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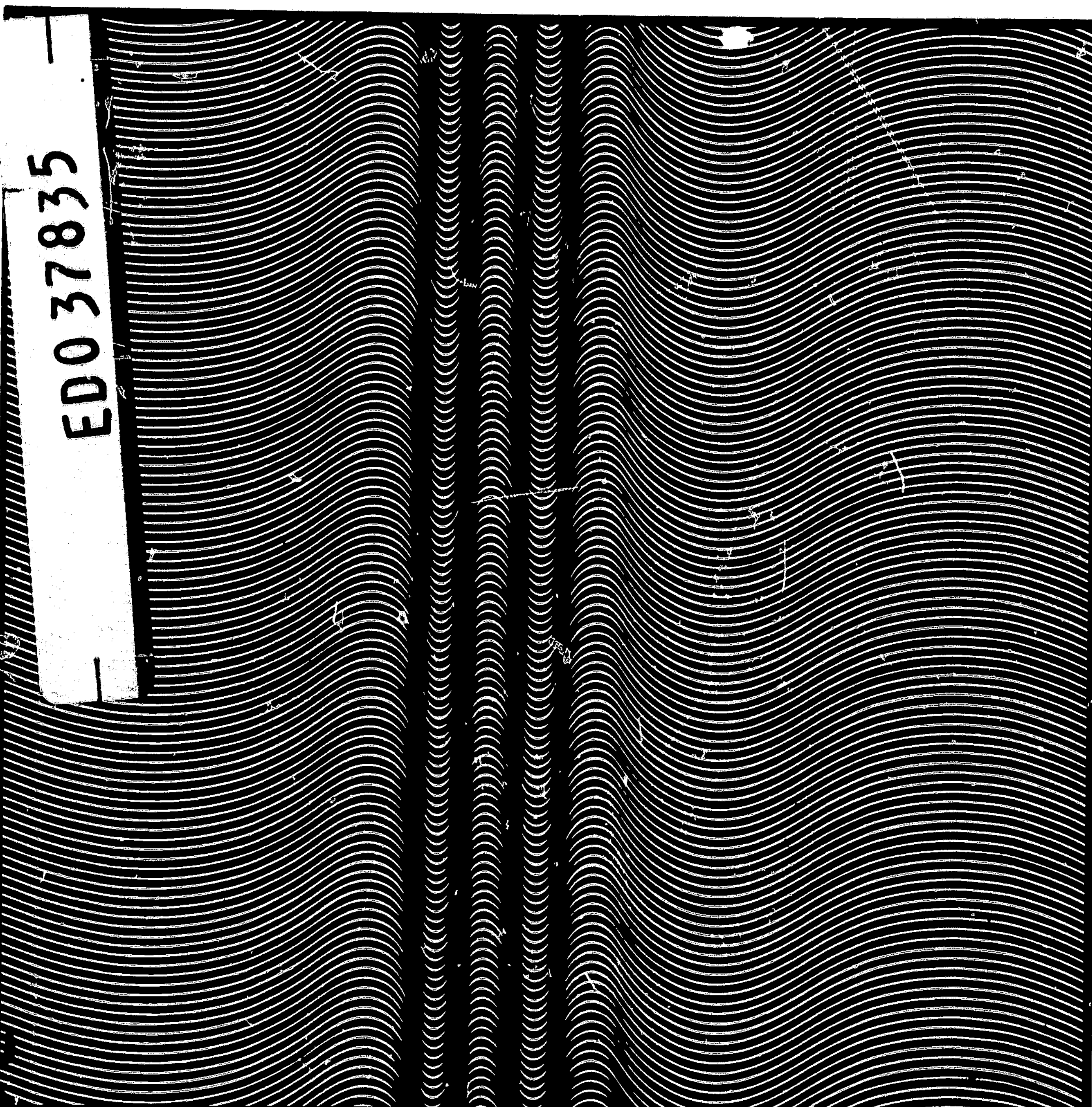
ABSTRACT

The proceedings include addresses by Logan Wright on highlights of human development from birth to age 11, Leonard A. Cohen on development and function of the mechanisms of perception, Eric Denhoff on motor development as a function of perception, and Alan Hein on exposure history in spatial-motor development. Also provided are reports by William T. Braley on the Dayton program for developing sensory and motor skills in 3, 4, and 5 year-old children, by Alice D. Coffman on personalizing early education, and by Louis Bowers on a program of motor development activities. A multidisciplinary exchange on perceptual motor development group discussions on learning and on future needs, and a conference summary are included. Appendixes list conference leaders, organizational representation, participants and observers, and questions raised by participants. (LE)

PERCEPTUAL-MOTOR FOUNDATIONS:



MULTIDISCIPLINARY CONCERN

Perceptual-Motor Foundations: A Multidisciplinary Concern

Proceedings of the Perceptual-Motor Symposium

Sponsored by the

Physical Education Division

of the

American Association for Health, Physical Education, and Recreation

National Education Association Center

Washington, D.C.

May 8-10, 1968

American Association for Health, Physical Education, and Recreation

1201 Sixteenth St., N.W., Washington, D.C. 20036

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Introduction

MEETING A NEED

The American Association for Health, Physical Education, and Recreation has been aware for the past several years of the rapid development of perceptual-motor programs for underachievers in the elementary classroom. Many of these originated as therapy programs outside the educational family, and schools throughout the country have become increasingly involved in programs of perceptual-motor development with special concern for children with learning disabilities.

Since the majority of these programs focused heavily on the role of motor activity in enhancing perceptual development, physical educators have been involved in cooperation with other school personnel in the implementation and continuing development of perceptual-motor programs. Their involvement, and their need for assistance, was reflected by the many requests the Association received for scientific information, methods, materials, speakers, and information on special workshops and clinics.

The Association leaders were fully aware that these programs were in an experimental stage, that there was a dearth of well-controlled studies, that practice was racing ahead of theory, and that many of the program practices and claims were not substantiated. At the same time it was recognized that many benefits were accruing for some children as a result of these programs and that many of the prescriptive activities might or should be found in a good elementary school physical education program for all children. No statements or publications were prepared on the subject, but a need for definitive action was indicated.

The culmination of this recognized need came in May 1967 when the AAHPER Physical Education Division Executive Council appointed a Task Force to study the issue. In addition, approval was given to solicit a scholarly article for the *Journal of Health, Physical Education, Recreation*.

A Task Force was appointed consisting of a school psychologist, a city director of physical education, and two university physical educators. The Task Force decided that a priority step should be a symposium where representatives from physical education and from other disciplines could begin a multidisciplinary exchange of information basic to future program implementation and research.

To ensure maximum communication among discipline representatives at this initial meeting, small discussion groups seemed essential. Attendance was thus limited to approximately 60 participants. The participants were sought from among those who were knowledgeable in the areas of perceptual-motor development and learning and who were actively involved in research, teacher preparation, consulting, clinical practice, or action programs in this area.

Participants who met these criteria were identified from several disciplines by the Task Force through recommendations and through their writings and contributions to the topic of perceptual-motor development as well as by letters of request received as a result of the announcement of the Symposium printed in the February 1968 *Journal of Health, Physical Education, Recreation*. They included psychologists, neurologists, physiologists, physicians, child development specialists, educators, and therapists. In response to the overwhelming number of requests for attendance at this Symposium, a limited number of observers who met similar criteria were invited to attend. Unfortunately, not all requests could be accommodated.

Additional financial support for the Symposium was sought and received from the National Institute of Neurological Diseases and Blindness of the National Institutes of Health. A fee was levied on all participants and observers to further support the project.

It is recognized that this Symposium is merely a first effort at what shall be a continuing project of the Association in the area of perceptual-motor development. The Physical Education Division has approved the continuation of a Task Force on Perceptual-Motor Development. Its function will be to identify needs and to initiate and plan future efforts to serve this area of interest.

Margie R. Hanson
AAHPER Elementary Education Consultant
Staff Liaison for Symposium

TASK FORCE PLANS AND PRIORITIES

The Task Force proceeded within its limitation to familiarize itself with perceptual-motor trends in curriculum. It soon became evident that the most pressing need was for identification of scientific information which would provide guidelines for development of sound and logical programs enhancing perceptual-motor development. Priority was given to the idea of a multidisciplinary symposium which would bring together theorists, researchers, clinicians, and teachers who have demonstrated specialized knowledge in perceptual-motor behavior.

The Task Force committed itself to planning a symposium which would focus solely on the phenomena associated with the development of effective perceptual-motor functioning of the individual. It was our belief that this type of meeting would serve to identify the scientific foundations necessary to increase understanding of perceptual-motor behavior. In turn, this hopefully would provide the direction needed for improving existing programs and for developing new and effective programs for widespread use in the schools.

The nature of the Symposium program was guided by the purposes outlined by the Task Force as follows:

1. To understand the evolution of perceptual-motor behavior
    a. Factors influencing learning: physiological, psychological, developmental, sociocultural
    b. Identification of known deficits
    c. The contributions of perceptual-motor development to behavior
2. To identify implications for the teaching-learning process
3. To explore interdisciplinary implications for child development
4. To identify areas of future study and research

Specialists nationally recognized for their work outside of physical education were invited to present the major papers which provided the scientific foundations significant to the focus of the Symposium.

The multidisciplinary nature of the scientific foundations of perceptual-motor behavior made it evident in the planning stages of the Symposium that persons from many disciplines should be involved in a discussion of mutual concerns. We in physical education are indeed appreciative of the enthusiasm, cooperation, and support given to this idea by all of the organizations and participants represented in these proceedings. The speakers and participants formed multidisciplinary groups to consider the implications of perceptual-motor development for learning and to identify means of implementing learning implications and future research. The efforts of these highly qualified persons working together in small teams will be found in this report of the Symposium.

Next Steps

The Task Force, as a continuing body, has identified major objectives to be pursued in continuing the excellent effort initiated with the Symposium. These objectives are as follows:

1. Categorize and analyze the suggestions from Symposium participants, and recommend structure and function for implementing these suggestions.
2. Assist regional groups in developing guidelines to be used in planning subsequent meetings for discussion of perceptual-motor behavior.
3. Urge groups responsible for planning national and district conferences to provide time in the program for highlighting implications of this symposium, particularly at meetings for teachers and supervisors of elementary physical education.
4. Arrange meetings of the Task Force to develop projected plans for enlarging the scope of its work.

Marguerite A. Clifton
Chairman, Perceptual-Motor Task Force
Symposium Director

EDITOR'S NOTE

The attempt was made in this report of the Perceptual-Motor Symposium to bring to the reader a detailed and complete picture of the content and progress of the meetings. This was believed to be of paramount importance because of the necessary limitation in numbers attending and the widespread interest in the topic under discussion. For this reason, speeches are presented in their entirety and discussions in general sessions are presented almost verbatim. Only in reporting small group discussions was material excerpted and summarized. There were instances where material, not presented at the meetings for lack of time, was sought and received from participants to bring added dimension to this report. Deep appreciation is extended to speakers and participants for their willingness to provide illustrations and additional materials.

Although the report attempts to bring the complete Symposium to the reader, no written report can fully capture the flavor of face-to-face meetings which establish communication and cooperative effort among many disciplines. To paraphrase a statement made at one of the general sessions, the strength of the Symposium is in its multidisciplinary approach, and yet a weakness is that we do not yet know how to work together in an interdisciplinary manner. We are starting something here and the dialogue must go on, with this conference only as a beginning.

We hope that this report will accurately reflect these beginning steps and point the way toward "next steps."

Grateful appreciation is extended to the participants of the Symposium and to the Editorial Committee whose efforts resulted in this report. The editor appreciatively acknowledges the assistance of the Department of Physical Education for Women at the University of Wisconsin in preparing the final manuscript.

Muriel R. Sloan
Chairman, Editorial Committee

Editorial Committee:
Alma Ward Jones
David E. Misner

Addresses

HIGHLIGHTS OF HUMAN DEVELOPMENT, BIRTH TO AGE ELEVEN

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The term "highlights" can possess at least two connotations as far as development is concerned. In one respect it might refer to those focal points or landmarks along the road of development (such as learning to sit alone, uttering a word or two, etc.) which we refer to as developmental milestones or developmental tasks. These "highlights" now represent an attraction for an increasing group of spectators, including parents, pediatricians and other physicians, psychologists, an emerging and rather heterogeneous group of professionals known as child development specialists, as well as physical educators and others interested in human movement and perception. A second connotation of the word "highlight" is that of a brief glimpse of recent news and other matters of interest such as: highlights of the Winter Olympics, highlights from the academy awards, etc. In this sense, highlights of human development between birth and 11 years would refer to what is new or newsworthy regarding knowledge about development during this period. Presumably, this second type of highlight would *not* refer to *descriptive* information about development such as milestones or tasks, but rather to new knowledge of an *explanatory* nature, such as information about why certain developmental anomalies occur, what can be done to accelerate the rate of development, means of increasing the upper limits of development, etc.

This paper will be divided into two parts. The strategy will be to first discuss the most important developmental milestones and developmental tasks, and then to explore some of the knowledge which has emerged in recent months about factors (particularly perceptual-motor in nature) which may influence development as it progresses from milestone to milestone.

Milestones, Tasks, Ages, and Stages

Three similar, but somewhat independent ideas have been used to point out the strategic landmarks or demarkation points that occur during the developmental process. These are the concepts of (a) developmental tasks, (b) age and stage periods, and (c) developmental milestones.

Developmental tasks: A developmental task can be defined as an important accomplishment which the individual must achieve by a certain time if he is going to function effectively and meet the demands which society will place upon him. Learning to take solid foods, learning to control elimination of body wastes, learning to get along with age mates, etc., are examples of such tasks. The idea of developmental tasks has been considered by Havighurst (22) and his colleagues comprising the Committee on Human Development at the University of Chicago. They describe the developmental tasks of six periods in life. Two of these periods — infancy and *early* childhood, and middle childhood — cover the major portion of time in our period of birth to 11 years. Havighurst suggests the following as examples of critical developmental tasks for infancy and early childhood (birth to 4 years of age): stability (of temperature, heart rate, etc.), ability to consume solid foods, talking, morale development and the emergence of a sense of right and wrong, etc. Examples of developmental tasks of *middle* childhood (4 to 8 years of age) include: physical skills necessary for performing ordinary childhood games, wholesome attitudes toward one's self, socialization skills and the ability to relate to others, sexual identification, etc. It is worth noting that five of the developmental tasks of infancy and early childhood clearly involve physical or motor variables. And, although the idea may have become "old hat" to most by now, Havighurst feels that children's games, as well as other physical and motor activities, play a crucial role in relationship to the developmental tasks of middle childhood. I hasten to indicate my awareness of the fact that the best recommended physical education programs for the elementary school are *not* games centered programs. Nonetheless, the first task listed by Havighurst under middle childhood is "physical skills necessary for ordinary childhood games." As far as the second task (wholesome self attitudes) is concerned, Havighurst feels that motor skills are important to both boys and girls in obtaining such attitudes. There is also empirical evidence (37) to support a correlation between one's physical self concept and his overall concept of himself. As far as the third developmental task of middle childhood (socialization) is concerned, the role of games is felt to also play an important role here. For instance, the late and well known psychiatrist, Harry Stack Sullivan (38), once noted that socialization requires that a child learn how to both compete and cooperate with peers. There may be no better laboratory than that offered by childhood games in which to teach competition, cooperation, and integration of these two activities.

Ages and Stages: The concept of developmental stage is somewhat different from the concept of tasks. It refers to periods of development (such as Freud's oral stage) which can be characterized by certain types of behavior (e.g., dependency and orality). Instead of referring to a specific point in time, stages generally cover a period of one year or more, and most theorists with age and stage schemes have divided childhood, or even the entire life's cycle, into ten stages or less. One or more developmental tasks is presumably accomplished during each stage (e.g., resolution of the Oedipal conflict during Freud's phallic stage).

One of the first proponents of an age and stage plan was Shakespeare. Interestingly enough he appears to have been the only writer until recent months to incorporate the entire life cycle (including senility) into his scheme. Shakespeare's stages were as follows: (a) the infant, (b) the school boy, (c) the lover (or adolescent), (d) the soldier (or young adult), (e) the justice (or middle aged man), (f) old age, and (g) second childhood (or senility). His six word description of the final stage of senility or second childhood, to me, represents a masterpiece of description, providing both impact and meaning. The individual for whom development had progressed to this stage, Shakespeare described as "sans teeth, sans taste, sans everything."

Since the time of Shakespeare, several theorists have set forth series of ages and stages. Some of these schemes are designed to describe personality and social development, some to describe cognitive and intellectual development, and some to describe development in general. For instance, the five Freudian stages (oral, anal, phallic, latency, and genital) are designed to describe periods in personality development. However, physical and motor activities are regarded as crucial for such development. A motor experience, sucking, is the single most important behavior during the first, and developmentally most strategic, stage of life. The motor responses and physical sensations associated with defecation are felt to play the key role during the second stage. However, psychoanalytic theorists since the time of Freud have advanced age and stage schemes to explain personality development which places less emphasis on physical and motor variables and greater emphasis on interpersonal experiences. These theorists include such writers as Erikson (12) and his *Eight Stages of Man* and Sullivan (38) with his seven stages of development.

In the area of cognitive and intellectual development, the stages of Piaget stand out. However, these will be treated later under the topic of developmental milestones. In the area of development in general (including motor development), Gesell's (18, 19, 20) stages are probably the best known. His stages are not named except by the chronological periods that they represent: for instance, 18 to 24 months, the six year old, etc. He proposes 21 stages which represent cycles of maturation. The good stages are known as "nodal" ages and represent times in which the child maintains a high degree of mastery over his immediate environment and is generally pleasant to be around. Nodal ages are sometimes referred to as "in focus stages." The opposite of a nodal age is an "out of focus" stage in which the child maintains a low mastery over his immediate environment and is generally not pleasant to be around. Two years, five years, and ten years are examples of nodal ages.

Developmental milestones: A developmental milestone can be regarded as similar, sometimes identical, to a developmental task. However, the milestone concept represents a somewhat different emphasis. Rather than representing an accomplishment which must take place if an individual is to adapt to his environment, this idea refers to strategic indicators of how far development has progressed. The ability to walk, talk in sentences, etc., are common examples of developmental milestones. These indicators are usually quite obvious, and it is easy to determine whether they are present or absent. The child either can or cannot sit alone, obtain a small object by means of pincer grasp, ride a bicycle, etc. Unlike developmental tasks, these accomplishments may not necessarily be crucial for adjustment in the world. However, they represent convenient criteria or yardsticks by which the rate and extent of development can be gauged. As far as developmental milestones are concerned, a professional person interested in human development can gain familiarity with the more traditional ones in physical, intellectual, and personality development from an inspection of any survey-type textbooks on human development.

Piaget's milestones: The work of Jean Piaget (33) can also be viewed in terms of developmental milestones. Actually, the genius of Piaget probably lies in his ability to identify milestones or demarkation points in development which have previously been overlooked. Piaget has observed the same behavior which was witnessed by parents and scholars for centuries: an infant's grabbing an object when it has been brought into view, moving his body in order to cause a mobile above his crib to move, searching for an object which has been removed from sight, etc. However, these behaviors possessed a different meaning to Piaget. He was able to see in them a hierarchy of cognitive development, with each behavior representing a different stage, step, or milestone. Thus, it is also appropriate to look at Piaget's stages in order to round out our view of the various approaches to the idea of developmental milestones. In doing so, an attempt will also be made to point out some of the more obvious relationships between Piaget's observations and perceptual-motor experience.

Before proceeding further, it should probably be pointed out that Piaget's theory is not an explanatory theory but merely a descriptive one. For this reason, he is best considered at this point rather than in the coming discussion of factors which may be capable of modifying the developmental process. However, an attempt will eventually be made to combine Piaget's ideas with data obtained by other researchers in a manner which hopefully provides a few insights into the underlying factors which influence development. Piaget divides early development into periods of epochs. The time between birth and 11 years is covered by three periods: the sensorimotor period, the preconceptual period, and the period of concrete observations. Piaget's developmental scheme includes a fourth period, formal operations, which is felt to begin at about 11 years of age. One of his periods, the sensorimotor, is divided into six stages which, collectively, cover the first two years of life. It is on the six substages of the sensorimotor period that we will focus our attention.

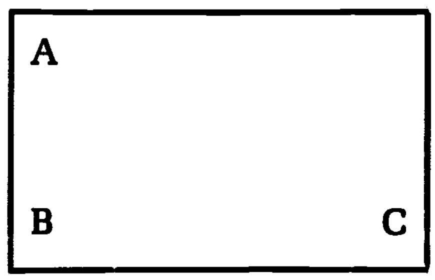
At this juncture an important point relating to the purpose of this symposium can be made. It is probably no accident that the term sensorimotor is translated as one word. Such a translation would imply that what is sensory experience and what is motor experience may not yet be firmly differentiated, particularly in terms of the impact which these two different kinds of experience have on the organism. In other words, sensory experience might have as much influence on motor behavior as perceptual behavior and vice versa. This then raises an extremely crucial question around which I would like to center this paper, and about which a great deal of research and educative activity has revolved in recent years. That is, can stimulation of one sense modality influence another modality as much or more than direct stimulation of the modality involved? To apply this question to a specific situation, is *indirect* experience, such as providing pure motor activity as suggested by Doman, et al (11) and Kephart (27) (engaging in exercises or being exercised by another person, etc.) likely to produce equal or better results in the area of intellectual development, as is direct intellectual stimulation such as form of remedial work, tutoring, etc.?

As far as Piaget's theory is concerned, it appears that, during the first two years of life (the sensorimotor period), stimulation is stimulation is stimulation. The modality which is stimulated does not appear to be crucial, and stimulation of any type might very well facilitate development in a variety of areas. There is additional theoretical support in the works of Hebb (24) which will be discussed later, for the idea that, during the first two years, stimulation of one modality influences behavior in others. However, a note of caution must be sounded regarding the role of indirect stimulation following the first two years of life. In spite of the idea on the part of some, that indirect stimulation (in the form of perceptual training classes, etc., during the grade school years) is efficacious, there appears to be an open and unanswered question as to whether or not such indirect stimulation is of equal or greater benefit to direct stimulation for children after they reach two years of age.

At this point I would like to cite two studies from existing child development literature which provide at least "soft" support for the merits of indirect stimulation during the first two years of life. The points to be made are that during the first two years of life, perceptual development can be influenced by motor experience and motor behavior can be influenced by perceptual experience. In order to make both points, two different sets of studies will be cited. The first was published in 1934 by Danzinger and Frankl (4). Their interest was in the swaddling practices of certain gypsy-like groups living in Albania. Swaddling, as you probably know, involves the practice of completely wrapping a child in cloth. In addition to clothing the child, it usually affixes him to a board or cradle of some type. In some cases (e.g., those used in the studies by Danzinger and Frankl) the swaddled child and his board are left in the same spot throughout the day. Other groups (e.g., American Indians) carry their swaddled children (papooses) with them on their backs during the course of the day's activities. In any event, swaddling significantly restricts the motor behavior of the child, particularly leg movement, walking, crawling, standing, etc. In the case of Danzinger and Frankl, the Albanian infants were swaddled and attached to a board and left in one place (usually the corner of a rather dimly lighted room) during most of the day. However, they were unswaddled on several occasions for cleaning and changing. The authors tested these children at one year of age by means of the Viennese Test of Motor Development. The results revealed motor functioning which was significantly below the norms for the Viennese test, presumably indicating a degree of motor retardation.

On another occasion, a study quite similar to the Danzinger and Frankl investigation was conducted by Dennis and Dennis (10). They studied the motor development of Hopi Indian children of the southwest who had been swaddled. The main difference between the American Indian children and the children in the Danzinger and Frankl study was that the Indian children were apparently not unswaddled for cleaning and changing as many times during the course of a day. However, the Indian children, rather than being left in one spot while attached to their cradle board, were most often attached to their mothers' backs and, of course, were carried with them through the day's activities. Unlike the results obtained by Danzinger and Frankl, the Indian children showed no suppression in motor behavior at the end of the first year. A comparison of these studies would indicate that the degree of motor restriction in each was similar, and if anything the American Indian children were more restricted, motorically, than the Albanian children by virtue of being unswaddled less frequently. The one difference which does stand out is that the visual-perceptual experience of the Albanian children was extremely restricted (remaining alone in one rather dimly lit spot throughout most of the day) while the visual experience of the Indian children was quite varied. By virtue of being attached to their mothers' backs, the Indian children were able to observe a continuing variation of perceptual experience. It might also be pointed out that the Indian children also enjoyed an apparent advantage over the Albanian children in tactile and kinesthetic as well as visual stimulation. Thus, whereas motor restriction apparently did not suppress motor functioning, deprivation of visual, tactual, and/or kinesthetic experience did.

A second set of studies which can be cited to support the idea that indirect stimulation (or deprivation) can be influential during the first two years of life were carried out by Thompson and Heron (39). In their studies, dogs, having experienced varying amounts of confinement, were compared on cognitive tasks. Specifically, pet-reared dogs were compared with a control group which had been reared in cages. The most obvious distinction between these two groups was the amount of motoric freedom, in the form of running and leaping about, etc., available to the two groups of dogs. In an initial study, the experimental and control dogs were brought into a room such as pictured here.



The dogs entered the room at point A, and were timed and observed in their movement toward reinforcement or reward (in the form of food) which could be obtained at point B. In an initial study, both pet- and cage-reared dogs did not differ in the time or direction taken in moving from A to B. After several trials under these experimental conditions (to where it might be presumed that the subjects had come to "expect" to receive reinforcement at point B), the dogs were brought into the room at point A with the reinforcement located at point C. In the case of the pet-reared dogs they went directly from point A to point C. However, the cage-reared dogs upon entering the room at point A, travelled to point C (the point of reward) via point B, rather than moving directly to C. The most logical interpretation of this finding would first involve labeling the differences in cognitive functioning (being able to go directly to point C as opposed to moving from A to C by an indirect route through B). However, the most obvious historical-experiential differences between the two groups was motoric in nature. Thus, the Thompson and Heron study demonstrates the suppression of cognitive functioning as the result of limited motor experience. Conversely, the Danzinger and Frankl study, in combination with the Dennis and Dennis study, was able to demonstrate a motor deficiency which was apparently brought about by restriction of visual experience. Although these studies were not designed in a manner which permits them to be definitive, they do support the notion that enrichment or deprivation of experience in one sense modality or area of behavior is capable of influencing development and behavior in another area during early childhood. Thus, the notion of indirect stimulation would appear to have some validity at least during the first two years of life.

To return to the discussion of Piaget's milestones or stages of development, we will first look at the substages of the sensorimotor period. During the first few days of life, the normal child is known to manifest an array of reflexes. These include the classic reflexes: sucking, rooting, walking, grasp and moro, as well as others such as Babinski, etc. However, reflexive behavior confines the child to a vending machine level of functioning in which a reflexive response is obtained for every reflex eliciting stimulus which the child is provided. Piaget's first stage of development does not come into play until the organism is capable of elaborating, to some degree, upon its reflex-like functioning. This occurs for the first time when the infant begins to grope for the nipple as it touches his cheek or some other area in the immediate vicinity of his mouth in a manner other than the rooting reflex. Thus, Piaget's first stage involves using of ready made responses or reflexes. This groping behavior on the part of an infant represents his first self-initiated (as opposed to stimulus-initiated) response, and indicates, according to Piaget, that the organism has reached its first stage in the developmental process.

Contrary to Piaget's observations, most newborn infants are capable of head turning and other coping or searching responses. However, in spite of this fact, our research at the University of Oklahoma Medical Center has involved us with prematurely born children who do not possess this capacity. In their case, a certain minimal amount of perceptual-motor experience (best provided in the form of frequent stimulation of the cheek) is required before this response can manifest itself. The implication of this phenomenon possesses direct relevance for our topic. It first of all demonstrates that progression along these stages of development is not a purely maturational process. Rather, infants can apparently benefit from perceptual-motor experience (tactile stimuli applied in the area of face and cheeks) in facilitating their advancement to Piaget's first stage of development.

Piaget's second stage (roughly one week to three months of age) is known as the period of "circular reactions" or "reciprocal coordinations." These terms refer to the infant developing a capacity for coordinating the functions of more than one sense modality. Very simply, this means that the child can bring more than one sense modality to bear in perceiving a given object. The child betrays the fact that he is capable of this kind of behavior when he does such things as reach out and grab an object which has just been brought into his visual field. Thus, something to be seen is also something to touch. In so doing, the child coordinates his visual ability with tactile experience, or there is reciprocity between vision and touch.

Piaget's third stage, which is felt to cover a period from roughly three to eight months, is called "secondary circular reactions." The term "secondary" in Piaget's writings refers to intention or the child's deliberately causing something to occur. Piaget (33:157) cites an example of such behavior in his daughter Lucienne at age three months. It was at this point that she discovered that shaking her legs would cause a joy-producing experience (movement of a doll suspended above the crib). In this case, a child for the first time, according to Piaget's observations, exercised control over her environment by causing an event to happen.

The importance of one's manipulating his environment is difficult to overstate. It is clear in observing adults that some exercise a high degree of control while others seem to remain at the mercy of their environment, allowing it to control them. The present social concerns in America relating to apathy in the culturally deprived child, welfare among the lower classes, etc., dramatize the importance of an individual's exercising deliberate control over his environment rather than assuming a passive dependency upon the environment and whatever it may provide. It is possible that experiences between three and eight months of age (Piaget's third stage), when the individual is first beginning to control his environment, are crucial in regard to subsequent adult behaviors such as apathy, dependency, etc. If the child has the opportunity for successful environmental manipulation at stage III, then such behavior has gotten off to an all important "good start." This increases the possibility that such tendencies will stay with him and flourish during the ensuing years of his life. On the other hand, if there is little opportunity (by virtue of minimal perceptual-motor stimulation or manipulable objects such as toys) to manipulate one's environment, then a process of apathy, or disinclination to engage the environment and manipulate it, may be set in motion.

Piaget's fourth stage is known as the "combination of secondary schemata" and is felt to run from roughly 8-12 months of age. The stage is characterized primarily by completion of the child's ability to distinguish between means and ends. It is possible to conclude that a child has distinguished between means and ends when he is capable of producing the same result (end) by more than one causative action (means). Prior to this time a child may feel that both means and ends are part of a single unit of experience. For instance, there is no way of telling at the third stage that behavior which combines leg shaking and doll movement is perceived by the child as a bifurcated cause and effect relationship. However, when a child discovers more than one means to a given end, it is apparent that the means and ends are no longer parts of a single phenomenon, but rather separate entities. An example of this kind of behavior is cited by Piaget (33:217) when his son Laurent, at seven months, discovers two different means to a single end (obtaining a box located behind an obstacle). The two means utilized by Laurent in this case are (a) passing around an obstacle and, (b) removing the obstacle. Under these circumstances, it is apparent that the distinction between a means and ends is complete.

Piaget's fifth stage, "tertiary circular reactions," is felt to run chronologically from 12-18 months of age. This is a period when the child manifests an increased variation in means. The child at stage III was capable of evoking only a single cause for a desired event and capable of evoking only two means at stage IV. However, at stage V, he begins to manifest manifold variations in means or causative types of behavior. This interest in varied ways of doing things may represent the beginnings of *curiosity* and/or *novelty seeking* behavior, commodities of crucial significance in later life. Observations #140 and #141 (33:268) illustrate an initial experience of one of Piaget's children in becoming fascinated with the variety of means by which a single end (falling of an empty case for shaving soap) may be obtained.

> Sometimes Laurent deliberately opens his hands and the case rolls along his fingers. Sometimes Laurent turns his hands over and the case falls backwards between the thumb and index finger which are separated, sometimes Laurent simply opens his hand and the object falls.

In the above quote, we observe a child relying upon at least three techniques for obtaining a desired end.

Stage VI is generally known as the "intervention" stage; it is felt to run from approximately 18 to 24 months of age. This period is characterized by the *creation* of means and not merely the *discovery* of means. The child's early examples of invention are usually quite similar to Kohler type problems which were felt to involve insight. In Kohler's studies, problems consisted of such things as giving a chimp three boxes in a room where reward (a banana) was placed on a high perch out of reach. To obtain the reward, the chimp had to "invent" a means of stacking the three boxes on top of each other in a way which allowed him to climb to the spot where the banana was located. In the case of an 18-24 month old child, similar behavior might involve utilizing a stick to obtain a toy which was just out of his reach in a playpen. Thus, at the end of Piaget's first period (the sensorimotor period) the child has obtained the ability to invent.

At this juncture, I think the point relating to Piaget's genius should be clear. Certainly the behaviors described in this portion of the paper are not new (searching for a nipple, leg shaking, letting go of a small case by a variety of playful means, etc.). However, the fact that Piaget has forged a series of stages from these behaviors and has made them stick, indicates a stroke of genius. In the interest of time, Piaget's preconceptual stage and his period of concrete operations will be omitted. However, this specific material is not deleted by accident. For one, I suspect that most of you already know a great deal about children at the later preschool and early elementary school ages by virtue of having worked with them. But mainly, the inclusion of Piaget's sensorimotor period and the exclusion of the later years is an act consistent with the main point which this paper has to make: the uniqueness and importance of the first two years.

What's New in Regard to Factors Influencing Development

Indications from Developmental Theory. It is of interest to note that Donald Hebb (24) another theorist, in addition to Piaget, has cited the time of 18 to 24 months of age as an end of the first stage of cognitive development. In the ensuing pages, an attempt will be made to dramatize the difference between this stage of development and subsequent stages.

Hebb's Theory. Hebb first became concerned with intellectual development as the result of two puzzling observations. One concerned the differential effects of early (first two years of life) and late (post-adolescent) brain damage. He was struck by the extensive impact on learning and intelligence of relatively minor brain insults and ablations during the first two years by comparison to the relatively inconsequential effects of more extensive damage in later life. Secondly, Hebb was puzzled by the long period of intellectual immaturity in humans by comparison to lower animals.

To begin his theorizing, Hebb distinguished two types of brain tissue. The function of one type of tissue was to manage impulses associated with sensory input and motor output. This so-called *committed* tissue presumably could not acquire functions which were not *present at birth.* A second type of tissue was called *associative* tissue. This tissue is not tied to sensorimotor functioning, and its functions must be "established." Associative tissue is presumably involved when new learnings or new associations take place. There is another important distinction between associative tissue and sensory-motor tissue. Sensory-motor tissues must be activated by external stimuli, while Hebb feels that the human organism (by utilizing associative tissue) is capable of *autonomous central processes.* These processes involve behaviors which are initiated within the organism and which do not require any external stimulation. In other words, by means of autonomous central processes the organism can insight itself to action.

The ratio of associative tissue to sensory-motor tissue is known as the A/S ratio. Hebb theorizes that the limits of intelligence are determined by the A/S ratio. The larger the proportion of associative tissue to sensory-motor tissue, the greater potential of the organism for cognitive complexity. It is quite obvious that the A/S ratio would differ from species to species and thus (at least according to Hebb's theory) one can explain the differences in intelligence between organisms at various points on the phylogenic scale. However, our concern is with differences in intelligence within a single species (humans).

There are two ways in which organisms within a given species might differ in intelligence. One means would involve inherited differences in the A/S ratio. The other means would result from the differential extent to which the functions of associative tissue had been acquired or established. This brings us to another very important aspect of Hebb's theory, the way in which associative tissue is established. Hebb's answer on this point is that associative tissue, as well as the autonomous central processes, are established by virtue of a wealth of sensorimotor experience during the first two years of life. During this time, the majority of the organism's behavior involves sensory-motor tissue. However, associative tissue and autonomous central functions are being established, even though they may not be particularly active. Therefore, differences in intelligence within a species are explained primarily by the differential extent to which associative tissue and autonomous central processes are established. Again, it is important to note that the extent of establishment is dependent upon amount of sensorimotor experience received during the critical period (the first two years of life).

This theory is now capable of accounting for the two observations which puzzled Hebb and which caused him to theorize in the first place. The lengthy period of intellectual immaturity in human beings is explained by the fact that humans possess such extensive amounts of associative tissue which must be established. Therefore, the first two years of life are spent primarily in sensorimotor activity, while the more advanced processess are being established. Other organisms, possessing lesser amounts of associative tissue, require a shorter period of time for establishing their functions. Also, the fact that the human organism possesses more associative tissue not only requires a longer period of immaturity during which time the associative tissue is being established, but the fact that more associative tissue is established enables the human organism to exceed, by far, the intellectual attainment of other species once these processes are established. These data fit nicely with the observations of Kellogg (26) and Hayes (23), who have reared chimps in a situation which allowed for direct comparison of their development with that of humans. Their findings were that the development of chimps far exceeds that of humans during the first 18 months or two years of life. However, at that point, the human infant appears to catch up in intellectual ability. Following this time, humans continue to widen the gap and, of course, far exceed the performance of chimps on intellectual tasks.

The above mentioned aspects of Hebb's theory also enables it to explain the differential effects of early and late brain damage, the second question which brought his theory into being in the first place. Early brain damage is felt to interfere with the process of establishing associative tissue and autonomous functioning. Thus, the impairment is extensive because a great deal of intellectual functioning is never established. However, later brain damage, occurring after the majority of intellectual functions has been established, would not be expected to have as extensive an impact. This illustrates why Hebb feels that the first two years of life are crucial for perceptual-motor experience. It is because these experiences are the basis for establishing the all important associative tissue and autonomous central processes which are essential to the highest and most complex functions of human intelligence.

Research Support For Hebb's Theory. One of the first and most obvious conclusions of Hebb's theory is that the human organism should be provided with a wealth of sensorimotor experience during the early, critical period of life when the autonomous central processes are capable of being established. This places an emphasis on the quantitative aspects of stimulation and suggests that the manner in which the organism is stimulated is not extremely important as long as there is stimulation through some sense modality. This hypothesis is consistent with Piaget's notion of sensorimotor period where it is implied that sensory experience in one modality has a facilitating effect on functioning associated with other modalities. (Recall the studies of Danzinger and Frankl, Dennis and Dennis, Thompson and Heron.) If Hebb's theory is correct, one would expect an increment of development to result from an increase in stimulation during this early period of development. The type of stimulation (in terms of the sense modality involved) and the qualitative aspects of the stimulation (noise versus opera music, good literature, mathematical problems, etc.) would not be crucial. The above hypotheses, concerning the effects of early stimulation, have led to studies of stimulus deprivation and stimulus enrichment during infancy with both human and infrahuman subjects. However, it must be reiterated that Hebb's apparent contention that the importance of quantity supercedes that of quality is applicable *only* during the first two years. There is considerable theoretical as well as research evidence (21) indicating that the qualitative aspects of stimulation are of paramount importance by at least four years of age.

Infrahuman research in stimulus deprivation. There are numerous studies showing the detrimental effects of early stimulus deprivation for infrahuman subjects. In addition to Hebb's own studies, investigation by Riesen (35), Brattgard (1), Chow and Nissen (3), and Forgays (13, 14, 15, 16), as well as the previously cited research by Thompson and Heron, are only a few of the studies which can be mentioned to confirm the detrimental effects of early stimulus deprivation on infrahuman subjects.

Stimulus deprivation research with humans. The literature on early stimulus deprivation for human subjects is much less definite and more fraught with methodological problems. An excellent critical review of the area of maternal deprivation with accompanying research suggestions is presented by Yarrow (42). The major conclusions of Yarrow's review are as follows: (a) there is a definite effect operating in cases of maternally deprived infants which produces a decrement in development; (b) this effect needs to be clarified and researched (presumably one of the variables involved would be stimulus deprivation); and (c) research in this area needs to be planned in a manner which is more systematic and rigorous, and where the question that is asked has at least some chance of being answered with a degree of definity. Most investigations of deprived humans other than maternal deprivation studies have necessarily been confined to investigations of isolates (children chained in dark rooms with food slipped under the door, etc.) and ferals (human children reportedly reared by animal parents such as the wolf girl of India, etc.).

