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ABSTRACT

Four issues related to psychological development are discussed. These issues concern: (1) the criteria by which the separate levels, or structures, or stages of psychological development are to be identified; (2) the principle by means of which these configurations are to be ordered; (3) the nature of the transitions taking place between developmental landmarks, stages, or states; and (4) the nature of the processes within the individual and between the individual and his circumstances which account for the transformations from one stage or state to another. Criteria used in producing six ordinal scales of sensorimotor development were: (1) ease of elicitation, (2) observer agreement, and (3) theoretical meaningfulness. Sequential organization of behavioral landmarks must come from longitudinal studies of infants examined repeatedly during their development; inevitable sequentiality calls for longitudinal studies of infants developing under as wide a variety of cultures and conditions as feasible. Behavioral landmarks imply any of several forms of transformation. The characteristics of the transformations between successive levels or states are implicit in the nature of the differences between the characteristics of the observable behavioral landmarks of successive levels. Cross-sectional data derived from children developing under three differing sets of rearing conditions and data from two longitudinal studies are provided, which indicate great variation in the ages at which infants and young children achieve the various levels of object construction which are correlated with their environmental circumstances. (DB)

SEQUENTIAL ORDER AND PLASTICITY IN EARLY PSYCHOLOGICAL DEVELOPMENT*

by

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The philosophers of nature were exceedingly slow to recognize that organisms go through a series of changes in anatomical substance and structure during their embryonic development. The ancient aphorism that "hair cannot come from not-hair," epitomizing the principle that no substance or structure can come from a substance or structure of a different nature, dominated human thought from the days of ancient Greece to nearly modern times. Over 2,000 years passed from the time of Aristotle's first observations of some of the epigenetic changes which occur in chick embryos until Casper Friedrich Wolff (1759, 1768) detailed so clearly the transformations in the circulatory system and the intestine of chick embryos that he convinced at least those informed of biological matters, brought an end to the doctrine of preformationism, and established recognition of the epigenetic nature of embryonic development.

Preformationism is no more than a historical relic in embryology, yet vestiges of preformationism remain in various of our views of psychological development. All too often we psychologists attribute even to very young infants whatever psychological realities get symbolized by such chapter headings as attention, emotion, perception, and even thought. Moreover, we tend to assume language to be a set of response-produced cues which designate, emphasize, and order things and actions in the world about. It has been the merit of Jean Piaget, perhaps more than anyone else, to recognize an analogue of epigenesis in the development of intelligence (Piaget, 1936) and knowledge (Piaget, 1937, 1945), and I should like to see epigenesis recognized in the development of motivation as well.

The potential impact of Piaget's observing and theorizing is great, and I believe the actual impact is growing (Hunt, 1969). Piaget offers a conception of what comes ready-made in the human infant at birth which differs sharply from the notion of a multiplicity of minute reflexes envisaged by Watson (1924) and later by Carmichael (1954). In accommodation, assimilation, and equilibration, he offers a conceptual way for environmental encounters to participate interactively in psychological development. Piaget's interactionistic view of the process of psychological development differs markedly from both the nativism of Gestalt theory and from the predeterminism of Gesell (1954), yet it avoids the extreme plasticity implicit in the idea of a multiplicity of reflexes which can be evoked and combined in an infinite variety of ways -- the modern version of John Locke's conception of experience writing on a tabula rasa (see Hunt, 1969). Piaget's (1936, 1937, 1945) observations of development in infants and toddlers during what he termed the "sensorimotor" and "preconceptual" phases lend substantial support to the conception of intelligence, knowledge, and motivation as hierarchically organized through interaction with environmental circumstances in a sequential order of transformations.

Despite the richness of Piaget's observations and theorizing with their potential impact upon both developmental and general psychological conceptions, his work has been more in the nature of an exploratory search than of a validation of his own formulations. Although I believe that he is the 20th Century's "Giant of Developmental Psychology" (Hunt, 1969), the open-endedness of his epistomological views would make it ironic indeed if his writings were to become the basis for yet another orthodoxy in psychology.

