

**PAN AMERICAN HEALTH
ORGANIZATION**

**ADVISORY COMMITTEE
ON MEDICAL RESEARCH**

FOURTH MEETING

**14-18 JUNE 1965
WASHINGTON, D.C.**

**MALNUTRITION AND
MENTAL DEVELOPMENT**

Ref: RES 4/11

28 May 1965

PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION

WASHINGTON, D.C.

MALNUTRITION AND MENTAL DEVELOPMENT.*

One of the recommendations of the PAHO Scientific Group on Research in Protein-Calorie Malnutrition was that a "meeting of active investigators and appropriate specialists ... be convened to discuss the design and techniques for study of mental and psychological development of the child in relation to nutrition, psychological stress and emotional deprivation..."* (see RES 3/2, 1964).

To implement the above recommendation a planning meeting was held on 22 September 1964 at PAHO Headquarters and a Conference on Malnutrition and Mental Development was convened on 14 December at the National Institutes of Health, Bethesda, Md.

1. Participating in the planning meeting, in addition to the PAHO staff, were: H.G. Birch (Albert Einstein College of Medicine), J.M. May (U.S. Agency for International Development), S.A. Richardson (Association for the Aid of Crippled Children), and B.T. Burton, H.H. Gee, and D.N. Walcher (National Institutes of Health, USPHS).

At this meeting great interest was coupled with apprehension based upon the researchability of the topic and the shortage of competent investigators (especially in the behavioral science disciplines) capable of preparing and executing research designs based upon newer understandings of the processes in mental development and intellectual function.

* Prepared for the Fourth Meeting of the PAHO Advisory Committee on Medical Research, 14-18 June 1965, by Dr. A. Yankauer, Health Promotion Branch, PAHO.

** A second recommendation, the development of a manual of procedures, reference standards and data analysis methods for somatometric measurements is also being implemented. Dr. R. Ramos-Galván of Mexico is preparing such a manual. Publication is anticipated in late 1965.

The etiological factors leading to protein-calorie malnutrition are complex and diverse. A group of cases does not have a common social and psychological denominator. The very traumatic and/or psycho-social factors leading to the malnutrition in some or all of them are known to lead to retarded neural development and/or differences in conceptualization, communication and intellectual performance. Data of this nature do not exist.

Relationships of the problem to genetics as a field of research and to animal experimentation as complementary to human research were mentioned, but discussion then restricted itself to the problem at hand: utilization of Latin American research resources and human ecological situations for heuristic or for pragmatic socially-oriented purposes.

The usefulness of a future conference was agreed upon, but its nature was not resolved. The possibility of small scale but realistic research in approaching the problem was acknowledged, but goals must be definable and attainable. A conference would serve to arouse awareness of the magnitude of the problem.

Drs. Herbert Birch and Stephen A. Richardson were asked to prepare an outline of relevant research considerations for the 14 December conference (see attached Appendix I).

2. A list of participants to the Conference on Malnutrition and Mental Development and a running summary account of the discussion of that conference was prepared by NIH and is included with this report (attached as Appendix II).

On 14 December, discussion deliberately did not follow the outline prepared by Drs. Birch and Richardson but, after a short presentation by the Latin American investigators (in order to orient the North American group),

focussed largely upon mental development and factors other than nutrition which influence mental development. The discussion was free rather than problem-solving oriented. The sharing of knowledge and insights as well as the informal interchange among individuals of different professional disciplines was useful to all.

3. Following these activities, the developments summarized below have occurred in Latin America:

3.1 Dr. Joaquín Cravioto, working in the Hospital Infantil de Mexico, has developed preliminary research designs and is receiving support to pursue them. Dr. Birch spent the month of April, 1965, with him (under the auspices of the Association for the Aid of Crippled Children). PAHO has offered to assist with short-term consultants should this be desired.

3.2 Dr. Henry Ricciuti (Cornell) will continue to work with Dr. George Graham. He had previously spent time in Peru and assigned a graduate student to collect data. Specific research proposals may develop from this collaboration.

3.3 Dr. Cipriano A. Canosa at INCAP prepared a contract proposal for consideration by NICHD/USPHS. This was carefully reviewed at another full-day NICHD advisory committee meeting, during part of which Dr. Canosa and Dr. Yankauer participated in discussions. A number of useful suggestions were made at this meeting, and the proposal was redrafted and resubmitted. It is phrased in terms of a one year NIH-PAHO contract which will enable INCAP to make provisions for the research facilities, psychology and anthropology staff and short-term consultants necessary to prepare a detailed research plan. The plan will benefit from special local data collection

and exploratory studies which the team will carry out. Toward the end of the year an advisory group meeting is contemplated which will consider and comment in detail upon the preliminary research proposal. This meeting should also provide an opportunity to reassess the total picture of research in this area in Latin America.