Infrahuman studies of stimulus enrichment. Studies involving stimulus deprivation have been supplemented in more recent years by investigations of the effect of stimulus enrichment. Most of the work with infrahuman subjects has come from three sources: the laboratories of Denenberg, Levine, and Kretch. Both Denenberg (6, 7, 8, 9) and Levine (29, 30, 31) have provided significant findings related to the effect of early infantile stimulation in animals between the time of birth and weaning. The result of this research has been the reasonably well established fact that early stimulus enrichment produces increments in later development. Both Denenberg and Levine have utilized a variety of means for increasing stimulation and have reaped results in several areas of development. Mild shock, handling, etc., have produced increments in physical development and learning ability and have decreased emotionality. Kretch (28) has summarized his findings of early enrichment programs utilizing rats. His studies are concerned primarily with stimulus enrichment by means of cognitive-motor experiences obtained by placing many interesting forms and toys in the rat cages and also through cognitive and other types of stimulation which result from rats being reared in cages with other rats (rather than in isolation). The facilitative effects of these manipulations have been supported by the subjects' ability to learn and also by changes in brain chemistry and anatomy as measured by postmortem analysis.

Stimulus enrichment research with humans. Only in the most recent years have we seen results of research on early stimulation programs with human subjects. A few investigators have attempted to study learning and conditioning among infants. Studies by Rheingold, Gerwitz, and Ross (34), Lipsett (32), and Kagan and Lewis (25) have been successful in demonstrating impressive, early learning in human infants. They have increased the rate at which infants learn, vocalize, and emit social responses. However, whether or not their work is the result of an earlier application of conditioning principles or whether the conditioning experience constitutes a form of early cognitive stimulation which increases cognitive development is difficult to ascertain. More firmly within the realm of early stimulation studies is the work of White and Castle (41). For example, they have attempted to produce an increment in perceptual development by means of increasing postnatal handling. They were successful in increasing visual exploration behavior among the stimulated infants. Also, Casler (2) has studied the effects of extra tactile stimulation in a group of institutionalized infants. He hypothesized that institutionalized babies receiving 1,000 added minutes of tactile stimulation over a ten week period would function on a higher level for the Gesell Developmental Schedule than would institutionalized babies who received no stimulation. As expected, the experimental infants *did* obtain a higher developmental quotient than did control subjects.

At this point, I would also like to mention some pilot work involving a project of early stimulation of premature infants being conducted at the University of Oklahoma Medical Center. In our study, premature children are provided 21 days of enriched stimulus experience. Each day they receive three hours of extra rocking in a mechanical rocker, two hours and 40 minutes in which they are carried about and exposed to a wide variety of visual cues (providing not only visual but tactile and kinesthetic stimulation), and 12 hours of additional auditory stimulation provided by means of FM radio music and talk. Although we have not run extensive numbers of subjects at this point, our results are quite suggestive. After 21 days it is possible to condition experimental children to perform a head turning response at the sound of a buzzer on the basis of a very few (30 or less) trials. We have not yet been able to condition the head turning response of an unstimulated child in spite of the fact that 100 trials have been attempted. Our stimulated infants are showing more rapid development according to neurological examination by a naive examiner. Finally, most dramatic of all has been the response of the nursing staff to the stimulated infants. They have been concerned that stimulated infants are too active and too responsive. They cry more while unstimulated infants remain quiet, passive, and almost vegetative in their cribs.

The results of research thus far seems to indicate that quantitative increases in stimulation during the early period of development (corresponding to the first 18 months or two years of life in a human organism) will produce a facilitative effect on development in practically every area. However, there is not yet any empirical evidence on, or sophisticated theoretical support for, the idea that indirect forms of stimulation are effective in facilitating development following the first few years of life.

Conclusions

What are the implications of the theories and research presented here for physical educators and other professional people interested in the impact of perceptual-motor experiences on development in children between birth and eleven years of age? Certain conclusions seem justified. One, it would seem appropriate to consider perceptual-motor experience as valuable where improvement in *perceptual-motor performance* is desired. Experience in running will help an individual to improve his ability to run. Experience in scanning will help an individual to become a better visual scanner, etc. Secondly, it seems safe to conclude that perceptual-motor experience can also be worthwhile where there is a *direct relationship of this experience to other areas of functioning*. For instance, perceptual-motor experience can help an individual to perform better in games. The ability to perform well in games is one of the important developmental tasks mentioned by Havighurst and others and may affect personality, social development, etc. Skilled children may become more popular; they may learn how to cooperate and otherwise function in give and take situations such as games. Ability to do well in movement experiences may effect such things as achievement motivation particularly if the individual is exposed to competitive sports and comes to desire success, learns to discipline himself in order to succeed, etc. However, under all of these circumstances, the relationship of perceptual-motor experience to the areas of development (such as personality and social development, cognitive and intellectual development, etc.) is not quite clear.

The big question which remains is whether or not perceptual-motor experience is of benefit as a form of *indirect* stimulation, such as improving development in the cognitive and intellectual area. For instance, does it do a child any good to walk a balance beam if you are trying to teach him to read? Such practices in many so-called perceptual training classes evoke memories of the programs pursued by a special educator named Bernadine Schmidt in the 1940's. She too attracted support from popular magazine articles such as, "They are feebleminded no longer," *Reader's Digest*, September 1947, pp. 111-15; and "Feebleminded children can be cured," *Woman's Home Companion*, September 1947, pp. 34, 55, 156-58.

The suggestion that a child attempt such activities as walking a balance beam in order to improve his reading is also reminiscent of the days of old faculty theory in psychology which went out of style about the turn of the century. The faculty concept of mental ability contends that there are basic mental abilities known as faculties. These are viewed much like muscles. The more you exercise the faculty, the larger it grows. It was felt that any activity within a given faculty would improve that ability or faculty in general. For instance, teachers in the public schools were encouraged to offer an extensive array of courses, such as languages, since it was felt that taking these courses would improve an individual's faculty for memory. Likewise, another faculty, reasoning, was felt to improve with experience in mathematics. Faculty theory was adopted unquestioningly, until in the early 1900's when it was subjected to an empirical test by Thorndike (40) and other psychologists at Columbia University. These investigations revealed that indirect stimulation of a faculty (e.g., language courses to aid memory, etc.) had no effect. It was only as there was a direct relationship between the experience and the desired behavior (language courses to aid in language development, etc.) that experience proved helpful. The historical fact that the theory of mental faculties was almost completely devastated as the result of being subjected to empirical investigation may account for the slowness with which proponents of current theories of indirect stimulation have moved toward subjecting their ideas to rigorously controlled, empirical tests on the part of unbiased investigators.

On the more positive side, there is both empirical evidence and theoretical support for the idea that sensorimotor stimulation, during the first two years of life, can have a crucial and facilitating effect on all kinds of development. This fact possesses implications for physical educators and other professionals interested in the impact of perceptual-motor experience on development. It suggests the possibility of an involvement, if not a focus, on the first two years of life. There is currently a trend to extend education downward to younger and younger children. Kindergartens are available in practically every state. Head Start programs, programs for culturally deprived children, and other forms of preschool education have been offered to children four years of age. Structured nursery school experiences are not uncommon for three year olds. However, these downward extensions of the educational system may represent a roundabout way for reaching children during the most important years. The most sensible approach might require physical educators to disassociate themselves from their exclusive link with public school systems and "shoot the gap" into the first two years. Physical educators and other authorities on perceptual-motor experience might find fruitful fields of service in day care centers for working mothers, as consultants in child rearing, as home visitors, etc. These ideas, as well as the logistic details for such a switch (in terms of training, recruitment and placement, etc.), I leave for you to consider. However, the scholar of human movement and perception might contribute more than any other professional to very young children.

This potential shifting of habitat is suggestive of the story of the ugly duckling who appeared initially clumsy and unattractive amidst a group of newly adopted peers. However, after the occurrence of a normal maturational process, he became the most promising and graceful member of the group.

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MECHANISMS OF PERCEPTION: THEIR DEVELOPMENT AND FUNCTION

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The topic of perceptual basis of motor activity is, of course, a very broad one since it can include all known senses. This could take a very long time to cover, even in an elementary manner, and consequently I think the most pertinent thing for our purposes is to restrict the discussion to those perceptual mechanisms which are universally concerned with performing motor activity. Thus, we would eliminate such occasional sensory participants in motor activity as taste, audition, and other senses which can be important in special circumstances but ordinarily are not concerned with the broad run-of-the mill type of motor activity with which we are concerned.

The physiological mechanisms with which we will concern ourselves are universal for all motor activities since they form the physiological perceptual basis upon which the organism can mount accurate motor responses in dealing with its environment. Regardless of the motor act, this physiological basis must be functioning properly before the organism can make an accurate motor response to his environment. This universal sensory basis of all motor activity has been called body spatial orientation. It includes postural mechanisms and also conscious perception of the body's image in relation to its environment. For example any one of us, assuming we are all normal in this regard, could close his eyes and still be aware of his posture in regard to gravity, and in combination primarily with vision which he can recall, he could also perceive a correct image of the spatial relationship of his body in this room, such as how close he is to the front or back wall and related spatial matters of this kind. These are obviously very important functions because they serve as the fundamental basis upon which we build up all of our motor activity. We could have a perfectly normal motor system in a very well-coordinated individual, but if the sensory information that comes to him, either preparatory to the motor act or while he is actually performing the motor act, is not accurate, then no matter how nice and how exquisite the function of the motor system is, it will not accomplish the desired results. Such a person will be clumsy, he will fumble, and he will reach for things where he thinks they are but different from where they actually are. Of course, the presence of spatial errors in reaching for objects degrades performance and the defect is sensory in nature and not motor.

One of the best approaches to quickly, and I think lucidly, give you the critical physiological information that we need for understanding body spatial orientation, and thus to set the basis for the following discussion, is to use what we call a bionics approach. I will identify each of the different major physiological components of the body which help to spatially orient the body in relation to its environment and I will then delineate the contribution of each component by comparing it with an engineering or hardware component designed to perform the same function. This bionic approach will not only facilitate general comprehension but will also enable us to compare the roles of each physiological mechanism concerned, by seeing what different engineering devices look like while performing equivalent functions. More specifically, we are actually going to consider a number of different sensory receptors, all of which help to create a conscious, accurate awareness of our body's position in space, during both static posture and motor activity. This is, as I said earlier, of obvious significance to the successful performance of motor activity.

The best point from which to start this analogy and to go through it all in a logical sequence is to start with a person looking at a visually fixated object. Thus the person starts with his eyes open, somewhere in his environment, and looking at an object in the landscape or in the room. The person wants to know what position his body has in relation to this object at which he is looking. He may want to reach for it or he may want to locomote toward it. He may want to avoid it if it is a threat, but it is essential in all cases that he correctly assess the angle and the distance and the overall spatial relationship existing between the visually fixated object and the organism, which is the person himself. The first spatial orientational component involved, obviously, is vision itself, and the rather redundant term of eye-vision is used because there are other eye com-

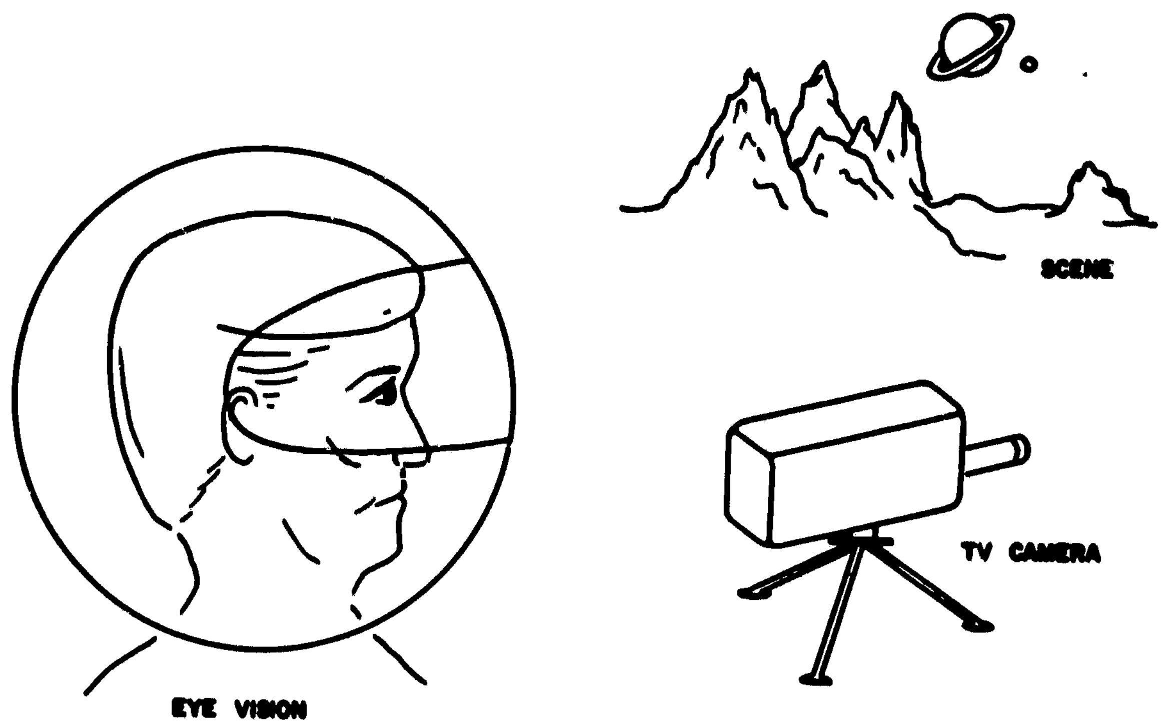

Figure 1. *Visual component: a television camera.*

ponents for body spatial orientation. Vision performs the same function as does a TV camera. It shows the spatial relationships between objects you can see (Fig. 1). You can tell from familiar objects in the visual field how large or how small the object of interest is. You see a very small man and you know that men usually are more than five feet or so tall, so you know he is very far away. If the colors are indistinct and there are other cues, such as objects of known size like telephone poles in between, this also helps. Thus the actual conformation of the retinal image gives a lot of information about the relationship between the visually fixated object and the organism who is looking at that object.

For subsequent discussion of our bionic analogy it is helpful to consider the various orientational components to be mounted on an unmanned vehicle in such a manner as to permit the vehicle to perform the same way as a man would in spatially orienting himself to his environment. Figure 2 shows a vehicle with two wheels, with television mounting on the turret to perform human visual function. Now of course, the human being has two eyes and they are capable of binocular vision. That is, a human can focus both eyes on the same object. Some of the other animals cannot do this. Horses, for example, have divergent eyes and cannot focus them both on the same spot in the environment. Eagles have eyes pointing in almost opposite directions, but man can focus both eyes on one object and this creates an angle of convergence between the visual axes of the two eyes. For near objects, the convergence angle for focusing the two eyes on the object is larger than for more distant objects. So, within up to about 30 feet distance from the individual, the biologic measuring of the convergence angle is considered to be an accurate means for judging how far an object is from the individual, merely by gazing at it. The analogy bionically is to use two television cameras that are coordinated so they both turn in together or turn out together and when they both are sending the same image, then you know they are both focusing on the same object and the angle between the two cameras is a direct measure of the distance of that object from the vehicle (Fig. 2). This is the way the two human eyes work in making a spatial perception of distance, while visually fixating an environmental object preparatory to reaching or making some other motor act to deal with the object. The receptors for this physiological component are located in the extraocular muscles of the eye (4, 5). They are stretch sensitive, and they are called muscle spindles. The are shown on the left of Fig. 2 and they are in reality very complex sensory organs.

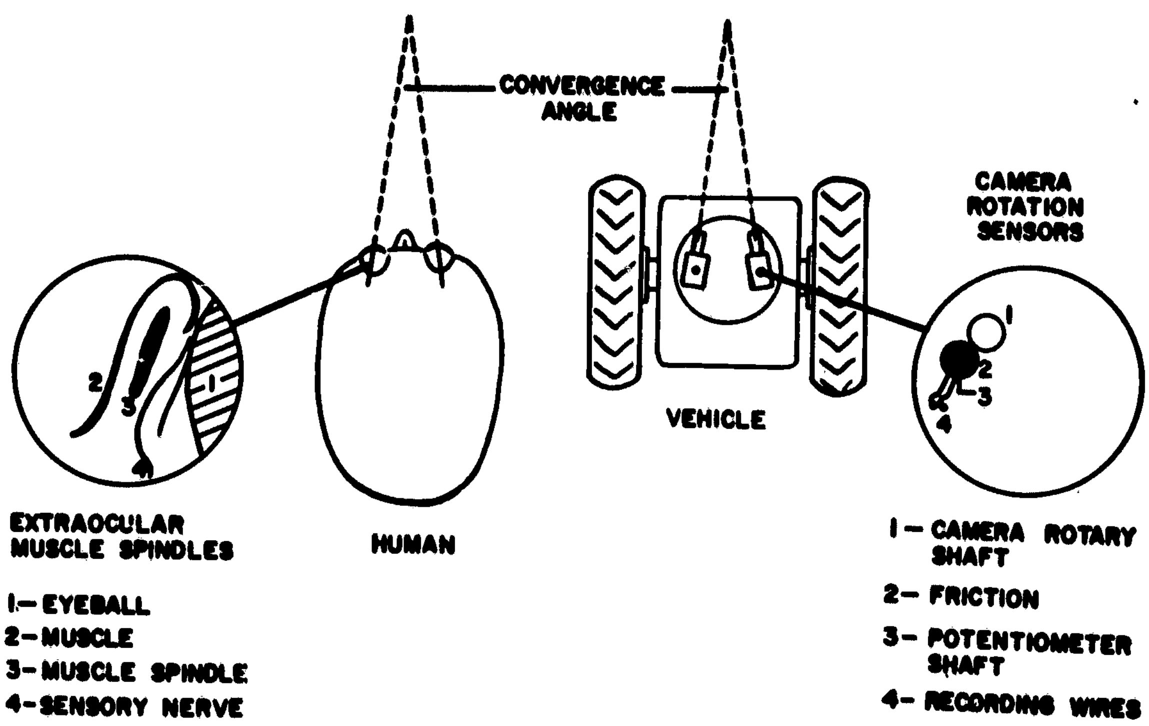

Figure 2. *Depth perception component: two conjugate television cameras.*

The hardware counterpart is actually much simpler, but the main function of this group of receptors is to tell us the position of our eyeball in relation to our head. This is essential, especially for example, in looking at different objects without moving the head. We can look at different objects in this room just by moving our eyes, and the only possible way we know that something is up and to our right, for example, rather than down and to our left, if we do not move our head, is to know that our eyes when they are looking at the object are up and to the right in relation to our head. When we look at another point in our environment, our eyes assume a different position in relation to the skull. So these sensing devices, the muscle spindles, are in the extraocular muscles and they measure the position of the eyeball in relation to the head. They also measure the position of the two eyeballs in relation to each other and by both these means they can help judge distance and also the spatial relationships between visually fixated objects.

Now we come to another important component. Logically, it would seem important to be able to measure the angle between the head and the body, because we still would not be well-oriented if we had a head floating in space, so to speak, without relating it to our feet and our body and especially without relating it to our limbs. The limbs with which we execute most of our motor acts are, after all, located on the trunk of the body. They are not located on the head, and in order to make accurate grasps and accurate motions with the hands and feet in relation to visually fixated objects, we must connect the eyes that are in the head with the arms and legs which are attached to the trunk of the body. The connection is, of course, through the neck, which is called the cervical component of body spatial orientation. The nerve fibers from these receptors arise from the C-2 and C-3 dorsal roots high in the neck and transmit all sensation that would come in from the cervical region. A bionic analogy for this would be to have the two television cameras on a movable turret and, in addition to the two cameras being angled to make conjugate or coordinate movements, the whole turret could rotate to the right or left, and with the proper sensing device on the turret we can measure the position of the turret in relation to the body of the vehicle (Fig. 3).

Up to this point we have now determined (a) the visual spatial relationship between the visually fixated object and other related environmental objects, (b) the angular relationship between the fixated object and the viewer's head, and (c) the distance of the object from the viewer's head.

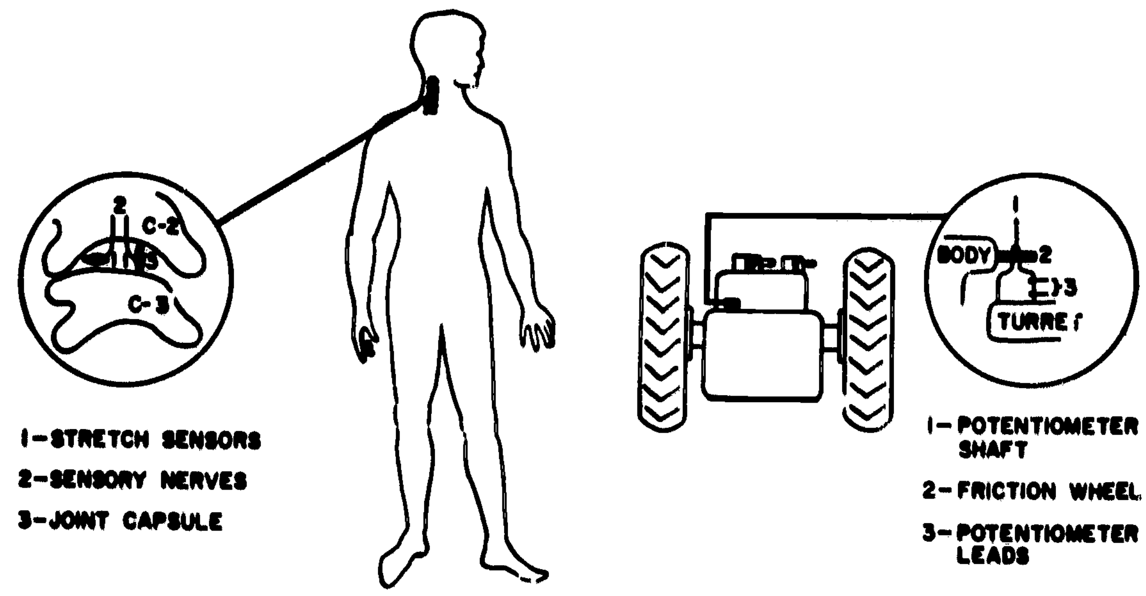

Figure 3. *Cervical component: a turret body sensor.*

Next, we come to the vestibular component. This is, I am sure, one with which you are better acquainted, since it contains the familiar semicircular canals. It is in a way unfortunate that many of you are so familiar with this, because I think that generally it is a defect in our education to have overemphasized the importance of these structures to the point of tending to relate all body spatial orientation and posture, and equilibrium and balance, to the performance of the semicircular canals and the otolith structures, which together with their neuronal structures we can call the vestibular apparatus. This is not only erroneous, but there is a great deal of important evidence to prove that cervical structures are at least as important. Thus, Weeks and Travell (21), Stuck (17), Cope and Ryan (6) in clinical studies on humans; Wapner, et al (18) doing experiments on humans; and Cohen (1, 2, 3) investigating humans and animals, have all clearly shown that the cervical component is every bit as important in the total orientation of the body in relation to visually fixated objects as is the vestibular apparatus. However, the vestibular apparatus does have an important function, even though it does not hold the sole monopoly of body spatial orientation. There are two major structures which are embedded in the mastoid bone behind each ear; one is the semicircular canals and the other is the neighboring otolith structures (Fig. 4).

The alleged specialization of function is as follows: the semicircular canals which are shown on the right in a bionics counterpart will sense any angular or rotary acceleration or deceleration to which the head is subjected. Any time you move the head or the whole body is moved, or if you are sitting in a car when the whole vehicle moves, this will cause a lagging behind of the fluid in these canals due to the fluid inertia, and the fluid inertia will cause a pressure upon the sensory receptors in these canals which will fire the associated nerves and cause, therefore, certain responses. This is the same type of system that is used by engineers in guiding missiles and is called an inertial guidance system. The engineers usually set up the "canals" in three basic planes at right angles to each other in order to cover all possible directions of movement, just as is the arrangement in the naturally occurring biological canals. Once a missile is set on a path, any deviation from that path can be sensed by such a device, just as the human can sense deviations from a path of travel, or deviations from the static posture of the head, by the same type of mechanism. The otoliths are considered generally to be, in contrast to this, sensitive only to gravity rather than to rotary

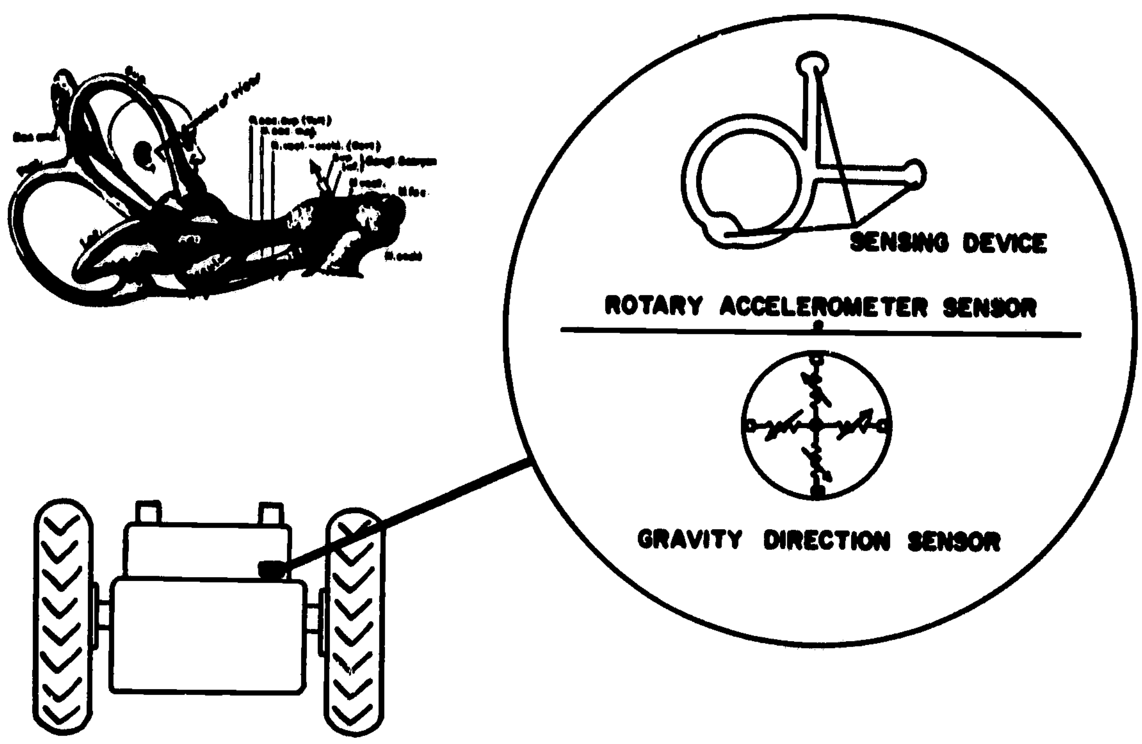

Figure 4. *Vestibular component: a linear accelerometer.*

accelerations and decelerations and they are represented by the lower bionic device in Fig. 4.

Of course, any accelerations, whether rotary or linear or even any static shifts in head posture in relation to gravity, can and must all be sensed by the cervical components as well as the vestibular component since it is ordinarily impossible to apply a force to either the head or the body without invoking inertia both of the head and of the canal fluid, thus simultaneously stimulating the cervical and vestibular components.

In our sequential consideration of body spatial orientation to a visually fixated environmental object, the cervical and vestibular components have now added the capability of determining: (a) the spatial relationship between the head and the trunk, (b) the static position of the head in relation to gravity, and (c) the directions and amounts of accelerations and/or decelerations to which the head or body, or both, may be subjected.

Now we may proceed to consideration of what we call the body contact receptors. These have general significance for total body spatial orientation because they are activated by contact with whatever is supporting us from the pull of gravity. When we are sitting, the pertinent receptors are the cutaneous and muscle receptors in the buttocks. When we are standing, the pertinent sensors are located mainly in the soles of the feet. These receptors yield vital cues for the total orientation of the body. They are of local significance only if you press indiscriminately upon these areas with pressures which bear no relationship to your posture. Ordinarily, however, if you are standing, sensors in the soles of your feet offer major cues for which way is up and which way is down. Therefore, the general receptors of touch and pressure shown by the insert in Fig. 5 take on special significance for total body spatial orientation by indicating where the supporting pressure is and therefore which direction is up and which direction is down.

Studies have been done by Mott and Sherrington (15) many years ago to show that when these receptors are denervated or detached in cats these animals seem to stand and maintain their posture adequately, but they were not able to climb complicated things like a ladder as effectively as they could with normal intact limb sensors.

The pertinent receptors are located within the articular capsule which bridges all joints and are called joint proprioceptors. In addition to these joint proprioceptors, there are tendon and muscle receptors (Fig. 6). The muscle receptor is a typical muscle spindle and it is similar to the muscle spindles that are found in the extraocular

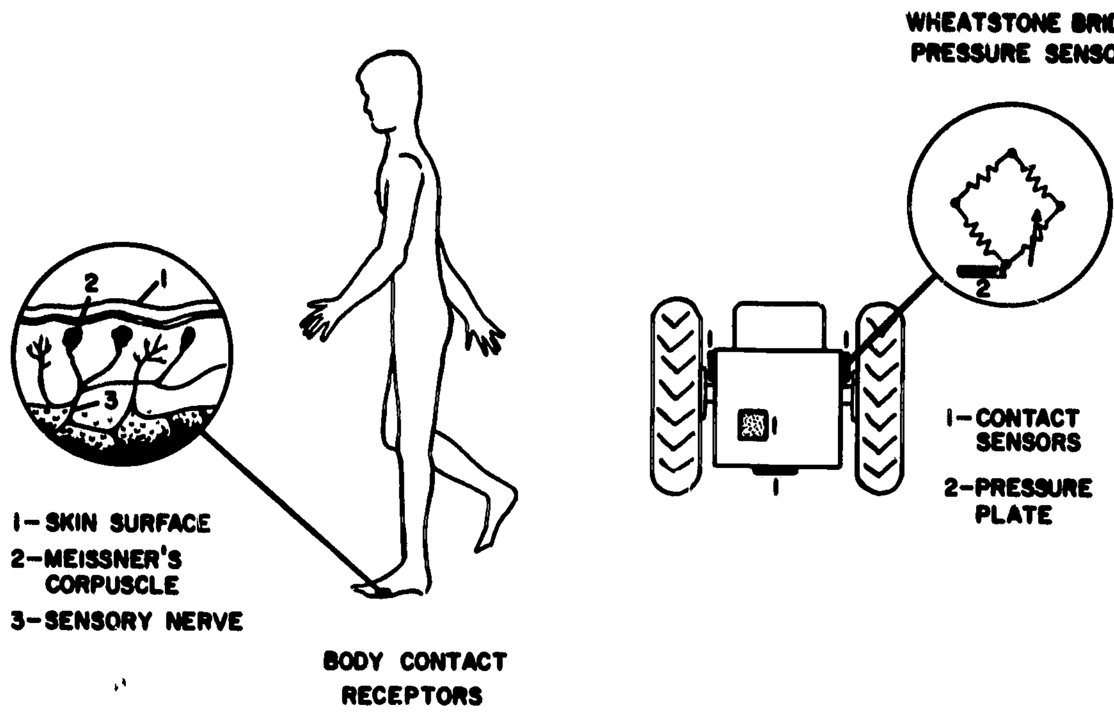

Figure 5. *Body contact component: pressure plate transducers.*

muscles of the eyes. We know that the tendon receptors respond to stretch, but we did not know how important they are in judging the angle of the limb. It is now felt that the major detection or determination of the position of our limbs in space without our having to look at them constantly is due probably to the joint receptors, although some experiments I conducted on humans have shown that touch and also muscle tendon receptors play significant roles as well, although their contribution to position sense accuracy is quantitatively smaller than the joint proprioceptors (1). Thus, joint sensors are probably most important, but all of these receptors have to function together properly in order to give us our normal human accuracy of approximately 3.5 cm. as measured at the end of the index finger of an outstretched arm in pointing experiments (2). This would represent the accuracy of position judgment arising from the human shoulder. The bionic counterpart of limb position sensors, especially in rhythmical position changes exemplified by locomotion, is a vehicular speedometer (Fig. 6).

By the addition of the body contact component and the limb position and motion component of body spatial orientation the organism, or vehicle, can now also detect the point of body contact with the environment and the direction of gravity, and position and rate of motion of the traction means of the body or vehicle.

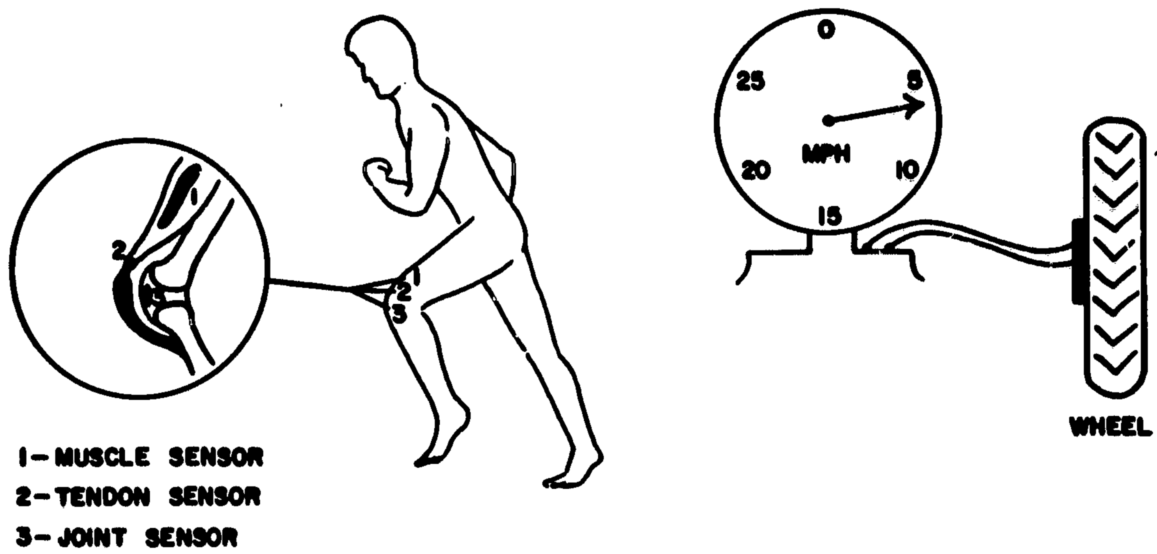

Figure 6. *Limb locomotion receptors: treadwheel speedometer.*

Figure 7 sums up the bionic analogy by mapping how the unmanned vehicle can direct itself in a given direction by using the biological orientation capability which has been built into it. A vehicle with the basic orientational components that have already been described can reasonably be expected to start out on a course aimed at a target, detect and correct for obstacles in its path, and eventually reach the target without any human direction. This is accomplished by the proper, let us say computer, coordination of the basic orientational sensors which we have already described. These basic sensors are, as I pointed out, modeled after the human sensors which construct our orientational ability and permit us to do the total function necessary for directing us, or one of our limbs, to accurately reach a visually fixated environmental object.

It is important to realize that in a normal individual performing motor activity, you can degrade a lot of these different orientational components and still not abolish all spatial orientation ability. A person can still reach fairly accurately, although certainly not with normal accuracy, toward objects at which he is looking, and he can be fairly effective in complex motor acts of precision, if one of the input components is malfunctioning. However, the more inputs that are destroyed or confused, the lesser is his total ability to accurately perform these motor acts, like placing his limbs on certain spots or pointing to a certain area, and any tests that validly measure motor positional accuracy will reveal an increasing deterioration of performance. There is a lot of overlap in the functions of the individual orientational components, so that a malfunction in some of these components can be partially compensated by other components. At the same time, each component is now felt to play a unique role as well, so that if the input from any one component is abolished, some specific function in the total ability will be lost. Even though part of the lost function is compensated for by the remaining components, that loss will be permanent. Therefore, we really must think of body spatial orientation as the major universal perceptual basis for motor activity. It is the vital perceptual base from which we are able to move out effectively into the different environmental situations which call for motor responses from us.

Now that the various specific physiological components which make up body spatial orientation function have been identified, one might logically ask what happens when one of the major components is activated. This should be a promising research approach for revealing the contribution which any given component makes to overall body spatial orientation function. Such experiments are best done on animals since one should like to cut the nerves or otherwise destroy one of the component inputs to see how the total motor orientational performance of such an organism would be affected. We decided to pursue this research approach and we selected the pigtail monkey — a primate as we are — to serve as the experi-

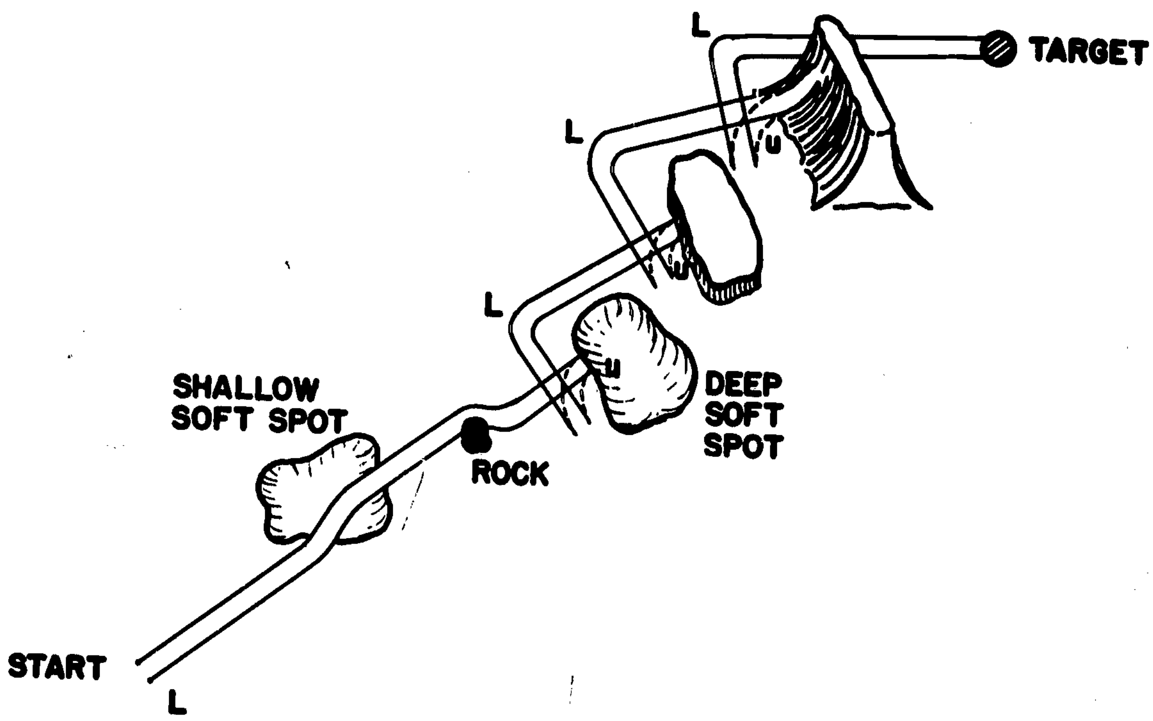

Figure 7. *Vehicle travel over rough terrain.*

mental subject. The two major components which were selected for the first phase of this study were the vestibular and the cervical components. Vestibular destruction was performed first to inactivate the vestibular apparatus. All of the semicircular canals and the otoliths were destroyed by performing bilateral labyrinthectomies. Classical labyrinthectomies destroy the hearing part of the ear as well as the vestibular portion and the present experiments are no exception. The surgical approach for labyrinthectomy was through the mastoid process behind the earlobe. In related experiments we also inactivated the cervical component by destroying the first three dorsal cervical roots in otherwise normal animals and measured how they perform in complex spatial orientation motor activity tests.

Spatial orientation was measured in a test situation where animals were tested for many months before anything was done to them in order to get a statistically standardized and stabilized climbing time under laboratory conditions. The test feature which required the most spatial orientation precision was the climbing of a pegboard in the test room, for which the monkeys had to actually place their four limbs in proper sequence on separate, randomly staggered pegs in order to go up and get food from a hopper at the top of the pegboard. The monkeys were interested in the foodhopper because they were always fasted the day previous to the experiment. Climbing times were repeatedly clocked during a given test and statistically treated. Motion picture films were taken for permanent records. By these methods we were able to demonstrate the vast potency of these two different physiological components of orientation for accurate motor coordination. A climbing ladder was also used, and the pegs could be individually retracted or extended to change the climbing pattern. An intact normal moves quite smoothly in performing the necessary motor acts.