In extending the epigenetic view of development from body to behavior and from anatomy to intellect and to epistemology, Piaget has raised, or at least put a greatly increased emphasis upon four large issues. I must admit here that I am borrowing this particular formulation of these issues from my ex-student collaborator, Professor Ina Uzgiris. The first concerns the criteria by which the separate levels, or structures, or stages of psychological development are to be identified. A second concerns the principle by means of which these configurations are to be ordered. A third concerns the nature of the transitions taking place between developmental landmarks, stages, or states. A fourth concerns the nature of the processes within the individual and between the individual and his circumstances which account for the transformations from one stage or state to another. These are large issues. They will keep investigators of psychological development busy for a long time. What I wish to tell you today touches in but very limited fashion upon the first three of these issues, but where the fourth is concerned, I shall introduce new evidence concerning the plastic nature of the processes within the individual and between the individual and his circumstances which account for the transformations in object construction.

ON CRITERIA OF LEVEL, STAGE OR STATE

Inasmuch as Professor Uzgiris and I have spent a good deal of time producing a set of six ordinal scales of sensorimotor development, it may be appropriate to consider briefly here the criteria we actually used to characterize the various steps in psychological development to which we usually refer with the terms landmarks and levels.

In the course of our investigations, we found ourselves unhappy with Piaget's six stages of sensorimotor development. First of all, we found a sequence of more than six behavioral "landmarks" on which observers could agree. It occurred to us, moreover, that one could hardly investigate the validity of Piaget's six configurational stages with a measuring tool which assumes their existence. Thus, we ceased to make this assumption in our choice of behavioral landmarks. Instead, we accepted as many as we could elicit with fair regularity and with high observer agreement. Because certain behavioral landmarks which could not be elicited with high regularity seemed to have a high level of theoretical meaningfulness, however, we retained them. Thus, our criteria for "landmarks" became three: (1) ease of elicitation, (2) observer agreement, and (3) theoretical meaningfulness. The landmarks we found served to characterize what we

have termed level of development. These levels are presumed to persist between transitions, whatever the nature of the transitional processes, which serve to alter the observable structure of the behavior. Rarely does an investigator have an opportunity to observe the transitional processes. One observes the behavioral landmarks which characterize a level.

Having all our behavioral landmarks grouped together proved to be both practically and theoretically clumsy. What we did, therefore, was to separate the landmarks of sensorimotor development into six branches or series. Actually, Dr. Uzgiris had much more to do with separating these developmental landmarks than I did. Such a separation raises the additional issue of the criteria for a branch. We were not very formal about our choice of either set of criteria. Our branches owe something to Piaget's schemes ready-made at birth, and also to his distinction between the organizations of sensorimtor schemes and the constructions and reality. Furthermore, they provided us with an intuitively meaningful organization of our landmarks.

The six branches have led to seven scales. One is concerned with visual following and the permanence of objects. It has fourteen steps rather than Piaget's six stages. The second concerns the development of means for obtaining desired environmental events. It has thirteen steps. The third branch concerns imitation, and it yields two scales: one for gestural imitation with nine steps and one for vocal imitation with nine steps. The fourth branch concerns the epistemological construction of operational causality with seven steps. The fifth branch concerns the construction of object relations in space with eleven steps and the sixth concerns the development of schemes for relating to objects, with ten steps. Even though we believe these scales to be very useful for investigation of a variety of issues including Piaget's theory of stages, we make no claim for having uncovered the ultimate nature of sensorimotor development. For this reason, we are entitling our monograph: "Toward Ordinal Scales of Psychological Development in Infancy."

SEQUENTIAL ORGANIZATION

The principle by which we have ordered the successive landmarks in each branch of sensorimotor development brings me to the first substantial term in my title. It is sequential. It was the sequentiality of Piaget's stages that first suggested to me the idea of ordinal scales of psychological development. On the other hand, the hypothesis of sequential ordinality calls urgently for empirical validation of hypothetical sequences of behavioral landmarks. Our first empirical test came with data derived from a cross-sectional study of infants differing in age. These infants were examined but once. Here the criterion of sequential ordinality was a matter of whether those who had passed a given landmark in a given branch could also have passed all those landmarks below it. In a cross-sectional study, some presuming was called for. The epigenetic nature of psychological development makes it highly unappropriate for