APPENDICES to RES 4/11

Appendix I: Research into Relationships between
Malnutrition and Mental Development.

Appendix II: Conference on Malnutrition and Mental
Development.

RESEARCH INTO RELATIONSHIPS BETWEEN MALNUTRITION AND MENTAL DEVELOPMENT*

The research question stated in general terms at the meeting of the PAHO Scientific Group on Research in Protein-Calorie Malnutrition (Bogotá, 16 - 20 March 1964) was: Does malnutrition or a history of malnutrition as such influence the course of mental development?

1. To consider the research concern as expressed, it is necessary to clarify and define each of the components. These are -

1.1 Malnutrition. Various criteria have been used to define malnutrition. These include -

- a. Clinical signs - Marasmus, kwashiorkor, etc., present at some time in the child's life course.
- b. Laboratory tests - biochemical measures.
- c. Height and/or weight of child at any age compared with some selected norms.

A more inferential indicator than a. or b. is c. above.

What aspect of malnutrition is conceptually likely to be most pertinent to neural development and intellectual functioning?

1.2 History (of malnutrition)

- a. What are the sources of information in obtaining a history?
- b. At what stages in the child's development did malnutrition occur, e.g., duration, periodicity, severity, nutritional course at times not reported?

1.3 Mental Development

- a. What is mental development being defined for?

* Prepared by Drs. Herbert G. Birch and Stephen A. Richardson for the planning meeting convened by PAHO on 22 September 1964.

- b. How is mental development defined during childhood, e.g., motor, language, school learning, traditional learning?
- c. Are measures of mental development comparable at different ages?

1.4 Other Factors. What factors, other than nutrition, are known to influence, or are suspected of influencing, the course and level of mental functioning?

- a. A wide variety of social, economic, and cultural factors.
- b. Diseases other than nutritional factors - e.g., encephalitis, parasitism, neonatal disturbances, obstetrical and other trauma, etc.
- c. Genetic and familial factors.
- d. Child-rearing practices during health and illness.

These factors which influence mental functioning may also influence or be associated with the nutritional status of the child - e.g., the political, economic and social structure and functioning and their effects on the selection, growth, distribution and utilization of food.

Infant-care practices which may result in malnutrition may also result in a social and biological environment that is inadequate for normal mental growth.

After clarifying and examining the above components - Malnutrition, History, Mental Development, and Other Factors - the measures to be used in the study have to be selected, developed, and defined, and a determination made of the reliability and validity of the measures.

2. Strategies and Problems of Research

2.1 Who is to be studied?

- a. All children in a community?
- b. Identified cases of malnutrition - e.g., hospital cases, clinics, etc.?

- c. Children identified as mentally subnormal?
- d. At what ages are the children to be studied?
- e. How many children are needed for proper study of specific questions?
- f. To what standards are the children to be compared?
- g. How stable (with respect to geographic mobility) a population is needed for study purposes?
- h. How can children be selected so that generalizations may be drawn from specific results obtained?
- i. What people must be studied in addition to the selected study cases - e.g., siblings, parents and guardians, the leadership of the community?

From these specific questions other more general questions arise - e.g., What are the pros and cons of selecting children identified in terms of nutritional status versus mental status? How will choice of children effect the requirements of study design?

2.2 What factors must be studied in addition to nutrition and mental status?

- a. What elements in the social, community, and family context in which the child is reared must be studied either cross-sectionally or longitudinally?
- b. What elements in the physical environment need to be known - e.g., climate, natural disasters, etc.?
- c. What disease patterns in the society are relevant to mental and physical growth?
- d. How may selective factors - e.g., migration, death, affect the study of the problem?

2.3 Over what period of time must the children be studied? Or, what questions are best approached by:

- a. Longitudinal study of nutritional status and mental status?
- b. Cross-sectional studies of nutrition and mental status?
- c. Cross-section combined with follow-up studies?
- d. Pseudolongitudinal studies?

For each of these approaches what are the optimal ages for the study of specific issues?

2.4 What research designs may be used? What questions may be best approached through:

- a. Epidemiology.
- b. Ecology.
- c. Planned intervention - e.g., disease control or supplemental feedings, health education, social and technological change.
- d. Taking advantage of changes or conditions not introduced by the investigator.
- e. Intensive studies of pathologic cases.
- f. The use of animal models and experimentation and the pertinence of these results to children.