As physical educators you will see a special importance in these experiments, since you should appreciate the fact that we need proper objective quantitative tests in order to measure spatial orientation. For example, a person might look as though he is clumsy or is just not performing well, and yet the real trouble might not be a lack of motivation or of motor ability at all, but may actually be a sensory orientational malfunction. There are not any really good tests, but we are developing some improved tests for humans and subhuman primates, and the present experiments show what can be done in objective quantitative orientational testing.

The animals displayed normal strength postoperatively, which tended to confirm the absence of any motor damage during surgery.

Most important in this regard, however, were the histological slides made of monkey spinal cords following autopsy. No damage to the motor system nor to any other part of the brain and spinal cord could be detected except for the cutting of the C-1, -2, -3 dorsal cervical nerves.

Figures 8, 9, 10, and 11 summarize some of the quantitative data that were gathered from a few years of study of the cervical and labyrinthine mechanisms. Originally each animal was tested over a long period of time and Figure 8 shows how the whole colony of animals stabilized their performance in the test situation before anything was done to them. Their performance times improved and then leveled off after about 100 days. In any one animal, the standard deviation of performance for about three weeks would have to be stable before we considered him trained and ready for experimental manipulations. It is against this normal level portion of test performance that postoperative results are compared.

After labyrinthectomy (Fig. 9) the performance went down very markedly, and after 50 days it still was only about half of normal and tended to level off at that level of inferior performance. The same results were obtained for the neck (Fig. 10). There is a drop in performance at the point of surgery and then some recovery again developed fairly quickly before it leveled off at a subnormal level in about 50 days. These data come from actual measurements of climbing times both prior to and following surgery taken from direct observation of the motion picture films.

Figure 11 summarizes experiments in which both operations were performed on the same animals. Recovery times are roughly the same although in this case recovery following cervical interruption was a little faster and to a higher level than following labyrinthectomy. When both surgical procedures are combined, the total deficit is much greater than with either procedure separately. Recovery is also less. Thus the defects are summated or cumulative, which is what you would expect from two different physiological components.

It was apparent from direct observation and also from the motion picture film records that the vestibular apparatus seemed most concerned with maintenance of posture. The animals fell over more when they did not have anything to hold onto, such as when they were on the floor or when they were trying to walk, and they did not miss as much when they were actually climbing or had things to hold onto which they could visually fixate. The converse appeared in relation to the cervical component of spatial orientation. In this

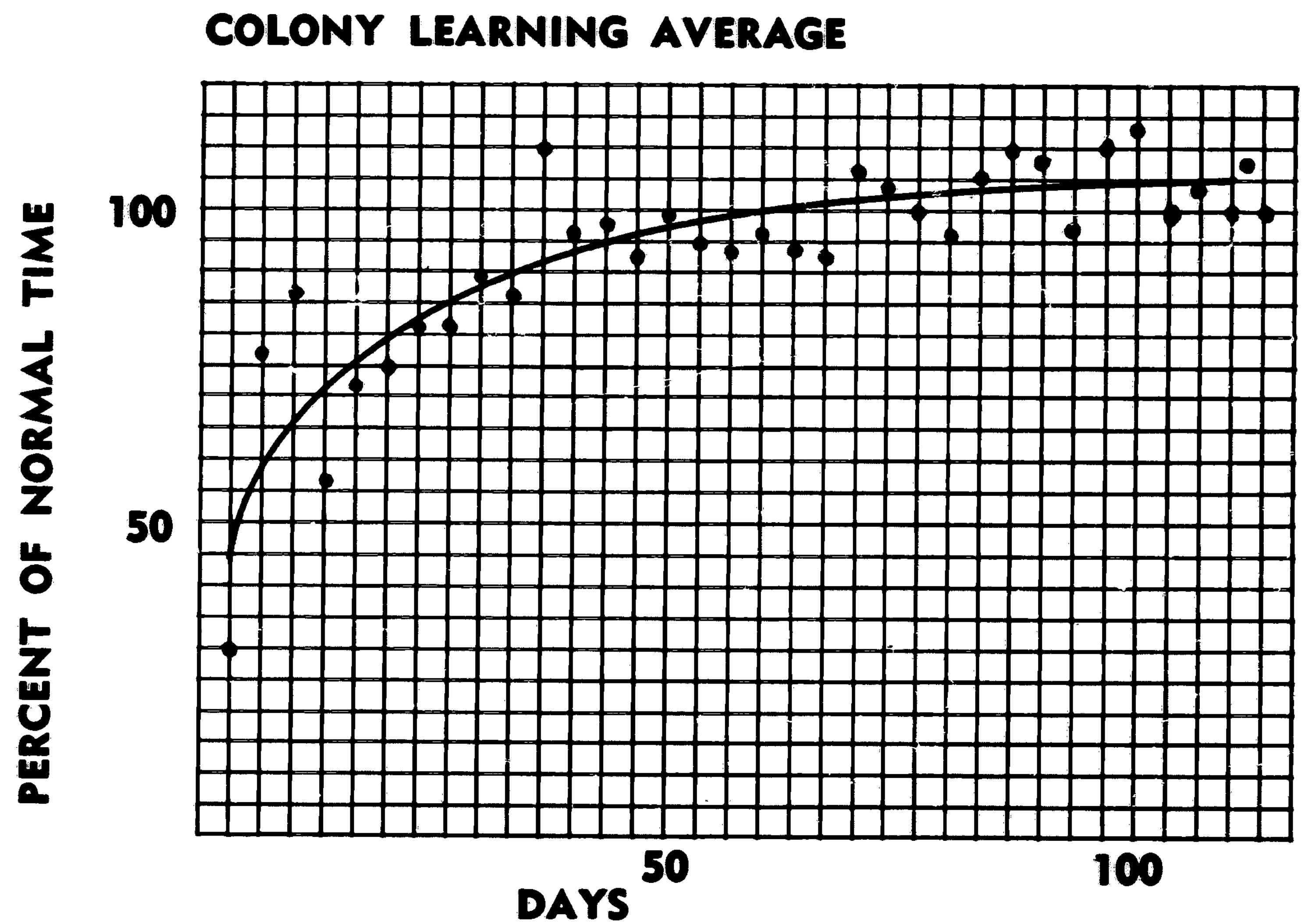

Figure 8. Colony learning average.

RECOVERY FOLLOWING VESTIBULAR DESTRUCTION

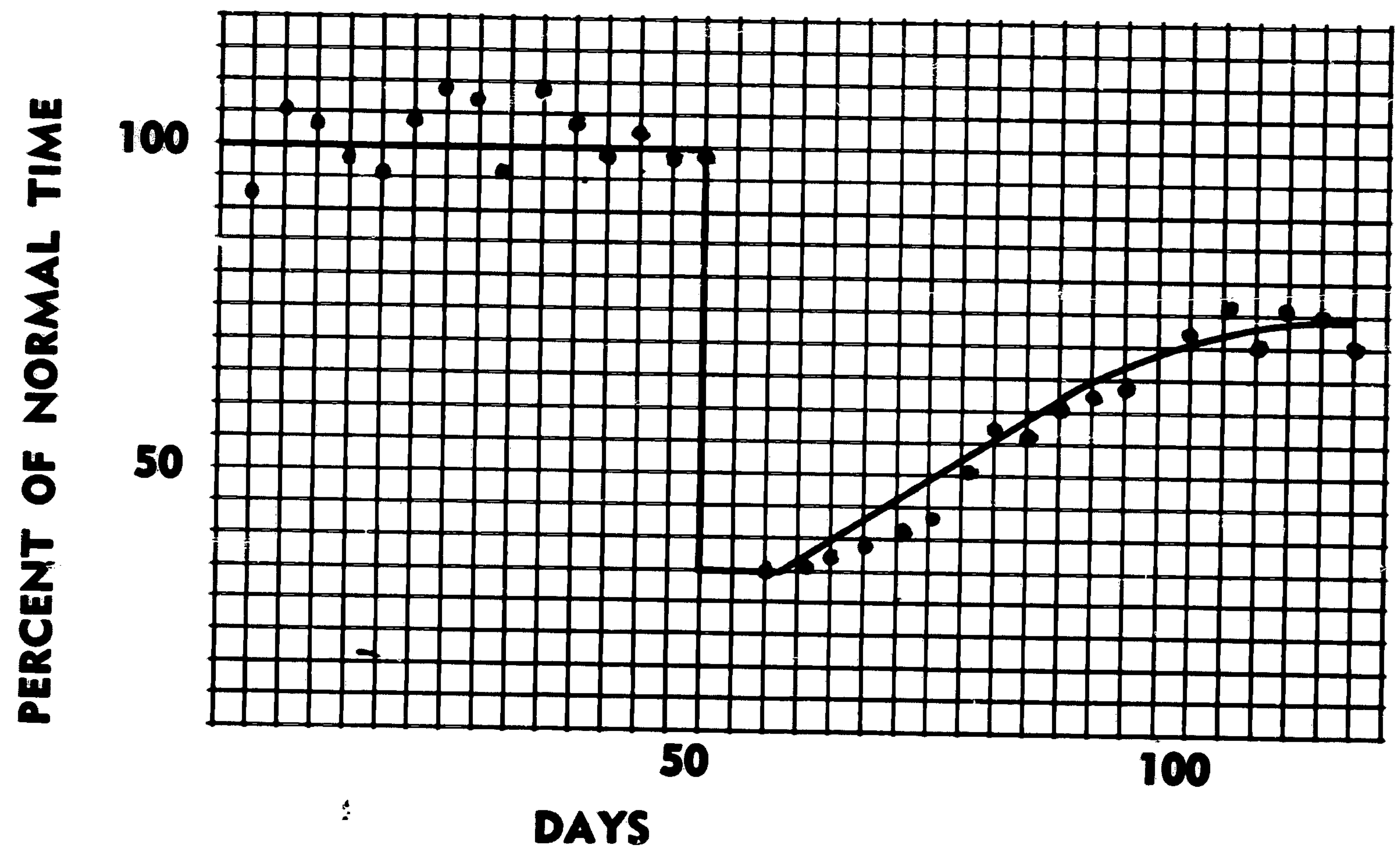

Figure 9. *Recovery following vestibular destruction.*

case the animals seemed to walk relatively well, although obviously were not normal, but there was very little falling over or complete staggering. However, these animals missed much more when reaching with their hands for discrete objects on which they had fixed their gaze. A general principle seems to be emerging, which needs a lot more study before being validated, that the cervical sensory component is concerned primarily with spatial orientation of visually fixated objects. We need to be able to relate the viewed object with the limbs that are going to deal with that object. In contrast, the vestibular apparatus seems concerned more with which end is up and which end is down and maintenance generally of what we call body posture in relation to gravity, and is not particularly related to the orientation of visually fixated objects.

In summary, it is clear that these different sensory inputs contribute to total body spatial orientation for an organism and are extremely important in this role. Even with perfectly normal motor coordination and operation of the motor system, one can see very bad motor performance if there is defective performance of some of these sensory inputs. Each one of these inputs makes an impor-

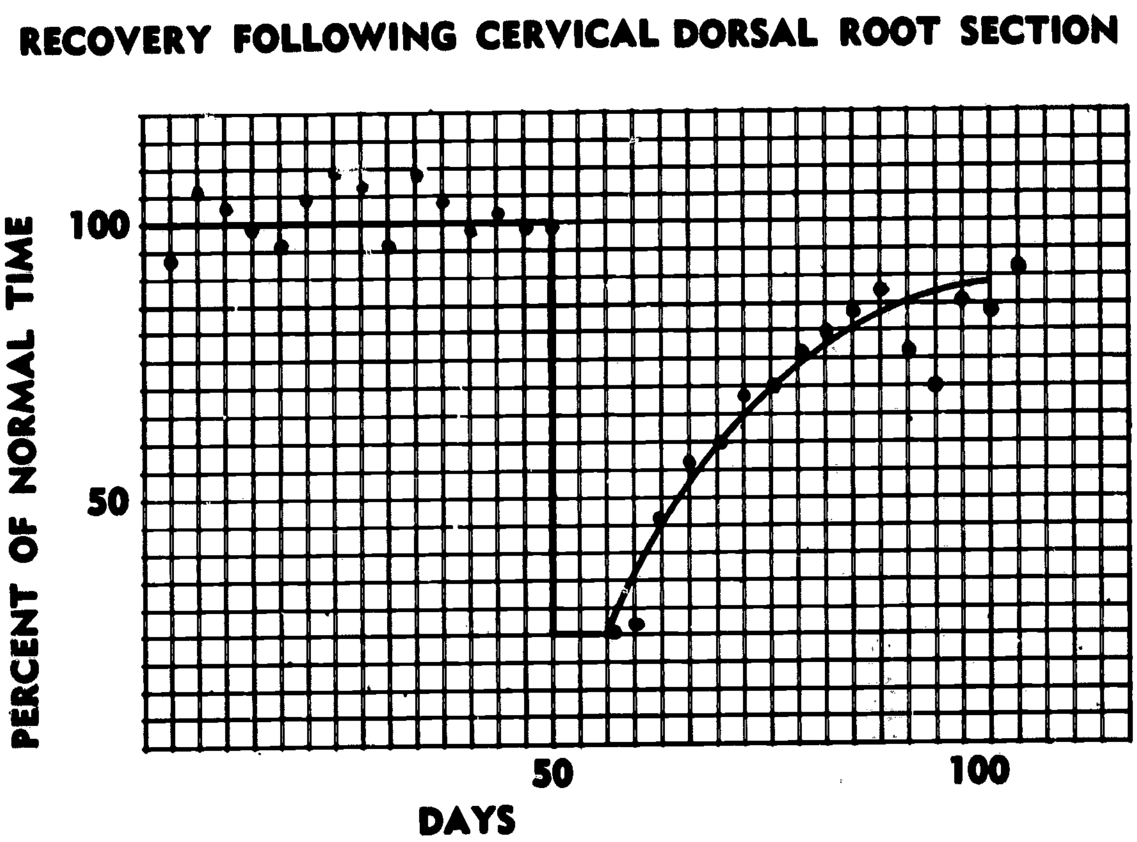

Figure 10. *Recovery following cervical dorsal root section.*

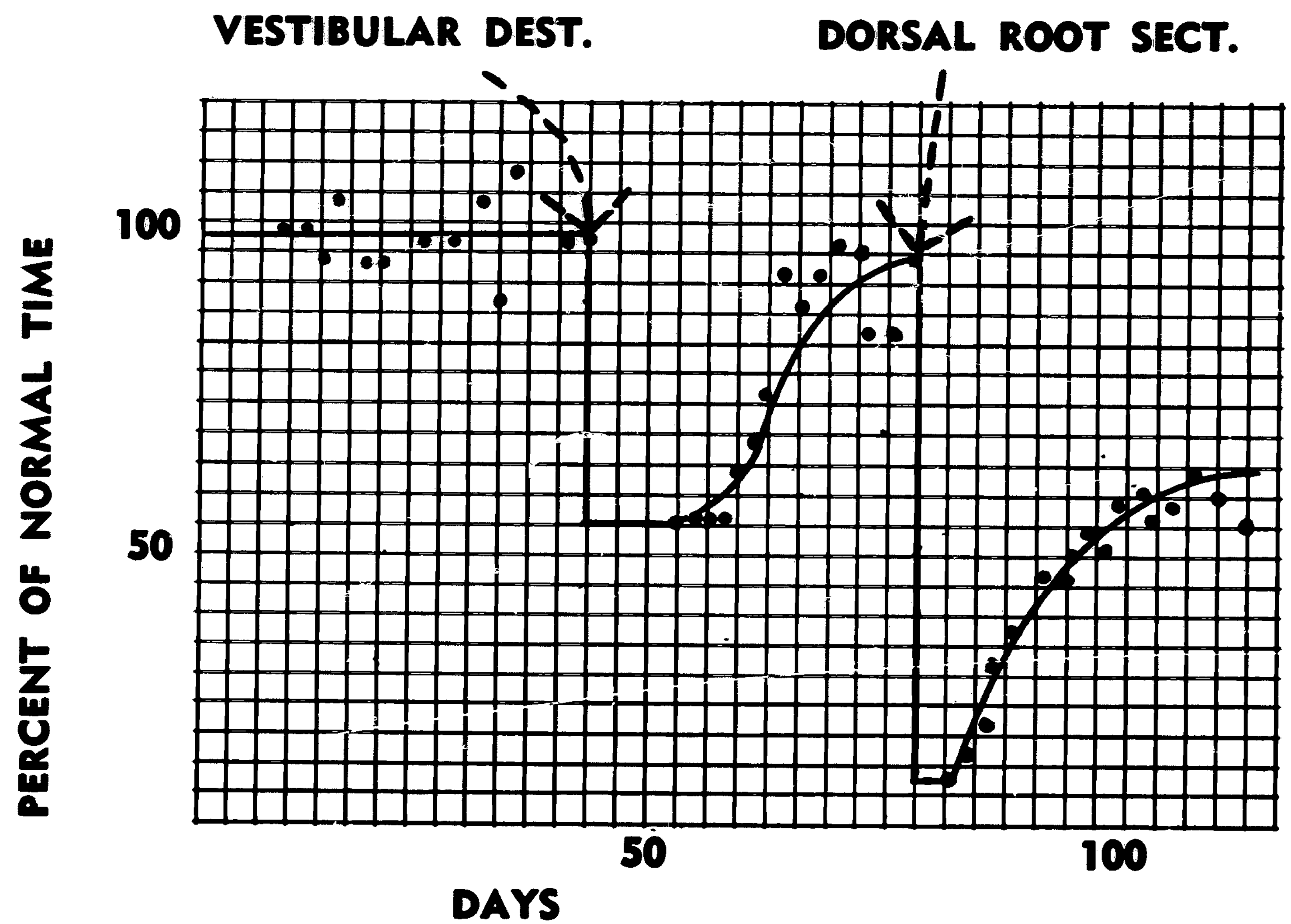

Figure 11. *Vestibular destruction and dorsal root section.*

tant contribution to total body spatial orientation and you degrade the total function, although not necessarily to extinction, by interfering with any one of these inputs.

There is a great deal of other information that can be brought to bear in applying the multicomponent nature of body spatial orientation to humans in ordinary environmental situations. This relates to reflex responses to orientational movements. A usual situation develops as follows. Something in the environment attracts the attention of the individual. He then moves his eyes toward the attracting object, and if it is far from his starting position of gaze, then his head will move as well as his eyes. The eyes may meet the target and come to rest and then the head will reach its resting position soon thereafter. The head will not produce as large a deviation from its neutral position as did the eyes. For example, if the object is 90° right, the eyes will move toward the new object first, the head lagging behind but following it, and the resting "on target" position may be a 45° right turn of the head plus a 45° right turn of the eyes, for the necessary total 90° of deviation. Later data show that the eyes start slowing down a little bit short of the target, while the head keeps moving, and then they both continue briefly to their resting target positions (8). Thus the necessary motion for visual fixation is carried out partly by the extraocular muscles, and partly by the neck muscles.

The body's orientational problem is greatly simplified if correct posture is maintained once the individual has fixated on the new object; and this is performed again by the various pertinent physiological components of orientation which have been detailed above. Now what happens as a result of these motions of the eyes, head, and postural structures? Obviously, these motions will activate eye, head, and body proprioceptors. There are two general classifications of responses that always occur following stimulation of these receptors. First, certain reflex effects occur, and second, perceptual effects appear. These are different although they all come from the same sensory receptor and therefore have a common afferent neuron as input. The afferents soon branch within the spinal cord, however, and each goes to a different part of the nervous system and each has a different type of neuroanatomical connection, and therefore each will perform a different function. One branch pathway will serve a reflex function and the other, a perceptual function.

There are many specific reflex effects that are studied, but one of the classical ones results from activation of neck receptors and is called the "tonic neck and labyrinthine reflex." It was first described carefully by Magnus and deKleijn (14). Basically, this involves extension of both limbs on the side toward which the head is turned and flexion of limbs on the opposite side. For many years it was thought that these reflex responses do not occur in normal individuals. They can be readily demonstrated in hydrocephalic children where there is a great deal of brain damage, but were not apparent in normal humans. Therefore it was believed that the normal cerebral cortex inhibits these basic reflex patterns and thus the patterns are only significant as a clinical pathological sign which would be indicative of loss of brain function. There is very convincing evidence now that this is not true (10, 11, 20). It has been shown that all of us exhibit tonic neck and labyrinthine reflexes when we move our head in relation to our body. The reflex will not usually produce major extensions and flexions of the limbs as is seen in decerebrated subjects, but it will alter the physiological tone in the muscles. Significant changes in motoneuron firing can be shown if you use sensitive enough equipment to measure it. One cannot expect overt reflex effects to appear in normal humans, as Magnus and deKleijn originally obtained from their acute preparations, but reflex effects are nonetheless present in normal humans and play a significant role in body spatial orientation during and following head movements. It has been shown that even without actual motion of the limbs there is nonetheless a difference in muscle tension arising from activation of head and cervical receptors so that the tone in the extensor muscles is increased on the side toward which the head is turned and the extensor tone on the opposite side is decreased (20).

This reflex tone can create all kinds of stressful situations and it represents a basic reflex pattern with which one has to deal whenever neck motion occurs. If there are certain motor acts which you want to train an individual to do, which oppose these natural reflex changes, then you are creating problems for the individual because you are going against a basic physiological pattern of response. These reflex effects will tonically condition the muscles, even when not producing major contractions. Magnus (13) also showed that elevating the head causes extension of both forelimbs and flexion of the hind limbs. Similarly, depressing the head toward the chest will cause flexion of the forelimbs and extension of the hind limbs. Any of these head motions then are going to produce tonic changes in the muscles, and if it is your happy lot in life to train people in motor activity which requires opposite responses, then it is an especially difficult training task. For example, in basketball shooting you may desire the person to look up with his eyes and head at the basket while simultaneously flexing his extended arms in order to get ready for shooting. This can be an especially difficult training task since you would first have to train him to erase the basic reflex linkage between the head and the arms that acts to produce a different response from the one you want before you could proceed to train him in the correct response. The tonic neck and labyrinthine reflex would facilitate arm extension during head elevation while you actually want arm flexion during head elevation.

The reflex responses to vestibular stimulation which have been most widely studied are the nystagmus movements. These are involuntary rhythmical back and forth motions of the eyes which go very fast and therefore are hard to see. It is relatively easy to record nystagmus. This is done quite frequently in aerospace medicine and in some hospitals or clinics because all that is required is to simply place electrodes at the two corners of the eye and lead the voltage difference between the two wires into a recorder. Since the back part of the eye is usually negative in charge in relation to the front part, as the eye moves the back part will get closer or further to either of the electrodes and thus appropriate electrical variations signaling eye movement will be obtained. The only difficulty is that nobody has ever shown what normal function, if any, is served by nystagmus. It is definitely considered to be an abnormal sign in many cases. Positional nystagmus is a clinical sign that indicates undue pressure in the fluid inside the ear which affects the hearing organ as well as the canals. It is highly questionable whether nystagmus ordinarily occurs or even validly measures any normal useful function involved in body spatial orientation. But it is recorded widely, nonetheless, as a measure of vestibular ocular reflexes. The way a clinician usually measures nystagmus is by irrigating the ear with hot or cold water, thus setting up convection currents inside the canals and simulating acceleration stimulation. Rotating a person in a chair tends to make him dizzy and nauseous and thus is more unpleasant than the injection of hot or cold water into the external auditory canals.

For awhile it was thought that the vestibular apparatus was responsible for certain other reflex responses of the eye which compensate for body movement. It is known, for example, that when you move the head in different positions a compensatory reflex movement of the eyes occurs which bears a certain relationship to the direction of the movement and postural relationship between the position of the head and body with the visually fixated objects. These compensatory eye movements were thought to be a response of the vestibular apparatus. A critical experiment was performed by deKleijn (12) who destroyed the vestibular apparatus and found that the compensatory movements of the eye still occurred in response to postural shifts. These are normal eye adjustments which occur in all people under proper conditions, and they are considered to perform a very useful function by reducing the deviation of the visual axes from horizontality when head position is tilted from its normal vertical position. Compensatory reflex movements of the eye are typically opposite to the direction of the shift in posture. It has been proven by deKleijn that these responses are mainly brought about by the neck receptors, since if you cut the first three dorsal cervical roots, you do *not* get the normal compensating eye reflex movements in response to a change in posture. The best we can do for the vestibular receptors is to say that possibly vestibular receptors also contribute something to these spatial orientation reflexes. Unfortunately, people who work on the vestibular apparatus in this type of experiment do not inactivate the neck receptors, and since they usually employ rotation or motion of the total organism as a stimulus, they are unjustified in assuming that any reflex change in the eyes or any conscious perception of body orientation changes were all due to the vestibular apparatus. Of course, this is not only unfortunate, it is completely incorrect. Any position movement of the body will stimulate cervical as well as vestibular mechanisms.

Philipszoon (16) has shown that nystagmus eye movements can arise even as a result of pure neck receptor stimulation. Vestibular stimulation can be clearly avoided in humans by the simple expedience of preventing head movement. A person is seated on a swivel so that his body can be moved while the head is kept constant in relation to the environment. Such movements will produce movements only in the neck, and yet will evoke nystagmus responses. So even in regard to nystagmus, which seems to be the most authenticated reflex adjustment of the vestibular apparatus, it is clear that this response arises from cervical receptors as well as from vestibular ones. I think we really have to mature beyond the simple "one physiological input" concept. We must at least include these three major physiological components: (a) the position of the eye in relation to the skull, which is the extraocular sensory device, (b) the vestibular component, which orients the head in relation to gravity and to the acceleration of the body, and (c) the cervical component, which orients the head in relation to the body and measures acceleration because of the inertial lag of the head in relation to the trunk.

All of these components contain reflex mechanisms which can produce illusions, and with correct experimentation on humans these can be shown. For example, one can change the direction of gravity unknown to a human subject by changing the speed at which he is being driven around on a human centrifuge. The subject is then asked to adjust a fixated spot of light in the darkened cupola of the centrifuge while he is being rotated. The subject obtains the impression that the spot of light at which he is looking has shifted upward, but actually it has remained stationary. The amount of apparent shift is proportional to the apparent shift in direction of gravity, which in turn is proportional to the amount of centrifugal force.

It is thus clear, that while the reflex responses of these physiological components of body spatial orientation do not produce a conscious awareness in themselves, nonetheless they manipulate the body, the hands, the head, and the eyes; by these reflex motor movements they are bound to affect the conscious perception of body spatial orientation which after all is composed of inputs from visual, vestibular, cervical, and body movement receptors.

This conscious perception is usually measured by a test of verticality and horizontality. This can be quantitated. It has been shown by Wapner and his group (18) that if you stimulate cervical muscles, for example, on the left side of the neck, that the apparent vertical will seem to shift toward the other side even though there has been no actual movement of the head nor of the environment. Similarly, it has been shown that in kinesthetic judgment of what is vertical, measured by a person feeling a ruler or yardstick which can be swiveled and then placing it in whatever position he considers to be vertical, that person makes greater errors when his body is tilted than when it is in the perfect vertical (19). Again, the errors are predominantly toward the opposite side from that toward which he is tilted. He tends to feel that the environment has shifted with him.

However, we have no good test of conscious body spatial orientation. We can measure depth perception as a specific entity. We can measure our ability to negotiate complicated motor acts, such as is done with monkeys in climbing pegs, and we can do this with people too. Graybiel (7) uses a rail test which is really little more than a modification of the police "walk a straight line" test for alcohol disorientation, the only innovation being the use of walking rails of different widths. However all of these tests are measuring different features of total body spatial orientation and there is still a great need for some good measure in humans of body spatial orientation as a total function, rather than only measuring individual aspects.

In the remaining space I would like to point up a serious physiological affront to the organism which many workers in human behavior commonly introduce as part of their professional philosophy, which traditionally ignores the importance of physiological stress. Using the previous discussion as a specific example of this, the orientational reflex effects are often ignored, as are the spatial disorientations, both of which are being introduced by certain environmental motor activity that the subject is being asked to perform. However these can be ignored only on the basis that the person still seems able to perform. Yet, there is a very serious error in this kind of "do or die" reasoning. The person's performance can subject him to a tremendous amount of physiological stress. The fact that somebody can do something does not mean that this is the right way to do it or that this is a good way to do it. We have not measured physiological stresses enough. I am interested in doing a study of school children in elementary and private schools in Philadelphia, using children in different learning situations with different postures and measuring what the actual physiological stress is. We want to measure two things specifically: first, muscular effort, as Harmon (8) has done with such inspiration by measuring the electromyographic (emg) recording on the surface of different postural muscles. This gives a direct measure of the neuromuscular system and of its physiological performance. You can measure the total area, let us say, under an emg curve rather than any actual peak of electrical activity or any frequency. Of course, a small amount of emg activity indicates there is little muscular activity. Conversely, a lot of activity in certain postures indicates ~~that the~~ same muscles are now performing much more strongly. From this we get a direct specific measurement of which muscles are being physiologically involved or stressed. We can present different postural situations, different desk relationships, different sitting positions, all while requesting performance of different visually oriented tasks. Secondly, we want to do some traditional physiological measures such as heart rate, respiratory rate, and oxygen consumption. These should be measured, including the emg's, by telemetry so as not to interfere at all with the classroom situation or with the patient. The fact that a student is performing in an awkward postural and orientational situation can produce significant quantitative changes in these measures, since total physiological energy requirement and, therefore, the responses of the heart and circulatory and respiratory systems would be changed. Furthermore, responses of specific muscles can be individually stressed in certain postures even though the general body might not show much stress.

Such recordings of physiological effort and stress in unencumbered human subjects is within the present state of the art and I think this sort of study must be done and really should have been done long before this. Harmon (8) showed, a number of years ago in the Becker School near Austin, Texas, that exposure of children to classroom situations actually increases the incidence of postural defects. Examples of postural defects are: dropped shoulders, development eventually of one leg that is longer than the other, a tilted pelvis, or other deviations which orthopedists and others would consider defects. For example, in grade 1A the children came in with 7.1 per cent postural problems. Grade 2 was up to 26.6 per cent; grade 3, 28.3 per cent; grade 4, 40 per cent, and grade 4B, 46.1 per cent (9). These data were statistically analyzed to show that the differences were significant. The differences are much beyond the random variation, and thus it is clear that in this school system the normal classroom environment was introducing postural problems. Apparently, the students were chronically exposed to a stressful situation. While individuals respond in different ways to stress, it seems clear that in the case of Becker School students postural stress developed which became manifest as postural deformations. It could be that the task the student is asked to perform is straining his total perception of spatial orientation, or it is introducing certain spatial reflexes which are making these things difficult to perform, and he will make certain postural adjustments in order to minimize these stresses although, admittedly, he cannot abolish them.

This is a form of adaptation and we all know how well the human body can adapt; but I would close with a plea that we do not try to *force* the human to adapt at all costs to his physiological system. Instead of saying "Can he do it or not" and then saying that somebody does it very well and therefore has greater ability or someone does not perform as well in his motor task and has a lesser ability, we should instead assume that everybody can perform as well in his motor task if we find the right sensory-motor conditions for each individual requirement. But most essential, we should set for ourselves the goal of "How can I minimize physiological stress?" We must change from saying "How can I *drive the person harder* so he will begin to perform the way we want under the conditions prevailing?" and replace this crude and physiologically insulting approach with the more sophisticated and physiologically more correct approach of "How can I manipulate the environment and man's relationship to it so as to *reduce body stress to a minimum and facilitate the task*?" Simply put, it means that we must stop concentrating everything on forcing the man to adapt to the task. Instead we should force the task-environment complex to adapt to man and his natural physiological norms and capabilities. This is not only a more humanistic approach but it also makes infinitely better sense biologically.

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MOTOR DEVELOPMENT AS A FUNCTION OF PERCEPTION*

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Let me summarize my curriculum vita by saying that I am a pediatrician who became interested in problems of growth and development. The lesson the neurologically deviant child teaches is all important. He tells us that our so-called "normal" child population is deviant. Thus, while my remarks will be about neurologically handicapped infants and children I hope the inference will not be missed. It is that much of the information on handicapped children can be applied to "stressed" infants and clumsy children. We suspect that a fair number of neurologically deviant children are contained within the normal population. The subject I have been asked to discuss—motor development as a function of perception—is a very difficult one because current information, as was brought out so far today, is based more upon speculation than documentation. There are many theories, and consequently many controversies about the relationship of motor function to perceptual enrichment. Barsch (2) has conceptualized a ten-component theory of movement as it relates to learning which is favorable to the motor-perceptual dependency concept. On the other hand from Lennenberg's challenging study of speech and language development, we may infer that there may be a biological timetable to motor-perceptual function as there appears to be in communication (12). Perhaps, in spite of environmental stimulation, motor sequences emerge in orderly patterns and perceptual development is also independent. Perhaps someday someone may show that RNA and DNA transmitted memory codes are the basis for perceptual-intellectual development and that structured repetitive movement patterns, today's topic, are overrated re-

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quirements of perceptual-cognitive function. The abundance of "perhaps" is the dilemma of the topic.

From the view of the physical education expert it seems very important to understand what the motor bases are and their significance to perceptual development, because it may help provide new and important directions your profession should take. I am referring to the emerging of physical education, not only into the preschool and handicapped child areas, but also into the area of "stressed" infant programs. Here, you could join forces with physical, occupational, speech, and language therapy, and the host of physicians who are now interested to explore this new, but vitally important, aspect of human growth and development.

However, before tantalizing you with promises of new territories to explore, let me present some pertinent definitions, discuss some theories, and finally present a developmental approach to motor-perceptual stimulation in which physical education, occupational therapy, speech, and language therapy—a team approach—play a very important role. Research and documentation may later show us better ways to explore young children or perhaps prepare young children for better lives. As I present current views we should be able to decide for ourselves what is fact, what is conjecture, what is good, and, perhaps, what is wishful thinking. These definitions which follow are not mine but are quoted from standard textbooks.

Motor Bases: the motor bases for perceptual development are stated to be posture, directionality and laterality, and awareness of position of body in space. I cannot talk about motor bases without also including definitions of perception and intelligence. One should not discuss motor bases in isolation. Motor bases, perception, and intelligence are three components which are inseparable in our clinical approach to school adjustment. *Perception* has been defined as the unified awareness derived from sensory processes when a stimulus is presented. There are varieties of perceptual abilities: *visual,* the ability to recognize forms and shapes; *visual-motor,* the ability to reproduce these symbols; *auditory,* the ability to recognize sounds, symbols, or words. *Intelligence:* the capacity to reason or understand.

Theoretical Framework

The relationship of movement and perception is more readily understood if we orient ourselves around the term "intelligence." This is not a fixed entity, but is favorably or unfavorably affected by a host of external and internal sensory, integrated processes as well as by social-cultural factors. Intelligence and perception are intertwined inseparably.

The fundamental processes of perception are present at birth. Whether intelligence and learning ability is interrelated with perception or is more related to heredity or environment is still something not readily known. If I may reinforce some of the items discussed earlier, let me remind you that a newborn can be conditioned to respond to sound within two to ten minutes after birth. He will respond better to low than high frequencies. At six months he can localize sound. If he is inattentive to ordinary auditory stimuli by six months, very often it will be demonstrated that during the second or third year of life this baby has neurological impairment, either in the visual area or the auditory area. He can discriminate and be conditioned to a variety of smells on the first day of life. Smell is a very significant initiator of perceptual development.

Visual perception now is known to be well-organized at birth. An infant's pupils will dilate to pleasurable stimuli and constrict when the stimuli are not pleasurable. An alert infant can smile within a week; he can distinguish his mother's face at two weeks; at two months he can smile at his mother; at four months at normal faces; and, at eight months he can laugh when one makes funny faces at him. At four months, he can see objects clearly at eight inches; he can accommodate for far and near almost as well as an adult. The ability to differentiate black and white occurs early after the birth. The important item, of course, is that with all of this information he must undergo over the long period the ability to process this information appropriately and put into proper sequence the multiple clues he receives to help him comprehend the meaning of the stimuli.

A fear of falling when placed in a high position is an early developmental feature but diminishes when depth perception develops. Dr. Cohen, the speaker before me, alluded to this. It is a very fundamental and basic feature, which, if unresolved, interferes with the habilitation of handicapped children.

At two months, an infant discovers his arms and fisted hands. Between two and five months, when a steel ball is rolled toward him, he will try to grasp it with a swipe of his hand. The important issue is that when, two months later, you roll the ball at him from an unusual direction he can perceive and know the difference in direction. A baby whose environment is enriched visually with colored mobiles, mirrors, and toys—and this was brought to your attention earlier today—learns to grasp between 52 to 64 days sooner than his nonenriched counterpart. Enrichment also accelerates the discovery of the hands.

Infants require feedback or stimulation from their own motor activities for perceptual learning. Normal behavior is delayed or distorted with sensory or motor deprivation. Experience and motivation influences perception. Children from low socioeconomic cultures who are hungry perceive identical coins differently. A quarter appears bigger to a deprived child than to a well-fed, middle-class child. I have even learned from doing my homework for you that the Zulu tribes in Africa who live in round houses cannot perceive straight lines like the white people in our Western culture who live in square houses.

Anticipation influences perception. Children draw larger pictures of Santa Claus ten days before Christmas than they do after the holidays. These are all very important issues if we are to develop a comprehension about the problem we are discussing today.

In mental deficiency, the largest numbers stem from adverse environmental conditions; prenatal, cultural, social. Even in cases where genetic (chromosomal) abnormalities are demonstrated as causative—in mongoloid, for instance, then sensory-motor stimulation, positive family attitudes, and environmental stimulation unequivocally produce better functioning retardates than children who are left untreated (13).

Motor Bases

Psychology, special education, and optometry have developed a very intricate, but unified, concept about the motor bases of achievement. However, it was Gesell, one of our early mentors in the Meeting Street School in Providence who helped set up our first programs in child growth and development, who first focused attention upon the intertwining of sensory-motor skills (9). Piaget, again, emphasized the importance of early sensory-motor learning as a necessary building block for later complex perceptual and cognitive development (8).

Kephart (11) has been a leader in developing a diagnostic-treatment program for slow learners based upon the idea that reading, writing, and arithmetic skills depend first upon the orderly development of motor patterns. He emphasizes the difference between the term "movement" and "motor." Movement is an observable response, while motor is an internalized event related to the motor "output" system. Motor activity is inherent and constant while movement patterns such as walking, sliding, and skiing are not. Kephart says that movement patterns depend upon posture, maintenance of balance, contact, locomotion, receipt, and propulsion. These are the integral components of an awareness of body position in space, or body image. Body schemas depend on information from sensory input and motor output systems derived from movement explorations in a feedback system. Body imagery matures in relationship to dimensional and directional maturity. This is demonstrated in an outdoor jungle gym. Here (in the slide shown) all are handicapped, cerebral palsied youngsters going up, going down, going sideways, going in, going out, going up—all of the directions necessary to survive in the concrete jungle of the "normal" world.

Barsch also feels that movement efficiency is a fundamental principle underlining human design. He implies that movement promotes energy which the perceptual-cognitive system transforms into information which, in turn, is transmitted through language.

Both Kephart and Barsch have had great influence on remedial education for mentally retarded and neurologically impaired children. Their programs, based upon a segmental, sequential body organization approach, concentrates upon supplying the child with concepts of posture, laterality, directionality, and awareness of position and body in space. These, they feel, are the necessary precursors to reading and writing readiness. These are the motor bases of achievement. Until scientific research points out new directions, and some were pointed out today, their ideas do seem to be clinically effective in a large number of children with neurological disorganization.

Others, such as Doman and Delacato (3) have built more complicated treatment sets around the theory that laterality and dominance, homologous and cross-patterning are necessary requirements to mature body functioning, perceptual enrichment, and learning efficiency. They state that disordered patterns can be corrected by returning to the movement patterns of our crawling Darwinian ancestors. They feel that optimal rehabilitation in a variety of psychoneurological conditions can be obtained by recapturing the creeping patterns which are said to be lying dormant in all of us.