an older infant, say of 15 months, to be expected to give critical reactions typical of infants of four or five months to some of our eliciting situations. If an infant gave the critical reactions characterizing two or three of the steps below the final one passed before failure on a couple of more advanced steps, we presumed that had the infant been examined at an earlier age, he would have shown the critical reactions skipped. For the seven scales, Green's (1956) index of consistency (I) ranges between a high of .991 for the scale concerning the construction of operational causality to a low of .802 for the scale on the development for relating to objects. Except for this latter scale and that concerning the development of means for achieving desired environmental events (I = .812), the remainder of these coefficients are .89 (for vocal imitation) or above. The ultimate test of sequential organization must come, however, from longitudinal studies of infants examined repeatedly during their development. Professor Uzgiris has fast completed the first of such studies, and others are underway. Evidence of inevitable sequentiality, moreover, calls for longitudinal studies of infants developing under as wide a variety of cultures and conditions as feasible. Such studies are now underway in Parent and Child Centers in this country and in an orphanage in Tehran.

This principle of sequential behavioral landmarks is far from new. Something resembling sequential organization was recognized by Binet and Simon (1905) in their use of complex psychological functions in order "to assess the intelligence." In starting their investigations with school children, they were distracted by various aspects of complexity and difficulty. In adopting the conception of mental age, they unfortunately confounded sequential organization with age. Apparently influenced by Galton's (1869) notions on mental inheritance, Wilhelm Stern (1912) suggested the intelligence quotient (IQ) and considered it to be a basic biological dimension of individual differences. In focusing upon rate of development, Stern, moreover, made time (or age) the major independent variable in development. The confused arguments over the constancy of this developmental rate have obscured our investigation of the principles by means of which levels or stages of development are ordered ever since.

In the ensuing debates over heredity and environment, maturation was conceived to be genetically preprogrammed while learning was considered to be under the control of the environment. Thus, when Mary Shirley (1931) uncovered a sequential organization in motor development, she saw it as evidence favoring "the maturation theory." Certainly genetic preprogramming is one factor in the sequential ordering of behavior, but it cannot be the only factor.

In certain instances, sequential order is logically built into behavioral development. Thus, for instance, following an object through 180° of visual arc clearly implies ability to follow an object under lesser degrees of arc. Measures of strength, speed, time of reaction, etc., all follow this principle. Such is the case generally where the assessment of the landmarks are based on finding points on continuous variables. In such cases, the matter of sequential organization is trivial.

In certain other instances, the sequential order appears to depend upon the persistence of representative central processes. This appears to be the case for the branch of object construction which would appear to be basic in the infant's development of knowledge of the world about him. I shall have more to say about this branch of development.

Sequential organization is far from trivial and far from preprogrammed not only for object construction, but in whatever branch of development the behavioral landmarks imply any of several forms of transformation. It is these forms of transition or transformation which provide the basis within the developmental domain for the hierarchical conception of the organization of behavior and thought. One can hardly discuss the matter, however, without taking into account what appears to be the nature of some of these transformations between successive levels of behavioral organization.

CHARACTERISTICS OF SOME TRANSITIONS AND TRANSFORMATIONS

Certain essential features of some of these forms of transformation are implicit in the difference between the characteristics of the observable behavioral landmarks of successive levels of development. This is true for successive levels of object construction. When in an early examination, for instance, an infant's eyes immediately leave the point where an object he has followed with apparent interest disappears, and then, in a later examination, lingers with his view where such an object has disappeared, it would appear that the object, which was without permanence in the first examination, had acquired at least a minimal degree of permanence by the second examination. Let us take another instance. In one examination, an infant will retrieve a desired object which has been completely covered by a single cloth, but when it is covered by three superimposed cloths, it gets lost and gives up. At a later examination, however, he persists in pulling one cloth after another off the object of his desire until he retrieves it. Again, the change in behavior implies that the permanence of the object has increased. Such increases can go on until the child can follow a desired object that has been hidden in a container through a series of disappearances of the container and do it by going first to the place where the container disappeared last and pursuing the places where the container disappeared in the reverse order of their disappearance. This reversal between the order of search and the order in which the container disappeared implies that the infant can review his representative central processes backward as well as forward. Such a performance is the top of the scale of object permanence.

Such changes as occur in the behavior of infants seeking objects which have disappeared from sight strongly suggest that the central processes which represent the desired object must have increasing permanence and, at the end, a new level of mobility. Whether this increasing permanence is a matter of preprogrammed neuroanatomical maturation or a matter of the number and variety of perceptual encounters with objects and events is simply an issue for investigation. On this matter, I shall shortly show you some evidence.

