicapped Infants

In our own project of intervention with multihandicapped infants we have been measuring a variety of developmental pinpoints over a two year period. This project was undertaken to define developmental pinpoints which meet certain criteria, (a) that they be fine grained enough to be sensitive to the slow development of multihandicapped children, (b) that they relate clinically and programmatically to the child's treatment and (c) that these pinpoints be easily and reliably observed and recorded in the treatment sessions and at home by parents. A second goal of the project has been to determine the differential sensitivity of various dimensions of direct measurement of emerging behavior such as the best observation time base for each behavior or each child, the optimal number of observations per session, the informational value of daily versus weekly charting,

and the merits of duration versus frequency.

To date the development of seven infants and young children has been charted. The procedure has allowed the identification of some target behaviors that are useably defined, easily and reliably observed without expensive equipment, and some measures of these behaviors that are functional for assessing program effects. The developmental goals of the intervention programs for these children almost always encompass postural control, body mobility and functional hand use; thus, the major effort in the development of pinpoints for tracking multihandicapped infants has focused on these three skill areas. Some useful behavioral components of these skills have been identified. Although there is a developmental progression in each child's growth in each skill, the individual components do not emerge or need to be developed in a single-track, strictly hierarchical arrangement that is identical across children; each handicapped child's idiosyncratic pattern of reflex development may affect the sequence.

The home and school based records of behavior development provide useful information along several dimensions. They facilitated the development and refinement of treatment curricula individually tailored to each child. An eight step sequence of components in the acquisition of functional hand use has been worked out (Whitney, 1976). The most sensitive measure of an individual child's progress through this sequence has been a record of the frequency with which a child emits the component behavior during a specified time period (generally five or ten

minutes). By also recording the number of times he is presented with an object the record shows both rate of occurrence of the target behavior and the ratio of success and failure.

The records have allowed the development of very sensitive measures of change in the children, something that was not previously available with existing measurement techniques. Changes in head control are easily noted; this is an easy target to define and for parents to observe and record reliably. The movement begins when the chin leaves the floor and ends when the chin returns to the floor. Edwards and Edwards (1969 a) indicate that the frequency of episodes of behavior related to postural control is sensitive to the development and decay of behaviors. The data on the course of development of head control in normal children confirm the sensitivity of frequency as a measure. However, the data from the multihandicapped children who change so slowly suggest that duration is a more sensitive measure of change in head control for that population and specifically that the duration of the longest of five consecutive head lifts measured daily reflects their change with more sensitivity. What seems to be happening is that the child each day or so can hold his head up a bit longer, but this does not maintain for each time he lifts his head. The data suggest, further, that for this population daily recording of this behavior may be no more useful than three times per week.

Another value of the continuously monitored behavioral development is that the records provide information allowing therapists to rather quickly assess the effectiveness of the gross

motor treatment programs designed to meet specific deficits in the individual children. Changes in weekly frequency of occurrence revealed when a child had reached a functional level in a skill, when a treatment procedure was losing effectiveness, and when a child had moved to a new stage of integration of skills. Whitney (1976) presents several case examples demonstrating these patterns.

The records of behavior development are also sensitive to changes in the multihandicapped child's current health status. The extremely slow recovery of behavior frequencies following illness contrasts markedly with normal childrens' findings. In some cases, following a prolonged infectious illness, a multihandicapped child never would return to pre illness levels. This finding points out another significant complicating and debilitating feature of the problems of the multihandicapped child.

Continuously monitored behavioral development expressed as frequency of occurrence of targeted skills provides a very promising basis for therapeutic decision making in the early intervention with multihandicapped children. It is thus a tactic as well for demonstrating program effectiveness, and, therefore, has value in meeting the requirements of program accountability.

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