If the movement theories are completely correct, then the gates can be opened widely to physical educators, along with physical, occupational, and speech therapists, to learn techniques which impose structured movement and which enrich perception. If their theory is correct, then we can apply it to an anticipated 12 million handicapped population, or 10 to 20 percent of our potential school failure population, and to our normal children whose upward-striving parents and demanding teachers are finding that they are getting fewer academic returns than they have anticipated from programed learning. The problem of tomorrow is the unnecessary numbers of mildly handicapped children. Are we prepared to meet these numbers?

For a variety of reasons, this panacea concept has bothered an increasing number of professionals with dedicated interests in child development. There are some investigators who feel there is no scientific evidence of anthropological retrieval. This issue was discussed at length at an American Academy of Cerebral Palsy Conference in New Orleans. Here, all of the promulgators of systems of treatment were brought together. Unfortunately, many could not justify by hard scientific fact that it was not anymore than their own personalities, their own dedication, and their own skills producing good results. There are some practitioners who feel that a "treatment system" demands too much from parents, or that returns are either too meager or can be obtained in other less demanding ways (1). There are those like ourselves, middle-of-the-road, service-oriented, who seek to provide honest, modern, and total service to concerned parents and deviant children. In attempting this, we often get side-tracked by new theories. We try them out, often becoming confused by the child who does not fit the rule and deviates from what we expect. We find a need to constantly question our own conscience and our own souls in order to continue on clearly defined pathways.

A good example about how facts do not jell can be made from the common knowledge that girls perform better than boys in skilled physical activity, as well as being better students. We believe that this is due to later maturity of the male species which is more apt, they say, to run free before settling down to a structured existence. Our documented study of 355 children, now expanded to some 1500 normal 6-7½ year-old first grade children in the New England area, points out that girls do perform better in complex integrative skills and bilateral synchronous skills. See Table I.

We assumed that those endowments of liking hopscotch, pick-up sticks, and jacks better than boys are natural inborn traits of femininity. We learn that such skills may come from DNA-RNA or hormonal transmission from gender to gender. Recently our acceptance of the natural physical superiority of the female was shattered with the report (10) that pseudohermaphroditic children (who appear

TABLE I (6) Meeting Street School Screening Test Items Showing Significant Sex Differences

ITEM NO.	DESCRIPTION	PERCENT BOYS FAILING	PERCENT GIRLS FAILING	PERCENTAGE
5	Touch Fingers	11	6	.07
10	Skip	19	6	.01
12	Run, Skip, Stop	12	4	.01
14	Hop	11	5	.05
16	Hop on Other Foot	11	4	.01

to have sexual organs of one sex, but by gonadal and chromosomal studies, are of the opposite sex), when assigned incorrectly at birth to one sex, develop a sense of and the skills of the assigned sex regardless of their true sexual identity. Further, after a few years they cannot undergo sexual reassignment even when there are serious biological contraindications. Thus, it appears that very early in life environmental attitudes and handling have a life-long implication, even concerning physical aptitude and sexual appetite.

The implication is that while all of the influences affecting growth and development are still unknown, the earlier in life anomalous behavior (physical, sexual, emotional) is recognized, the greater the opportunity for subsequent modification through imposed techniques.

Another bit of information which disturbed us at one period in our own development was the finding that dominance and directionality or the ability to discriminate right from left and unilateral eye-handedness was greatly influenced by maturation. We found that mixed dominance and laterality occurred in over 25 percent of normal six- to seven-year-old children. This often persisted until ages 8 to 12, while gross motor skills, fine patterned movements, visual-perceptual-motor skills, and language skills matured before 7½ years. See Table II.

On the other hand we found that skills such as hop, skip, and jump, sitting up from the supine, fine finger dexterity, positions in space, and some of the language problems matured before the age of 7½. It is true that a large number of clumsy children who fail in school have mixed dominance and laterality. I find that in my clinical practice, however, it is also true that a high number of nonclumsy, nonschool failure population also have mixed dominance

Table II (6) Developmental Characteristics of Selected Meeting Street School Screening Test Items Over the 6 - 7½ Year Age Range

I ITEMS MOST STABLE OVER AGE RANGE	II ITEMS LESS STABLE OVER AGE RANGE	III ITEMS NOT ESTABLISHED IN AGE RANGE
Touch Fingers Skip Draw a Square Word Reading Trace Star Draw a Diamond	A. *Changes at 6½ Years* Hop Down Line, One Foot Hop Down Line, Other Foot Sit from Supine Pick-up Sticks Wind Spool	Right to Left Discrimination Look Thru Tube (Crossed Dominance)
Write Whole Name	B. *Changes at 7 Years* Curved Road Sentence Fill-In Sentence Memory	

and laterality. Should an entire rehabilitation program then be based around this issue? This is the question that I think we must ask ourselves.

An Early Developmental Program in Children With Cerebral Palsy and Related Disorders

We use, as early as possible, a sequential developmental approach in the hope that we can favorably influence distortions of growth and development. These may stem from impaired neurosensory input systems and motor output systems, or from integrated systems. Normally, these systems supply a substantial amount of information in developing perceptual-cognitive structure. It would appear reasonable to assume — and this was brought out today — that inadequate or incorrectly applied information impedes the development of mature perceptual-cognitive-communicative processes. Such a philosophy is fortified by superb studies of Windle and his collaborators (14). Windle did a monumental piece of work for those of us in cerebral palsy and child neurology by stressing the role of oxygen lack in the newborn to later neurological defect. He studied the brains of monkeys in a systematic, concise way. One of the problems today is that neurology is still anatomically and pathologically oriented. Our entire philosophy of behavior is based upon appearance of the brain at post-mortem. Today, infants and children do not die unless they are severely damaged or by accident. Since deaths are at a minimum, we cannot and should not base our reasoning about brain function and behavior upon cases that come from custodial institutions, that is, cases of severe mental deficiency. We have to find our answers in living children. This is hard to do, and harder to document. Thus, we resort to the monkey studies of Windle.

When experimentally-produced oxygen deprivation is given for 0 to 7 minutes there are no clinical signs; 8-12 minutes of oxygen deprivation results in stress. As every mother knows, and every pediatrician finds difficult to accept, there are problems in sucking, swallowing, and later in clumsiness. With monkeys, after initial difficulty in feeding, things get better for a while, but then they develop clumsy fine-finger skills, and then seem to get better. But there are the hidden disabilities — fear of heights — the area we are talking about today. With a higher degree of anoxia, from 13-19 minutes, monkeys develop overt cerebral palsy. And, after 20-30 minutes, the very serious types of cerebral palsy and amentia develop upon which most of our human pathological findings are based. With over 30 minutes of oxygen deprivation death occurs.

Concerning sensory input systems, after 8-12 minutes of experimental anoxia, minimal defects in sensory intake systems and motor output systems occur 6-9 months later; 10-36 months later, impaired gait and growth coordination and fear of heights occur. Translate that in human infants to body awareness and body imagery disturbances, to finger-hand clumsiness, and to vocalization deficiencies. These are the bases, not necessarily the motor bases, that occur in monkeys. They do, believe me, occur in infants. Up until now we have said, "he will outgrow it, leave him alone, he is clumsy," or, "you folks need not begin to work on him until he is at 6, 7, 8, or 9." These things do not get better by themselves. We must help these kinds of children very early. With increasing degrees of anoxic stress increasing amounts of brain damage occur.

We find that with experimentally-produced trauma the occipital lobe is impaired first; this relates to visual-perceptual and visual-perceptual-motor skill. The temporal lobe is impaired next and this relates to communication deficits and to behavior control. Lastly, the frontal lobe with its integrative processes and cognitive storage areas is injured. Again, if we return to the findings of basic research, we find that we are able to at least get some correlative impressions about what we are doing and finding. Our system of management of the neurologically impaired and the neurologically suspect young selects the best aspects of the Gesell-Piaget-Kephart philosophies. We enrich the environment with psychological and social aids to provide a firm supportive basis for parents as well as for the child. We feel that this can be one of the answers to new directions professionals involved in development can take to provide services for the deviant, the minimal, the marginal. The early development program concentrates on: (a) ability to manage one's own position of body in space, and (b) eye and hand coordination (7). We feel that position of body in space is the aspect that is most important to the total development of the young child.

We stimulate independence of motion by positioning and taking advantage of the benefits postural reflexes afford to help establish awareness of the body in various spatial relations. We depend upon the Moro, TNR, vestibular, and optokinetic responses. We use the prone position as a starting point to develop head strength, body strength, and limb strength, to overcome fear of movement, and achieve independent sitting and walking.

Neurologically impaired infants can learn to overcome fear of movement through repetitive, pleasurable movement such as a father tossing the child gently into the air and catching him, rolling him over like a ball and twirling him around. Rather than leaving him alone, we now take the neurologically impaired youngster and toss and turn and twist him and stand him on his head, so he too can overcome fear of movement. We use practical home devices like magazines to develop strength. We concentrate on position in space, and we avoid isolated muscle exercises. We obtain muscle strength and dexterity through pleasurable, planned, competitive exercises. Between the ages of two and three (See Table III), the motor bases for improving the experience of body awareness are rolling, wheelbarrow walking, obstacle courses and climbing; at 3 to 4 years, we use somersaults, upside-down exercises, balancing on a rolling barrel; at 4 to 5, trapeze bar stunts, building pyramids, walking on a balance board. During the same period we strengthen bilateral leg power and control by tricycle riding, jumping and kicking, hopping and catching, jumping rope, and skating.

We lay the ground work for improving eye-hand coordination by activities to increase bilateral and unilateral hand-eye coordination. The emphasis on the eye-hand coordination, of course, is obvious. These children do have to go to school. They do have to learn to read and write, and again we cannot work in isolation.

Table III (5) Gross Motor Skills Program for the Preschool Child: the Five Basic Areas of Physical Need Plus Activities for Each

	1. *Experiences for Enhancing Body Awareness in Space*
Ages 2-3	Rolling on the floor
	Wheelbarrow walking
	Obstacle course — walking up ramps, across catwalks, sliding down slides, crawling through barrels
Ages 3-5	Somersaults
	Upside-down stunts
	Balancing on a rolling barrel
Ages 5-7	Performing stunts on a trapeze bar
	Building pyramids
	Walking practice on a 2″ x 4″ balance board
	2. *Activities to Strengthen Bilateral Leg Power and Control*
Ages 3-5	Tricycle riding
	Jumping practice
	Kicking balls with alternate feet
Ages 5-7	Hopscotch
	Jumping rope
	Roller and ice skating
	3. *Activities to Increase Bilateral Hand-Eye Coordination Skills*
Ages 2-4	Climbing activities
	Wheelbarrow walking over small object obstacle course
	Throw—catching bouncing large balls
Ages 4-6	Batting Practice—using flat bats, push-away fashion
	Rope games—tying knots, designing shapes
	4. *Tasks to Improve Unilateral Hand-Eye Coordination Skills*
Ages 2-4	Bean bag throw games
Ages 4-5	Bowling with one hand
	Bouncing ball with one hand
Ages 5-7	Batting practice—traditional side stance
	Horse-shoe pitching
	5. *Activities for Refining the Basic Gait Pattern*
Ages 2-4	Running practice—tag games
	One foot standing balance, alternate feet
Ages 4-7	Hopping on one foot
	Galloping
	Skipping

The early developmental program is a multipronged approach to help organize the infant or the young child to achieve some measure of orderliness in his development. We use everything we know or think we know, and let me say that again, *think* we know, to provide a comprehensive, attractive package which is supportive to parents while the child embarks on the developmental ladder. We encourage and stimulate, but fundamentally we provide him with the opportunity to show us how he will emerge in his battle for survival. Having provided supportive help he can be in the position where parents can see for themselves where the progress has been made when you do something for them. When you do something for them parents will listen better to counseling than if they are left to their own perogatives.

Our present level of sophistication finds all professionals programing for children. Regardless of our area of proficiency, whether servicing children with atypical problems of motor development or involved with creating special physical education programs, we need an organized concept and plan for management. If we do not, then the marginal people, the quacks, and the over-enthusiasts take over and begin to develop programs that are uncontrolled and have no real meaning. Today parents with normal youngsters and with marginal youngsters are demanding some method of management — not treatment, but management. The Meeting Street School philosophy has been expressed in the literature, predominantly for a medically-oriented population up until now. We feel it should reach all professionals. We are interested in early medical education diagnoses and in early medical education intervention. We are interested in supporting families. We are interested in involving all specialists in a multidisciplinary approach to the treatment program.

Several years ago we attempted to outline the stages of development of children with cerebral palsy in order to design a multidisciplinary management program. We divided motor behavior of children into 6 stages: (4)

1. *Unorganized* — in which the main therapeutic principle is *stimulation.*
2. *Uncoordinated* — in which the main therapeutic principle is *promotion.*
3. *Poorly coordinated* — in which the main therapeutic principle is *exploring.*
4. *Semi-coordinated* — in which the main therapeutic principle is *experiencing.*

5. *Body Control* — in which the main therapeutic principle is *advancing*.
6. *Early Skills* — in which the main therapeutic principle is *repetition*.

The motor behavior of the infant in Stage 1 is one of reflex activity, and the therapeutic principles are stimulation of total body joint ranges of motion through passive manipulative exercises, bright and noisy toys, and personal contact. The stimulation of sucking and swallowing is done by decreasing nipple hole sizes when feeding the infant. The Bobaths in England have developed a well organized scheme for inhibiting persisting reflex patterns in the infant and for the excitation of appropriate reflex postures.

In Stage 2 the motor behavior picture is characterized by poor sitting balance and poor ability to move from place to place under their own muscle power, poor hand grasp, and poor hand to mouth coordination. Though babbling is present, there are unconditioned tongue reflexes and little tongue motility present. Stimulating techniques that will promote total motion of the trunk and limbs and varied sitting experiences are important. Promoting gross arm functions is done through the use of dangling toys and encouraging own bottle holding. By gradually thickening foods and through spoon feeding, greater tongue mobility is stressed.

Stage 3, the poorly coordinated stage of development, is one where independent sitting balance has been accomplished but standing balance is lacking; tactile grasp is present but spontaneous grasp and release is still undeveloped. Conditioned tongue and lip control is present but spontaneous grasp and release is still undeveloped. Conditioned tongue and lip control is evident, and sound and word association are in process.

Therapeutic stimulation can be achieved through active strengthening exercises for the entire body, with particular emphasis on varied supportive standing experiences, and in teaching falling. Play experiences for achieving arm control and more skilled grasp and release patterns of the hands are aided through soap and water play and squeeze toys. The goal of independent drinking is initiated.

Stage 4 is a level of semi-coordination. The ability to remain in the upright position for relatively long periods of time and to use supported ambulation for exploration of the environment is observable. Mature reach, grasp, release, and transfer patterns are present bilaterally. Tactile-kinesthetic patterns are ready for embellishment. Biting and chewing needs further development, and the building of auditory-visual pathways is important. At this stage the therapists stress varied supportive walking experiences and active exercises that continue to strengthen total body musculature. Playing with manipulative, textured, and take-apart toys helps to train hand to eye coordination. At this point, initial cooperation in dressing is encouraged. Language stimulation involves the association of specific sounds with specific toys as well as use of accurate verbal symbols for the increasing movements of the body through space.

Stage 5 is the emergence of physical self-sufficiency. There is control of walking as the preferred form of ambulation about the environment and awareness of the body in space. Bilateral hand and finger motions are mature. Eating functions are well established, and there is voluntary control of mouth airflow for speech with simple phrases and sentences emerging.

The normal infant travels through these stages by two to three years of age. Children with complications may take longer but the route is still the same.

A retrospective review reminds us that the development of muscular strength and coordination started with the head and moved downward and with the limbs moved from the center outward. Awareness of the body in space came first through movements of the body on a horizontal plane, later on the vertical plane. Successful independent function was achieved through concrete learning experiences. Through it all there is constant repetition of all the motor acts within a fairly stable design, from beginning to end. We attach great importance to purposeful activity in all spheres of motor development. That is, rolling takes place on firm surfaces consistently, in the crib or on the floor, with visual stimuli reflecting the near boundary of the crib and the information received when rolling over in the more wide open spaces of the living room floor. Varied sitting experiences and standing and walking activities perpetuate the normal joint ranges of motion of the head, trunk, and limbs.

Early tumbling, falling practices, experiences in viewing the environment upside down, climbing in and out, over and under, up and down are essential ingredients of all movement patterns. Learning from the beginning the consequences of fast and slow, smooth and jerky, firm or wiggly, near or far are important for learning more sophisticated athletic and fine motor skills. The standard stimuli carried by the proprioceptive mechanisms are transmitted in an orderly manner. Information regarding touch, pressure, weight, and arcs of movement are received in a functional plan. Space and movement are organized, and, hopefully, the body's awareness of its performance in space is developing in a sequential pattern.

Table V (5) Home Development Guidance Program—Infant Level

Gross Motor Skills
1. Head tone strength
2. Sitting
3. Standing/walking
4. Early activity on feet

Fine Motor Skills
1. Visual and auditory attention
2. Grasp and release
3. Sensory differences
4. Active play

Communication Skills
1. Tactile stimulation/lips introduce sounds
2. Encourage lip and tongue movements/vocal play
3. Biting and chewing/sound repetitions and word associations
4. Blowing/use of senses/visual and auditory attention

Home Development Guidance Program—Preschool

Physical Self-sufficiency
1. Body awareness in space
2. Bilateral leg power and control
3. Hand-eye coordination—bilateral-unilateral
4. Gait pattern refinement

Visual-Motor Improvement
1. Aware of parts of the whole
2. Individual and multifinger control
3. Total motor coordination

Communication
1. Develop M, K, L, W sounds
2. Expressive skill
3. Matching
4. Learn to listen
5. Build associations
6. Stimulate expressive activities

Efficient and effective movement patterns can be introduced and guided by parents and professionals that will, hopefully, lay the superstructure for more advanced, coordinated precision gross and fine motor planning.

Exactly what body awareness in space is we are not entirely sure but we certainly see many youngsters today whose basic gross motor skill performance reflects some degree of apraxia and inadequate coordination and control of body movement as compared to the athletic prowess of their peers. Such substandard performance has its consequences in learning new and more advanced play and recreational activities and is worthy of the professional's attention and remedial efforts.

Fine Motor and Sensory Skills

Coordination comes about as there is synchronous integration of the visual-sensory and motor systems. This process occurs as developmental growth and as learning takes place. While it is not clear which system has most influence over the others, it is evident that: (a) each develops in a sequential pattern; (b) each can enhance the function of the others; and (c) functional integration of these systems is a learned process (whether this learning takes place spontaneously or must be directed).

It is the directed learning process which is of most concern to the therapist and educator when planning a program for children with perceptual-motor dysfunction. Three concepts of learning theory are considered: (a) learning takes place as a function of reward or reinforcement; (b) one learns what he does; and (c) learning takes place because there is a purpose for its taking place.

We have placed great emphasis on *functional or purposeful activity* when establishing a training program for our children. By synthesizing onto genetic maturation sequences, the developmental schedules of Gesell, Piaget, etc., and techniques of neuromotor facilitation, one can provide orderly and meaningful activities.

EXAMPLE OF PROGRAM COMPONENTS: (5) (The following are achieved through the use of play activity suited to the child's level of interest.)

A. *Visual Motility:*
1. Ability to fixate on a visual target for increasing lengths of time.
2. Ability to follow a moving target with smooth pursuit and a minimum of head movement.
3. Ability to visually scan the environment and localize a desired goal (object, part of room, word on the blackboard).
4. Efficient use of eyes in guiding hand manipulation.

B. *Sensation:*
1. Develop awareness in quality of sensation (pain, touch, temperature, pressure, sound, light, taste, position in space, and direction of movement).

2. Balance response of body to external stimuli (neither hypo- nor hypersensitive).
3. Develop discrimination between different intensities, duration, and localization of sensation.
4. Conceptualization through several combinations of sensation, i. e., stereognosis.

C. *Motor Development:*
1. Encourage activity via utilization of natural reflex patterns (TNR and reflex grasp).
2. Develop control to inhibit reflex patterns and gain voluntary control of specific movements, i.e., reach, grasp, release, and prehension.
3. Establish patterned movements in both unilateral and bilateral activity.
4. Develop ability to plan sequence and direction of specific motor activity (construction toys, coloring, etc).
5. Establish dominance and develop motor skills (writing, tie shoes).

Social-Emotional Growth:

In addition to our concern for early motor stimulation, we feel that social-emotional growth contributes much to overall perceptual development and function. When the child is functioning below a two to two and one-half year level, stimulation seems best provided within the home environment by the parent and family as part of the daily routine of caring for the child. Handling for feeding, washing, and dressing can produce an abundance of auditory, tactile, kinesthetic, and language bombardment. The therapist's role is to guide and direct the therapeutic program in conjunction with medical planning. The parents' role is to carry out such a program. This allows parents to actually participate in their child's development with understanding of purpose and confidence in handling. When parents know the "how" and "why" of programs, they can be more realistic and relaxed which is often reflected in the emotional stability of the child.

As the child begins to master some basic skills and become more aware of himself, he further explores his environment. With increased social awareness he expands contacts to persons outside of family. The child can and should be exposed to small organized groups such as in a play yard or nursery school where he can join other children in both parallel and joint play. It is important for the child to develop trust in people outside the family. Here the therapist or teacher can be accepted as a friend and helper, and other children can be the source of motivation for attempting new or difficult tasks. Here is where to begin to prevent the separation — anxiety neuroses which are so common today with the child who is fearful of going to school and into the world he cannot handle.

Today we have not talked about the brain damaged youngster or used the term minimal brain dysfunction. We are talking about biological, psychological, and neurological inefficiency. Do you know what this term means? I don't really know what it means. Perhaps it is just that we do not know what is wrong with lots of these children because we cannot dissect their brains. Are there some biological factors that they lack? Some of these youngsters do respond well to medication. There are loads of psychological factors in their background and neurological inefficiencies in their examinations. In these changing times we are no longer talking about severely handicapped children. Good obstetrics and good preventive pediatrics have gotten rid of these. We are talking about inefficient children with inefficiencies that we can begin to spot at 6 months of age, 9 months and 12 months of age, and 18 months of age. *Mama* spots them at 6 weeks of age and 3 months of age. Doctors often say "Wait, and he'll outgrow it."

We find words alone will not help parents, but stimulation in the home environment and teaching the famliy what to do seems to be the best measure of help until the youngster shows us the way. Therapists are used to guide and to direct. Here therapists become front line psychiatrists. Often it is silly and wasteful to send young children to psychotherapy and child guidance clinics before you have solved some of their physical and educational problems or at least helped them to taste success in their own area of defeat. Too often we identify and treat immature parents, rather than identifying and managing immature brains. Here is my message: Unclear knowledge about movement and perception is still present with us. We must look to basic science to show us the way. We will translate their data into practical techniques. I cannot do it as a doctor. Doctors, psychologists, and educators must work together. Team work, motivation, reality, and honesty are important issues. We cannot promise new children. We can only show that if a child has been affected at birth, before birth, or after birth, the brain never returns to its original status. There is always a deficit. Our goals are to permit children to function at optimum potential.

Where does the physical educator fit into our scheme? Must he be limited to the gymnasium and the summer camp, or can he join forces with us to round out the team? Must he limit his gymnastic "know-how" to its use on the orthopedically handicapped child, or can we accept him as a mutually competent partner in developing the motor-perceptual-cognitive processes?

Summary

(a) Theories and practices related to the motor bases of perceptual function have been discussed.

(b) We consider position of body in space or body imagery as the fundamental motor base to achieve good posture and balance. We develop muscle and body strength and encourage the emergence of good bilateral and unilateral body skills to sustain good body imagery.

(c) Good eye-hand coordination and communication skills are also necessary enrichers of perception.

(d) It is important to provide parents of handicapped and marginal children with well-planned common sense programs to help them stand by while the child emerges into an appropriate developmental level. There is no proof that stimulation techniques are responsible for a child achieving a higher than anticipated level, but there is no proof that such techniques are wasteful or harmful.

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EXPOSURE HISTORY IN SPATIAL-MOTOR DEVELOPMENT

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The initial purpose of this Symposium is, as I understand it, to consider available evidence on the course of normal perceptual development, and on the derailment of such development by congenital defect or post-natal trauma. Our eventual goal is to utilize these findings to develop effective procedures for enhancing motor-sensory development in both normal and abnormal individuals. Most participants in this meeting are concerned with helping children to perfect motor-sensory capacities. I will describe some work which clarifies the contribution of motor-sensory feedback to acquisition of these capacities.

The motor-sensory feedback loop consists of motor outflow and those sensory inputs which accompany the organism's self-initiated movements. In this presentation I will be considering primarily motor-visual feedback—the change in *visual* stimulation which ordinarily accompanies normal movements.

Let me begin by explaining why my colleague, Richard Held, and I came to consider that operation of the motor-sensory feedback loop is important for the normal development of space perception and perceptual-motor coordination. As a graduate student at Brandeis University I worked with Dr. Held on studies of the conditions for adaptation of hand-eye coordination to a transformation of the visual field. Our experimental subjects wore prisms which displaced the visual field laterally. At first the prism wearer made gross errors when reaching for objects. However, as Helmholtz had observed 100 years earlier (10), after the subject watched his moving hand for a brief period he showed substantial adaptation to the visual displacement. We suggested that adjustment to the displaced visual field depends upon the association of self-produced hand movements with the novel positions of the hand as seen through prisms. When hand movements are induced by some force outside of the organism, the opportunity to associate the position of the hand as felt with the position of the hand as seen should not by itself lead to adaptation. To test our hypothesis we compared adaptation under two conditions of exposure which were identical except for the source of movement. In one case the subject's hand movements were self-produced while in the other they were not.

Our general experimental procedure employed a test, exposure, and retest sequence with the apparatus diagramed in Figure 1. The subject, whose head was held fixed with the aid of a biteboard, looked through apertures cut into the front face of the apparatus. The position of target (T) and mirror (M) was so adjusted that the virtual image of the target coincided with a piece of paper at T'. The subject was required to make several pencil marks at each intersection of the virtual image. The fully reflecting mirror was placed so as to interrupt the line of sight between hand and eye. Thus, normal hand-eye coordination could be measured in the absence of information obtained from simultaneously viewing target and pencil mark.

After a set of pre-exposure markings was obtained, the paper and mirror were removed and a pair of laterally displacing prisms was positioned in front of the apertures. During this exposure period the subject could see his hand and arm which were now strapped to a lever. The lever could be oscillated around a fulcrum located just below the elbow. The background consisted of a flat black sur-

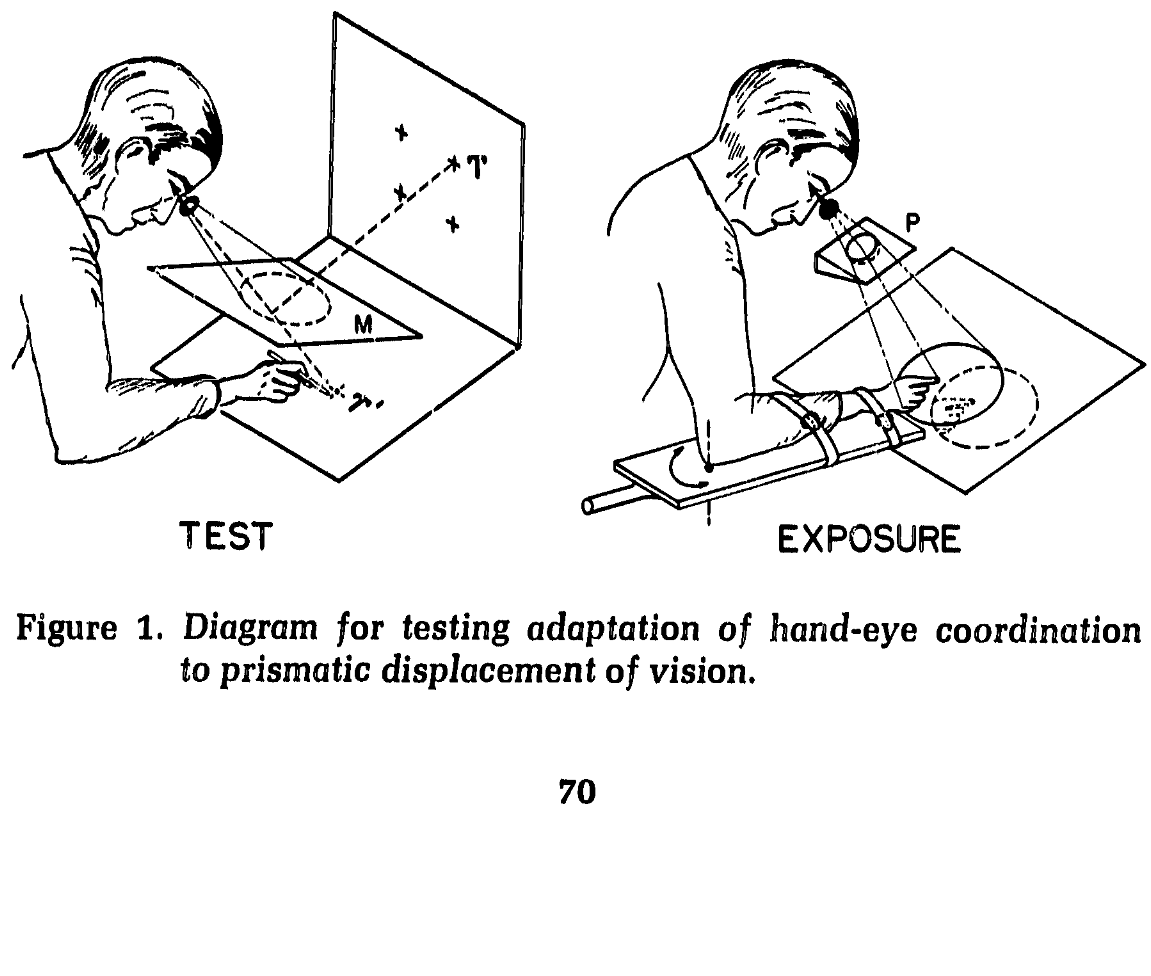

Figure 1. *Diagram for testing adaptation of hand-eye coordination to prismatic displacement of vision.*

face which contained no target points. The subject viewed his moving hand and arm under one of two conditions. In Condition I, he oscillated his own arm in time with a metronome; in Condition II, his relaxed arm was moved for him by the experimenter. Under both conditions the hand remained within the visual field at all times. Following three minutes of exposure under one or the other condition, hand-eye coordination was retested. As we expected, a brief exposure period produced significant adaptation. However, this adaptation was restricted to Condition I, in which the subject moved his own hand; in Condition II no significant adaptation occurred (8).

This finding may at first appear to be quite obvious and trivial. Everyone knows that you have to *do* in order to learn. One cannot perfect a skilled movement like batting a ball by placing the relaxed hands on a bat while somebody else moves the bat for you. However, there is an important difference between learning to perform a skilled hand movement and adaptation of hand-eye coordination to prisms. When perfecting a skilled movement a person utilizes visual information about the kind and degree of movement error he makes. In the current experiment no target was present and the opportunity to use error information was minimized. Such information does not appear to be necessary for adaptation to prisms. The use of error feedback by the adult pre-supposes visual-motor coordination. For the neonate, the ability to process error information in order to *develop* visual-motor coordination cannot be assumed. These considerations suggest that since the mechanism which underlies adaptation to prisms does not require error information, this same mechanism may also operate for the initial acquisition of visual-motor coordination during the neonatal period. This mechanism may be far more primitive than any involved in the learning of skills.

In the experiment just reported, information about the discrepancy between seen and felt positions of the hand was available to prism-wearing subjects, both in the active condition and when the arm was moved passively. In the passive condition, this information was not sufficient for adjustment of hand-eye coordination; its role in adaptation during active movement remains open. I would like to offer the results of the following experiment as evidence against the importance of such discrepancy information and propose that sight of the hand itself may be entirely eliminated without interfering with adaptation (5). We suggest that when the hand is seen it serves merely as a source of feedback from an illuminated object and that identification of the object as the subject's own hand is unnecessary for prism adaptation.

In the experimental test of this hypothesis the subject never sees his hand. After we obtain the set of pre-exposure markings without prisms, the subject is asked to close his eyes and the room is darkened. We then move the prisms in front of his eyes, slip a glove onto his hand and strap the gloved hand and arm to the lever. A one-fourth inch circle of luminous paint is on the back of the glove. When the subject opens his eyes, the only thing he can see is a dot of luminous paint in an otherwise dark surround. Of course, he is not told that prisms have been moved in front of his eyes. When the hand is stationary, the nervous system has no input with which to detect the prism-induced transform of visual space. As the subject oscillates his hand the luminous dot describes an arc which is displaced in visual space by the prisms. Under this condition, when the subject actively moves his hand and arms for as little as three minutes, the post-test markings reveal adaptation to the displacement. The amount of compensation observed when the spot of luminous paint is viewed is about the same as that following exposure when the hand itself is seen.

The conditions of exposure in this experiment eliminate most of the information usually available to reveal the presence of displacing prisms in front of the eyes. Since there are no objects in the visual field aside from the luminous spot, there can be no error feedback during movement. Elimination of the hand from view precludes recognition of a discrepancy between seen and felt positions of the hand. Information about the movements intended and the accompanying visual feedback remains available. Under these conditions, sufficiently prolonged viewing of the moving spot yielded complete adaptation to the prismatic displacement of vision.

That the operation of a motor-sensory feedback loop alone is sufficient for *complete* compensation of coordination to displaced vision increases the likelihood that this mechanism might also account for the initial acquisition of visually-guided behavior. Austin Riesen and his colleagues at the University of Chicago presented the first studies which experimentally implicated movement in the acquisition of normal perceptual capacities. Riesen had earlier reported that animals reared in the dark show significant visual deficits when first brought into light. Cats and chimpanzees deprived of light from birth do not readily learn form discriminations or perform visually-guided behaviors (12, 13). The Chicago group later discovered that comparable visual deficits follow rearing with exposure in light limited to periods when a kitten is restrained in a holder. Riesen at first suggested that these animals failed to develop visually-guided behavior because movement restriction decreased the normal level of variation in visual experience (11). Reduction in stimulus variation might slow development of the links between neural elements in the sensory system. Hebb had claimed that opportunity to develop these sensory-sensory links was important for the acquisition of visual space (1). Riesen's theory of development was consistent with Hebb's in emphasizing the elaboration of sensory capacities.

Richard Held and I proposed an alternative explanation for Riesen's exciting results. We suggested that the essential deprivation for a restricted animal was elimination of the opportunity to link body movements with their normal visual consequences. In our view the development of motor-sensory links, rather than sensory-sensory links, was critical (6, 9). We contrasted Riesen's hypothesis and our own with the aid of the apparatus shown in Figure 2.

Kittens used in this experiment were reared in the dark until they were large enough to be placed in the apparatus. Beginning when they were 8 to 12 weeks of age, they spent three hours each day in a normally illuminated room. As soon as they were removed from the dark they were placed at one end of the levered apparatus and held there with the aid of a neck-yoke and halter arrangement. The feet of one animal (Condition A) touched the ground and he was free to locomote. The other animal (Condition P) was in the gondola, suspended off the ground. Kitten P was able to perform some movements with his limbs and head, but was prevented from walking.

The locomotory movements of kitten A induced passive transportation of kitten P through a series of mechanical linkages. The equation of movement for A and P, and the radial symmetry of the visual surround assured that kitten P would have at least as much variation in retinal stimulation as kitten A. However, for the active animal change in retinal stimulation was correlated with self-produced movements. For the passively transported kitten this correlation did not obtain; visual stimulation was de-correlated with self-initiated movements of the kitten in the gondola. The kittens were exposed under either condition A or condition P for three hours a day. Following this exposure and a short test period, the kittens rejoined their mother and littermates in the dark. The schedule of three hours of controlled exposure in light, a short test sequence, and about 21 hours in the dark was maintained for the duration of the experiment.

We tested both the A and P animals daily for the presence of a response which had been called visual placing but which we now

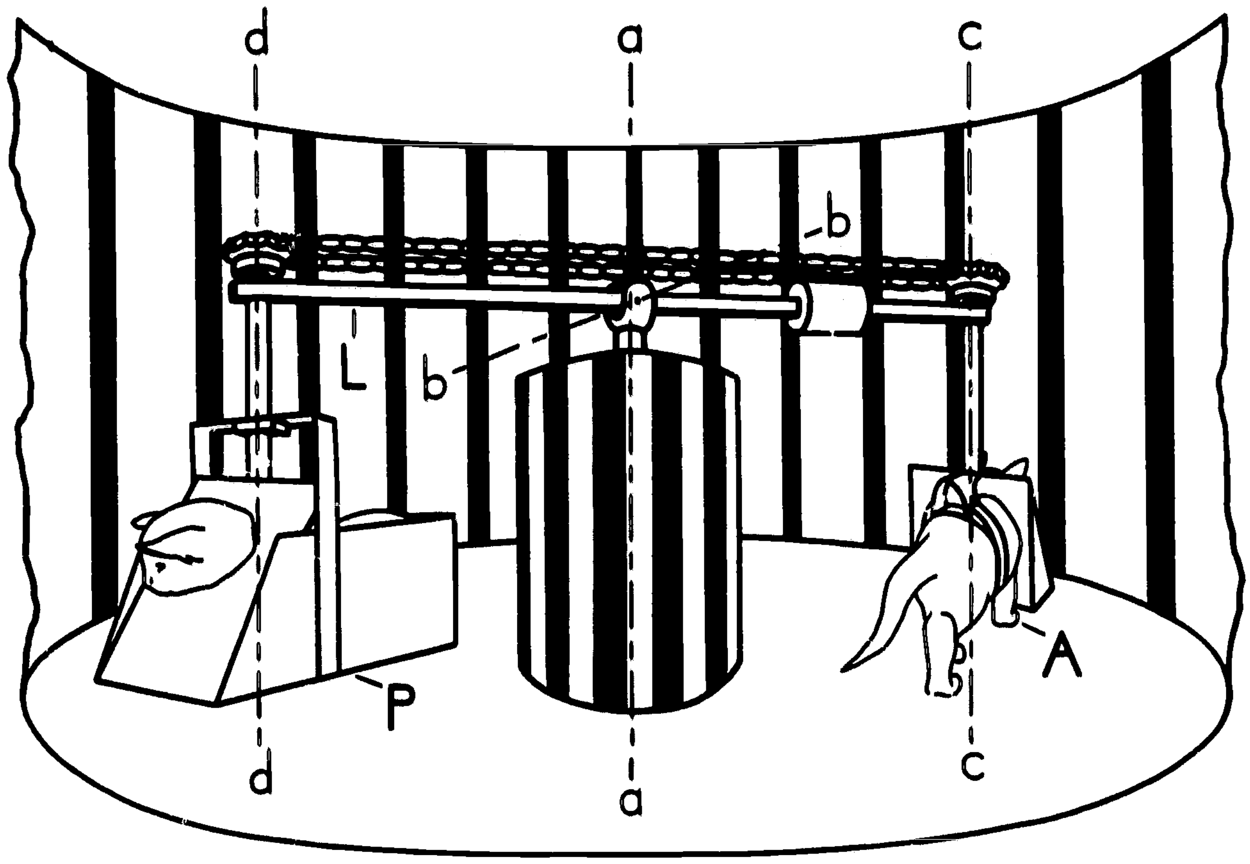

Figure 2. *Apparatus for equating motion and consequent visual feedback for an actively moving (A) and a passively transported (P) kitten.*

refer to as visually-elicited extension. In this test the kitten is carried obliquely downward toward some convenient surface, usually a laboratory table. If transported slowly, a normally reared kitten will extend its forelimbs when it is close enough to contact the surface with the palmar surface of its paws. After several days, all of the kittens which had been free to locomote showed visually-elicited extension. The P kittens with equivalent visual experience never extended their limbs before contacting the surface with their nose or the dorsum of the paw. There is then evidence for a form of depth perception in the actively moving kittens which is absent in those passively transported.