In other instances, the behavioral transition implies a form of transformation consisting of coordination of sensorimotor systems or schemes which were previously relatively separate. Thus, at one point in his development, an infant can follow objects with his eye, and he can move his hands about, yet, when he is presented with a colorful object, his eyes fixate on it, and his hands are extended generally toward it. He may show evidences of excitement in his breathing and expression, but only accidentally, do his fisted hands actually touch the object in the course of crude swipes. I am trying to describe for you what Professor Burton White (1967) has termed "fisted-swiping." Later, when the same infant is presented with the same object, he looks at it, he extends his arms directly toward it, and on the way he shapes his hand or hands for grasping it. Eyes and hands have been coordinated in what White has called "top-level reaching." Similarly, as Piaget (1936) has pointed out, "sounds heard become something to look at," "things grasped become something to suck," in a series of coordinations of the sensorimotor systems present at birth in what Piaget has called the "primary circular reactions." He himself has reported evidence of considerable variation in the age at which such coordinations are achieved (Piaget, 1936, p. 115). In passing, moreover, it may be worth noting that the hospital-reared infants in White's (1967) studies of eye-hand coordination achieved top-level reaching at ages considerably earlier than did the home-reared babies who served as subjects in the investigations which led to our ordinal scales, but our home-reared infants achieved vocal pseudo-imitations much earlier than did his institutional babies.

Transitions based upon coordination of previously separate systems is not limited to the sensorimotor phase, for symbolic communication through language appears to derive in the course of psychological development from a coordination of object construction with vocal imitation. Object construction provides the perceptual knowledge of what is symbolized, and the acquisition of vocal symbols is apparently motivated by the child's interest in imitating what are to him novel vocal patterns. Such coordinations supply what is perhaps the clearest evidence for the hierarchical organization of behavior, intelligence, knowledge, and thought. At the present time, from the limited evidence to which I have had access, I suspect that even these early pseudo-words are impossible until an infant has developed object construction to the point where he can follow an object through at least one hidden displacement and has become interested in imitating vocal patterns after hearing them only a few times. It may be worth noting here that, at least hypothetically, both branches of development must have achieved at minimum a fairly high sensorimotor level before the transformation comprised of their coordination can occur.

Another form of the implicit nature of the transition between successive behavioral landmarks appears to be motivational in character. The landmarks consist in such behavioral evidences of interest in various kinds of environmental circumstances as prolonged looking, efforts to retain or to regain perceptual contact, and preoccupation with an activity, an object, or a subject. Because it appears to be based upon a limited number of perceptual encounters, I have been inclined to think of it as the attractiveness of emerging recognitive familiarity (Hunt, 1963, 1965, 1970). It appears to account for the attractiveness

that motivates looking longer at familiar patterns before looking longer at novel patterns (Uzgiris & Hunt, 1970; Greenberg, Uzgiris & Hunt, 1970; Weizmann, Cohen & Pratt, 1971; Wetherford, 1971). I suspect that it may also be the motivation for such repetitive autogenic behaviors as hand-watching and non-distressful vocalization (Hunt, 1965, 1971). Repeated encounters ultimately lead, however, to interest in what is novel, and this may well be the intrinsic motivation for exploratory behavior and the imitation of novel gestures and vocal patterns. Such attraction appears to be based, however, on an optimum of novelty, complexity and challenge. Although the precise nature of what it is in the organism-environment relationship which must be optimal to be attractive is still a matter of debate (Berlyne, 1971; Hunt, 1971), it must be related to the kind of relationship which Hebb (1949, pp. 227-234) considered in his theory of pleasure. I suspect we will be puzzling ourselves about such phenomena and investigating them for some time before we understand them well.

Yet another form of the implicit nature of the transition between the landmarks for successive levels of behavioral organization remind me at once of what we commonly call acquired generalization or what Harlow (1949) called the "learning set." The transition from interest in the familiar to interest in the novel may not be entirely a matter of the hedonic value of recognitive familiarity. Whereas infants appear to me to be relaxed and pleased when looking at objects which have become recognitively familiar through repeated encounters, they typically wear an expression of intent and concern when they are focusing on unfamiliar patterns. This seems to me to be true even late in the first half year of life. I wonder if that expression of critical scrutiny may not reflect the achievement of the first learning set that "things should be recognizable," whence comes what Woodworth (1947) called the goal of perceptual activity.