3. The Analysis and Interpretation of Data

What are ways in which the modes of analysis may be anticipated and built into the design of the study?

What are appropriate methods for the statistical treatment of longitudinal and cross-sectional measurement?

4. Personnel and Resources Needed to Implement Research Plans

RESTRICTED

Conference on Malnutrition and Mental Development

at NICHD

Bethesda, Maryland

December 14, 1964

Preliminary Draft - Not for Publication

Report Prepared by Leora Wood Wells

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Conference on Malnutrition and Mental Development
December 14, 1964

This conference was convened under the joint sponsorship of the Pan American Health Organization, the National Institute of Child Health and Human Development, and the Association for the Aid of Crippled Children, with Dr. Alfred Yankauer of PAHO presiding. Participants included representatives of Latin American research groups and U.S. hospitals and universities. The focus of the meeting was on the relationship between the widespread malnutrition of Latin American children and their mental development.

The purposes of the conference, Dr. Yankauer told the group, were threefold: to develop possible topics for future meetings in Latin America, to determine whether support of such meetings constitutes the most effective contribution PAHO can make to research which needs to be undertaken, including possible cross-cultural studies involving such groups as the NICHD and the AACC.

PAHO has found, Dr. Yankauer said, that one of its most useful functions is to bring together investigators and specialists of different disciplines who have a common interest in a particular problem. The resulting exchange of experiences and thinking can be helpful in highlighting common problems, defining broad research objectives, and suggesting new approaches to specific research objectives.

Some Current Latin American Studies

To set a framework for the thinking of the group, Dr. Yankauer asked the directors of three of the Latin American research groups represented at the meeting to report on the conditions revealed by their current research projects in protein malnutrition. Dr. Moises Behar is Director of the Instituto de nutricion de Centro America y Panama. Dr. George G. Graham is with the Clinica Anglo-Americana in Lima, Peru. Dr. Joaquin Cravioto is chief of a research group at the Hospital Infantil de Mexico.

Dr. Behar

Using slides to illustrate his remarks, Dr. Behar presented an overview of the population with which his project is dealing and the principal economic and cultural problems which contribute to the malnutrition of the children under study. The project is in rural Guatemala where the majority

of people live in small, primitive villages. The ethnic background of the population is Mayan Indian, white of predominantly Spanish origin, and Ladino or mixed Indian and Spanish.

The nutritional status is in general deficient, with the greatest deficiency being in animal proteins. Protein availability for the total population of Guatemala is very low, and the poor rural population is a particularly deprived group. Cultural factors make the protein intake of the preschool child after weaning especially low, since custom precludes giving small children protein foods even when they are available. This is a negatively based belief that certain foods are harmful. But there is no positive concept of foods that are good for children. For some time after weaning the child receives clear broth in which beans are cooked but no solid foods, not even the beans. This is not done through any wish to deprive the child but rather because of the wish to protect him from harm. As his condition deteriorates further, he is given still more delicate amounts of food, and a "self fulfilling prophecy" of malnutrition is created. There is a tendency to offer girls less food than boys, although this does not seem to be based on conscious discrimination on the basis of sex. Data show that this feeding pattern may be reflected in nutritional status, however. By contrast, Dr. Graham reported no sex differences in growth curves in his study in Lima, although some differences in care of male and female children have been assumed.

Older preschool children in Guatemala, Dr. Behar continued, receive a high starch diet deficient in both protein and calories. It consists of various corn preparations, some legumes, a few vegetables and coffee. Since no milk source is available except the mother's breast, children do not receive milk after they are weaned. Any child, a premature, for example, who is unable to take the breast, dies of malnutrition. The average age of weaning is 18 months, but many children remain on the breast until they are much older. The older child must often share the breasts with a younger infant, so that neither child receives an adequate supply of milk.

Sanitary conditions are poor, leading to a high prevalence of infectious diseases, especially those of a diarrheal nature. The combination of weaning and the consequent loss of the protein supply, introduction of new foods comprising a high starch diet, poor hygienic practices and frequent exposure to infectious diseases makes the second to fourth years of life particularly hazardous for these children. While infant mortality is 4-5 times that of the United States, the mortality rate for the 1-4 year age group is 40-50 times greater than in the

United States because of the factors listed above. Those who survive show retardation of weight and height curves, bone maturation and other parameters. Dull, lifeless hair and edema are widely found among these children.

Extreme apathy is noticeable, and it has long been assumed that sadness is a racial characteristic of Mayan Indians. The results of dietary therapy and other care refute this, however: children given an adequate diet and care in the hospital setting often become much more alert and responsive and laugh and play with the eagerness usually associated with childhood.