In a second test we determined if the kittens blinked in response to the rapid approach of a visual target—the experimenter's hand. If the hand is brought swiftly toward the head of a normally reared animal it will blink; a dark-reared animal will not. Following several days of exposure the A group kittens did blink to an approaching hand while P group kittens did not. On the first day that one member of the littermate pair blinked and showed visually-elicited extension of his forelimbs, both kittens were observed during repeated descents from a visual cliff. Our version of the visual cliff apparatus consisted of a narrow platform raised four inches above the center of a large piece of plate glass. On one side of the platform, a solid looking checkerboard pattern is fixed directly to the underside of the glass. A similar pattern is located three feet below the glass on the other side of the platform. Normally reared kittens descend to the optically shallow surface and avoid the optically deep surface. The animals which had moved actively in our apparatus also avoided the deep surface. Kittens which had been passively transported failed to discriminate shallow from deep surfaces and made half their descents toward each side. Thus, these animals failed to exhibit depth perception as measured either by a locomotory response or by the other response tests which we have described.

The finding that these behaviors develop only in animals which are free to locomote supports our original hypothesis. Opportunity for motor-visual feedback is important for the acquisition of at least some types of visually-controlled behavior.

Certain alternative explanations have been offered to account for behavioral deficits shown by passively transported animals. We have heard the suggestion that passive transport either reduces attention to visual stimulation or suppresses visual control of movement. This suggestion implies that the animal whose movements are restricted whenever the environment is illuminated, learns that his movements are irrelevant to his experiences and finally stops responding to the position of targets in visual space.

In order to choose between these two kinds of explanations we need to demonstrate that the passively transported animal not only attends to visual stimulation but is fully capable of making appropriate responses to it. This can be done by using the same animal for both active and passive conditions, i.e., by exposing each eye independently.

The pairs of animals we used in our next experiment with this apparatus always wore an occluder over one eye. For three hours each day, each, either actively moving or passively transported kitten, viewed his environment with one eye only. Then the occluder was switched to the contralateral eye and the positions of the two kittens were exchanged. For the next three hours each kitten viewed the environment only with the previously occluded eye and in the other condition of movement. Thus, one eye was exposed only during active movement and the other eye exposed only during passive transport. After sufficient exposure each eye was independently tested. The behaviors tested included visually-elicited extension, blink to an approaching object, and avoidance of the deep side of the visual cliff. All kittens showed development of visually-controlled behaviors when using the eye which had been open during active locomotion. This is evidence that appropriate responses are available to visual control. However, when the kitten used the eye which had been exposed while he was in the gondola, these tests did not reveal any visually-controlled behavior. Thus, neither learned inattention nor response suppression can account for our original finding.

Restriction of visual-motor development to the actively exposed eye has other important implications. It points to a specificity in the motor-sensory feedback mechanism which should permit identification of the components of visual-motor coordination. Subsystems of visual-motor coordination may be selectively developed with appropriate control of exposure conditions.

In one experiment (7), six kittens were reared in the dark until they were four weeks old. Subsequently they were permitted to move freely for six hours each day in a normally illuminated environment. During this time they wore opaque collars which prevented sight of the limbs but had little effect on locomotion. For the remainder of the day the animals were kept in the dark. Figure 3 illustrates this apparatus. The results of previous studies indicated that these animals would show visually-elicited extension when carried toward a broad surface. However, an animal who had not seen his moving limbs should *not* be able to juxtapose the limb to the exact position of a small target.

In order to differentiate these two visual-motor capacities, we developed a new testing procedure. Instead of a continuous horizontal surface toward which the animal was lowered, we used a board with spaced cutouts. Figure 4 shows this apparatus. If the response is visually-guided, the paw should almost always strike the solid part of the surface. Without visual guidance, the paw should fall into the cutout as often as it strikes a prong.

Normally reared kittens contact the surface about 95% of the time; as they are lowered they extend the forelimb and direct it right or left toward one or another prong. In contrast, kittens who wore collars that prevented sight of their limbs extended their forelimb as they approached the surface but in an individually stereotyped fashion. As the animal was carried downward, the extended limb fell into a cutout as often as it struck a prong.

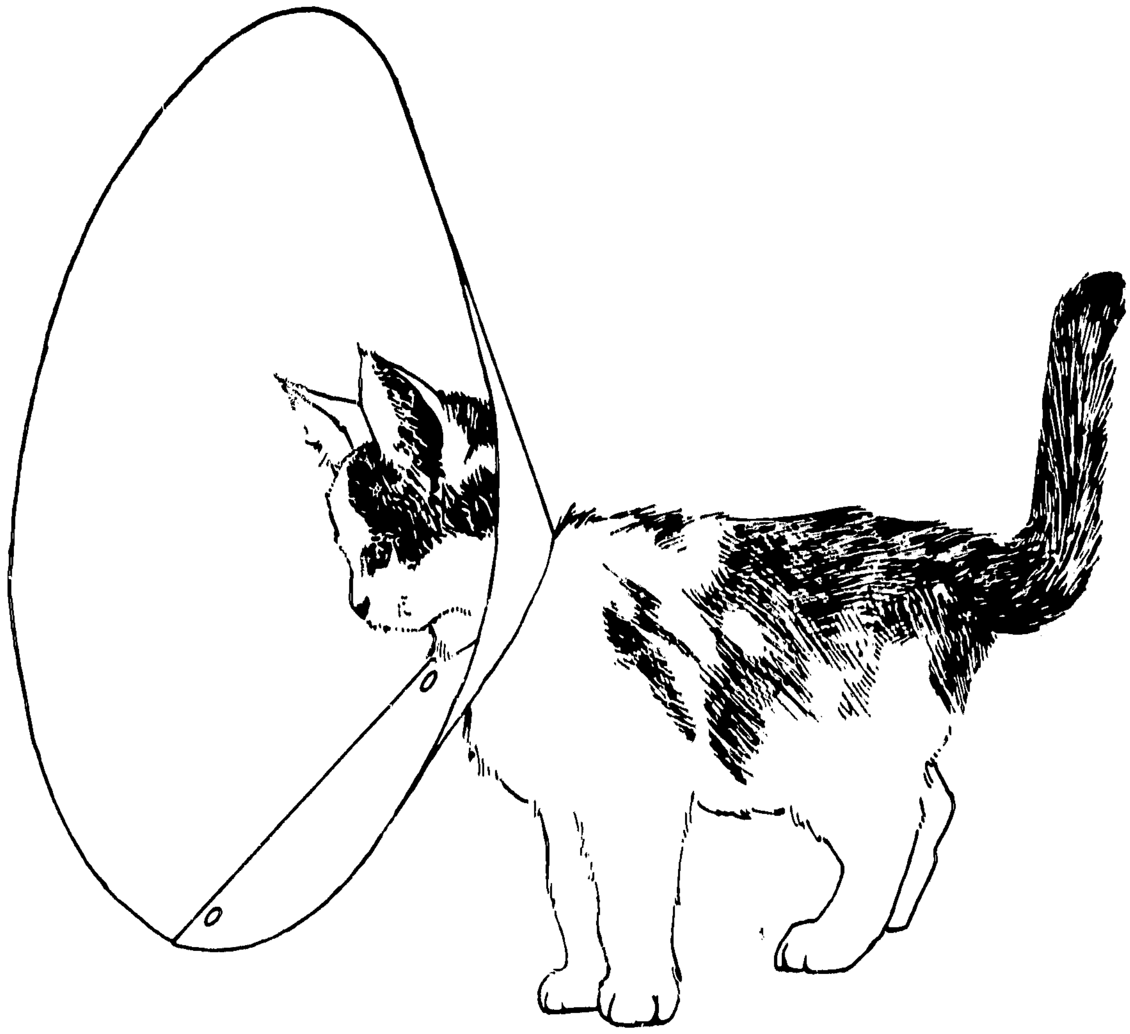

Figure 3. *Kitten wearing a collar that prevents sight of limbs and torso.*

In another test of eye-paw coordination, we observed reactions of the experimental animals to a ball swinging on a string. A normally reared kitten strikes with great accuracy, even when the ball moves quickly. The animals who wore opaque collars oriented their heads and eyes to the moving ball but their striking responses were remarkably inaccurate. This result gave further support to the idea that an animal who has not seen his limbs cannot visually guide them to a target. This same experimental animal was able to discriminate the shallow from the deep side of the visual cliff, revealing a capacity for some visually-guided behavior. Note that opportunity to locomote in a normally patterned environment is sufficient for development of this visually-guided behavior.

Further manipulation of exposure during the neonatal period should reveal the sufficient conditions for acquisition of particular sensory-motor capacities.

A group of kittens was reared from birth in a normally illuminated environment while wearing opaque collars which prevented sight of their limbs. When these kittens were five weeks old, the opaque collar was replaced with a transparent collar and one eye was occluded. After several hours of such exposure, the collar was removed and the animal was tested for visually-guided reaching. When using the eye which had viewed the limbs the animal was able to guide his limbs to the prongs and to the swinging ball. This ability did not transfer to the eye which had not previously viewed the limbs (3).

Let us examine some other exposure conditions which should have specific developmental consequences. An animal who wore a

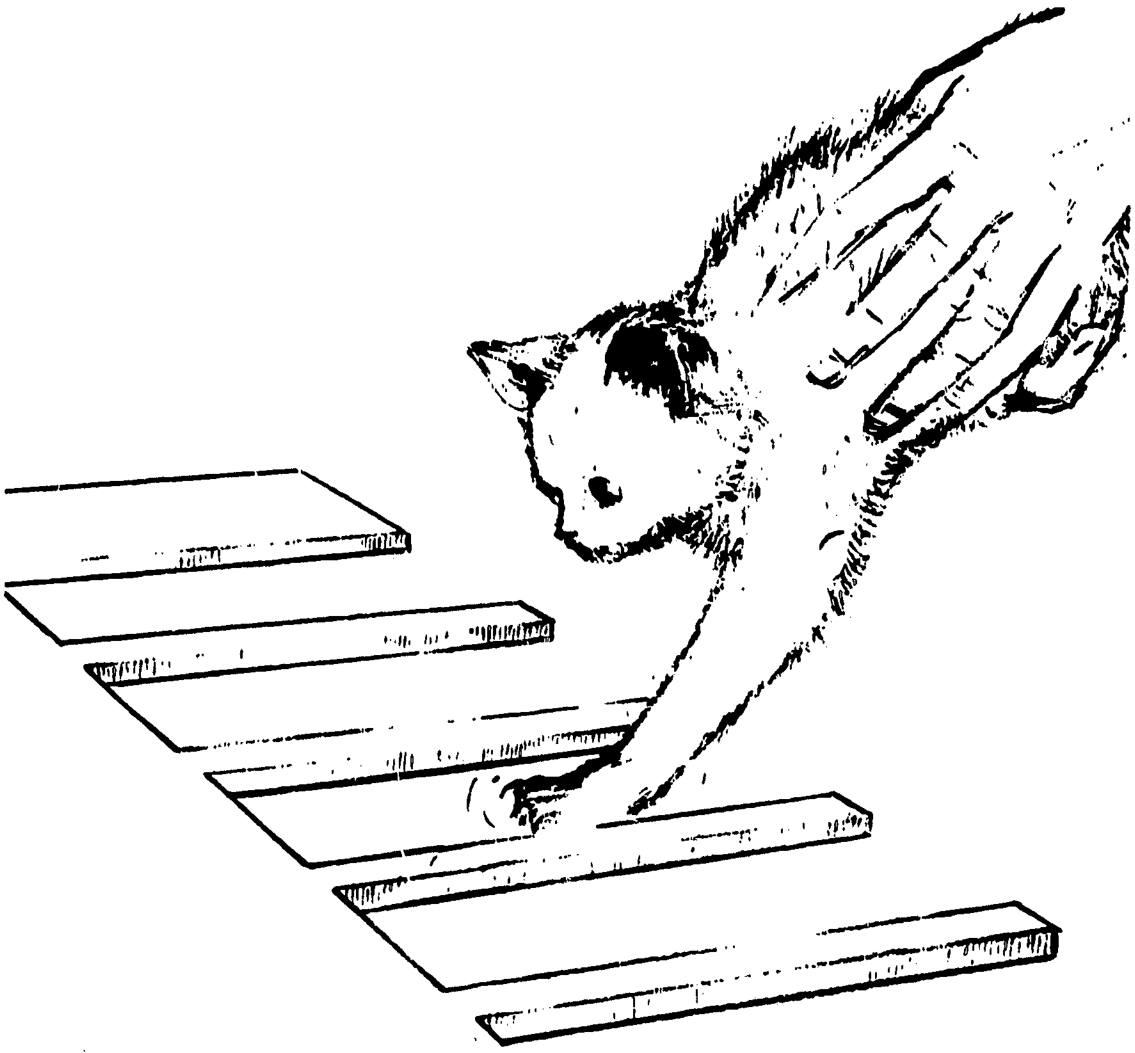

Figure 4. *Apparatus for testing visually-guided reach.*

collar was able to locomote although he could not see his limbs. In another group of animals, movement was further restricted by placing the kitten in a plastic cylinder as illustrated in Figure 5 (2).

Although his head protrudes from the cylinder the animal cannot locomote or see his limbs. We predicted that these animals would fail to show guidance of the limbs and, unlike the animals with the collar, would also fail to discriminate the two sides of the visual cliff. The animal in the cylinder is free to move his head back and forth. We reasoned that visual feedback from head movements alone should permit development of visually-elicited extension. When tested after several hours of exposure in this restraining device the animals did indeed show visually-elicited extension.

To determine if visual feedback from head movements is necessary for acquisition of the extension response we tested a new group of animals. Kittens were restrained in a cylinder with their heads in a holder; they received visual stimulation without feedback from head movement. Unexpectedly, these animals did show extension.

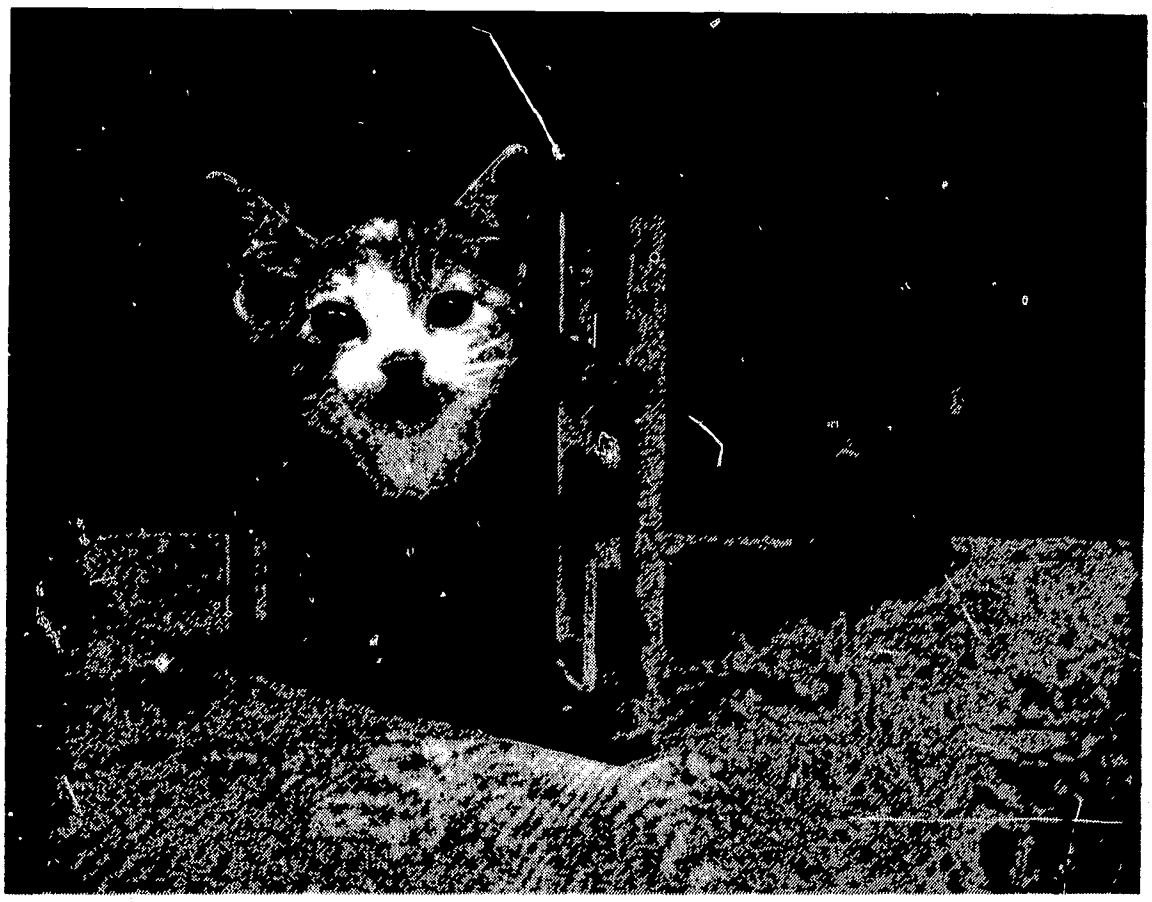

Figure 5. *Kitten in a cylinder which prevents locomotion and view of the limbs.*

We concluded that visual feedback from head movements is not necessary for acquisition of extension responses. What remaining source of motor-sensory feedback could be supporting the acquisition of visually-elicited extension?

Although adult cats do not have much eye movement, kittens do show some convergence. The essential motor-sensory feedback loop could consist of changes in visual stimulation accompanying convergent movements. To examine this possibility, we reared kittens whose only exposure in light was in the cylinder and head-holder apparatus with one eye occluded. We tested these animals and again found extension responses.

The only remaining source of motor-sensory feedback involves the muscles which control the curvature of the lens. We paralyzed the ciliary muscles with atropine and occluded one eye before placing members of a new group of kittens in the restraining apparatus. These animals received patterned light stimulation but no motor-sensory feedback. After several hours of exposure this group also showed visually-elicited extension.

These results suggest that exposure in patterned light is sufficient for acquisition of the extension response. The question of whether patterned light is necessary remains open. In our next experiment, we deprived kittens of patterned light by fitting diffusers over both eyes. After several hours of exposure in diffused light these animals also showed visually-elicited extension. Evidently even patterned light stimulation is not necessary for the development of this response. However, patterned light is essential as a component of the motor-sensory feedback loop and, as such, is necessary for the acquisition of visually-guided behavior. This suggests that two separate mechanisms operate in the acquisition of visually-guided and visually-elicited behavior.

The results of two further experiments support the distinction between elicited and guided components visually-controlled reaching. In the first study, one eye was exposed in diffused light and the other was occluded. As expected, when the exposed eye was tested, the animal showed visually-elicited extension. When the previously occluded eye was tested the animal also showed extension. Control of visually-elicited extension transferred to the eye that had no prior visual exposure.

In a second experiment we allowed the animal to view his environment with only one eye while the other was occluded. Subsequently when we tested the exposed eye, the kitten showed visually-guided reaching and locomoting, in addition to visually-elicited extension. He showed only visually-elicited extension when using the formerly occluded eye. Visually-guided behavior does not transfer interocularly; visually-elicited extension does. This result is consistent with our suggestion that these two components of visual-motor coordination are under the control of separate mechanisms.

Ablation studies performed with kittens in our laboratory have provided parallel evidence for the separability of these two mechanisms. Prior to surgery the kittens showed normal visually-controlled behavior. We removed the entire visual cortex and allowed the animals to recover in darkness. When the animals were removed from the dark we found that visually-elicited extension had survived the lesion, but visually-guided behavior was lost (4).

The Gondola Paradox

The development of visually-elicited extension despite increasing restrictions upon movement indicates that motor-sensory feedback is not essential for acquisition of this response. Exposure in diffused light is sufficient. Why then does an animal who has been exposed in patterned light while passively transported lack the extension response?

Despite the neck yoke and halter, the kitten is able to make some movements of head and limbs while being transported in the gondola. Thus, the essential components of the motor-sensory feedback loop, self-produced movements, and patterned light stimulation are present. For the actively moving animals these components were systematically related; for the animals in the gondola they are relatively independent. We speculated that it is this independence of movement and visual input which prevents the development of visual-motor coordination. The deficiency in coordination includes the extension response. Of all animals exposed in light under any condition only these passively transported kittens fail to acquire visually-elicited extension. We conclude that exposure with passive transport undermines the acquisition of this response because it de-correlates movement with visual feedback.

Summary

We suggest that the experiments reported clarify the role of motor-sensory feedback in visually-controlled behavior. Opportunity to correlate self-produced movements with visual feedback underlies the acquisition of visually-guided behavior in the kitten. Adult human subjects fully compensate for prism-induced transformations of the visual field if they are permitted to view the self-produced movements of their hand. Taken together these results suggest that the mechanism which utilizes motor-sensory feedback operates throughout the life history of higher mammals for the maintenance as well as acquisition of spatially-guided behavior.

The development of component subsystems of spatially-guided behavior requires particular and specific opportunities for motor-sensory feedback. If the animal's experience provides opportunity to correlate movement with visual feedback, he should develop normal visual-motor coordination. If visual feedback is independent of self-produced movements, this coordination cannot develop.

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Multidisciplinary Exchange

INTERACTION PANEL

Following the papers presented by specialists in the various disciplines on the first day of the conference, those who made the presentations participated in a panel discussion. Panel members were: Leonard Cohen, physiologist; Alan Hein, experimental psychologist; and Nancy D'Wolf, physical therapist (colleague of and substitute for Eric Denhoff, medical doctor). Jack Keogh and Hope Smith were selected to represent scholars in physical education. Participants in the symposium were asked to prepare questions as they listened to the papers by the specialists. Some of those questions were selected for discussion by the panel. That discussion provided the beginning of the interdisciplinary communication and integration which is vital for developing unifying concepts and questions to guide the establishment of priorities for future research and creative practice in perceptual-motor training of children.

Panel moderator Marguerite Clifton presented the following questions for discussion by the panel of specialists:*

Question I — What is perceptual-motor development?

Question II — What would be an example of trying to change performance that can cause physiological stress?

Question III — Are there some questions concerning the methodology of Wertheimer, Werner, Wapner, and, recently, Witkin that might lead to questions concerning their findings?

Question IV — What are the conflicts in findings concerning advantages and disadvantages of early sensorimotor stimulation? Are they caused primarily by poor measuring instruments and research methodology?

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* These questions were selected from the many submitted. A synthesis of questions was compiled and is included in Appendix I.

Question V — What is the effect of teaching children to move while blindfolded, to move on command, to visualize before they move while blindfolded?

Question 1 — What Is Perceptual-Motor Development?

Dr. Hein. I previously addressed myself to this question in another symposium. My answer then was that what develops in perceptual-motor development is the "hyphen." In the context of my talk yesterday, this is not simply a quip but an abbreviation for the idea that this development is an integrative process. Visual space can be said to exist for the animal when his response repetoire has been linked to the information in the visual stimulus so that the animal responds to the location of objects in three-dimensional space. This linkage is an extremely important part of development and may be conceived of as the development of motor skills and the development of purely perceptual capacity.

Dr. Wright. When we ask for a definition of perceptual-motor development we run a danger of overlooking one of the more obvious problems we are confronted with as scholars and practitioners in being involved with a definition in the first place; that is, high tolerance for ambiguity. We are working in an area which has infinitely more questions than answers. The answers we have are quite qualified. When we say "let us define perceptual-motor development" we may be trying to impose more structure on what we are working with than the facts will justify. There may be a false security in getting a definition to perceptual-motor development. We may also be reacting to false hazards if we say we have to have a definition of perceptual-motor development. People may need to define this differently. There is no automatic built-in hazard to doing it this way. It would be best to think twice before trying to standardize ourselves at this point.

Dr. Hein. I take issue. You have to ask the question and you have to define the term. There are certainly many questions that can be asked and I realize that the question I am addressing myself to is the initial acquisition of visual-motor capacities. I haven't the foggiest idea of what the proper questions are when one gets beyond the primitive capacities that I am studying. The problem for those in education who do not get to work with children until they are perhaps five years old is very different from the one to which I address myself. But thinking of what are the fruitful questions is absolutely essential to the progress of science.

Dr. Wright. I would like to make a point of agreement in that you cap those comments in the plural—questions and definitions. This is important, granted the fact that Dr. Hein's interest may be in one area and other people's interest may be in different areas. There really is a multiplicity of questions and a multiplicity of definitions. I would certainly agree with that.

Dr. Cohen. I would like to attempt a definition. I do not know if it's because I am from a different discipline or not. Definitions are a necessity. They are personal things and they reflect the point of view of the person who is making them. All those functions of the body that have a voluntary motor component and, of course, depend on some kind of sensory feedback and some kind of sensory perception prior to the motor act, would fall into this category. It would be hard to think of a motor act that does not require either prior perceptual awareness of some kind of stimulation in the environment or at least require some kind of sensory feedback during execution of a motion. It is a physiologically valid term even though some traditional disciplines consider motor activity separate from sensory activity. The body doesn't do it that way. The body combines them constantly, and maybe that is why we have trouble giving examples of motor activity without perception. Possibly it never exists. In that regard it is an improvement to use the term perceptual-motor development because we consider this one function as the body and brain considers it one function and not as two separate systems, the motor system and the sensory system.

In terms of the third word, development, there is always an element of maturation or growth in development. In the use of the word development I would also include the idea of training. I would say that even in mature life where you have to develop a new motor act, it is going to take a lot of physical training that will depend upon perceptual-motor activity interaction. In other words, you can develop perceptual-motor skills as a mature individual as well as a maturing individual.

Dr. Keogh. If I started from the motor point of view, my primary interest, this implies there should be some difference between what is "perceptual-motor" and what is "motor." I suppose that I would take a point of view somewhat like Dr. Cohen's. It seems totally impossible to me that there is a motor act which does not involve whatever we mean by perception; that is, if I am talking about sensory inputs which are integrated in some manner in order that I make some motor act or movement. Therefore, I have always found it rather difficult to imagine the term perceptual-motor as used by many people. It seems to me that this term "motor" says I am talking about movement; in this case, the movement of man and not the movement of a bus. This implies to me that there is some sort of perceptual input. Therefore, if I am going to use the term "perceptual-motor" I am implying some specific notion internally, in the totality of what is "motor."

Pursuing this just one more step, it would also seem that we ought to consider the term "motor-perceptual," because most of the time people are talking about motor-perceptual. I would wager that if we did not have concern for learning and achievement in all the ways we have today, we would not have a concern for perceptual-motor, per se. It is because of our concern for certain skills which we seem to think have some perceptual basis to them that we are concerned about the motor-perceptual process. Perhaps we are egocentric in our position in starting from the motor, but people outside of the physical education field have also said that the motor has some hyphen effect connecting it to the perceptual.

All I'm trying to say is that we have a whole variety of ways of looking at these. In support of Dr. Hein's point we, operationally, have to pick a definition when we ask a specific question. But, as stated by Dr. Wright, it would seem that there are many possible definitions for what we are talking about. I would like to know what the other person is talking about, and I would like to know in very operational terms what perceptual-motor is in terms of what behavior is expected of the child.

Dr. Smith. I take issue with the term "motor-perceptual" as suggested by Dr. Keogh because in physical education in the past we have done just that. We have looked at "motor" and have not even put the hyphenated "perceptual" on the other end of it. We need to know more about the perceptual field. In putting motor first, we keep looking at motor without linking it up with perceptual factors. Many of the problems we have considered to be motor may, in fact, not be motor at all, but perceptual problems. Both Dr. Cohen and Dr. Hein have said, and I think, that physical educators must know more about the whole area of sensory input and as much as there is to know about perception and about the integrating mechanism that is involved. I would like to keep the term "perceptual-motor."

Dr. Keogh. My argument is that we, here, are talking about motor-perceptual. We keep talking about the question of how we can enhance this perceptual process. Dr. Hein is discussing with us the factors that influence vision and the variable we are acting upon is perception. We are not trying to improve motor performance at this particular moment. Our conversation has been totally in the direction of trying to improve the child's perceptual performance, which is fine. My particular concern however, is to improve his motor performance. I would still argue that if we are going to use the term "perceptual-motor" then let's get rid of the word "motor" by itself, or let's find some distinction between what is "motor" and what is "perceptual-motor."

Dr. Cohen. Just one point on perceptual-motor again. I think a lot of the use of the term originated in neurophysiological and neurological literature and also in neuroanatomical literature. Since these disciplines were responsible for the confusion it might help to briefly define it because there are very rigid and clear cut definitions. Motor system, to people in these disciplines of neurology, neurophysiology, and neuroanatomy, means the system that arises in the brain and then goes down in the cortico-spinal or pyramidal or some of the extra-pyramidal tracts and eventually makes contact with ventral horn cells through intermediate neurons. They are all efferent, going out of the spinal cord and brain. Sensory is anything coming in and it would include—which is why they call them sensory neurons—the afferents that come in. Of course they are generally ascending, coming from the periphery and going to the spinal cord and some up to the brain. This is very clear cut, anatomically, physiologically, and neurologically, and we speak of two systems, the motor system and the sensory system. They are easy to define, and even to tell exactly what anatomical structures we are talking about.

But physiologically, of course—and I think that is what our panel is getting around to and it is good we all agree on that general thing—there may not be any justification for this because you probably cannot get motor activity without the perceptual. We ought to consider them as one system even though as students, it is easy to learn them as two systems; and when you teach students you usually teach them two separate systems. Since this is an advanced seminar, maybe we can combine them and make an advance in that way.

Question II — What Would Be an Example of Trying to Change Performance That Can Produce Physiological Stress?

Dr. Cohen. I assume that what the question means is, first, examples of types of postural, physiological stress, and second, how this could be overcome. It is helpful to classify this into four categories. First, is postural reflex stress? This touches on some of the postural reflexes, tonic neck, and labyrinthine reflexes. You get extension of the limbs on the side to which the head is turned and flexion on the contralateral side. It was pointed out that experiments have proven that even though you don't get overt acts in normal people with intact brains, nonetheless, you can show by more discrete means that there are changes in the muscle tone which conform to extension, activation of the exterior muscles on the side toward head turning, and flexion of muscles on the opposite side. These are functional, tonic reflexes that operate in all people.

Now in a situation, such as in basketball and football, this is apparent where one trains a person to make a feint in one direction in order to catch an opponent off guard and then to go around him in the opposite direction. One of the most effective ways of doing this is what they call a head feint. The head is moved first in one direction, let's say to the right, but one steps off with the left foot in the opposite direction. So, while the opponent is going toward your right where your head started to lead, you are going to the left.

Some people find this very difficult. Of course, this opposes the traditional tonic neck and labyrinthine reflexes. You expect, ordinarily, when the head is turned to the right that the right foot should also be extended in an attempt to move in that direction. What you are asking, actually, is that there should be flexion in the right foot and extension in the left. Ordinarily, the body always follows the turning of the head and moves in that direction; that's why it is an effective way to feint an opponent out of the way.

A way to overcome this is always difficult. For some people, it is easier to make a false start in the direction, to actually move to the right when you move your head to the right, and move with your right leg, but to stop quickly and move in the other direction. Here is a case where you are going to slow down the act. It is not as efficient as if you can disconnect the reflex activity from the learned motor activity. It is understandable why this is very stressful and some people never can learn to move their head in one direction and move the body in the opposite direction. It takes a lot of practice even in those who develop it well.

A second type of stress is that which would be produced, not due to reflexes, but due to the natural anatomy of the body. Harmon showed that there are certain postural positions for students sitting at a desk doing visually-directed tasks which require less energy from certain of the back muscles, for example, than other positions, and he came up with the position of minimum exertion. By electromyographic recording and by using different optical lenses on these individuals he could push them either farther away from their paper and desk or bring them closer to it by making them a little nearsighted or farsighted. In most cases, increased electromyographic firing was obtained from selected muscles of the back with certain ones doing more flexion and others doing more extension of the back. So this again indicates the physiologic stress. There are certain postures which require minimum energy and there are others which are more fatiguing and require more energy expenditure to maintain them. This is a very new area and there is no reason why it should not be systematically explored for all kinds of activities and postures in order to find the minimum energy expenditure positions for different tasks.

A third category is the postural occular stresses. It has been shown that in certain accelerations of the head you get, of course, compensatory eye movement. Any type of activity where the student, for example, is required to copy something from the blackboard and the blackboard is off to his right or to his left, he constantly has to look up from the board to the paper, involving a whole series of reflexes producing accelerations and decelerations of the semicircular canals. Every time you accelerate or rotate the head in one direction, the fluid in the semicircular canals will lag behind and cause stimulation of the nerves. When you stop that motion, the fluid keeps moving and you get a deflection in the opposite direction. You can observe this in nystagmus as rotary nystagmus and post-rotatory nystagmus. The direction of the fast phase of nystagmus is opposite in post-rotatory from that which prevailed during rotatory, which is what you would expect.

Every time the head moves, you are getting all this stimulation, both the starting stimulation and a stopping stimulation of the vestibular apparatus. Also, the cervical receptors, which are affected by this and institute reflex movement, try to adjust the eyes to new positions and you keep changing the eyes between two targets. You are getting sort of an overloading stress. You are not conflicting reflexes and you are not particularly stressing any one system, but you are involving a lot of automatic reflexes and also the total ability for a correct spatial orientation by all this motion. It is a complex situation, which, if it could be simplified, would reduce stress. Simplification could be to have mimeographed sheets that can be copied without moving the head, just by moving the eyes.

The fourth category, which I may take up later, is stress of the other modalities; for example, the auditory system. It has been shown that under some conditions different sensory modalities can facilitate, let us say, a visual response. Under other conditions, certain types of sensory modalities can inhibit. Inhibition is extremely important; it is oftentimes neglected. Neurophysiologically, for every excitation we know of, there is always some concomitant inhibition that occurs. We often times think of the excitation, but we should also look for the inhibition because sometimes an unobtrusive motion or posture does not produce much of an excitation or overt response, but it can produce some inhibition of some other sensory perception. This can degrade function. This is something which we have evidence of, but it is just beginning to come out and a lot more work should be done.

I have given you four general categories of physiological-postural stress, the approaches that you can consider in appropriate situations, and a rationale to permit a physiological approach to overcome these or to minimize these.

Nancy D'Wolf. This is the kind of situation that physical therapists deal with every day of the week with handicapped children. You are strengthening muscles of the trunk, let us say, and you have a youngster on the floor and want to move him up to the first important functional level of sitting. This can be a youngster who can eat on the floor, who can crayon, and who can play with take-apart toys. Then you put him up into even a supported sitting posture and you get all kinds of head deviations which you thought were basically under control. You see hands that are not moving as well as before and you observe real physiological stress, even though you have a youngster who is well-motivated and who is trying to cooperate in the situation.

Dr. Hein. One of the ways we can find out about perceptual-motor capacities in animals is by doing rather simple brain operations. If the animal has been normally reared and when tested before the operation had all his visually-guided capacities intact, you can test him when he recovers from the operation. We find that after visual cortex removal all of his visually-guided capacities are absent. Visually-guided means those capacities which indicate the animal's ability to orient himself with respect to positions in three-dimensional space. He does not discriminate on the visual cliff; he does not do guided reaching and he bumps into objects in an obstacle course. But he does retain the visually-elicited extension response. There are pupillary responses and some visual centralizing functions which survive.

More interestingly, perhaps to you, is what happens subsequently. I remind you that an animal without a visual cortex has a massive lesion. I suspect you certainly would recognize a human being with a comparable lesion. When we allow this brain damaged kitten to run around in the colony room for two or three weeks, our tests suggest that it functions normally again. He makes visually-guided reaching movements, he discriminates on the visual cliff, and he avoids objects in an obstacle course.

When we ask these kittens to learn discriminations through training procedures, they take longer than normal to train. Whether this is a specific result of the lesion upon perceptual processes or is due to other effects of the operation is not clear. But these animals *can* learn to discriminate horizontal from vertical striations. They are even able, at a slower rate than normal, to learn to discriminate some obliques from verticals. They may not be able to make as fine discriminations as unoperated controls; these experiments are still in progress. Cats that receive these brain lesions when they are adults show very little recovery of visual capacities when compared with young operates.

We have found that motor-sensory experience, which is essential for the initial acquisition of a capacity by the neonate, seems to have been replicated for the reacquisition of the capacity in the animal with absence of the visual cortex. A kitten that, after the cortical lesion, wears a collar to prevent his viewing his limbs, shows the same capacities and deficiencies as a normal animal that has worn a collar from birth. Both the lesion animal and the unoperated animal develop the capacity to discriminate on a visual cliff, make the visually-elicited extension response, and can avoid obstacles. However, both animals cannot make guided reaches with the limbs. Several comparable procedures show similar parallels between the initial acquisition and reacquisition. Are any of the cues that we get from this work on initial acquisition suggestive as to what you can do to retrain people with damage?

Question III — Are There Some Questions Concerning the Methodology of Wertheimer, Werner, Wapner, and, recently, Witkin, That Might Lead to Questions Concerning Their Findings?

Dr. Cohen. I referred to Werner and Wapner yesterday. These people have done a lot of study in judging verticality in people in test situations involving change in vertical reference frame. In the case of Witkin they would have a room that could be tilted for the vertical lines in the corners of the room and the door, or the subject's chair could be tilted independently of the room. There were different types of stimulation, auditory and so forth. They studied how subjects judge verticality. Of course, verticality and the ability to judge it accurately varied in proportion to the amount of postural deviation and also the visual reference frame deviation. I would like to see these people enlarge these studies to move the body independently of the head — keeping the head stationary but being able to tilt the body and thereby get only cervical stimulation which is extremely important and separating it from the labyrinthine reflex, both of which you stimulate when you move the whole body.

The only thing I really object to with them is the use of new terminology, sensori-tonic. The idea that there is sensory tone, just as there is muscle tone or motor tone, is fine. Sherrington, a long time ago, said that the nervous system is a system in which all parts are ultimately connected to all other parts and in which no part is, almost certainly, ever completely at rest. This, of course, will include the sensory system as well as the motor. Once you have said that, you have really said it. There is always motor tone; there is always activity in the nervous system. It is against this background of activity that the special perceptions and motor acts are mounted. In that regard, I do not see the novelty or the additional contribution of sensori-tonic theory. To my mind, it fits into classical wisdom and only adds new specific experiments to that wisdom.

Dr. Smith. A psychologist colleague of mine tried to replicate some of these experiments merely by changing the directions given to the subject. He was able to change significantly the responses of the subject to their avowed perception of verticality. The sensori-tonic theorist never has, at least to my knowledge to date, studied voluntary movement and its effect. They have always moved the subject according to his verbal instructions. It seems to me that some of the things they have reported have meaning for us in the kind of research that we might do in physical education. If we could somehow link up a voluntary-moving situation with a human being, then we could study what effect this has on visual perception and auditory perception.

Question IV — Are the Conflicts in Findings Concerning Advantages and Disadvantages of Early Sensorimotor Stimulation Caused Primarily by Poor Measuring Instruments and Research Methodology?

Dr. Wright. Our long silence before responding to this question indicates that there are doubts as to what conflicts are in the mind of the person posing a question. I do not see this as an area particularly fraught with conflicts. That may be because I tend to work in an area which is even more fraught with conflicts with the relative benefits of various types of psychotherapy and with intelligence testing. Comparatively, I do not see this as a terribly conflict-impacted area.

Dr. Hein. I quite agree. I don't know what conflicts are being referred to. In the animal literature, there is conflicting information as to whether the early handling of animals will, as most people seem to find, enhance their ability to perform tasks, make discriminations, learn a maze, and respond with minimal emotional responses in a novel environment. The usual finding is that handling enhances the ability of an animal to tolerate stress when it is older. But opposite effects are also found; sometimes early handling is associated with poorer adult performance and heightened emotionality.

This discrepancy may be due to genetic strain differences between the animals used in the experiments. Geneticists have produced strains of mice which benefit from early handling and other strains which show detriments. Similar behavioral differences have been found among breeds of dogs at the Jackson Laboratory at Bar Harbor. There are certain breeds of dogs which, if you mishandle them when they are young, push them away, and don't coddle them like a puppy, will grow up to be terribly loving and clinging animals. Other breeds with identical handling become extremely aloof. On the other hand, you can play with some puppies and produce an aloof animal and with another breed, play with them and produce an extremely dependent animal.

Question V — What Do You Think of Teaching Children To Move While Blindfolded, To Move on Command, To Visualize Before They Move, Even Though They Are Blindfolded?