Similarly, a few encounters with an action which leads to an interesting effect produces behavior which implies that the child anticipates the effect. It is this implied anticipation that led Piaget (1936) to speak of "intentions." In the language of Skinner (1953), these intentional actions would be called "operant respones." Evidence from a variety of sources that I dare not take time to synopsize here suggests to me that the acquisition of a series of such intentional actions where the infant can obtain, probably with effort, the expected outcome, leads to a kind of "generalized confidence" such as E. H. Erickson (1950), with greater interpersonal emphasis has termed "trust." The child acts as if he had come to believe what one might put in words as "if I do something, I can make interesting things happen."

The motivational learning sets represent highly tentative formulations, but there is one such which is fairly well established in the domain of language development. It has it's historical origins from a change in Helen Keller's behavior. This change came in the well-known incident at the pump, when "Teacher's" differing manipulations of Helen's hands for <u>water</u> and for <u>cup</u> led to a sudden change in Helen's behavior. Helen turned to manipulate "Teacher's" hand in such a fashion as to spell the word <u>water</u> several times, and then the

word cup. Then, excitedly, after touching various objects nearby, Helen extended her hand to Teacher to have her spell the names of these objects. Within a few hours, Helen added 30 new words to her vocabulary. A similar change has been observed very commonly in children. After gradually acquiring a number of words, or pseudo-words, the referents of which at least those who know the child well can recognize, the child begins to ask, in one way or another, the names of objects. It is as if the child had generalized the proposition that "things have names." Such a change in behavior has been repeatedly associated with sharp upward shifts in the rate of vocabulary building (McCarthy, 1954). I suspect that such learning sets, or generalizations, constitute the nature of a good many of the transitions between the behavior characteristic of successive levels of psychological development.

The main point here, however, as we shall see, is that the persistence of central process representative of objects, and the coordinations of previously separate systems, and of such generalizations as I have been describing, are not necessarily preprogrammed. It seems more likely that they derive from the infant's on-going interactions with his environmental circumstances.

IMPLICATIONS OF SEQUENTIAL ORDER FOR ASSESSING DEVELOPMENT

The existence of dependable sequences in several branches of sensorimotor development provide us with a basis for several fortunate modifications in the strategy for assessing development and for studying its structure. First of all, dependable sequences permit the construction of ordinal scales. Such scales make no assumption of automatic progress in a unitary power without consideration of the interrelationships among the various kinds of behavioral achievements. Second, inasmuch as ordinal scales are based on a series of hierarchically arranged behavioral landmarks for each branch, they provide a method for investigating organizational structures and of testing the validity of those described by Piaget (1936, 1937) as stages. Third, ordinal scales disentangle psychological development from age. They thereby make it readily feasible to use age as the dependent variable with which to assess the impact of various independent environmental variables on development. Fourth, ordinal scales permit one to get psychological meaning from a child's performance directly. In traditional scales of development, the meaning derives from the interpersonal comparisons of performance implicit in such statistics as percentile ranks, standard scores, IQs, and even mental ages. Although one can readily compare children on ordinal scales, it is unnecessary to make such comparisons in order to obtain the psychological significance of his performance. Several of these modifications of strategy in assessment will become evident in the data I wish to report on the plasticity of object construction.

PLASTICITY IN OBJECT CONSTRUCTION

The readers of Piaget's works disagree about their implications for what I have listed as the fourth issue, namely, that concerning the nature of the causes and the processes underlying the transitions between levels or stages. Although this issue can be refined indefinitely, the broadest division is that between the time-honored poles of maturation and learning. Here, however, learning must be extended to include all of the adaptive effects of informational interaction with the environment. On this issue, the impact of Piaget's work is ambiguous. On the one hand, his theory, with his constructs of accommodations, assimilation, and equilibration and with such aphorisms as "use is the aliment of a schema," clearly gives to the on-going interaction between the infant and his environment, both social and inanimate, a major role in the fostering of development. On the other hand, Piaget's empirical method associates each successive stage with an approximate age and his evidence consists of behavioral landmarks which come at about the same age for all the children within each of his various small samples. So far as sensorimotor development is concerned, the number of subjects in his sample is only three -- his own three children. The children in his other samples are presumably from middle-class families of Geneva.