Dr. Dodge inquired whether the relative importance of nutritional and environmental or psychological factors in development could be determined by keeping in the hospital as controls a group of inadequately fed children who, otherwise, received the same care and treatment as those being fed adequate diets. Dr. Behar responded that it is not possible to attempt this for any length of time without endangering the children, since those who enter the hospital are in such poor condition that prompt dietary therapy is essential.

Observation in the natural environment is the only way this relationship can be studied. For five years in his program, three similar villages have been under study. In one an intensive program of nutrition education and a supplementary food program have been introduced, with other characteristics of the community remaining unchanged. In the second village, nutrition conditions have been left unchanged but complete medical care has been offered and measures to control infectious diseases and improved sanitary conditions have been introduced. In the third village, no changes have been made. Observations of morbidity and mortality rates, physical growth and other parameters are being made.

Dr. Graham

One of Dr. Graham's research groups in Peru, in contrast to the rural character of Dr. Behar's study groups, is primarily in an urban environment. A half million of the people of Lima live in slums. Many of them are recent in-migrants from the rural areas where they have raised their own food supplies. Attracted to the city by what seem to them fabulously high wages, they soon find that it is necessary for both parents to work if they are to make a go of it in the money economy.

The mother returns to her job within a month or six weeks after the birth of her baby, trying to continue to nurse the baby at night and in the morning. As a result, said Dr. Graham, "the breast milk soon dries up and so does the baby." As in Guatemala, only clear broth is offered as a substitute. Thousands of cases of infant marasmus are seen each year in Lima. At the age of a year these children often weigh less than they did at birth. Thus the problem of severe malnutrition appears in an earlier age group in this urban Peruvian setting than in the rural Guatemalan group.

Another arm of Dr. Graham's research group is working in a rural setting, but one which is very different from the Guatemalan group. It is a feudal society, a sugar plantation with a stable population of 9000 in the central hacienda and four subsidiary haciendas with approximately 1000 inhabitants each. Although economically and culturally related, these subsidiary haciendas are physically and socially independent of each other.

Because these people are geographically separated into several units yet have almost identical backgrounds, work activities and habits, they make an unusually satisfactory study group. About half of their food is supplied by the hacienda as part of their wages. It has therefore been possible, with the cooperation of the plantation owners, to supply different dietary supplements to two of the subsidiary groups and retain the other two as control groups with un-supplemented diets. Dietitians have instructed the mothers in preparation of the supplementary foods, which are primarily noodles. Periodic unannounced visits at mealtime are used as a means of observing the use actually made of the supplements. Two-year data show a striking improvement in heights and weights of children between 6 months and 6 years of age.

The average duration of breast feeding is 9 months, so malnutrition develops later than in Lima but earlier than in Guatemala. Comparisons of height charts show a direct relationship between height and age of weaning: height of children weaned later is appreciably greater than that of children weaned very early.

But, said Dr. Graham, in Peru, "At the time of weaning, whether it be in the city, in the hacienda, or in the sierra, the child starves. He may get some corn starch pudding, potato starch pudding, a little rice and noodles, but mostly he gets coffee with sugar, tea with sugar, rice water." Consequently there is a high mortality rate and significant retardation of development in those who survive.

Dr. Cravioto

Dr. Cravioto's group is studying the ecology of growth and development of children in the village of Tlaltizapan, located in a subtropical region about two hours driving time southwest of Mexico City. This agricultural village, established around 1500 B.C. by Indians, now has a 100 percent mestizo population (people of mixed Indian and Spanish origin). Population is about 4000, with an average family size of 5.2. About 200 children are born each year. The mortality rate is seasonal, the rise coinciding with the beginning of the rainy season in May and reaching a peak between August and November. December has the lowest rate.

There is little migration, contacts with the outside world being limited primarily to trips to marketplaces. Illiteracy in persons older than seven years was 25 percent in 1957. Most children go to school through the third grade. Dollar income of those who work in the sugar mill or cotton factory ranges from \$20 to \$1000 per person per annum.

A maternity and child center is available for prenatal and postnatal care. Although the nursing mother carries the child about with her everywhere she goes, weaning is abrupt and the child finds himself suddenly left to the random care of other relatives. Weaning often occurs when a new pregnancy is recognized, as popular belief holds that the milk of a pregnant mother is poisonous to the child. Other available foods are distributed according to age and sex in the family, with the father and older boys getting the largest amounts, then the women and girls, then the young children receiving small amounts.