Dr. Hein. There may be a necessary sequence for development of a particular capacity. Under normal conditions which allow a great deal of stimulation and lots of movement, you cannot identify this sequence. It seems likely that there are some capacities which must develop prior to other capacities. For example, the developing organism might need the capacity to define the position of his eye in the orbit before mapping eye position onto head position. When eye and head are related he may then map the head onto the torso via the neck. Perhaps only after that is accomplished can the organism develop eye-limb coordination. I would expect that if an infant human or animal were allowed to view his moving limbs but no other part of his body and no part of his environment it would never develop the capacity to use those limbs to reach targets. He would not develop visually-guided reaching unless he previously acquired a more generalized spatial matrix which comes from moving the eyes and the head, moving the head on the torso, and, in fact, moving the body around in space. When this generalized performance capability is developed, limb movements may be mapped upon it. If we deprive the animal of the opportunity to make any of the preliminary mappings, it may be that the animal will not develop visual-motor competence. There may well be an optimal sequence for training a human patient with loss in visual-motor capacities.

Dr. Keogh. My response would be that we basically move in our world with our eyes open and therefore, this is the development we are looking for in those circumstances in which our eyes are open. I am also, though, of the ilk that will try all sorts of strange and marvelous things because I think they may have other benefits. So I might, from a very pragmatic point of view, have the child move blindfolded or with eyes closed. I would not do it with the intention that what I am doing would transfer to something for the sighted function. I would do it from a teaching point of view, simply because I might find it a very useful device for the motivational state of the child. It may give the child other ways "to think about what he is doing."

If we look at the data which we have collected on the relationship between a child doing something with his eyes open and with his eyes closed on a balance activity, we find that the correlations tend to be reasonably small. One of the things this suggests to me is that the child who is good in the one state, blind or sighted, is not necessarily predictably good in the other state. Some children who are not very good with their eyes open may turn out to be relatively good with their eyes closed. I would like to look at those individuals.

Dr. Cohen. The question of blindfolding is really a question of whether eliminating a particular sensory input will sensitize the remaining sensory inputs or not — and that is really a lead into a generalization which I feel very strongly about. I doubt whether it is original with me, but it ought to be mentioned to this group. There is a whole question of variability of sensory input versus repetition of a given sensory input — whether one should reduce sensory input to the point where children are almost isolated so that all sorts of sensory inputs are reduced in order to get them to calm down and concentrate on their work.

All these questions really revolve around two extremes, either one of which is bad. One is the complete absence of sensory inputs, or at least what we call sensory deprivation, which can be extremely disorienting. People without sensory input, or greatly reduced sensory input, will hallucinate; they will try to manufacture sensory images where they do not exist. They, in terms of spatial orientation, are badly disoriented. On the other hand, overstimulation, again using the example of spatial orientation, produces what you call motion sickness, which is very incapacitating, abnormal, and unpleasant. So, there has to be some kind of optimum here where you avoid the two extremes. You can make a very monotonous sensory input which eventually will lose its effect. At the same time you can produce so many distractions by varying the sensory input that this can be difficult.

Another way of producing spatial disorientation, leaving everything at the same level of activity, is by taking two inputs and manipulating the environment so that they are conflicting. This is another way of stress and I think that one ought to realize, therefore, that if you are talking about either extreme view or getting close to the extreme, either of abolishing or of over-stimulating, then you are going to produce an unpleasant, stressful, and disorienting type of situation. Either of these extremes can be equally bad.

Nancy D'Wolf. You may be interested in a very practical experience I have had with this. At Meeting Street School we have children at the pre-school level in groups of from roughly 10 to 12 youngsters. I had tried to figure out a way to give the children a feeling and awareness and to build in some clues about movement — the basic movements of up and down and around. We did this in a group. We stood up and we squatted down, and we talked about the words up, down, and around. I did things such as spin them, holding onto one foot and one arm.

All the children were sitting in a circle and then for some unknown reason I decided that it would be interesting to see what would happen if we blindfolded them. These were children with a variety of handicaps: hemiplegics, ataxic, etc. All of them could walk independently. First of all, we had trouble getting the blindfolds on because they would pull them away. Psychologically, there was great anxiety within the group and we worked through this. We started just one to one, with all the children sitting in a group. Interestingly enough, the children started putting words to the movement the one youngster was doing with me. We just stood up and squatted down. These were the only two movements, plus spinning them around with the hand and foot. Then after everybody had a turn with me I got the blindfolds on. All the children could stand up and squat down. There was what I would call definite relaxation or lessening of anxiety in the group, but I am not really certain.

We took the blindfolds off and a day or two later went through the same thing. The children were much better at going up and going down to verbal command and could demonstrate going around on verbal command. What do you have here? Do you have just a better teaching technique or do you have suddenly the adequate reinforcement that you needed to teach what you wanted to teach? I don't think anybody knows, but it is a very interesting way, or at least another, possibly, that can lead us to reaching some of our goals.

Dr. Wright. Dr. Cohen's comments have given me additional perspective on this question which had not occurred to me earlier, and I think there is, historically, some data which also will bear on the question couched in the terms which he defined and with which he responded to the question. Clinically, we deal with children who have impairments in one sense modality or another, for instance, deaf children. As a clinician working with these children, it has raised in me and a few of my colleagues a question about sensory compensation. It is really an old question. Does a person who has an impairment in one modality compensate for this by increased functioning, by some means or another, in another modality? This question is relevant to the question that is being raised, which is a fact that I had not thought of until listening to Dr. Cohen. If you want an area that has problems, this has a lot of problems in it, because there has been a great deal of research in the area and it has been very inconclusive research. The studies have not been very good, methodologically, perhaps due to no fault of the investigator. It may be a function of the questions being asked.

The results are half on one side, half on the other. In terms of acuity, it seems that there really is no basis whatsoever to assume that a child who is deaf has greater visual acuity. But you still see, occasionally, children who seem to be more adept at vision who are deaf. You do not have to hypothesize an acuity type mechanism to explain this. It could be a set mechanism. They may have the same acuity, but they may be able to focus or lock-in better. We have tried in studies to demonstrate this and we have not been able to do it in spite of the fact that we get clinical observations which indicate that some children do compensate visually. The literature in this area does not support this idea. Our own attempts to prove it have not been successful.

It seems to me that we do not have a very firm foundation from which to launch into any kind of an applied research or action program. Before one begins to do something on the assumption that there is sensory compensation, more basic work would be appropriate.

OPEN DISCUSSION
PANEL AND PARTICIPANTS

Following the interaction among the panel of specialists, the total participant group was invited to present additional questions to the panel or to contribute brief statements on topics related to the problem of perceptual-motor development and training in children.

Mark Ozer. The question is, can we really begin to define these behaviors in terms of the very specific taxonomy that we are interested in modifying, rather than some global concept. And secondly, once you define the task or the behavior you are interested in achieving, then you would have a program for developing that particular behavior. Can we have as our probes for this, concepts that are derived from the stress syndromes described by Dr. Cohen?

Dr. Cohen. I would think that a new type of team would be indicated, clinically. There should be a joint approach where the psychologist, pediatrician, and physiologist involved in the treatment would work together. You just have to set up exactly what the task is that you want and then you should work out any stresses from existing wisdom. Then you set up a number of alternatives. "This" is less stressful "here," but it doesn't have "that" advantage, and you come up with the best program, compatible with current wisdom.

Dr. Keogh. In all of this we seem to be operating under the assumption of motor deficiency. If the child doesn't have a motor deficiency, then our providing a motor program for him would not seem relevant. Therefore, it would seem critical that we can define the nature of motor deficiency. I have the notion that we may then come up with certain difficulties which would be critical in certain kinds of movement, but not necessarily with others. If, therefore, we could find that deficiency, we might be able to get at our taxonomy. At the present moment, we tend to look at failure in single tasks, and these tasks are components of many things.

Dr. Wright. I think the question raised by our pediatric-neurologist (Dr. Ozer) can among other places, be applied to the question of motor training for things like reading. It is this kind of question that is in the back of all of our minds. What are the specific behaviors we are looking for and can these be defined?

The rationale seems to go something like this: Will motor training help a child to read? Many people will say "yes" because reading involves a motor response. Therefore, we will try to improve the motor responses associated with reading by giving motor training. Then people raised the question — Does this work? — and the answer comes back "yes, we had this group of children and they did not read and we gave them motor training and now they do read better."

But there's an important concomitant of this kind of question and answer research game that I think is now emerging as the strategic aspect of everything that is going on and that is the question, Are you sure it was the motor training that did this? The only way in the world you will be able to answer this question is by controlling your research so that you have everything constant with the exception of the motor experience. Can the child have equivalent interpersonal experiences in the control group as in the experimental group, and so on. I think it is this kind of molecular research for which the situation is now ripe. Maybe the research strategy at best was carried out by asking, Can we take an omnibus approach and with all of these variables produce a change? Maybe the answer is yes, but now I think the question is appropriately more of a molecular one.

Julian Stein. Let me draw an analogy. Several years ago all athletes were taking various vitamin pills and for some it had dramatic effect; for others it had no effect. For those on whom it did have dramatic effect it was meeting a vitamin deficiency. We have a parallel here. Some youngsters who are having reading problems improve with perceptual-motor training. This is getting at their particular need and we cannot generalize and say that this program is going to work indiscriminately with every child who has, apparently, the same problem.

Janet Travell. I want to give a specific illustration of how motor training can affect reading ability and it starts with Dr. Cohen's observation of the disassociation of eye movement with head movement. The person can be taught to scan the reading material on the desk if it is at the right focal length by turning the eyes, by looking down, by looking over, by looking up, by looking around, without actually moving the head. If he has a short focal length and the material is too far away, he can tilt his head forward and by excessive use of neck muscles, physical fatigue and discomfort results. So we come to a very simple problem in which neck muscles fatigue owing to lack of eye movement independent of neck movement which, in turn, affects vision. Discomfort and pain produce distraction and inattention, just as an arbitrary stimulus or over-stimulation can suppress visual perception. Darrell Boyd Harmon has very interesting experiments that I think have not been recorded which show that the position of the neck modifies the so-called reading length and that the military stance with the neck retracted interferes with vision in many people.

Dr. Cohen. Dr. Travell has done much pioneering work in some of the clinical manifestations of the importance of the cervical mechanism. She showed that spatial disorientation and dizziness can occur from focal points of cervical pain — abnormal sensory stimulation from neck muscles. And I am glad also to hear her emphasize that postural stresses can make maladjustments in people, or motor stress can make postural maladjustments. Sometimes a person can perform a task very well, but the physiological stress that he has to exert in order to perform the task can be damaging and it will not show up in the particular task that is causing this. He can perform well because he is sacrificing something else for that. You can get, as Dr. Travell has recently published, such things as mechanical headache. She lists a number of valid causes of this. It can be postural stress, malocclusion of the teeth, or poorly fitted glasses. Dr. Francke made the comment that he thinks that bad vision is one of the greatest sources of these postural maladjustments. Also, you will get things like one shoulder being higher or lower than the other, a person sort of continually tilting his head back to one side or the other and then having a permanent upset of his visual axis. All of these are maladjustments to stressful situations. They then serve as the basis for new motor activity different than the original motor activity that caused these maladjustments to begin with. It can produce a situation which looks permanent, can look anatomical, and yet if you correct the physiological cause, in time, these postural maladjustments will improve too. This then reduces psychological stress as well as eliminating the physical deformation.

Dr. Wright. Affect and emotion can also influence motor potentials. The muscles in your neck and back can be influenced by your affect, and if you have a training program which is designed to help children overcome this problem, you have interpersonal contact with these children which may influence their affect. The mechanisms or the variable by which the motor responses in the neck change may not have anything to do with physiological stress. It may have to do with pure emotional affect. Find out what it is. The only way we will do that is with controlled molecular studies. While waiting for these I think a posture of caution is well recommended.

Dr. Hein. I have been asked if I find any difference in the way an individual adapts to visually distorted environment with reference to different sides of the body, i.e., the dominant side versus the non-dominant side. The reference is to adaptation of hand-eye coordination to prismatic displacement of vision. The answer is no. Whether the subject uses one or the other hand, the amount of adaptation seems to be substantially the same when the exposure conditions are otherwise the same.

Dr. Crouch. I do want to state one point before bringing up my question. I still feel very strongly in working with children as a practitioner that some of the things we are doing may go against the experiments that are being done. I could cite many cases in which one experiment shows one thing, yet another experiment shows it the opposite way.

Nothing has been said yet about chemotherapy. Everybody in this room is interested in the area of the use of drugs for reducing learning problems. Is there some application to perceptual-motor difficulties from experimentation you may have done?

Dr. Wright. I can respond very briefly to that. We do work in a Child Center with children with these kinds of problems who are medicated and it works.

Dr. Ozer. We do not operationally define these children adequately to determine for what kinds of situations these drugs will and will not work. The drugs do not work in any specific fashion but change the standard conditions under which the child is operating. At that time, if you modify your program in relation to this child so that the level of the program you introduce is relevant to his level of performance, you will then get him in phase and then the drugs will work. When they work and when they do not work is not a function of our present diagnostic categories because they are not operational enough. This was the comment I was making earlier in terms of any motor program that you want to establish. You must have criteria for what your goals are so that those behaviors you work with are relevant to the goals you have established. Then you can begin to evaluate the validity of any of these programs.

Dr. Wright. I think this comment reveals to me a part of your earlier comment, which I did not perceive, and it raises this whole question of nosology. Our nosology, as you just indicated, isn't very much help to us, and, in fact, you are speaking from the medical standpoint. From the psychological standpoint it seems to be getting in our way a great deal. We have used a variety of terms for children that are placed in so-called perceptual-training classes in the Oklahoma City area. We have called them minimal cerebral dysfunction, perceptual problems, and minimal organic involvement. There are all kinds of terms. We have gradually come to the use of a term "learning disability," not because it helps but because it stays out of our way better than any of the others and we really are not helping the parents much when they come in with a child and they say, "You know, we have a problem, our child won't learn." We go through this long diagnostic process and then we scratch our chins very wisely and say "Aha, your child has a learning disorder," which is just rephrasing what they said when they brought the child in.

It would seem to me that one of the very, very helpful services that someone might render would be to search for appropriate nosological terms which would match. For instance, what do you call that group of children for whom dilantin or phenobarbital seems to help under these conditions? We should get away from the use of these fantastically gross terms. Maybe we will have to have a thousand terms. I do not know. I hear my medical colleagues referring to the old days in medicine when they used to talk about the "fevers" and that included diphtheria and a thousand other things. It was not until we began to break down what the fevers were in specific nosological categories which made some sense that anybody made any progress in doing something about the various kinds of fevers.

Charles Drake. We're going to end up with a "succotash syndrome," which is what we have at the moment. We're finding a whole group of children, and we test at least eight a week, who certainly have learning disabilities but who do not have the gross motor incoordination that we read about in the literature. These children can be identified in a number of ways. Usually, they are the high performers on the Wechsler with a much lower verbal skill. They tend to have very severe auditory problems. It is time we begin to be a little brave and to talk about some specific different symptomologies. Otherwise we are going to end up with a pure mishmash and none of us will know what we are talking about.

Everyone of us has a different population. The mid-western section, for example, reports having high performance, low verbal children. Until 18 months ago, we never saw a high performance, low verbal child. Then suddenly, when we tapped into another structure within the community because of federal funds and because the school system began to pay for the diagnosis rather than the parent paying for it, suddenly we began to see these. I think we are at the point where we can begin to talk about this. Otherwise, we're going to keep on prescribing the "pill" for everbody and as far as I know the "pill" is not very good for males. I would say that if there is any possibility of our beginning to at least encourage research in this, this meeting would be of great value to all of us.

Dr. Wright. I think it is in people in positions in which you are functioning that we find the greatest hope for the dilemma we are confronted with. I don't see the panel helping us very much. The help is going to come from people who are working with children in programs and from these people taking the necessary precautions and care and applying the necessary structure to what they are doing to find answers and to be able to communicate those answers to other people. There are innumerable programs all over the country which are funded and motivated toward service needs. The tragedy is in the shortsightedness of it. People do not realize that not getting good knowledge generation out of these programs is really going to hurt our services in the future. Instead of simply offering programs to meet the needs of public school parents and their children and having a program while not really knowing what we are doing and whether or not it works and why it works, we could certainly save the next generation a lot of time and trouble if we just take that little extra step necessary to be able to control, to find out something, and have something that can be communicated through scientific literature to others. I would like to goad anyone that I could, in any way, to engage in that process.

Dr. Keogh. The thing that happens is that the people who are involved in the program at the moment are doing very well to keep their heads above water to work with that given child. Therefore, we need Dr. Wright to go down to Imperial County and sit there and watch the operation and between the two of them get the job done. I really think as long as we keep these two entities separate, we're not going to get to the answers in the live program.

Aileene Lockhart. Dr. Cohen stated that the team approach is probably the only way we are going to be able to attack this sensibly. We have to attack it where the action is. I would like to ask the psychologists and child development people to please get busy on developing some sort of objective measures of perceptual dysfunction or function so that those of us who are in motor programs, or about to be, could discover through good objective evidence whether, in fact, the problem is an effect problem or it is an input problem. We have no really good test for finding this out. If we could get the kinds of measuring instruments needed and then subject the children to various program treatments and retest, we might get some answers to some of our questions. So I would like people in psychology to develop some usable testing instruments and measuring instruments.

Muriel Sloan. We've been talking about the child with high motor achievement, low verbal skill. I would like to look at the low performer with high verbal skill, because these exist too. I am thinking more of the normal child with whom those of us who are in physical education are concerned. Related to the point made by Dr. Ozer about the need to define goals and tasks as a basis for programs that will develop desired behavior, on what basis does one answer the question, Is it good or bad to teach children to move while blindfolded? This question is unanswerable unless you know *why* you are blindfolding these children. What is the purpose of this activity? Are you working on perception? We seem to use the word "perception" to mean visual only, and to be concerned with the use of movement in order to facilitate or to develop visual perception only. It would seem to me that if one is equally concerned with other sources of perception, for example, the kinesthetic and its function in motor skill, then one might assume that the question of blindfolding children should create a discussion of whether it is good or bad in relation to developing movement skill. Skill certainly involves the visual, but referring to an earlier suggestion of the term motor-perceptual, perhaps we need to focus as well on movement and perception thereof, with which physical educators are concerned. I would like to see the psychologists, physiologists, and medical people help us in order that we can better help with problems of visual perception. But also to help us to do a better job with developing the motor side which, in turn, might influence the visual perception side. There we would have a meeting point where each, in his own specialization, will make a contribution to the total child's development. We, in physical education, do not yet know enough about kinesthetic perception, and I think that kinesthesis is something which cannot be left out in terms of developing movement. What I am asking is that we consider the other side of the coin here as well.

Unidentified speaker—woman. We have been talking about reading and there has been an implication that movement would improve reading and now we are referring to reading as a neuromuscular skill and as a cognitive skill. Shouldn't we be using a term that indicates some improvement in the avenues of learning? For instance, as has already been demonstrated in reading research, children learn under the Initial Teaching Alphabet; children are capable of learning with phonetics; children are capable of learning with words and color. At the same time these same research studies show that some children do not learn under those programs.

Dr. Drake. The question is an excellent one because it reveals that we are in exactly the same mess in reading that we are in this whole motor control because we have never defined our terms. Reading consists of a number of sequential acts and the first of these is some scanning mechanism which allows us to target in on a series of graphic symbols. This leads, hopefully, to a decoding process which, however, is largely devoid of meaning. One can learn to decode a nonsense language or foreign language without knowing anything about the content of it. One goes from the decoding into comprehension. Comprehension skills are very different from decoding skills because they move immediately into the cognitive area. When you talk about reading, therefore, you have to draw a four-celled paradigm before you can really begin to talk about it. In any fourth or fifth grade class you have children who decode and comprehend beautifully. You have another group who have no trouble decoding but who have major difficulties in the comprehension. You have just the opposite where you have children who can do neither of these skills.

As far as our research indicates, the average child who has trouble comprehending only, has perfectly normal and often very high, perceptual-motor skills. It is the individual who is having the decoding problem who normally is associated with perceptual-motor disability. Before we can talk about any sort of reading problem, we have to talk about with what aspect of reading we are concerned. If we take 100 children who are all having reading problems, who are manifestly below average in their ability to read on a silent reading test which does not attempt to separate these various aspects of reading at all, we have never found over 40 of them who will have perceptual-motor signs.

Therefore, any motor research which aims at getting at this particular group which has no motor problem is nonsense. There is a beautiful example of it in an article which appeared in Volume 2 of the new *Learning Disabilities* magazine in which a person had taken "poor readers," that is, the children who had scored within the lower third of the population on a silent reading test, and had then given them a finger-tapping test. They found that the good readers and poor readers did not differentiate on this particular tapping test. Therefore, there is no motor problem with poor readers and anybody who has a motor program for poor readers has no evidence to support it. I would submit that this is like casting a fish line into a bucket and thus proving that there is no such thing as whales. It has become this ridiculous on both sides because there are people on the other side who are saying, "If you will give motor training, it will help all poor readers." There is no evidence for this and I think we have done ourselves a great disservice by making excessive claims.

David Pearl. It may be stating the obvious but if you are going to be dealing with children beyond the first several years of life who are relatively normal and not too terribly abnormal, it is important to consider the reports and history that the parents provide of the child in terms of particular kinds of activities. If you are going to apply a particular source of therapeutic program to these children, you are not going to get uniform results because these may run counter to their previous learning histories. Any kind of program is going to have to be individualized to at least some extent.

This may very well account for the findings in terms of high performance, low verbal or low verbal, high performance children. This may be dependent upon the kind of encouragement and reinforcement provided the children, the kinds of home interactions that children have enjoyed and the kinds that have been inhibited. If you are going to be dealing with children whose parents have, for example, inhibited exploration and instilled a fear of activity, you are going to get a completely different result than from children who have not had that handicap. It might not be amiss to work with parents in some instances.

Dr. Lockhart. I am talking to the point discussed earlier of who should be doing something about this. I am not denying a problem, but I wonder if you would respond to this kind of reasoning as legitimate or not. It seems to me that action should be based on principle, and defining the principle or principles upon which action is based requires controls. The only place this can occur is in the laboratory. It can't be stumbled upon by practitioners at the expense of all children. Good action can be developed only after we find the "why" and it is not very apt to be found—that is, we probably cannot identify what we find if it is all mixed up in vegetable soup.

Dr. Wright. I would like to make a very brief response to the last comment before responding (to another question presented to him by the moderator). First, I followed that reasoning quite well. The one thing I was not sure of is where this laboratory is going to be located. In the public schools? In the medical center? Or where? It seems to me that the people are already in business. You can call them laboratories or what have you, but they are in the public schools. I feel the question is, who is going to invite whom? We have already said we ought to get together, and it seems to me that it should be at the home of the people with the programs in the public schools, primarily. As a research psychologist, I would say that it's at your house and, if you will invite us for a duck dinner, we'll bring the duck.

A request has been made for an amplification on the comment about quantity versus quality in sensory-motor stimulation. For example, noise versus opera music, etc. At what age may the qualitative aspects overshadow the quantitative aspects? It is only at, roughly, the first 2 years of life in humans that there seems to be support for the idea that the quantitative as opposed to qualitative aspects of stimulation are of anywhere near equal merit. So the answer to the question is, as best we know now, somewhere near the end of the first two years of life. Workers with culturally deprived children and others have suggested explanations of what is wrong with these children in terms of figure-ground problems, meaning that they cannot discriminate relevant from irrelevant stimuli. They cannot tell the difference, in a very general sense, between opera music and noise. They don't know the difference if they are confronted with both. They don't know which to attend to. And so I would say that by two years of age, if not before, but certainly by two years of age, we need to be giving consideration not only to the quantitative aspects but selectivity.

Dr. Cohen. I think it would be wrong to leave the group with the idea that it's all sort of hopeless to get objective data. This is one area in which physiology, or at least technology, is much more advanced than you may realize. It is possible, for example, by techniques of biotelemetry to record such things as eye position in relation to the head, heart rate, respiratory rate, the electromyographic pattern of muscles and how much they are involved in particular postures, how they fatigue. It is possible to do this without any attached wires on children in the normal classroom environment, without any investigator being present. We have a six-channel device that weighs about a half a pound that is self-powered and includes a radio transmitter for transmitting six channels of information simultaneously. The information can be picked up in a neighboring room very accurately and go for hours. It can be worn as a belt or next to the skin by a student. There is the opportunity even to modify these things to measure things like auditory perception and visual alertness, or to produce visual stimuli and see where the eye moves in response to the stimulus. Things of this kind can be devised quite easily without interfering with the classroom situation at all. There is a lot of gold here and it ought to be mined. You ought not feel negative. You ought to let other people from other disciplines help draw the curtain back and show you how to use these things and we could get a lot of really objective data, and come up with some facts based on data from the classroom situation.

Action Programs

Films or slides illustrating three action programs were presented, followed by comments from a reactor panel and group discussion. Narration summaries are included in this text to describe film content. The summaries of the first two film presentations are brief, reflecting only 10-minute showings of selected film. The third film was shown in its entirety, and the accompanying narration is presented verbatim. Because time did not permit detailed description of the programs illustrated, the three speakers were asked to prepare a program description for inclusion in this report.

I. THE DAYTON PROGRAM FOR DEVELOPING SENSORY AND MOTOR SKILLS IN THREE-, FOUR-, AND FIVE-YEAR-OLD CHILDREN

Presented by *William T. Braley*, Sensory-Motor Consultant, Early Childhood Education Project, Dayton Public Schools, Dayton, Ohio.

Program Description

As a part of the Early Childhood Education Project of the Dayton Public Schools a preventive-type program in the sensory-motor areas has been developed. Through preplanned daily classroom experiences aimed at developing sensory acuity and motor skills, we hope to provide children with a varied sensory environment. It remains to be seen whether or not this training will help children to achieve significantly in the learning situations at the first grade level.

The rationale for this type of program stems from the fact that recent research (Heron, 1957) shows how important a wealth of sensory experiences is for the integrated functioning of the brain.

It is known that the development of these experiences has been denied many children because of one or more of the following reasons: (a) some type of cerebral dysfunction; (b) a lack of natural childhood experience due to cultural disadvantage; (c) emotional upset; or (d) overprotective parents who stifle the child's natural instinct toward pursuing his own developmental processes.

It is felt that if a "readiness" program designed to develop perceptual awareness in children who fall into any of the above categories can become a part of the daily curriculum, many of the problems in these areas can be prevented. The children enrolled in the program, therefore, could be helped to overcome some of the perceptual difficulties often linked with school failure.

In the 1967-68 school year, 821 children were enrolled in 21 schools in the Early Childhood Education Project (preschool classes). A "Sensory-Motor Manual" was provided for each teacher to use. The purpose of the manual is to encourage teachers to provide a wide experience-type program for three-, four-, and five-year-old children.

Three sensory-motor consultants were placed in the five schools having the highest incidence of deprivation. The consultants demonstrate once a week using activities found in the manual. An assignment of activities is then made in the manual. The classroom teacher is asked to integrate these activities with the daily curriculum.

In order that a developmental sequence could be followed, the manual was arranged as follows: (a) Body Image, Space, and Direction Awareness, (b) Balance, (c) Basic Body Movement, (d) Symmetrical Activities, (e) Eye-Hand and Eye-Foot Coordination, (f) Large Muscle Activities, (g) Fine Muscle Activities, (h) Form Perception, and (i) Rhythm.

In all of the above areas a constant effort is made to develop auditory discrimination. It is felt that perhaps this is one of the areas of greatest difficulty for the type of child enrolled in this program.

Research done this year on the program indicates that children can be trained to develop in these areas. A matched-pairs concept was used for this research, matching children who had had training with children who received no training. The children were matched using age, sex, and environmental background.

A promising feature of this program is involved with its effect on the child's feeling about himself. The child in this program is able to perform in areas which help build his self-image because the curriculum is designed to appeal to the child's natural aptitude for play. Most children can achieve in this natural environment of play, and this helps them to become more emotionally stable and able to cope with programs of academic stress.

Although many of the skills developed in this program are not new to education, we feel that many teachers should be encouraged to recognize the need for perceptual-motor activity before expecting the child to achieve in academic work.

As a further aid in helping teachers and parents toward better training in the sensory-motor areas, two movies have been developed. One movie depicts children with problems in the motor area. This film helps in identification of children with problems. The other film depicts all of the types of training used in the program. The film shown illustrates some of the problems identified and a few glimpses of some of the training methods used.

Narration Summary

The first child shown was a boy who could not hop or skip and who had difficulty even in lifting one foot off the ground. In kindergarten he sat and cried if anyone interfered. Follow up with the home revealed he had not been allowed to go outside because of the neighborhood in which he lived. There was nothing wrong with the boy except that he had not been allowed to move. He made remarkable progress in a relatively short time. He had activities in the classroom, gymnasium, and out-of-doors.

Another boy had a severe case of nystagmus. He had a problem of even knowing where the ball was. He could not move from side to side, and balance was poor. In four months time he was catching a ball and moving considerably better in a variety of ways. The film indicates considerable work on the trampoline, out-of-doors in normal movement and play-type activities, as well as some specific work in the gymnasium on balance, skipping, hopping, etc. This spring, this boy was observed on the stage at the University of Dayton in a dance program.

II. PERSONALIZING EARLY EDUCATION

A selected group of slides from the School District of University City, Missouri, were presented and discussed by Alice D. Coffman, Director of the Prekindergarten Research Center, University City, Missouri.

Program Description

Thirty-five millimeter colored slides depict a segment of a program which is a part of a three-year research study underway in University City, Missouri. The purposes of the program are to identify children's learning needs early, before problems arise, and to design specific learning activities which sequence small steps of success toward the growth and development of each child. Four-year-old children participated in the personalized developmental skills program. The children were given an hour and one-half battery of tests to determine the levels of functioning in receptive (visual and auditory), cognitive (association, integration, recall), and expressive (language, motor) skills. Children showing a severe lag in any of the skills have spent 20 minutes a day in activities planned to strengthen the weak area. The remaining part of the two hour and 45-minute day focuses on a well-balanced prekindergarten program planned to extend social, emotional, physical, and intellectual growth. Each class is composed of approximately 25 children guided by one teacher and two teacher aides.

The slides shown concern the type of activities provided for those children who were performing well below their peers on the pretest in motor skills. Specifically, the skills have been classified under the following headings: (a) awareness of self, (b) gross motor control, (c) fine motor control, (d) position in space, (e) eye-motor, and (f) creative motor. A 182-page book, *Developmental Skills #1: Motor Activities*, containing suggestions meant to foster the development of skills in each of the above six classifications, is used by the teachers. Also parts of the book are related to commercial materials and check lists for on-going evaluations.

In addition to the motor program, the project has also focused on children who have shown evidence of needing help in the development of visual, auditory, and language skills. For those who seem to have no apparent weaknesses, a program based on Piaget's theories with emphasis on fostering the development of logical thinking was followed. Activities centering upon each of the above skills have been put into booklets for teacher use.

Each year of the study the parents have played an important part in the program, attending conferences, workshops, and meetings. They have been responsible for constructing materials such as flannel boards and flannel cutouts, templates, bead patterns, sound shakers, lotto games, dominoes, and sequence cards which have become a part of the Parents' Corner and, along with the books, pamphlets, and records, may be checked out by all parents to be used at home. *Developmental Skills #5; Fun While Learning At Home,* comprised of games and activities calling for no materials or requiring only items usually found in the home, is also available from the Parents' Corner.

In-service workshops for teachers and teacher aides have been held regularly to explain the rationale of the project, related research, the test battery, test evaluations and interpretations, and each developmental skill. For example, two physical educators working with a group of children demonstrated ways of developing concepts such as near-far, over-under, up-down, left-right, etc., through games involving large muscle movement which not only helped each child internalize the concept, but also increase his awareness of his body in relation to the space about him.

One hundred experimental children have been in the program each of the two years. In addition, 200 control children were given the same battery of tests each year, but did not participate in the program. Post-tests are administered to both experimental and control groups at the end of each year of the study so that pre- and post-test comparisons can be made. The overall purpose of the research is to measure the effect of the personalized program on achievement in school. These results will not be available until the first group of children has completed primary-one, at the end of the 1969-70 school year. Findings from the first year show that children performing well below their age-mates can, after participating in a six-month personalized program, reach a level comparable to or above the average of their peers.

It is hoped that findings from the second year, which will be forthcoming in July 1968, will substantiate the encouraging results of the first year and that both research studies will be indicative of the importance of developmental skills in laying the foundation for academic success.

Narration Summary

The slides shown illustrated a few of the youngsters who had scored well below their peers in the motor area. Some examples of activities were (a) a child pointing to his body parts as he looked in a mirror, and (b) assembling a body on a flannel board. The children became familiar with the body parts, how they are attached, and how the body parts move.

Several gross motor activities were illustrated. These were game-like activities, many of which the children made up themselves. Slides depicted the inchworm, duckwalk, scooters, horizontal bars, jumping on a large tractor innertube, and other upper torso and arm activities.

Finer motor activities were shown. The point was stressed that before a child used a template and circle, etc., he had lots of activity internalizing what a circle is, walking around a group of children in a circle, drawing imaginary circles in the air, and then circles on the blackboard with templates.

The first year results indicated that boys had not benefited as much as girls, so more "boy-type" activities are now used. Metal pipes and pipe fittings were shown being built into all sorts of things, obstacle courses (some created by the children themselves), and activities stressing going over, under, in, around.

Position-in-space activities involved balls, targets, eye-motor movements and eye-hand motor movements such as hand following dots or tracing dots of the cat. Plastic sheets were used which would easily erase and enable another child to do the same task.

The activities were natural, child-like, creative, and all part of a classroom and play curriculum.

III. A PROGRAM OF MOTOR DEVELOPMENT ACTIVITIES

A film made at the University of Southwestern Louisiana in 1965 was presented by Louis Bowers, University of South Florida, Tampa.

Program Description

One basic and very unique contribution physical education makes to the education of children is the development of motor skill. I am pleased to have this opportunity to share with you an approach to accomplishing this objective through a program of sequentially arranged motor activities.

This program of activities was developed specifically for mentally retarded children or other children of average or above average intelligence who have specific learning problems. The purposes of the program are, briefly, to help children gain greater awareness and control of their bodies as they move in their environment and to develop a motor readiness for learning game and sport skills which is consistent with the child's chronological age.

An important recognition in this program is that all the children in the program, regardless of their individual problems, are first of all more like normal children than they are different and they are also quite different from each other. This individual uniqueness is displayed not only in varying levels of motor performance, but also in their ability to understand, to be motivated, and to relate to others. The motor development of the mentally retarded as reported by Francis and Rarick (1) indicate that the motor abilities of the educable retardate are organized in much the same way as in normal children and the development of these abilities follow similar developmental curves, although at lower levels than for normal children.

The child development studies of Gesell (2) and McGraw (3) show clearly defined patterns of growth in children. Briefly, the random exploratory movements of children displayed in early infancy become purposeful and controlled movement as the child grows older. The development of control of movement of the parts of the body proceeds from the neck, to the trunk, and then to the upper, followed by the lower, extremities. The gross movements of the body produced by the larger muscles develop in advance of the more precise movements produced by the smaller muscles. Initially, there is greater participation in and control of simple movements involving a few body parts; then the child progresses to the more complex activities of moving a number of different parts in a coordinated manner. It must, of course, be recognized that there do not exist segmented states of development, but rather that each state is progressing simultaneously, with certain types of motor control being more advanced than others.

Other development considerations are the use of both hands or either hand without perference until a later selection of a preferred side is made, and the need for a high degree of activity which seems to be characteristic of young children. There are, of course, considerable differences among all children in regard to both the time of onset and the duration of each developmental stage.

In view of these recognized patterns of development a program of motor developmental activities was constructed in which activities were arranged in a sequential order progressing from simple movements to complex ones, gross movement to finely coordinated movement, movements of the neck and trunk proceeding to the upper, then lower, extremities, bilateral performance, to movement of the preferred side. This sequential pattern is followed in each of four areas of activity—exploration of movement, balance, airborne activities, and hand-eye manipulative skills.

The philosophy of this approach to developing motor skill involves taking a child where he is developmentally and taking him forward at his own rate rather than imposing activities which seem appropriate for where the teacher thinks he should be. The child starts the program with basic movements in the developmentally arranged sequence of activities which allows for early success experiences. As he continues to progress to the more complex movements and reaches a level of performance which proves to be difficult, the activity is broken into its component parts and he engages himself in a variety of appropriate movement experiences.

Poor performance in any activity does not prohibit participation in the more difficult activities if some degree of success can be attained. Movement experience at a higher level provides an opportunity for the integration of lower level movement patterns with the total performance.

The ordering of activities in the program is not rigid, but rather serves as a guide for the teacher. It allows for the creativeness and innovation of the teacher and child. There is no unique importance attached to any one movement pattern in the sequence, but rather its importance is determined by the needs of the child.

References

1. Francis, R. J., and Rarick, G. L. *Motor Characteristics of the Mentally Retarded.* U. S. Office of Education Cooperative Research Project No. 152 (6432). University of Wisconsin, September 16, 1957.
2. Gesell, A., et *al. The First Five Years of Life.* New York: Harper and Row, 1940.
3. McGraw, M. B. *The Neuromuscular Maturation of the Human Infant.* New York: Hafner Publishing Co., 1963.

Film Narration

This is a body orientation exercise moving the body left and right with the body extended (from prone position on his face to his back). In a curled position he moves to his right and left, forward and backward. The child is encouraged to verbalize the command he is performing in order to associate the musclar feeling with the word.

This is an inflated innertube and, with the assistance of the teacher, will provide a feeling of roundness. (The child is inside the innertube being rolled forward and backward.)

In the push-up position, the child is rolling from back to front, using the hands to move from the right to the left, initiated first by the teacher and then copied by the student. This is a fine agility drill used by wrestling coaches.

The same movements are used in this sequence but the individual ends up in the all-fours position (push-up position). Slow movements in the movement exploration area begin with flat crawling where the boys like to pretend they are soldiers crawling under obstacles. Initially, he goes forward stretched out on the gym scooter. Progression is then made to performing an alternating-arm swim pattern.

The experience of maneuvering through markers calls for a judgment of space and body size. (The markers used are the same as those used on a road marking.) Some are self-conscious about being down on all fours, but if a challenge is presented such as tunnel creeping, it can become a game. Creeping can be performed not only forward and backward, but up and down and inclined forward as well.

Follow-the-leader can be played crawling in a group or through an obstacle course. The emphasis here is to have the child turn the head in the direction of the lead hand. The most advanced stage of creeping displays a cross pattern in which the lead hand and the leg on the opposite side are brought forward simultaneously. When the child displays adequate cross-pattern creeping, little time need be spent in this activity.

As the child assumes a position for upright locomotion, walking, he takes on a smaller base of support and raises his center of gravity, both of which decrease his stability. Walking with one foot placed in front of the other calls for a greater degree of balance.

Moving the arms and legs together is required in many basic motor skills. The feet then cross over the midline of the body. The use of cut-out foot patterns pasted or painted on the floor or the sidewalk help the child to see where each foot should be placed. The exercise becomes more difficult when the child is required to bring the leg and arm on the same side simultaneously across the midline.

A rope held at varying heights provides an obstacle to go over or under. This calls for a judgment of distance and space in relation to the body.

An inflated innertube presents another challenge of mobility. (The children are going through the innertube.) Coordination of hand and leg movements is required with the knees drawn up high and touched with the hand on the same side. The hands are then crossed over the midline of the body to touch the opposite knee.

In this group there are varying individual approaches to performing the skills of the two-footed jump. Reduced base of support calls for increased ability and balancing.

Footprint patterns are utilized for a two-footed jump in this scene which gives a child a target to jump to. The two-footed jump may be performed for a long distance, height, or for jump rope skills. The locomotive pattern becomes increasingly more complex and ends here with a change of action from one side of the body to the other.

A side-step pattern is a technique like walking, but one foot is not placed in front of the other. Instead, one foot is moved away from the midline of the body and the movement of the other is toward the midline. (They are in a circle and the leader is holding the hands of a girl and leading her in a slide.) This can also be done with musical accompaniment.

Jumping in place with the knees brought up high demands considerable coordination. (The knees are slapping against the hands.) The jumping jack involves the movement patterns learned earlier.

The approach found in balance activities involves making constant and varying changes in each individual's base of support. (They are moving the leg behind and then the hand in front.) The objective is not to develop a particular balance skill but to make the individual capable of adjusting to constant changes in the body in relation to his base of support.