If one takes Piaget's theory more seriously than his evidence, one would expect to find considerable variation in the ages at which infants achieve the successive stages of sensorimotor development. In fact, where visually-directed reaching is the behavioral landmark, Piaget (1936, p. 115) makes an explicit point of the role of experience in the fact that his own three children achieved this landmark at ages 3 months, 4 months, and 6 months. It is to the restraints of clothing dictated by birth in winter that he attributed the relatively retarded development of this landmark in Jacqueline.

Contrariwise, if one takes the bulk of the evidence which Piaget presents in his many books more seriously than his theory, one would expect little variation in the ages at which infants achieve the various behavioral landmarks as his successive stages. The matter did not interest Piaget much, but it is clearly one for empirical investigation, and it calls for the use of ordinal scales of sensorimotor development on children developing under conditions of rearing which vary as much as possible.

It was partly such a consideration that prompted me to plan the cross-sectional investigations of sensorimotor development in orphanages with differing regimes. This led ultimately to the study which John Paraskevopoulos and I got done in Athens (Paraskevopoulos & Hunt, 1971), and to the ones I have underway in Iran and in the Kibbutzim of Israel. Because I have become centrally interested in the development of the symbolic processes and of symbolic communication, I have used in these investigations only the Uzgiris-Hunt scales of object permanence and imitation -- with emphasis on vocal imitation rather than gestural.

The cross-sectional data which I wish to report today derive from this Greek study (see Figure 1). They come from children developing under three differing sets of rearing conditions. One set consists of those rearing conditions in the Municipal Orphanage of Athens where the infant-caretaker ratio is about 10/1. The second set consists of the rearing conditions in Metera, the Queen's Orphanage which aims to be a model baby center, and where the infant-caretaker ratio is, at least during the time of waking-play, of the order of 3/1. The third set consists of that variety of rearing conditions to be found in a sample of working-class homes, and most of the babies were examined while they were in a day-care center for working mothers.

The other two sets of data presented in Figure 1 derive from two still unpublished longitudinal studies. One of these has been conducted by Professor Ina Uzgiris. Her sample has consisted of a dozen home-reared babies from middle-class families in Worcester, Massachusetts. Here, I believe, the babies were examined every other week during their first year, and every fourth week during their second year. The central purpose of this investigation was to get evidence concerning the sequential order of the landmarks in our presumably ordinal scales. The other set of longitudinal data derive from a similar series of repeated examinations on eight children from families of poverty where the mother-caretakers have participated in a Mother Training Program at the Parent and Child Center at Mt. Carmel, Illinois. In obtaining these data, I have had the collaboration of Mr. David Schickedanz, who taught two paraprofessional workers at the Center to use the Uzgiris-Hunt scales and tested the subjective reliability of their assessments, of Mrs. Earladeen D. Badger who taught the mother-caretakers, and also of Mr. Melvin Noe who is the Director of the Center. Today I shall present only the evidence concerning object construction from the scale on object permanence. I do this partly because of the limitations of time, partly because I find that psychologists and educators typically find plasticity in the development of object construction more surprising than they find plasticity in vocal imitation, but chiefly because the data on vocal imitation from the longitudinal studies are still incomplete.

In Figure 1, the abscissa represents a selection of five of the fourteen behavioral landmarks representing the fourteen successive levels of development in our scale of visual following and object permanence. Four levels below that on the extreme left, the examiner has already determined that the infant subject desired the object being used. The infant demonstrated that desire by reaching for the object, first when it was completely uncovered, then when it was partially covered, and we start here with the level at which the infant recovers a desired object which has been completedly covered. There are five columns ascending from the abscissa for this level. Under each column is the number of subjects participating in the mean and standard deviation of age for the condition of rearing represented by that column. For the next level represented along the abscissa to the right, the infants have recovered an object covered by three screens. In the third level to the right, they have retrieved an object which was hidden in a box after that box had disappeared under a

cover and been returned empty. For the fourth level, the infants have retrieved the desired object after it had been hidden in a box, and the box, in turn, had disappeared under a series of three different covers and been returned empty. Here, the infant proceeded to look under the covers where the box that hid the object disappeared first and proceeded to the other screens in the same order in which the box disappeared. In the level represented at the extreme right of this figure, the infants have retrieved a desired object after such a series of hidden displacements, but each looked first where the box disappeared last and then explored the covers which hid the box in an order the reverse of that in which the box disappeared. Such a performance implies that the infant at this level can replay the central processes representing the events of the eliciting situation in an order opposite to that in which the disappearances occurred.