Although the children of this village show weight gains similar to those of children in industrialized nations for the first four to six months of life, the weight gains dip during the age period of six to thirty months. From thirty months to five years the weight gains again become comparable to those of children in industrialized regions. A correlation between growth in height and weight and performance on psychomotor tests has been found. Although data on coordination and reflex activity during the first year of life have been collected, these have not yet been analyzed.

Copies of Dr. Cravioto's recent address, "Malnutrition and Behavioral Development in the Preschool Child", were distributed to the participants. This paper was presented at the International Conference on Prevention of Malnutrition in the Preschool Child, December 7-11, 1964, in Washington.

Following these three presentations Dr. Yankauer opened the floor for discussion of general areas suggested by an outline prepared by Dr. Birch and Dr. Richardson.

The Nature of the Research Problem: Two Sets of Questions

In the settings described by Drs. Behar, Graham and Cravioto, the participants said, we seem to be dealing with two sets of questions. One is the reversibility of an acute set of nutrition-related mental changes which are superimposed upon a chronic problem after the child has passed early infancy. The other is the relationship of reversibility to age of onset.

In the first case it appears that the changes induced by acute episodes of malnutrition are reversible. The child can be expected to return to the level of functioning that was normal for him before the acute episode and consistent with the pattern of the population of his community, even though chronic sub-acute malnutrition may keep all of them below the functional level of fully healthy, well-nourished children.

But in the second case, where acute malnutrition occurs at a very early age as described by Dr. Graham, are the mental changes reversible? As yet we do not know the answer to this question, although experience leads us to believe that the age of onset is one of the most important factors, as it is in other conditions of cerebral damage. There is evidence that there is some correlation between early brain damage and growth. There is evidence, for example, that brain-damaged children in a socially homogenous population of children tend to be shorter than children whose brains are not damaged.

Strategy and Problems of Research Design

Dr. Yankauer asked the group to discuss strategy and problems of research design. Many pertinent questions emerged in the general discussion, and others took the form of specific research questions requiring further exploration. Some were mentioned as being suitable topics for additional meetings which might be sponsored by PAHO.

In considering research design, we need first to look at our current knowledge and our current problems, members of the group said. This will lead us to research of a certain kind. There are many possible types of research ranging from broad cross-cultural studies to comparative studies of the effects of two types of diets to epidemiological surveys of what conditions currently exist in communities.

There is no such thing as a good research design per se, it was pointed out. The best design to use depends on what questions you are attempting to answer. You must first decide "which end of the stick you wish to grab." One can start with a population of children who are functioning in a subnormal way and search out variables including nutritional status. Or one can look at the nutritional status of children in a community and follow up which children function well and which ones function poorly, and what clues this provides.

Several basic kinds of research design applicable to the problem of malnutrition and mental development were discussed:

- . assessment of the status of the child as a function of developmental change and as a function of known treatment (longitudinal study)
- . assessment of mental status, psychological development, etc., in a child of a particular age known to have had malnutrition of some severity, with attempt to determine to what extent his status is a function of malnutrition and to what extent a function of other variables (longitudinal study requiring comparisons with adequate control groups)
- . the effects of treatment and other variables on similar population groups (comparison study: some receive nutritional supplements, some do not; variables like education are changed for some and not for others)
- . repeated cross-sectional studies on the same population at set intervals. A larger group can be covered this way than in a continuous longitudinal study. The sample does not necessarily have to remain constant.

Separation and Assessment of Variables

A principal problem of research design is how one can ferret out and measure the effect of malnutrition independent of the social environment, to determine its effects on mental development, educability, etc. Is it possible to assess the role of a single independent variable like nutrition?

How can variables related to mental development be quantitated? Can the social scientists develop meaningful, systematic ways of measuring behavior, child care, social structure, value systems, community leadership? Some variables can be quantitated fairly easily, but others require more profound knowledge from the social sciences, anthropology, and sociology. What are the problems which can be quantitated and assayed?

Is it possible that we are giving too much emphasis to separating out the effect of various factors? Should we rather attempt to define a "poverty syndrome" which shows a common pattern associated with malnutrition and determine how this affects mental development?

Yet we must question whether the concept of a "culture of poverty" has any real meaning. Oscar Lewis uses this phrase to indicate that everyone who is poor in the world thinks alike. It is true that poverty poses certain common problems everywhere. But the remarkable thing about human culture is that people have found different ways to handle these common problems, so we must also consider the forms of adaptive behavior in poverty cultures which affect the nutrition and the total developmental pattern of the children.