The child is now walking on a low four-inch balance beam with a mirror serving as a visual feedback.

Catching a bean bag or ball while balancing on the beam or later walking across it develops other motor skills involving eye-hand coordination.

If an obstacle, such as a stick placed across the balance beam, is to be overcome, a flexible-type balance must be present. Shifting the body weight from right to left on a balance tilt requires a constant adjustment of body parts. (This balance tilt is made of half a barrel with a board across it. The board is nailed to the half barrel.) Adjustment here takes place from front to rear. (The child is now facing sideward on this, rolling forward or backward.)

Balancing performance then progresses to a low two-inch wide balance beam. A tilted balance beam provides an exercise in maintaining balance while crossing the legs and the legs and arms over the midline of the body. Balance activities become more realistic when the child imagines he is trying to get across the stream of water by stepping on rocks. The higher balance beam (approximately two feet) is the hardest of all because of the element of fear.

Prior to jumping on the trampoline, a similar experience on the lower balance board allows the child to experience and improve motor skills of jumping and catching the ball. The trampoline is an apparatus used to enable the child to perform such movements as turns to the right and left, jumping on alternate feet, bringing the knees up to the chest, jumping jacks, etc. After many movement patterns are experienced and mastered, the child is encouraged to perform the usual trampoline skills such as knee drops and seat drops.

Inflated innertubes have multiple uses and the basic locomotive skills are performed here under different conditions. (The child is jumping through them, and then jumping from the edge of one to the edge of the next.)

Two growing indications of a child's hand manipulatory development is the ability to easily turn the hand over with the arm bent. (The palm is up, and then down.) Since the eye-hand manipulative skills develop after the large muscle skills of the body, initial exercises concentrate on large muscle movement patterns.

Lines are drawn simultaneously with the right and left hands forming the center point. It becomes increasingly more difficult to perform this task as the lines approach the horizontal. (The child is drawing a semicircle connecting the dots simultaneously.)

A beanbag or a large ball gives the child with poor hand-eye coordination more time to catch the object. A large ball is used with a decrease in the size of the ball as the child improves. Beanbags also provide an easier object to catch and one which does not have to be chased. The ball is first rolled to the child where he can catch it and then thrown on the bounce. Throwing with two hands is emphasized initially (the two-hand chest pass). After mastering two-handed catching and throwing skills, one-handed throwing skills are undertaken. (They are throwing the ball through the innertube.)

The ability to control the movements of the body and its parts is inherent to the performance of sports skills such as bowling, horseshoe pitching, and others. Motor skills which will permit the child to participate in activities with other children is one of the ultimate goals of the program.

Experience in kicking a playground ball with either foot facilitates showing, explaining, and even guiding the movements leading to place-kicking a small football. Special techniques and equipment are helpful, but of primary importance is the teacher who inspires confidence in them and presents a challenge to each child.

REACTOR PANEL

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Dr. Lockhart. First of all, I would like to say I found the films very interesting and I appreciate the opportunity of having seen all of them. I found some things in them that were superior to some of the things I have seen in practice. Mainly, not so much repetition and sameness in the kinds of activities that are offered.

What I would like to say is not based just on the films, but on my total observations on what we have done here and the things I have seen and read. I think that in many of the programs in operation there is entirely too much repetition of the same activities and narrowness of activities. I don't think that there is anything precious in some of these particular things—like the continued angles, continued crawlings, and continued so many other things of the sort which we see so many times. There is no substantiation that these are better than any other activities.

Now, in some of the films that we have seen tonight, we have seen a recognition that we should be doing something other than just developing the self and awareness of the self. We also have seen some involvement with other children. In some of the programs with which I am acquainted, this aspect of physical education I think is completely omitted. And yet, this is one of the things that heretofore we have always thought to be rather unique—one place in which we should contribute a great deal.

Also, we saw here some recognition of the universal interest in developing creativity. Again, some of the programs with their repetition seem to me to be the very opposite of any emphasis on any creativity. They always end up being what someone during these meetings has called a "vending-machine type of an approach." We punch a button and a certain response is supposed to come out and that's that.

I believe that learning is learning and that all learning involves perceptions. It is true that some of our activities are more educational than others. It is true that some of them may be more developmental than others. But I see no reason for us in practice to come out with stereotypes and that, I fear, has happened in some places.

The second observation shows cur preoccupation with dysfunction. I see nothing in the title of this Symposium nor anything implicit in the words "perceptual-motor" that makes me think we should be interested only in extremes and then only in one of the extremes. I in no way, though, mean to imply that doing something for these people in unimportant. We do need to help them. I think there is some danger these days in assuming perceptual-motor means only activities for people with dysfunction. It should, I think, rather include the complete domain. Further, the practice of assuming that because some of the activities may be helpful for some children, therefore they are necessary for all of our children, is just as though when one child needs one-fourth of a teaspoon of castor oil, we will give them all a cupful, whether they need it or not.

I am also disturbed somewhat with our sometime-called "exploration"; that is, trying all sorts of possible movements that we are emphasizing and encouraging what is in efficient movement. We have seen, and you will recall in some of these movies, practice of things that are fostering inefficient movement. I suspect that some of the most skillful people would have great difficulty in doing some of the things that we saw. For example, using the same arm and the same leg, trying to bounce with something that is far from the body. Later on, we shall try to teach these people, and instead of carrying something that way, we shall have them carry it close to the body.

Basically, I think it's a little amiss. I am very concerned. We think of a whole gamut of all children. I think it is encouraging that some of this has done one thing—to make us focus on the individual and what the individual can do. And one of the things that I have received from this conference is the wonderful interplay with people of other disciplines and getting to know one another. Perhaps our biggest charge, in order to do our mission most effectively, is that we can learn to do it as a member of a total team of educators focusing on the individual. Then we will do a great deal.

Dr. Walters. I would like to concur with what I heard said so beautifully. But I gathered that many of the films were made with the fact in mind that we are going to see some improvement in the child who is not functioning "normally." So, we are trying to expose 100 percent of the children to a program which involves, at most, 15 or 20 percent of the children who are neurologically damaged, and it should be assessed with that in mind. In that way it might be a clinical approach. We need to know what their specific disabilities are. Then a particular child would be put into a particular help program and not be exposed to a general program in which he could not function as well as the average child. Many people in physical education say that we must learn to identify these youngsters early. I think this goes back to the early identification problem which we were talking about before. Early identification probably is possible, but not possible by us because we do not get to them early. I can think of studies, however, in which we might do developmental diagnosis for gross motor and fine motor differentiation and follow these youngsters through because they follow definitely through the maturation process although they are influenced by enriched experience or deprivation.

If we could reach them early enough, I think we could help them. You might say we could help to build into the organism, a little bit better, these earlier experiences that they need.

Dr. Berson. I think we have an opportunity here to do some great things with these children. I think we also have an opportunity to do great damage. One of the things we know, certainly, is that some of these disadvantaged children live in crowded quarters and have very little opportunity for mobility. They certainly do not have safe places in which to play. I would like to see us take a broad look at this. Here is a child three, four, or five years of age who is a kind of sensory-motor individual. And we also have to work on language. And I think we could take a look at our playgrounds and view them not just as places for exercise, but as places of great adventure.

We can strengthen children by having a place where they can climb trees, by hanging ladders around, by having more tunnels, and by having all kinds of wheel toys that a child can use. But there is more to it than that. Think of the sensory development we encourage when we develop an outdoor facility. This is where the child has first contacts with water in a pool, with sand that he can manipulate. He certainly can develop many fine motor skills from this.

What worries me is that we sometimes take a point of view that if we fix the motor part, then we can sit the child down and we can fill him with the language that he missed. It doesn't quite work this way. I think that as long as we are using money and we are working with smaller and younger children, we should look at these children, not as having disabilities, but as having a lack of opportunities. Take the kindergarten child and notice how rapidly he is able to progress in his motor development. But I would also like to see this child, and all children, accomplish this in an atmosphere of beauty.

I think we need to take a look at our indoor and outdoor environments, and to see whether they are filled with many things to explore, learn from, touch, feel, and smell, so that it is impossible for the child not to be enriched. And I plead with people who study the sensory-motor not to divorce it from cognition and to view children, no matter how poor their language is, as individuals who need a great big kind of opportunity—an opportunity to be creative. We also talk about children being self-directive. If you are continually following directions, you will never become self-directive.

Dr. Malina. First of all, I would like to make a few comments on the factors which underlie, or, you might say, determine the sequence of perceptual-motor development in children. It is generally assumed that these developmental milestones occur in a regular sequence. Dr. Wright spoke yesterday of the sequence from birth to two years and how it might be aided by richness and stimulation.

I feel we should also pursue other factors not necessarily in the perceptual-motor domain. For example, in some of the work out of the Fels Longitudinal Series (Fels Research Institute, Yellow Springs, Ohio) they are attempting to relate the size of the parents, both in stature and build, in terms of parental mating types, to the early motor progress of the child. Children of larger parents, both in stature and in body build, tend to be larger in body size, advanced in skeletal ossification status, and advanced in gross motor development as assessed by Gesellian items at least from birth to the second year of life.[1]

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[1] Garn, S. M.; Clark, A.; Landkof, L.; and Newell, L. "Parental body build and developmental progress in the offspring." *Science* 132: 1555-56, 1960.

I would like to bring in the influence of cultural factors. I feel that child rearing practices are essentially critical here. How can we best qualify and quantify the environment in which these children are living? How do factors related to the nature of child rearing practices affect the sequence of perceptual-motor development and learning progress? There is also a need for cross-cultural studies here. Perhaps, if someone is lucky enough to get some research funds to study nonliterate peoples, this may be a fruitful area for study. We may find different sequences perhaps, or different emphases on certain skills for perceptual-motor factors that are of specific importance in a particular cultural setting.

Now I would like to also address my comments to the problem of children with different perceptual-motor deficits. It has been suggested that children receiving specific perceptual-motor training for different activities generally improve, for example, in reading abilities. Does this represent a type of catch-up growth?[2] Clinical data indicate that when a growth inhibiting factor is removed (for example, an adrenal tumor), there is an acceleration of growth velocity to the child's own path of growth and development. Does this hold true for children with perceptual-motor difficulty? Assuming the perceptual-motor problem is the inhibitor, say for reading development, does the specific motor training and subsequent improvement in motor skills represent removal of the inhibiting factor, with resultant improvement in reading skills? Does this represent a type of catch-up growth? At what rate does it progress? Is it permanent? These are a few of the questions which certainly warrant further controlled inquiry.

Reference to the physical growth status and progress of children with perceptual-motor problems has been generally overlooked in the conference. A cursory view of some of the films shown here suggests that many of the children with such problems are generally linear in build, a characteristic usually observed in slow growing children. Does the fact that these children might be slow growers (retarded in skeletal maturation relative to chronological age) predispose them to perceptual-motor problems?

Mrs. Jones. I agree with much that has been said stressing creative experiences for children in an environment as rich in opportunities for sensory-motor and other activities as possible. Research clearly states the earlier in development this occurs, the better. It is good

[2] Prader, A.; Tanner, J. M.; and von Harnack, G. A. "Catch-up growth following illness or starvation: an example of developmental canalization in man." *Journal of Pediatrics* 62: 646-59, 1963.

that we are hearing emphasis on preschool years and parent education. I would pose some questions as guidelines: What do we know about the earlier life styles of many of the children with deficits? How restrictive were their environments?

Much of what we do is based on norms that were obtained some time ago. Some recent evaluations in Dayton suggest that current culture may change the so-called "normal" sequence. Children from deprived areas did well in general motor activities but had difficulty with fine motor tasks. In the more affluent areas, children did better in the fine motor areas and had difficulty in the more general or large motor activities. Do we need to take a new look at what we term "normal" in perceptual-motor and movement activities? What are we doing to update our norms? Do we have the instruments to do this?

Today, much emphasis is on the individualization of instruction. Schools are concerned with all kinds of deficits—children unable to relate, language, motor, etc. Schools can no longer afford the luxury of waiting for children to outgrow all of them. It has become apparent that some never will. The films showed approaches by schools to help children with deficits in the perceptual-motor area. Most of what was seen was not the much discussed routine patterning kind of program. We need to be careful that we do not assume all programs do the same kind of thing. True, research is as yet empirical and much remains to be done. But some facts cannot be ignored—teachers emphasize the dramatic changes in some children. Principals in one school system stated that the body management program was one of the last they would give up because of the differences they saw in children—not just in the perceptual-motor area, but as total people. For some it seems important. The question is for how many, for how long, and to what else do the gains relate? It is dangerous to do the same to all children. It is just as dangerous to do nothing about the problems children bring to school. Some need help as much as some language problems need speech therapy.

Do we have the instruments to select?

Which deficits would maturity take care of and which ones need programed aid?

Which deficits would a good primary physical education program help?

Which ones should the regular teacher take care of?

How many, then, are we talking about who need the highly specialized approach?

If all children had optimum environment and opportunity, I am sure our job would be much less. Optimum development for all should be our goal. If we do this, the remedial needs would be much less. In the meantime, we have to do the best we know how but should never cease to research, refine, and question. I was pleased that in not one of these films did I hear "We do this to make a better reader." Some well-known programs have said this. It is easy to assume all perceptual-motor activity programs do this, and this is not the case. Children with these deficits frequently have many other kinds and also a varied assortment of learning problems. Thus, there is the need for a multidisciplinary approach. We have yet to be sure of all the relationships. The approach offers another technique. Let us use it with caution. It is encouraging to know of the research now underway in these programs and we look forward to knowing the results.

Dr. Ozer. It seemed to me that for our purposes this evening, out of the many things we have to discuss, the first film illustrated nicely the way motor training seems to help motor skills and there is justification in working with these things in a program for more individual work.

The second series of slides, I think, illustrated this fact, actually in greater detail than the full series of slides which you did not have a chance to see. There are some results of this study which Mrs. Coffman, perhaps, would like to talk about tonight which seem to be quite significant.

In this sense specific programing does affect motor performance in the specific areas that are deficit areas. It was pleasing to me to see the kinds of things they were doing. It seemed to me the things they were doing were more relevant to the kinds of behaviors they were interested in helping: for example, working with targets, working with tracking, and so forth. These seemed to be, perhaps, more relevant to the concerns of most of the people here, which is with how motor training can be relevant to the concerns of parents and the schools in terms of other kinds of problems such as reading and other types of learning.

In a sense, the kinds of behavior they were working with seem to be relevant to this rather than the concerns of some of the other types of developmental programs which start in the areas which are not relevant to the eventual goal. Another very important aspect is that the kind of program and the level on which the children are started is quite individually assigned so that they do not improve in things just because it is the thing to do, but because it is relevant to their needs and relevant to this particular project's goals.

In relation to the third film, I think that the emphasis I would like to make is that when one develops the motor skills of a nature that might be relative to the child getting along with his peer group, having some success with the peer group, and giving the basis upon which he can feel himself a person of some worth, then a person has received success in a way that he can build upon in other areas.

What has not been answered, and I do not know that it can be, is the degree to which all of these concerns are generalized to the areas of reading and other kinds of learning situations and which seem to be motivation for a lot of interest in this field. I do not think there is any evidence that motor training, per se, is generalizable unless related to the very behaviors it is trying to achieve.

The advantages of the types of programs that were described tonight are that the last film did relate to specific goals in terms of providing a child with success in areas in which he connects with the outside world.

The second program describes a relatively limited goal in terms of relevance to the child's particular needs. I do not think any of these programs would help answer whether motor training, per se, generalizes to all kinds of skills. I suspect that in taking on that responsibilty we well enhance the failure in proving this, as well as leading one into all kinds of areas that are already filled with problems. We hope we would begin to describe, in a way that would provide some policy statement for people throughout the country who deal with these problems, in a way that would begin to answer questions, rather than have all children go through all kinds of programs.

Audience Questions and Comments

Dr. Bowers. In connection with the statement by Dr. Lockhart on inefficient movement, we all recognize the importance of body mechanics and skilled performance. I think the very fact that we talk about the accuracy and inefficiency of movement implies a lack of exploration in a given movement.

Movement is important when a child is trying to discover what his body can and cannot do effectively, and particularly in the reference to the example made of movement of the weight from one side of the body to the other.

The film was lacking and remiss in that it did not point out that the child discovers what is inefficient and what is efficient in bringing the weight in close to the body. Unless we pose the problem when the child experiences this, the youngster must learn for himself how he feels and how efficient it might be.

If we impose instruction too early the mechanical soundness which you all recognize to be important in the high skill performance might be destroying some of the creativity or initiative or problem-solving explorations.

Dr. Lockhart. I am sure that you felt that way about it and all good teachers, of course, would bring out the point and put into it how it applies to the students and so on. I guess I was disturbed, somewhat, because I have seen so many demonstrations where so-called "exploration" was interpreted in so many ways and what they finished with was worse than what they started out with.

For example, take throwing. So everybody throws at the beginning, and then, after trying many different ways of throwing, they were far worse at the end of the performance than to start with. That is what I'm saying.

Dr. Francke. One other thing of which I think you are aware should be implied. The child is not always going to be unable to operate in the different situations. He will become able to do the skills in the extreme situation when necessary.

Dr. Bowers. I am sorry you said that. Particularly in the balance area, he is not going to be placed in situations where he will just balance. There will be many situations where you have to adjust balance.

Dr. Goldberg. I just want to say a few words. I am pleased that I feel the reluctance of physical educators to accept fadism into their area. This is an area where fads might come in and be accepted since we are using all the different "shot gun" therapy in some of these areas.

One other thing I want to talk about is the third case of the first speaker where he mentions nystagmus as being a diagnosis. A dangerous thing for physical educators to do is to make a physical diagnosis. I am not saying it was done in this case, but I will say that it is a danger. This child obviously had brain damage. That was the basic cause. I say he had brain damage because: (a) of the hyperactivity of the child, (b) he could not do the psychological studies on the blackboard with the square, triangle, etc., and (c) of the myopia and the nystagmus which are part of the brain damage. I think we must not forget that we need an interdisciplinary approach before we embark on projects of our own.

Mrs. Jones. I would like to add that, in this particular case, the boy had had a medical diagnosis and this was not the school diagnosis.

We are encouraged by the multidisciplinary team approach to work with many of these children. In the past we have often thought not to do so; because they were neurologically involved we should not touch them and no one should be doing anything about it. I am not saying that I am in favor of all the things that are happening and are being done, and I don't want it to be interpreted in that way. But there are things that can be done and there are improvements, and it can't all be done at the clinics.

David Misner. Physical educators need to start learning about this. I think it is very easy to ask physical educators to start doing something without knowing what they are doing and why they are doing it and to relate this to the needs of the child.

This has been repeated over and over. But at the same time, I think it is very important that before we judge things, we really learn what is involved. Some things that start out to be fads turn out to be sound and others turn out to be fads and are dropped. I think we have to remain open and I think we also have to study them.

One thing that we have found to be important has come out of this. That is the problem-solving attitude that physical educators can develop when they learn to study this approach. As a matter of fact, we have even found that gymnastics coaches, instead of telling the performer exactly what to do at the competitive level, have this performer discuss his mistakes after he makes them. They have him see what was wrong with it and have him think it through.

I observed this several times when coaches just started doing it, and it is an enlightenment to the student. The performer himself can really analyze and solve these problems. I think this is an approach that physical educators can apply much more than they are doing now. We can be the feedback system for these learners, but it is a lot better for them to use their own feedback systems and analyze their own problems.

Unidentified speaker—woman. It seems to me that a point Dr. Ozer made, and one that we should pay attention to, is that we try at some time to make a policy statement. It may not be possible to do it during this conference, but surely during this conference we can start the exploration of it. Then, through an interdisciplinary follow-up, we can come up with something that might be acceptable and would help carry forward the movement in our minds so that we would not have to be defensive about what we are doing, providing we go on to be creative in ways that sort out the sound aspects.

Some people have said the strength of this conference is the interdisciplinary approach. One of the weaknesses of it is that we do not really know how to work together in an interdisciplinary manner. It seems to me we are starting something here and that the dialogue has to go on. This conference is only the beginning.

SESSION SUMMARY

Dr. Fleming. I would like to make several statements from the overall curriculum viewpoint as a type of summary.

1. *It seems important to discuss the program in terms of needs.*

   In the current era in which we are living, the word "need" is not an old-fashioned one and we should continue to emphasize it. What we have seen tonight have been illustrations of attempts to get at specific program elements that were responses to particular kinds of needs for particular persons.

   The groups who presented these films are to be congratulated, for it is thrilling that we are now beginning to get such material. For so long many talked about meeting needs, but we did not really get to see it. This may be the beginning of the "new" physical education programs. We have had the "new" mathematics and the "new" social studies. Now we have a way to get at the "new" physical education.

2. *We think in terms of physical education for all the children.*

   It is important for us to keep in mind that physical education is not an isolated area of the curriculum. In one of the films the impression was left that it took 20 minutes a day. I do not think that is really true. I have a hunch that it was "spilling over" into various other experiences that these children had during the school day. It seems a bit short sighted for us to think of a movement specialist in physical education working alone. Rather, we should think of it as a broader area in which we are using a team approach.

3. *The panel emphasized an interdisciplinary team.*

   Within a given elementary school you also have the potential of an interdisciplinary team. We have demonstrated that there is a psychologist, a physical education person, the school nurse and physician, the school guidance counselor, the artist, the musician, and others. It seems that we need to learn how to better use these resources and those now available from other disciplines.

4. *We have placed a great deal of emphasis on beginning early.*

   All of your meetings have emphasized the importance of an early beginning. In the panel discussion tonight this was underscored. There was also concern for the longitudinal study. You are actually making a case for continued inquiry, study, record keeping, and assessment of the program.

5. *The purposes to be achieved were emphasized.*
Reference has been made repeatedly to specify the purposes or behaviors to be modified. This was highlighted in the films in terms of relating behaviors to specific behavioral goals. Here again, physical education is not unique because all the areas of the school curriculum are trying to take another look at what is meant by behavioral purposes and goals.

6. *There appears to be great power in movement and in the perceptual area.*
It seems that you have a kind of "gold mine" in your backyard. One of the elements of power in the theme of this conference has to do with the role of motor activity in freeing, releasing, and enhancing the learning of children, giving them many opportunities to move, to swim, to roller skate, to dance, and to explore what they can do with balls, ropes, and materials.

7. *One of the consequences of freeing and releasing children is that it helps to remove some learning blocks.*
This then, makes it possible for some of the things to occur in the reading area and in other areas of skill development that are important. You have a great opportunity to create a setting in which the children can become increasingly free, relaxed, successful, competent, and resourceful as the team approach functions achieving a variety of purposes.

8. *There is a need for a new look at the way in which teachers are prepared.*
It seems that you are going to have to work on a variety of fronts. One of the fronts is the teacher-education front. It has been called to our attention that some teacher aides were used. Some may be using aides to assist in a variety of what could very well be professional activities. We need to take a very serious look at what we are doing when we bring in nonprofessionals and assign professional tasks to them. This seems relevant to the teacher-education problem.

And finally, when we reflect over the films we must not make the assumption that all of the schools are so effective in the area of physical education. Do not make the assumption that the fine things you are hearing about are in operation everywhere. They are not. There is a big job to be done in terms of communication about the work yet to be done. I am sure we need the "lighthouses" and the staff to direct them. We also need to make substantial gains in the schools near each of us.

Group Discussions

SIGNIFICANCE FOR LEARNING

Teams of eight participants, representing a cross-section of professional interests, met for a two-hour session to discuss the significance for learning of the material and views presented by the main speakers. One member of each group was designated recorder and it is from the recorders' notes that a summary has been compiled.

It was evident that considerable discussion time was devoted to attempts to clarify the roles of the disciplines represented. That this was a necessary beginning, not satisfactorily concluded in the brief time available, attests to the validity of one of the main purposes of the Symposium—that of multidisciplinary communication. It was further evident that participants were reluctant to cross an apparent gap between available knowledge of development and learning variables and their implications for learning programs. Central to this reluctance was the acknowledgment that these variables still eluded definition and explanation.

The discussions wove themselves around related issues. One was the significance placed on the role of movement experience in learning. For some, perceptual-motor programs were of interest only as they might contribute to classroom learning problems and to rehabilitation of the dysfunctioning. For others, it was significant primarily for the development of skilled motor behavior. For all, it was an opportunity to begin to link the therapeutic and diagnostic values of perceptual-motor activity. Other areas of discussion dealt with developmental norms and sequences and with the factors which might influence development and learning.

Affirmative or factual statements were made with great reservation and reflected the questions and opinions of individuals. The statements below do not represent group concensus, but are intended only to show the scope of the discussions. Omitted from this summary are the many statements made which could be interpreted as necessary "next steps," the topic of a second discussion session.

Views of the Role of Movement Programs

I. Concern with dysfunction and with classroom learning problems.

   A. Two divergent views were expressed:

      1. Motor precursors are critical to appropriate development and, therefore, to correction and rehabilitation.
      2. Desired behavior must be specified and shaped without a need to consider motor precursors except as they might be relevant to the task.

   B. There is a need to define the *kind* of retardation that exists. An activity program for a deprived retardate may help, but if a child is biologically retarded, an activity program may not be effective with respect to improvement of I.Q.

   C. Too little attention has been given to the role of kinesthetic perception in concept formation and learning.

   D. Evidence, such as presented by Dr. Hein, suggests the necessity of movement experience for the development of perceptual abilities.

II. Concern with motor development and motor learning.

   A. The prime concern in motor learning is to develop effective motor behavior in whatever situation an individual finds himself. Interest in perceptual abilities centers mainly on their influence in learning and performing motor tasks.

   B. Is the problem of reading readiness the problem of physical education or are motor tasks our main concern?

   C. Caution is advised against building physical education on the basis of developing better readers until more evidence is available.

   D. If physical education programs are "good," they will contribute to sensorimotor needs basic to reading programs.

III. Linking of concerns.

   A. Research should be centered on the child in the learning situation with top-notch educators to head research teams, rather than following an old-line medical model.

   B. Graduate students interested in perceptual-motor dysfunction should be encouraged to take an interdisciplinary approach in their studies. Laboratories established for the purpose of studying perceptual-motor disabilities and remedial centers should encourage students from diverse backgrounds to become part of their programs.

C. *If* it is demonstrated that motor development influences perceptual and cognitive abilities then physical educators should be responsible for programs to enhance this development.

Factors Influencing Development and Learning

I. Individual Differences.

A. The still unclear role of environmental influences on the development of perceptual-motor abilities precludes individual diagnosis and treatment. These variables might be: sex, sibling order, socioeconomic status, family structure, cultural experience.

B. Individual differences must be considered in defining perceptual-motor dysfunctioning because learning disabilities may represent a transient (temporary) deficit or lack of readiness. Overemphasis on a temporary abnormality may prove detrimental.

C. A rigid list of developmental steps is assumptive. Developmental sequence may be defined too rigidly in some programs, thereby ignoring individual differences and needs.

D. Programs of the future must be highly individualized. There must be diagnosis and prognosis for *each* individual rather than panacea programs.

E. Traditional school syllabuses do not meet individual needs, nor does grouping by grade level or by chronological age.

II. Enriched Sensorimotor Environment.

A. The importance of an enriched environment seems to be established. This environment should be enlarged and enriched by improving the quality as well as the quantity of stimulation.

B. Multisensory stimulation can be provided through a team approach to development and learning.

C. Movement is another sensory modality for learning.

D. Motor skills, such as locomotor patterns, can be realized earlier through provision of an enriched movement environment.

E. Children need experience in patterned movements to reinforce inherent motor tendencies.

F. The resolving of "fears" through motor enrichment may lead to skill enhancement.

G. The importance attributed to providing a rich sensory environment implies a new role for physical educators; namely, to learn to work with young children and with parents in places other than in the public schools.

III. Stress.

A. There is a need for good stress (alerting level) in learning. In other stressful situations there is active inhibition of some sense modalities. It is possible to measure critical stress levels in learning situations, that is, when facilitation is taking place and when inhibition appears.

B. A basis for "exploratory" movement is given by work done on levels of stress. Eliminating critical stress through such movement experience may facilitate learning.

IV. Body Posture.

A. Body posture influences one's visual perception of the world. Visual acuity, per se, is the least important factor in perception.

B. Poor posture may cause perceptual problems, and perceptual problems may cause poor posture.

NEXT STEPS: A COOPERATIVE VENTURE

A second group discussion session focused on the future. Much of the questioning and the reluctance to make definitive application to learning which characterized the first group sessions is reflected by the nature and scope of the "next steps" outlined here. The first section of this summary consists of brief verbal reports given by group chairmen at the closing session of the Symposium. The second section is an amplification of these summaries based upon recorders' notes, organized according to the main points of the discussions. These were: (a) multidisciplinary concerns, (b) the role of phys cal education, (c) the role of AAHPER, and (d) follow-up by the task force.

Summaries by Group Chairmen*

GROUP H: *Robert McAdam*, chairman
Harriet G. Williams, recorder

We are directing our suggestions to the Task Force Committee, and I will read these because there have been some pains taken to list them and to phrase them:

1. That a position paper be prepared which would clarify knowledge about this still undefined "perceptual-motor development" and which would be readily available to the practicing physical educator.
2. That physical educators be encouraged to learn more about the perceptual-motor process, and about their role and its role in modifying motor performance.
3. That the professional preparation programs, or the institutions conducting such, be encouraged to consider, as part of the curriculum experiences which relate to child growth and development, practicums for both the typical and atypical child.
4. That the Task Force encourage regional and district meetings for clarifying, as far as possible, the notions of the role of activity in perceptual-motor development. Also to offer to assist in lining up resource people for such meetings.

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* Group discussion summaries appear in the order in which they were presented at the Symposium.

5. To encourage the setting of specific goals within an established program with at least a descriptive evaluation of progress made toward these goals.
6. To consider the establishment of an AAHPER committee to review, evaluate, and disseminate research findings in the field of perceptual-motor development.
7. That there should be encouragement to conduct definitive research in the following areas:
    a. Visual perception and its effect on motor performance.
    b. Mass vs. distributed practice with respect to learning and retention.
    c. Kinds of verbal stimulation, word cues for example, that would elicit specific motor responses.
    d. Transfer of training.
    e. The area of kinesthesis.

GROUP G: *Muriel R. Sloan*, chairman
Naomi C. Grothjan, recorder

Many of the suggestions that have just been given are similar to suggestions that we have made and those will be omitted. One of the focal points of our discussion, and the direction toward which our suggestions were oriented was the question, what we could do for maximal development of all children? We attended particularly to the first two years of life since the speakers stressed the importance of early sensory-motor experience. We tried to direct our suggestions toward how we could implement the need for rich sensory-motor experience for all children, and tried not to limit ourselves to the school orientation which most of us have.

Some specific suggestions are these:

1. That there be centers established that one might call parent-child centers where parents could come with their children and actually learn how to play with their children and to do things with their children. It was suggested at first that families from disadvantaged areas were most in need of such centers. It was believed that the criterion for sensory-motor disadvantage was not solely economic, however, and that it is a matter of teaching *all* parents, if possible, to work better with their children in order to give them adequate sensory-motor experience.
2. That nursery school experiences be extended for all children, and that in preparation for this, schools try to better train

people in physical education to work with young children, and not necessarily only young children who are of school age, in order to provide personnel who are knowledgeable about movement work at the nursery school level.

3. That research projects be instituted wherein universities which have strong physical education departments might set up play centers for research so that a number of different universities would be working with children in the play area. This would be multidisciplinary research. These university play research centers would then be laboratories, not only for students of these universities to learn about how to play with children, but also to be a source of evaluation of outcomes on a nationwide or regional basis. Such a project would be a source for gathering of information we do not yet have.

Another potential source of parent education discussed was the role of the schools in educating students who will be future parents. This has great implications not only for physical education programs, but for other programs within the schools. Rather than delay such education until someone becomes a parent, schools should educate all people toward the needs of children and their developmental strengths.

Discussion also centered on the need for improvement of physical education programs, the need for physical educators to call in other disciplines, and for other disciplines to call in physical educators in working with both the normal and the dysfunctioning child.

GROUP F: *Maryann Waltz*, chairman
Mary C. Rodgers, recorder

We were primarily concerned with what we do not know rather than with what we might do next. The tenor of the discussion throughout was that we needed very much to clarify the whole field of inquiry in human movement; to identify what we mean by it, what the structure of it is, and what is movement competency?

What are the real variables involved in what we are talking about when we say perceptual-motor or any other kind of efficient or evaluative competency in moving? What is it we are testing, and why? What do we know about it?

But, we needed to look also beyond the perceptual-motor to the experiences of the human being. What does this have to do then with the consolidation or organization of his movement behavior and its ultimate significance? There may be more than simply situational conditions. There may be more than the activity as such involved in what is happening to a child. We felt that we needed to systematize what we are looking at. How do we observe movement? What can we look at, what then can we see, what then can we measure? Ultimately, what can we explain, what are the critical factors?

Are we, in some of our indexes at the present time, really measuring intelligence of one kind or another and is there a movement intelligence? Is there a true movement intelligence as opposed to some other sort of intelligence?

Throughout all of our conversation, and we were a group representing varied disciplines, the general perspective of the group conveyed the message that we need to look at the human being moving in his environment, and its meaning to him.

More specifically, the group felt very strongly that physical education people should have a more sound preparation in human development and, particularly, in understanding the patterns of development in human movement as should other people working with young children. The previous group suggested this also in terms of preschool children. We would add also the elementary age group and perhaps in teacher education at all levels. Can we make a contribution to all teachers by helping them to learn to identify movement characteristics? Should they understand the pattern development of human movement and help screen in this sense?

In emphasis of what has also been mentioned before, there is the very great need to organize and disseminate knowledge in our field; to identify what is known, and therefore what is not known, with its implications of what we need to find out as far as meeting structure is concerned.

There is a suggestion that meetings of this kind at the national and sectional levels are certainly desirable, that perhaps all people concerned with a particular aspect of movement inquiry should be drawn into such meetings, and that they be structured around particular kinds of problems or particular kinds of variables in movement.

GROUP E: *Hope M. Smith*, chairman
Dorothy Allen, recorder

Many of the previous suggestions have dealt with a concentration on developing more objective measures of movement performance. We also wanted the optometrist, psychologist, physiologist, etc., to establish certain protocol to identify perceptual-motor dysfunctions. There are some usable kinds of instruments available, but not many.

We would hope that *a priori* research designs would be developed for both short-term and longitudinal studies of children in movement programs. Further, that these studies would involve both theorists and practitioners and be multidisciplinary in nature so that the total child could be studied.

Since it is now possible to measure stress in learning situations, teachers should be made aware of positive and negative stress situations in the classrooms. Fortunately, we had Dr. Cohen with us in both discussion sessions and he thinks that it is possible to help teachers to identify quite clearly those classroom situations that are building negative or positive physiological stress in the classroom.

Movement programs should become more diagnostic and descriptive and more individualized for all children and not just those who are having learning difficulties.

Perhaps we should think of scheduling motor activity programs more frequently and for shorter periods throughout the week and the day. We should consider this rather than fighting for the traditional one-hour-a-day idea.

Physical education should have as one of its prime concerns the promotion of efficient body management, and programs should be planned to have this occur.

Among the "next steps" we discussed the following:

1. Physical educators should be prepared to be, and asked to be, consultants for setting up physical activity programs for 10-15 minute movement breaks for the working population. It was suggested by the optometrist in our group that the activities should be task-oriented as well as for release of tension since there was some evidence given that production went up, not just because it was a release of tension but because the task was differentiated from the one the worker had been doing. He asks physical educators to help develop movement activities for people doing close work and people in industry; not calisthenics, as some countries do for the industrial people, but for other kinds of things, rather than "walking to the water cooler," as he put it.
2. A follow-up committee should be composed of people in physiology, optometry, education, psychology, etc., to examine stress in the learning and working situation and the subsequent visual deviations which may occur from these stress situations. Also, that we have meetings for teachers and edu-

cators that would consider the implications which this may have for the school day in the public school.

3. To work closely with physiologists to devise ways to improve body spatial orientation and to test results so that we have objective findings.
4. To shift the emphasis to preschool children because when we are working with learning disabilities in the school age child only, we are fighting a holding battle rather than doing a preventive job that should start much earlier.
5. That we educate parents in the kinds of experiences that should be available to their youngsters. We discussed the kinds of toys currently available to parents. The toys are designed to sell to parents, and not particularly to children. There should be an extensive evaluation of toys, equipment, etc., for early ages, and a subsequent education of parents in the kinds of toys most appropriate for youngsters. This should be a combined effort of all the disciplines concerned along with our association.
6. Relative to the community we felt that perhaps city regulations could be established which would allow adequate space for movement. Perhaps this would be in the form of zoning regulations. We talked of architects being drawn into the planning for space for movement in living centers and living areas and of having physical educators serving on this kind of consultant capacity.
7. Any efforts to promote standards, directions, and programs should be tied to research designs with multidisciplinary collaboration, and these studies should be conducted on the playgrounds, in the schools, or in centers wherever children are being worked with.

GROUP D: *Vern Seefeldt*, chairman
Mary Lou Puleo, recorder

Our group addressed itself to suggestions of implementation for the task force. Those which have been alluded to, but not covered specifically, are as follows:

1. That a national clearinghouse be established for the purpose of disseminating information about current research, promising practices, and demonstration projects leading to perceptual-motor development from birth to maturity.
2. That physical educators reassess their function in the multidisciplinary role of solving perceptual-motor problems and

redesign their program objectives. More specifically, if motor training is specific rather than general, what roles do the various professions have in the motor development of children?

3. That the sequence of skills from motor, social, and intellectual development be redefined to reflect such modifiers as sex, body build, family position, culture, and socioeconomic status.
4. That the AAHPER Professional Preparation Panel re-evaluate its recommendations for the preparation of teachers to reflect an increased emphasis on the study of human physical and motor development.
5. That a multidisciplinary team find ways to identify children who are not fulfilling their potential kinetic endowment, especially those who have exceptional potential but who are operating within average limits and find ways to enhance their development.
6. That the relationship between gross motor activity and progress in such fields as reading, spelling, writing, and speech be more clearly established. If there is a positive association what is it that transfers from gross motor activities to academic programs?

GROUP C: *Arne L. Olson*, chairman
Margaret Steinhebel, recorder

As the only AAHPER staff person presenting a group report, I have one comment to make at the outset. During our meeting this morning suggestions for different projects have been made. We have a number of projects of the type that have been mentioned which are in the embryo stage and need further development. If interdisciplinary projects are projected with physical educators, then we should define and describe and disseminate the role of our discipline in general and to other disciplines so that other people have a better idea what it is that physical educators do. Then, if physical educators have a role in perceptual-motor development, it might be well to develop and define what that role might be. It might be well if those in other disciplines with a role in perceptual-motor development define and describe their role.

1. In the conference area, we suggest that we (in addition to the other things that have been mentioned) encourage other groups such as educational administrators, and other disciplines as well, to sponsor conferences of the type we have had

here today, and then perhaps participate as physical educators in those.

2. In the research area, we suggest the possibility of repackaging research information that is available for whoever might be the users. For example, one might repackage it differently for medical people or for psychologists or for other groups that are involved.
3. We should consider the possibilty of a Task Force of some type to sharpen our questions, so that they might become researchable topics. In the same sense we need to sharpen our focus relative to our instrument, tools, etc., so we can look at those questions more carefully.
4. We might sponsor data analysis training sessions which might involve other educational research specialists who might help us identify ways of evaluating our present collection of data or future collections of data relative to perceptual-motor questions. We might have other educational specialists to help us interpret some of the data that we already have.
5. If we are going to consider a multidisciplinary approach, then it seems that we need to consider a common language. Our best thought in this regard was that we needed to have a common language of scientific evidence, and with this all the disciplines could communicate more effectively.

GROUP B: *Hally B. Poindexter*, chairman
Arthur H Steinhaus, recorder

Without exception everything we discussed has certainly been alluded to, if not specifically spelled out. We did feel very definitely that there should be an advisory committee which perhaps would turn into a clearinghouse on a multidisciplinary level. This committee or board or clearinghouse should review, synthesize, summarize, and publish the essential points of research and program activities. We were very concerned that this committee be not only multidisciplinary but also open-minded and not hypercritical.