The dependent variable here, represented on the ordinate, is age. The top of each column represents the mean, and the line extending above and below represents the standard deviation of the ages of the children in the sample at that level. Now, the independent variable consists of the rearing conditions for each of the five samples represented by the columns over each level of development.

The first three columns over each level of object construction derive from the Athens study, and the data are cross-sectional in character. That column at the left of each group of five represents a sample of children who have developed since a week or ten days after birth in the Municipal Orphanage where the baby-caretaker ratio was 10/1. The second column represents babies who have developed from birth, or within ten days after birth, at Metera Baby Centre where the infant-caretaker ratio is of the order of 3/1. The third column, that central in each successive group of five, represents home-reared babies from families of working-class status in Athens.

These variations in rearing conditions constitute the independent variable for the means of the ages of the children at each level of development assessed. I should remind you again that the Athens study was cross-sectional. Every baby aged between five months and five years was examined with the scales of object construction and imitation. A similar sample of home-reared youngsters were examined in day-care centers for children of mothers who worked. Thus, each of these first three columns over the successive levels of object construction represents a different group of individual children.

The fourth column in each group of five within Figure 1 derives from the longitudinal study of infants from middle-class families in Worcester by Professor Uzgiris. Since this is a longitudinal study, the 12 babies represented in each of the successive four columns are the same ones.

The fifth column also represents a longitudinal study. Here the subjects are the babies from the families participating in the program of the Parent and Child Center at Mt. Carmel, Illinois. Here, not all of the babies entered the

program at the same time. The two represented in the fifth column at the extreme right of the first group of five columns at the left of Figure 1 are children of mothers from the poverty sector who have the status of paraprofessional workers in the Mt. Carmel Center. These two infants have literally participated in the day-care program of the Mt. Carmel Center since about a week following their birth. For a time, they were its only participants. There were ultimately 8 children recruited into this program, but the examiner failed to examine one of them at the proper time, so Mr. Schickedanz and I have omitted the child from the sample represented at the extreme right.

What do the results show? First of all, there is an obvious tendency for mean ages to increase with each successive level of object construction. It is equally clear that the babies of the Municipal Orphanage, where the infant-caretaker ratio is of the order of 10/1, are the oldest of those at each successive level. Although the slope for their mean ages appears from inspection to rise more steeply than do the slopes for the mean ages of either the babies from Metera or those home-reared, this apparent interaction between conditions of rearing and rate of development is not statistically significant. On the other hand, these infants of the Municipal Orphanage of Athens are significantly older than are the children growing up in either Metera or in their own homes. Although the children of Metera average older than do those home-reared, these differences are not statistically significant.

Note the lines representing the standard deviations for the ages of the Greek children at the three levels at the right of the graph: one hidden displacement, a series of hidden displacements, and a series of hidden displacements with reversal of order. Note how much smaller the standard deviations are for the children of Metera at these levels than for the children of either Municipal Orphanage or home-rearing. This is an interesting finding which we did not anticipate. At Metera, where the infant-caretaker ratio is approximately 3/1, the caretakers are student nurse-teachers who are carefully supervised. The conditions of rearing among children at Metera differ little. The standard deviations of age reflect this. At the Municipal Orphanage where the infant-caretaker ratio is 10/1, it is extremely hard for a caretaker to be responsive to all 10 of her charges. Inevitably they develop favorites and consequently others are neglected. This is reflected in the standard deviations of age at which the children achieve these upper levels of object construction.