It is extremely difficult to separate the effects of the environment from the status of the organism. In experimental animals, for example, when some animals are deprived of an adequate diet and their litter mates are not, those who have been deprived respond poorly on tests. On the other hand, if all the animals are well fed but environmental restrictions are imposed on some, the latter group does poorly on tests in spite of good nutritional condition. The problem is an interactive one, and it may not be possible to answer the question by separate analysis of the interacting variables.

We must ask still another important question. If we do separate each factor out, is there a danger of misinterpretation? Does each factor tell us the same thing it would if considered as part of the total system or are we understanding only part of its significance?

We can, however, profitably ask whether there is a significant relation within a community between children who have grown well and those who have not. If there is a systematic relation, this leads to a second series of questions: what factors in the background course of development differentiate children who grew well in that community from

those who did not--infection? nutrition? a combination of the two? subgroup organization within the community? This provides a schedule of investigation under which we move on to each succeeding step only as evidence from the previous step gives us reason.

In such studies the range of difference in the population must be considered. We must recognize that studies of restricted range (single level of mental development, socio-economic status, etc.) require attenuation of variances, which affects the correlation or lack of correlation shown, whereas broad range studies may show a higher correlation, for example, between growth and IQ or growth and social class. This raises questions of interpretation.

There are also hazards in trying to compare two end results without having any longitudinal data. For example, you may have two small children. How do you evaluate differences in their nervous system development without knowing that one had protein deficiency malnutrition at the age of seven months while the other had no severe malnutrition until his brain was relatively mature?

Transferability of Findings

We must ask whether certain differences we have found are also found in other communities or whether they are peculiar to this "case study" of a given community. Does the same kind of difference in development also exist in another region? By looking at cross results, we have the basis for a number of problems. But given a wide range of variables, we must ask to what extent one can draw generalizations from the facts of any specific study to the problems of nutrition and growth as a whole.

Available data suggest that some generalizations may be possible. A correlation between the growth of the child (height and weight) and performance on psychomotor tests has been found in two communities in Africa, five in Mexico with three different ethnic backgrounds, two in Guatemala, from the Peruvian data, and much of the American literature. The differences in test performance are strikingly large.

In order for generalizations to be meaningful, it is necessary to develop tests which are as culture-free as possible. In the past, test efforts have sometimes failed because even the problem used has been

inappropriate. For example, a test involving recognition of a boat has no meaning for a child who has never seen one and has no way of knowing its function. Mere translation of test material from one language to another is not sufficient to overcome the problem of the culture-bound test.

In attempting to develop reliable tests, the following questions need to be explored:

. what are the cognitive and evaluative structures of given population groups which affect their attitudes toward nutrition? What are the implications of behavioral gradations in handling cognitive materials? Is there a relationship between low levels of cognitive functioning and malnutrition?

. can systems of measurement of cognitive functioning be devised which will be applicable in cross-cultural studies or is there too much variation in what children in each culture are expected to do at certain ages? Can normative tests developed for nonverbal species (e.g. primates) be adapted for use with human infants in a variety of cultures?

. if it is not possible to develop culture-free tests, can tests be devised which are reliable measures within a given culture, and for specific groups of children within this culture?

Research Problems that Need to be Explored

This proved to be a fertile field for the conference group. Discussion on some topics was detailed; others were mentioned only briefly.

Protein-calorie malnutrition

Dr. Yankauer asked for discussion of the question: what aspect of nutrition is conceptually likely to be most pertinent to neural development and intellectual function?

Protein-calorie malnutrition, answered Dr. Behar, though the condition may be complicated by other deficiencies. His research group is particularly interested in the moderate chronic malnutrition unrecognized by parents or physicians. How can this be evaluated and measured?

Anthropomorphic measurements are one reliable parameter, especially height. But there is a need for other measures also, such as biochemical indices--nitrogen and creatinine levels, amino acids in the blood, etc. In Guatemala, biochemical differences in protein metabolism are being recognized between infants of mothers of low socioeconomic level families, even though the mothers in the low socioeconomic level families lack clinical manifestations of malnutrition, and the birth weights of their infants are not affected.

The present method of testing is sufficiently sensitive to differentiate these biochemical indices among newborns who show no other differences. Low levels of certain nutrients can be detected before an actual deficiency occurs; for example, a low vitamin C level which may indicate not a deficiency but that the child will become deficient if he continues to be fed his present diet. The next stage is metabolic implication and the third stage anatomical alteration. The aim is to prevent the second and third stages from occurring.