Another point is that we feel AAHPER is a very strong organization and has potential in this area which it should explore. It should be actively in contact with related organizations such as the Association for Childhood Education International and the Center for the Study of Instruction to convey what we are doing in both perceptual-motor development and in elementary school physical education programs.

Politically, the Association should be alert to federal programs while they are in the writing stage. It was suggested by one of our committee members that had we known about Head Start before Head Start was completed, we might have had some influence in writing motor needs into this program. The same might be said about other programs just now moving into the operational phases.

GROUP A: *Jack Keogh*, chairman
Mae Stadler, recorder

We have heard many of our points made already but just one to mention is that we as a group did not develop specific suggestion statements heard from other groups. It seems that we touched on things and kept moving or returning, but we did not resolve statements as such. Let me put forward a few points on which we spent some time and which will emphasize our conversation.

1. We discussed the need for some type of systematic notation system, particularly one which could be simplified to serve in a more universal sense and to be useful in observation of movement.
2. We discussed certain research needs, most of which have been mentioned earlier, except for the critical nature of teacher effectiveness in terms of preparation and service.
3. Another need expressed was in improvement of communication, which is why we are here today. This in two general kinds of categories:
    a. Through information transmission by means of articles solicited by the *Journal of Health, Physical Education, Recreation*, position papers, etc.
    b. Through personal contact meetings of this symposium type, regional meetings, and meetings at particular centers where people are doing specialized work.
4. Questions were also raised of who is doing what and where, where one might be welcome, and under what basis; and what kinds of programs are there for people to come to work individually, and not necessarily as groups?

Multidisciplinary Steps

I. Research

A. Establish multidisciplinary teams for laboratory research and for programing and research in school and clinic settings

B. Conduct research in a variety of areas such as:
   1. the "normal" child's development and movement
   2. basic research on the mechanisms of development
   3. visual perception and its effect on motor performance
   4. massed vs. distributed practice with respect to reminiscence and retention
   5. verbal stimulation and eliciting of specific motor responses
   6. transfer of training
   7. kinesthesis
   8. effectiveness of teachers and clinicians
   9. identification of cultural aspects of movement competency and range of variability for such factors
   10. initial preparation and in-service training of teachers and clinicians
   11. analysis and observation techniques such as videotape, simplified notation system, etc.
   12. evaluation of perceptual-motor programs

C. Organize and test competitive schemes from various disciplines

D. Create a follow-up committee composed of people in physiology, psychology, optometry, and education to explore physiological and psychological stress in learning and work situations and the subsequent visual deviants which may occur

E. Develop a research task force to sharpen our questions; to specifically focus them so that topics can be researched

F. Institute "Learning to Play" centers at selected universities to become laboratories for preparation of teachers and for controlled observation and study of the effects of play

II. Information Collection and Dissemination

A. Develop policy statements to improve communication among disciplines
   1. define and describe the physical educator's role in perceptual-motor development
   2. define and describe the role of other disciplines in perceptual-motor development

B. Establish systematic ways of collecting, relating, and disseminating knowledge
   1. establish a clearinghouse to maintain information on programs, research, tests, teaching aids, etc.
   2. establish a multidisciplinary advisory committee to review, analyze, summarize, and publish essential information on current and completed research and programs

C. Repackage available information for the most effective use by different groups; for example, teachers, therapists, parents, physicians, etc.

D. Publish information and recommendations for broad educational fields through NEA and AAHPER

E. Compile and distribute information about the work engaged in by Symposium participants

III. Programing, Education, Standards

A. Behavioral objectives and standards
   1. decide on the basic needs of all children for optimal development. Base programs on these and then individualize if needs have not been met in particular children. (Begin with likenesses of children rather than differences).
   2. establish ranges of "normal" efficiency
   3. encourage setting of specific goals within established programs with at least a descriptive evaluation of progress made toward these goals
   4. identify the nature of "perceptual-motor ability" including the variables by which it can be observed and measured
   5. find ways to identify children who are not fulfilling their potential genetic endowment, especially those who have exceptional potential but who are operating within average limits
   6. recognize that skill in using the body effectively is an important area of behavioral objectives

B. Evaluation tools and standards
   1. develop evaluation tools which can be used by all persons who work with children
   2. institute a team approach to test spatial orientation and other aspects of development in place of the current fractionated approaches

3. re-evaluate what are considered "norms" for children in relation to movement, etc., before tests are standardized

C. Teacher preparation and in-service training
   1. establish cooperative planning of teacher preparation programs
      a. AAHPER should work with other disciplines producing teachers and recommend minimum course work and experience related to understanding child growth and development, especially in the early years
      b. promote adequate movement development knowledge in the education of preschool and elementary school educators
   2. teacher preparation programs consider, as part of their curricular experiences, a practicum for both the typical and atypical child
   3. involve undergraduates in independent work in programs for the dysfunctioning
   4. include study in the areas of physiology and psychology
   5. introduce perceptual-motor learning courses and applications to teaching
   6. develop minimum requirements for the paraprofessions
   7. develop formats for effective in-service training

D. Programing
   Physical educators should be consultants for establishing physical activity programs for 10-15 minute breaks for the schools and for the working population. Activities should be task-oriented as well as for release of tension

E. Environmental standards
   1. establish urban design standards which allow adequate space for movement
   2. link efforts to promote standards for zoning and housing regulations to multidisciplinary research
   3. include architects in plans for providing adequate movement space
   4. enlist FHA to provide leverage for adequate space provision

F. Preschool emphasis

Steps to implement the recognized importance of early sensory-motor experience for optimal development:

1. parent education
   a. educate parents in child development needs through:
      (1) use of TV medium to reach parents of preschool children
      (2) establishment of parent-child centers where parents learn to play with children as a means of providing adequate early experience
      (3) prenatal education
   b. encourage schools and colleges to educate future parents through curriculum offerings in child development
2. establish day care centers
3. expand nursery school programs
4. evaluate for certification of toys and playground equipment for early ages, with subsequent education of parents in their value and use

IV. Multidisciplinary Conferences

A. Continue personal contact meetings such as the Symposium which are significant means of multidisciplinary communication and understanding of respective functions

B. Hold meetings at local, state, and regional levels. Leadership identification is needed for involvement at all levels

C. Hold regional meetings at centers where programs and research are in progress. Leaders and scholars from other fields can be invited and findings can be related, new problems identified, and follow-ups planned

D. Structure meetings around specific questions concerning human movement. Invite scholars in other fields to relate their findings to these questions in problem-defined conferences vs. "topical" ones

E. Encourage other groups—educational and administrative—and other disciplines to sponsor conferences and to invite physical educators to participate

F. Supplement the kinds of disciplines or scholars participating in symposiums as suggested by reference to how learning occurs and to the various sociocultural factors that may be significant to understanding perceptual-motor etiology

Physical Education and Its Role in Perceptual-Motor Development

I. Need for Definition of the Discipline of Physical Education
   - A. Objectify and re-evaluate the behavioral goals of physical education
   - B. Clarify the role of physical education
   - C. Recognize the necessity to undergo a period of describing, setting goals, and evaluating progress
   - D. Recognize that those outside of physical education have a negative picture of programs based upon:
     1. generalizing to physical education from seeing programs "tailored" for the dysfunctioning
     2. seeing physical education as a program of games only, or of discipline only

II. Professional Preparation
   - A. Prepare physical educators to know more about perceptual processes and their role in development and in motor performance
   - B. Include a foundation of knowledge of human development in all professional preparation of physical educators and promote inclusion of such knowledge in the general education of all people
   - C. Train physical educators to work with young children through field experience with both normal and dysfunctioning youngsters

III. Research and Evaluation
   - A. Develop adequate tests of motor ability which involve evaluation standards for movement competency based upon more fundamental variables than sports skills
   - B. Progress toward some agreement as to what is effective or efficient movement
   - C. Meet the need for carefully designed and controlled research programs to hasten acceptance and implementation by related disciplines

Role of AAHPER

Although some of the following suggestions are duplicated under multidisciplinary steps, they are repeated here to provide focus for implementation.

I. Information Dissemination
   A. Establish an AAHPER committee to review, evaluate, and disseminate information about research and programs
   B. Devote an entire issue of JOHPER to perceptual-motor development and institute a regular column in each issue
   C. Solicit articles for JOHPER from related disciplines; for example, make available evaluation tools such as the "standardized motor examination" developed by Mark Ozer of Children's Hospital, Washington, D.C., to be given by school physicians

II. Develop a professional position paper

III. Encourage the AAHPER Professional Preparation Panel to reevaluate its recommendations for preparation to reflect increased emphasis on study of human physical growth and perceptual-motor development

IV. Set up appropriate committees where leaders can contact known specialists in related disciplines to develop useful taxonomies, evaluation instruments, programs of special study, etc.

V. Be active in relating to organized groups such as ACEI, CSI, etc., which are influential in determining elementary school curriculum

VI. Maintain active contact with school administrators, suggesting standards and giving direction to perceptual-motor programs

VII. Establish a link with other countries on research in movement and methodologies in teaching movement to normal and dysfunctioning children

VIII. Implement a program of pilot studies to examine perceptual-motor objectives, programing, and evaluation

IX. Be alert politically to the writing of federal programs so that our professional knowledge can influence legislation. For example, Head Start could have had some motor needs written into the program, and early childhood and PCC programs are now moving into operational phases.

X. Provide more consultants

XI. Assist in finding resource people for conferences and for programs

Follow-Up of Perceptual-Motor Symposium

The suggestions which follow are directed specifically to the AAHPER Perceptual-Motor Task Force. As is evident, some of these appear elsewhere but are given separate listing here to focus on potential implementation.

I. Continue the beginnings made at the Symposium in the exploration of perceptual-motor development after evaluation and direction from the Task Force

II. Initiate, co-sponsor, and encourage additional face-to-face meetings of the symposium type

III. Encourage local and regional meetings and offer to assist in providing resource personnel

IV. Prepare a position paper which clarifies knowledge about perceptual-motor development and which suggests the direction in which the Task Force believes physical education should move

V. Locate the Symposium concern within a logical framework for inquiry in human movement

VI. Identify issues relative to research findings and existing programs, and identify the theoretical frameworks upon which procedures and programs are based

Closing Session

SUMMARY AND REFLECTIONS

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It has been a privilege to attend this meeting and to become aware of the enthusiasm and imagination with which this group is establishing and evaluating new programs to meet the physical needs of the developing child. In these discussions, it has been observed that these needs are not the same at all ages and stages of development. Our objectives and expectations must be different at different ages. Thus, as pointed out by Logan Wright earlier in this program, massive stimulation of the child during the first two years of life appears to have a general or global effect on intellectual and psychomotor development. In the older child, such stimulation is ineffective. It requires a specific training or stimulus to achieve a specific result. Thus, in developing programs of physical training, we must have clearly in mind the goals we may hope to achieve at any age.

These findings cast doubt on the statement that was made here yesterday that "learning is learning." On the contrary, they suggest that in the older child, learning is very specific. The educational experience probably relates very closely to the material to be mastered. All experimental evidence supports the thesis that in the school age child there is little transfer effect from one learned subject to another. Those of us then, who wish to suggest that such divergent training as physical aptitude or coordination will have an impact on intellectual performance must be prepared to provide solid experimental proof if these claims are to be accepted.

Viewed in this light, it was especially encouraging to hear the report yesterday from University City, where there has been set up a carefully controlled study. From such a controlled study, with defined objectives, can come factual information regarding the tangible benefits of this special program. The taxpayer is entitled to have such factual data.

To return to the question of the definable objectives of a school program of physical education, there are several. First, children require exercise to achieve good health and physical development. This in itself is enough to justify a well-structured physical education program in any school system. It has been pointed out that for some children the mastering of a task, or an opportunity to excel in some field, can provide an important boost to morale. This could be a second objective of such a program for some children, although it is also important that there be success in academic goals as well. Another worthy objective is the use of the games and sports for character building. We can find these days in this country many examples of a failure of young people to recognize the basic principles of fair play. Is there any environment where this is better learned than on a well-supervised playing field?

But at this meeting, there has been still another emphasis — that there is a relationship between physical education and the development of perceptual-motor skills, and, that in turn, improvement of perceptual-motor skills is a prerequisite to academic learning. Such an objective of physical education reflects two premises: (a) that physical education can lead to general improvement in the perceptual-motor skills underlying learning (as opposed to the mere learning of a particular motor task) and, (b) that improvement in perceptual-motor skill thus accomplished will contribute to or facilitate the educational and academic advancement of the child.

I have reviewed the literature in an effort to find factual empirical evidence regarding these premises and can present a limited number of relevant studies.

Figure 1 summarizes the results of a study of the benefits of physical education in improving the I.Q. scores of mentally retarded boys. The students were divided into two groups: one received physical training, the other had none. The graph reveals a striking improvement of I.Q. among the group receiving the special training. Figure 2 reveals that there was a flaw in the first study. In the second study, the boys were divided into three groups. One group received the exercises, one group had none, and a third group of "officials" attended the exercise periods, but did not exercise. The results show that both of the special groups benefited by the experience. Evidently it was the special attention rather than the exercise that led to their improvement.

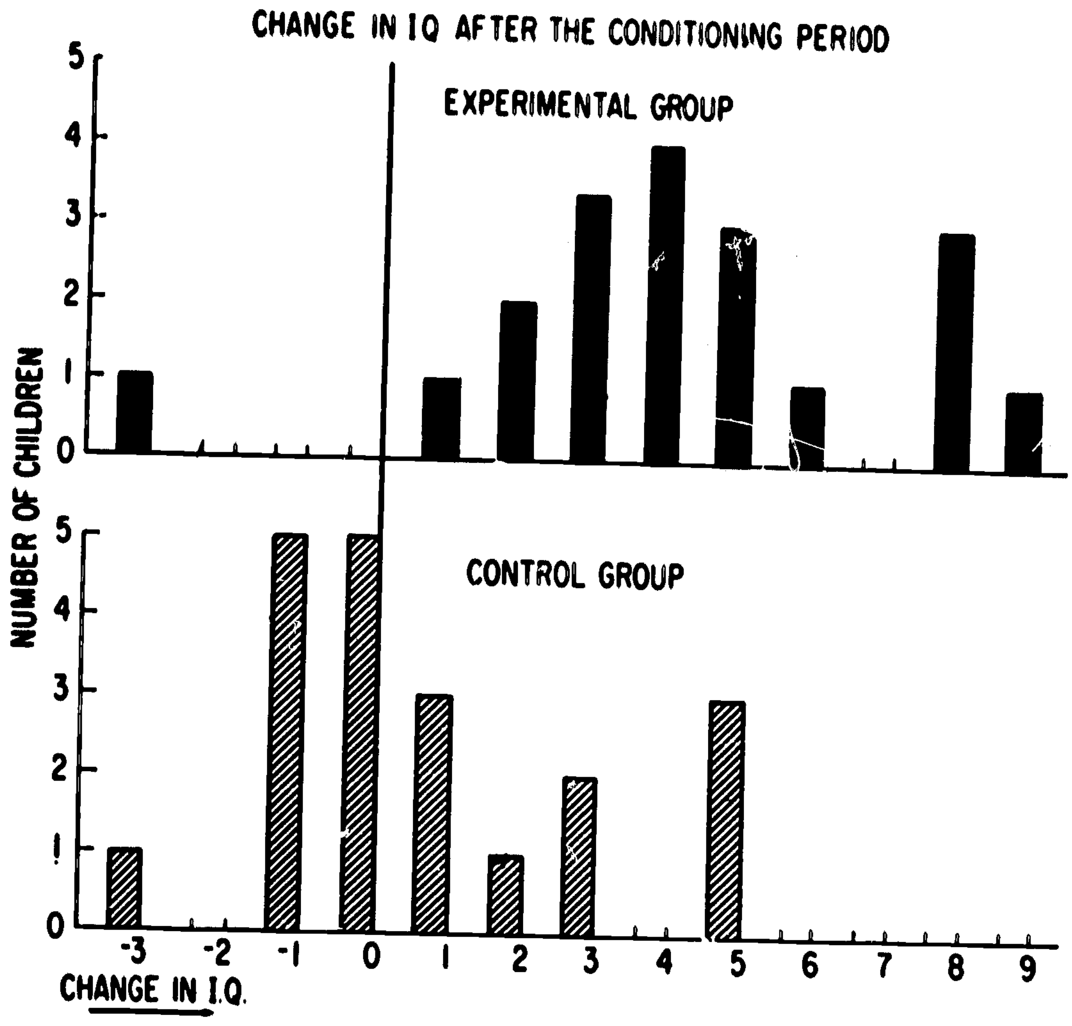

Figure 1. From Oliver, J. N. *The effect of physical conditioning exercises and activities on the mental characteristics of educationally subnormal boys. Brit. J. Ed.* 28: 155-65, 1958.

Two groups of educationally subnormal boys at a boarding school were the subjects. One group received a ten-week course of systematic and progressive physical conditioning. The control had only the regular school program. Graph shows the number of children exhibiting the indicated change in I.Q. points.

The next study (Fig. 3) was to evaluate the benefit of the Doman-Delacato regime as an aid to reading in normal children. Here also there were three groups — a control, a treated group, and a third, who received nonspecific exercises not recommended in the Doman-Delacato regime. The study failed to demonstrate any differences in the three groups. A similar study (Fig. 4) with a group of retarded readers produced a similar negative result.

There are other studies directed to an evaluation of some more specific types of perceptual-motor training. Figure 5 summarizes the study by Genevieve Painter of the results of specific perceptual-motor training in a group of least able kindergarten children. It reveals significant gains in the Illinois Test of Psycholinquistic Ability and other measures in the treated group of preschool children. However, a similar study (Fig. 6) conducted at the first and second grade level was carried out by Dr. Rosen using 25 classrooms. Half of the children received 30 minutes a day of perceptual-motor training. The other half had an equal period of time devoted to special reading instruction. In the aggregate, the children receiving perceptual-motor training improved most in perceptual-motor skills. Those receiving reading improved most in reading skills. A possible exception was observed in a limited group of severely retarded readers in whom perceptual-motor training appeared to enhance reading performance.

The findings from this limited number of clinical studies find support also in a variety of basic investigations emphasizing the specificity of the learning process. In general, the more closely related to the ultimate task is the learning experience, the more significant is its beneficial relationship.

There are several lessons in this for those concerned with physical education programs. First, the program and its objective should be appropriate to the age of the child. Second, where handicaps exist, they should receive specific recognition in the training program. Third, the older the child the more directly should the learning experience relate to the specific task to be mastered. Finally, in view of the extremely elementary state of our current theoretical knowledge, there is an urgent need for the critical scientific evaluation of the practical effectiveness of the new programs being developed in this field.

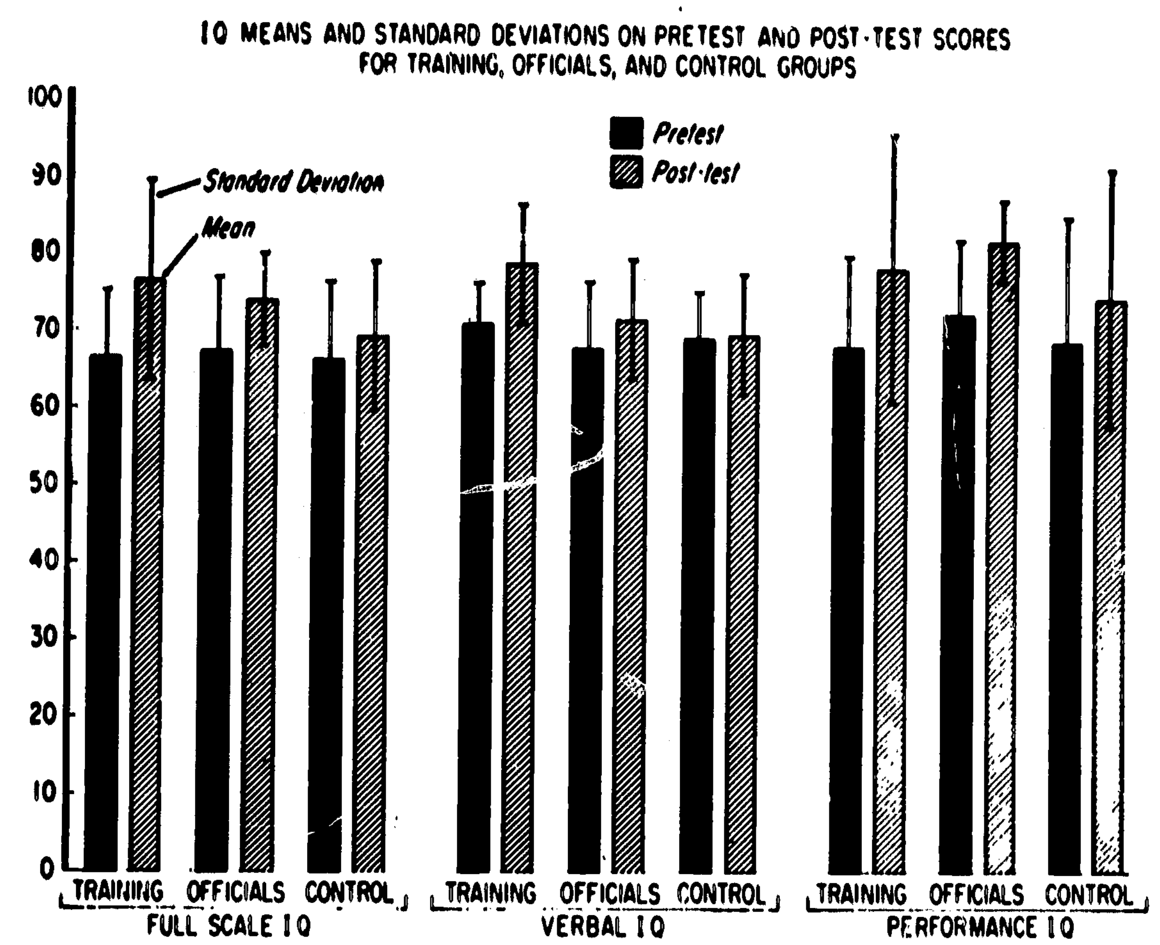

Figure 2. From Corder, W. O. *Effects of physical education on the intellectual, physical and social development of educable mentally retarded boys. Exceptional Children* 32: 357-64, 1966.

Twenty-four educable mentally retarded boys, age 12-16, at a day school were divided into three groups. The "training" group had 20 days of exercises and track events. The "officials" were present but had no special exercise. The "controls" did not participate. Graph shows pretest and post-test Wechsler scores of each group. The "training" group showed significantly greater gains than the "control" group on full scale and verbal, but not performance I.Q. The "training" group did not differ significantly from the officials.

EFFECT OF THREE MONTH SPECIAL PROGRAM ON READING SCORES

	Control	Experimental	Non-Specific
Pretest	2.15	2.43	2.18
Post-test	2.91	3.12	3.05
Gain	.76	.69	.87
% Gain	35	27	40

Figure 3. From Robbins, M. P. *A study of the validity of Delacato's theory of neurological organization.* Exceptional Child 32: 517-23, 1966.

The subjects were three groups of elementary school children. One group received special training as recommended by Dr. Delacato. For two months, emphasis was on sleeping position and the development of sidedness. For a third month, there was training in homolateral patterning and the use of color filtration to develop eyedness. A second group, "nonspecific," had other types of patterning activity, music, and games. The third group had normal curriculum. Table shows pretest and post-test standard reading grade scores.

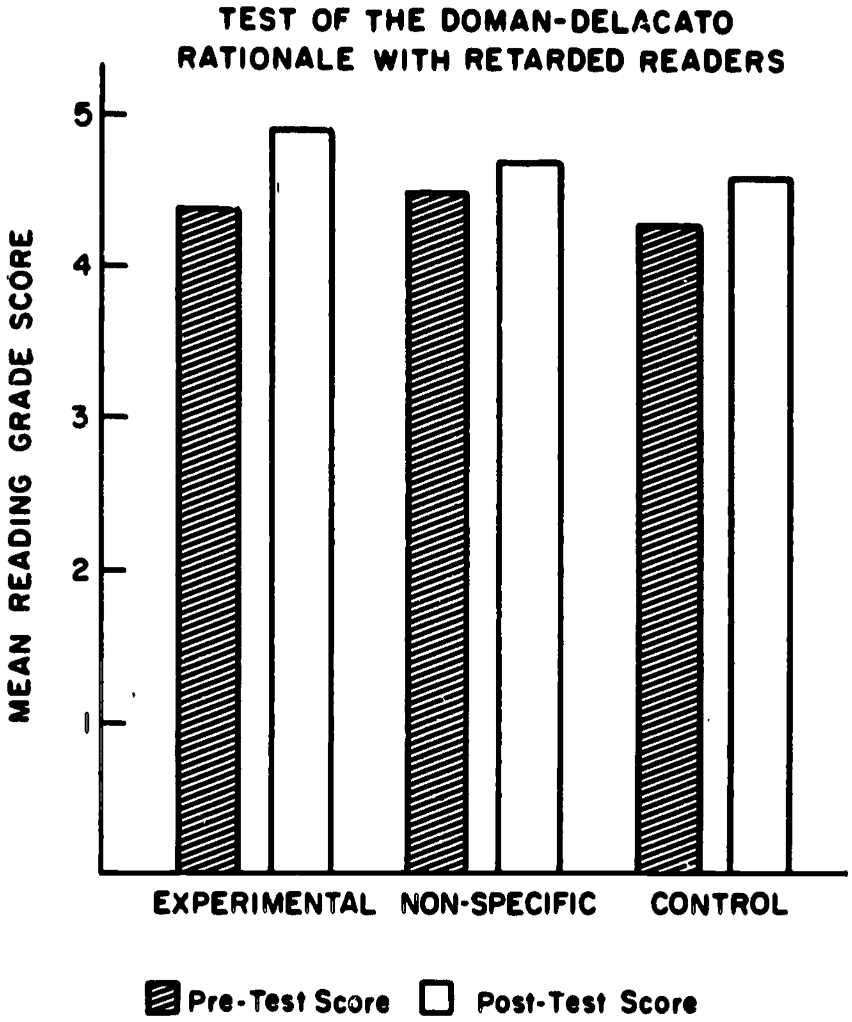

Figure 4. From Robbins, M. P. *Test of the Doman-Delacato rationale with retarded readers. Journal of the American Medical Association* 202: 389-93, 1967.

The study involved 250 students from grades 3 through 9 attending a two-month summer reading program for retarded readers. Children were randomly assigned to three groups. The "experimental" group received a home program of cross-pattern creeping, cross-pattern walking, special sleep position and lateralization activities where appropriate. The school program included similar activities plus color filtration to develop a dominant eye. The "nonspecific" group had a home program of active sports, quiet games, increased musical activities, and nonspecific sleep positions and received similar activities at school including a nonspecific color filtration procedure. The "control" group had only the normal curriculum. The graph shows pretest and post-test mean reading grade scores of the three groups as measured by the Stanford Achievement Test. The three groups did not show significant differences in the recorded gains.

Representative Mean Gain Scores for Experimental and Control Groups

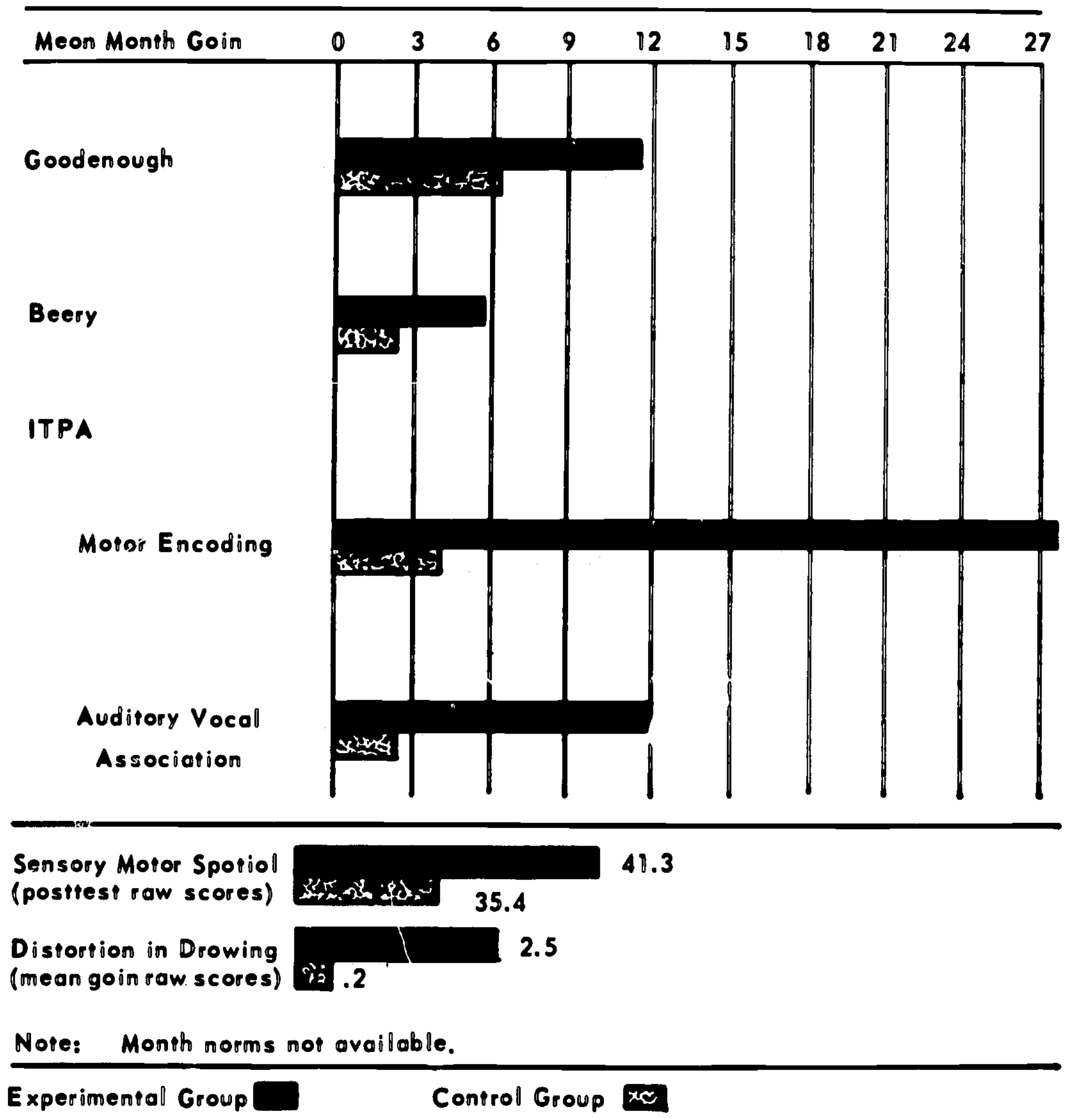

Figure 5. From Painter, G. *Exceptional Child* 33: 2, 1966.

The 20 "lowest" functioning children of a kindergarten for normal children were divided into two groups. One group received 21 special half-hour sessions over a seven-week period. The program emphasized perceptual-motor training — see and move, hear and move, dynamic balance, spatial awareness, rhythm, etc. The other received only the regular kindergarten program. Graph shows comparison of the gains exhibited by the two groups in I.T.P.A., Beery test of geometric forms, and Goodenough draw-a-man test.

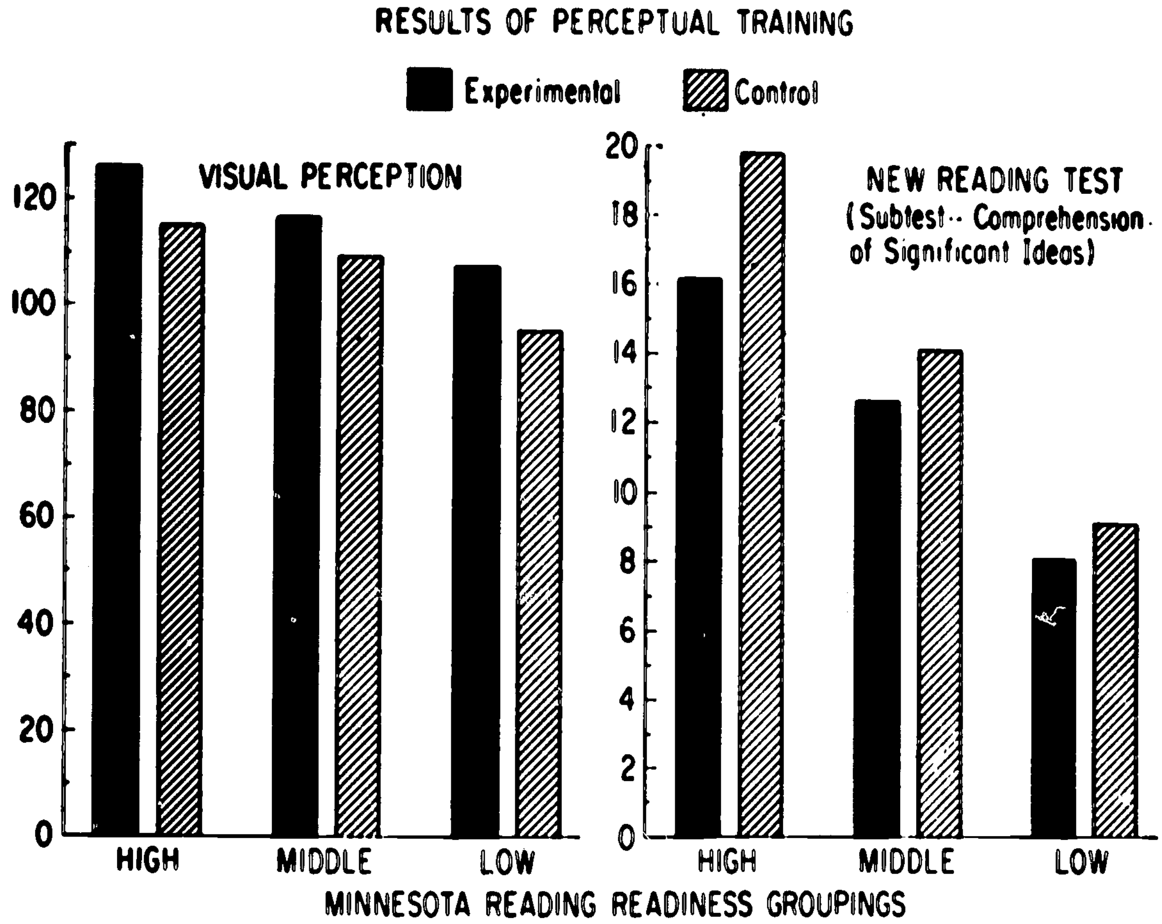

Figure 6. From Rosen, C. L. *An experimental study of visual perceptual training and reading achievement in first grade. Perceptual and Motor Skills* 22: 979-86, 1966.

The study was conducted in 25 first grade classrooms. In 12, the children received regular instruction plus 30 minutes special instruction by the "Frostig" program. In 13, the children received 30 minutes of additional reading instruction. For purposes of analysis each group was divided into three subgroups of high, middle, and low score readers. Graphs show the post-training reading scores of the experimental (Frostig) and control (reading) groups.

Appendix I

TOPICAL SYNTHESIS OF QUESTIONS RAISED BY PARTICIPANTS

I. Early Development and Stimulation

A. Are the conflicts in findings concerning advantages and disadvantages of the early sensorimotor stimulation caused primarily by poor measuring instruments and research methodology?

B. What evidence is there that culturally deprived children, 3-6 years of age, are deficient in motor performance?

C. Within the framework of infantile stimulation studies and Piaget's sensorimotor development period, can you (Dr. Wright) offer an explanation for the gross motor precocity observed in Negro children both in Africa and the United States? What is the relationship, if any, between skeletal and gross motor precocity in the Negro infant, both in Africa and the United States?

D. Would you (Dr. Wright) please amplify your comments on the quality vs. quantity of sensory stimulation — "noise vs. operatic music." At what age may the qualitative aspects over-shadow the quantitative aspects?

E. You (Dr. Wright) stated that the quantity and not the quality or kind of stimulation was important. Does not the CNS tend to selectively filter out those sensory signals which are irrelevant or nonmeaningful so that they do not reach the higher centers? Thus, after a period of exposure to relatively unchanging or monotonous stimuli, their effectiveness for stimulating the CNS should be diminished. Shouldn't this suggest that meaningful or selected stimulation would be most effective?

F. Was there no evidence (Dr. Hein) that proprioceptive information from the eye muscle of the occluded eye aided in the development of depth perception?

G. Isn't there a need to direct knowledge of activity (physical education) for preschool and babies to parents and potential parents — rather than depend on the physical educator who is still having difficulty treating the lower grades adequately?

H. Would you (Dr. Cohen) comment on the emphasis the Doman-Delacato system places on the rise of the tonic neck reflex positioner in their perceptual-motor retraining system?

II. Physiology As Related to Motor Performance

A. Does the ratio between extent of eye movement to head movement influence significantly the motor responses in terms of body spatial relationships? Has any research been done?

B. Will you discuss your findings (Dr. Hein) in relation to Sperry's split brain (corpus callosum division) observations in man?

C. Could motor training in the area of balance help a child overcome nystagmus?

D. What would be an example of trying to change performance that might cause physiological stress?

E. Relative to cutting the C_2 and C_3 dorsal roots (Dr. Cohen), what effect does disturbance of the stretch reflex circuit have on the strength of contraction in activity involving the stretch reflex via area 6 and the reticular formation and the gamma fibers?

F. Why is it so difficult to bring back the amblyopic eye?

G. What evidence have we that *muscle spindle generated input* registers in the cortex or in consciousness?

H. Isn't there some controversy concerning the existence of extra-occular muscle spindles?

I. It seems established that muscle spindles do not give muscle length information. If this is true, how can occular spindles give such information (length of occular muscles)?

J. Have the two different kinds of brain tissue mentioned (Dr. Wright), *association* and *sensory*, been differentiated in a physical or biological fashion, or merely reasoned to exist by virtue of observing behavior?

I. Please explain (Dr. Wright) reasons for rise in IQ after programs of concentrated physical education-physical fitness with mentally retarded children (4th grade age).

J. What is the relationship of critical period of rate of maturation? If the first two years of life is critical, would it be expected that slow maturing children-retarded children would have a correspondingly longer critical period? (Dr. Wright)

K. What specific activity can be used to develop "depth perception", to help child overcome fear of height?

L. Is there any evidence (Dr. Denhoff) of relationship to mental (brain) stimulation and thus to intelligence and need for the C.P. to "think through" motor acts?

III. Sensory Modality Comparisons and Feedback Mechanisms

A. What role might auditory sensory mechanisms play in motor performance particularly those involving the manipulation of objects apart from the body, e.g., ball bounces, the sound of an implement striking a ball, etc.?

B. Re "indirect stimulation" (Dr. Wright), why was it hypothesized that the lack of movement restriction in Hopi infants was related to adequate visual experience when these infants also received the tactile and kinesthetic stimulation of motion on the mothers' backs?

C. Are there any studies relating to deprivation of the tactile sense and/or auditory sense such as the one on motor and visual with the Hopi Indians?

D. What do you think of teaching children to move while blindfolded; to move on command; to visualize before they move; with mentally retarded children; slow learners; braindamaged?

E. Could you (Dr. Hein) go over again, your ideas about trial and error learning vs. specific feedback mechanisms mediating motor behavior? It sounds as though you are saying that with feedback conditions denied, trial and error cannot occur effectively.

F. Please define feedback with respect to error information and cybernetic theory.

IV. Dominance

A. In your work with humans (Dr. Hein) have you found any difference in the way an individual adapts to a visually distorted environment with reference to different sides of the body; i.e., dominant side (hand) versus non-dominant side (hand)?

B. How is foot dominance determined? Is not the balancing foot just as important as the leading foot? Hand and eye dominance is not difficult to determine but foot dominance is complicated by the balancing necessary for one-footed activity.

V. General

A. What would be the most appropriate professional journals to assist physical education to keep abreast of current research in perception, learning problems, and perceptual-motor development, etc?

B. What is Perceptual-Motor Development?

C. Are there some questions concerning the methodology of Wertheimer, Werner, Wapner, and Witkin that might lead to questions concerning their findings?

Appendix II

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