Dr. Graham indicated an accidental finding which has led his group to feel that the biochemical factor is more influential than the environment. A group of children under care had progressed well, becoming happy and well-adjusted. Experimental substitution of certain vegetable proteins in their diets brought a quick regression to morose, unresponsive behavior. This pattern was again reversed when milk was restored to the diet.

The question must be raised, however, whether biochemical tests measure anything more than the recent diet, or in the case of the newborn, the mother's recent diet. Their most significant value may not be in what they show about individual children but what they show about the nutritional status of a group of children and the diet of the community over a long period of time.

In addition to height and weight measurements, head growth data have been kept on the children in Dr. Behar's study. There is evidence that head growth is affected by the age of the child when the malnutrition insult occurs and by the degree and duration of the nutritional

deficiency. At present, however, no correlation between head size and mental maturation has been established.

At present the end result of differences in protein metabolism are not difficult to evaluate, but the identification of specific contributing factors often is. The research problem here is that the effect of these differences on the future development of the child cannot yet be evaluated. These children have lower reserves and capabilities for normal development than other children. But does this represent malnutrition? Will they overcome the difficulties? What is the effect of early introduction of a good diet? Answers to these questions are not yet known.

Genetic Blocks Which Lead to Mental Aberration or Retardation

Dr. Witkop proposed that a protocol be designed on specific signs and symptoms of genetic blocks which lead to mental aberration or mental retardation and that it be determined where in the biochemical system of cells the blocks occur.

The influence of nutrition in this connection came to his attention when amino acid defects with high histagene levels were recognized in a group of protein-deprived Indian children in the Carolinas. These children had oral symptoms and oral sensory changes similar to those found in pernicious anemia. They also showed auditory aphasia or scrambling which resulted in speech defects. There were some mechanically-caused mispronunciations. Response to visual intake of information, however, was normal, although some eye weakness was identified. With dietary therapy the high histagene level disappeared within a matter of days.

However, it is not clear whether this is a deficiency disease or a toxicity disease. There is some danger that the clinical effort to correct certain deficiencies can overload the child in other ways, upsetting the delicate enzyme balance and producing defects. More research needs to be done to determine the factors in addition to genetic factors which affect the ability to make certain enzymes. For example, do certain deficiencies exist only at certain stages of development before the entire system is "turned on", rendering a child particularly susceptible to conditions induced by malnutrition insult at these stages? What are the effects of chronic long-term insults or

repeated insults on enzyme production? Is the question one of abnormal enzymes or a decreased synthesis of enzymes? Are these defects reversible? Is their effect on the mechanism of memory different at different developmental stages?

Such questions are important not only in relation to the public health problem of certain population groups; they have implications also for better understanding of the general problem of mental development.

Clinical Status as a Measure of Severity

Dr. Ricciuti asked for discussion of the usefulness of a systematic rating of the clinical status of the infant as a measure of severity. Can the lack of emotional response, the apathetic expression, etc. be rated in such a way as to be useful supplements to the biochemical and physical measurements? Even clinical signs like edema and skin lesions do not always provide reliable measure of severity. In analysis of 2000 cases, no significant correlation emerged between these signs and mortality, since factors like infection complicated the assessment. It is even more difficult to determine whether signs like apathy are manifestations of malnutrition or are due to environmental factors.

What are the environmental variables which complicate assessment of severity? The group suggested several:

- . size of the family
- . the kind of care the child receives in the hospital and at home
- . the amount of stimulation he receives
- . sudden changes like the arrival of a new baby
- . amount, type and distribution of food available
- . sanitary environment and hygienic practices of the family and community
- . exposure to infection
- . the communication network within the community and the family's geographical proximity and general receptivity to this influence
- . social structure
- . cultural practices
- . socio-economic and educational level (although there tends to be little variation in this among the groups now under study in Latin America. This in itself makes the effect of these levels difficult to assess, since there is not enough differentiation to provide a frame of reference.)

Pertinence of Animal Models to Nutritional Studies of Children

In addition to the possible usefulness of animal models in devising culture-free tests for human infants, the group mentioned other animal studies which might have applicability.

. induced kwashiorkor-like states in pigs (Nick Barnes, Cornell). One finding: that pigs who develop kwashiorkor conditioned more easily than normal pigs in a Pavlovian conditioning situation but did not extinguish as rapidly. In a similar study (Plant, London) anatomical lesions in the central nervous system have been identified.

. the effect on young rats of nutritional deprivation due to weaning. Such a study would have a carry-over to research with human babies because it can be done at a comparable developmental stage of the human and animal organism. In most food deprivation studies with animals done so far the developmental level of the animal has been lower than the level at which human infants customarily suffer malnutrition.

. the relation of milk deprivation in the young rat to cholesterol concentration in the blood and possible delay in myelinization.

. what are the implications for human study of research on nutrition-related brain pathology in animals? Since most malnourished children who die, die of infectious disease processes, accidents or causes other than malnutrition, their brain pathology is difficult to evaluate.

Psychological Effects of Malnutrition

. what are the effects of malnutrition in varying degrees of severity on psychological development? Is there a systematic relation between growth outcome and psychological developmental outcome? These relationships need to be separated out from the effects of social and genetic factors.

. how are these effects related to age of onset, severity, duration and type of malnutrition?

. are these effects temporary or reversible, and is there a critical period during which the effects are not reversible? Can we facilitate optimal development by nutritional and environmental enrichment?

. how does one evaluate psychomotor development and mental development

on the basis of psychological tests only or in combination with biochemical tests?

. it was suggested that a followup study of the mental outcome of central Europeans who were malnourished as children in the 1880s and 1890s would have valuable implications for the study of current malnutrition problems. These children suffered from what was then called melmarshidson. The symptoms closely resembled kwashiorkor: apathy, growth failure, edema, diarrhea. No longterm followup study appears to have been done.

Socio-Cultural Influences in Malnutrition

. in what ways can cultural differences be exploited to improve the nutritional condition of children? For example, in Malaya the children of Chinese traders rarely have kwashiorkor, whereas the children of the Malayan natives very commonly do. This has been related by some observers to the higher aspirations of the Chinese for their children which is reflected in their effort to provide milk and other dietary essentials for them. This is primarily a difference in value systems rather than an economic difference. Are certain of these positive elements transferable from one cultural group to the other?

. is malnutrition an adaptive phenomenon? Why have people in certain cultures not discovered for themselves that if you feed malnourished children they get better? Is this a subconscious form of population control? This seems unlikely since these societies are multiplying at a pace which is of increasing concern to technologically more advanced societies.

. migration from rural to urban areas in Latin America: implications in relation to malnutrition and mental development (longitudinal study). According to migration theory, it would be the people with more intelligence and initiative who would migrate; yet data from Peru seem to suggest that "the more intelligent people are coming out of the rural areas only to breed less intelligent people in the cities."

Other Topics for Study

. can electroencephalograms provide useful information about nutrition-related changes? It is possible they may mirror developmental stages quite accurately, especially when combined with studies of evoked response. Their value needs to be explored further.

. the relation of the genetic load to mental performance. Latin American population groups are quite stable and are heavily inbred. What are the implications? In some Southern states in the U.S., close to 40 percent of the Indian population have some sort of serious or moderately serious hereditary disease, indicating a high genetic load. In other areas like Guatemala, selectivity has tended to reduce the genetic load because many homozygous individuals fail to survive long enough to reproduce.

. successfully functioning malnourished children. We know that not all malnourished children function poorly, but no systematic study has appeared in the literature and none is known to have been done.

. can behavioral differences be related to a history of malnutrition in the absence of a known history?

The Role of PAHO

Dr. Yankauer asked the group to summarize its thinking about the most useful contributions PAHO can make to research relating to malnutrition and mental development. What specific forms of help should PAHO offer?

The group suggested the following:

. make available advisors to work with the directors and principal investigators during the planning stage, discussing methodological and other issues.

. make available advisors to go over research in progress with investigators, analyzing data and helping to plan the next stage of the program. Advisors should, however, be aware of their consultant status and not move in too authoritatively.

. sponsor meetings of various research groups to encourage standardization of design and assure comparability of data.

. provide opportunities for investigators with similar programs to visit each other's projects and exchange experiences.

. provide funds to support research. Meetings are meaningless unless backed by funds which make further action possible, including securing adequate personnel.

- . provide training for multidisciplinary research teams and help in determining the specific kinds of training they need and the balance among the disciplines which will be of most benefit to the study projects. This training should include specific orientation to the objectives of the study. Special emphasis needs to be given to training those who will be in the leadership positions in the project, so that they will understand and be able to direct the functions of the team.
- . develop a catalogue of specialists available for consultation.
- . circulate useful documents like reports of pertinent meetings.

The Ultimate Concern

The possible directions malnutrition research might take are almost endless--and all of them have important implications for the future. Relatively speaking, malnutrition does not kill a great many people. Our concern, said Dr. Graham, is for those who survive--but survive as diminished individuals. We would like to know just how diminished, physically and mentally, they will be, and what this means in terms of the future development and self-sufficiency of these populations.