Note that the standard deviations for the ages at which the home-reared children reached the upper levels of object construction are even larger than the standard deviations for those in the Municipal Orphanage and much larger than those for the children developing at Metera. This finding was unexpected. It was also somewhat surprising to Dr. Paraskevopoulos and me. What this finding suggests is that whatever genotypic variance there may be summates with the developmental fostering, or development-hampering, impact of the variations in child-rearing within these families. Clearly the evidence from the differences between the means and these standard deviations indicates that the environmental circumstances encountered have a very substantial influence on the ages at which children achieve these higher levels of object construction.

The data from the cross-sectional study are not comparable with those from the two longitudinal studies for two reasons. Cross-sectional studies test children more or less randomly across the ages during which they remain at a given level of development indicated by the behavioral landmark used. Because longitudinal studies measure repeatedly every two weeks during the first year and every fourth week during the second year, they detect infants very soon after they have achieved the behavioral landmark indicating any given level of development. Secondly, the repeated examining which is inherent in the longitudinal method undoubtedly helps to foster development and make the ages at which samples of children achieve the successive stages younger than those for children in cross-sectional studies. How much the advantages depicted here for the two samples of children in the longitudinal studies is a matter of such spurious methodological factors and how much to the development-fostering characteristics of their rearing cannot be determined.

On the other hand, the finding of the means at which the Mt. Carmel sample achieved the following of a desired object through one hidden displacement, and then through a series of hidden displacements with reversal of the order in which the container disappeared is of interesting significance. Even though these children of the Mt. Carmel sample came from families of the lowest socio-economic status in a small Illinois town, the average age at which they follow an object through one hidden displacement is ten weeks younger than the average age for the Worcester sample of babies from middle-class background. Even more impressively, the age at which these Mt. Carmel babies achieve following an object through a series of hidden displacements with reversal of order, averages 19 weeks younger than the mean of the babies in the Worcester sample. This is a difference of nearly 5 months. This difference is of theoretical importance for it calls into question the proposition that environmental interaction operates in threshold fashion. It also calls into question the farily commonly held view that the child-rearing practices of the middle-class approximate the optimum.

The bits of evidence I have been describing clearly imply that the infant's interaction with his circumstances makes a substantial difference in his rate of sensorimotor development. While such investigations yield evidence of the importance of informational interaction with environmental circumstances in development, they have limited value for our understanding. They do not indicate, for instance, the nature of what in the infant-environment interaction is important for fostering object construction. In order to get some inkling of what the infant-caretaker ratio means with respect to the characteristics of the infant-environment interaction Paraskevopoulos and I are conducting studies of that interaction in the Greek orphanages.

One can get some inkling of what in infant-environment is important from the nature of the program instituted at the Parent and Child Center at Mt. Carmel. This was the Mothers Training Program developed by Earladeen Badger, (1971a, 1971b, 1971c, 1972). It is an extension and improvement of the one originally employed and tested in the investigative program of Merle B. Karnes (Karnes, Teska, Hodgins, & Badger, 1970). Conceptually it is quite simple. First, the

mothers and caretakers are encouraged strongly to believe that how they interact with and arrange the situations for their babies will make an important difference in their development and in their future. Second, while their babies are very young, they are encouraged to be responsive to any behavioral indicators of distress, and to remove the sources of that distress. Third, they are taught that infants need time for interaction with play materials and with models and they are taught to observe their infants for behavioral indications of interest and surprise, of boredom, and of that distressful frustration that comes with situations with which an infant cannot cope. Fourth, and in close connection with the third aspect, they are encouraged to provide their infants with materials and models which bring forth the behavioral signs of interest, and to remove those which elicit behavioral signs of either boredom or distressful frustration. Fifth, they are shown something of the sequence to be found in developing abilities and interest. From such information, observations of the nature of the materials and models in which an infant is presently interested provides them with a basis for choosing materials which will shortly become interesting. In this fashion, Mrs. Badger has attempted to solve what I like to call the "problem of the match." Finally, she empahsizes the importance of talking to their infants about the materials with which they are occupied and about what they are doing, and to utilize the pseudo-imitation and, later, genuine imitation, to encourage vocal interaction. Such evidence as we have presented here suggests that this Mother Training Program is promising.

CONCLUSION

In the foregoing,

(1) I have outlined the criteria of levels of development, criteria which might also serve for stages or states, and have noted that our ordinal scales do not assume Piaget's six stages of sensorimotor development;

(2) I have indicated that sequential organization is far from preprogrammed, that is far from theoretically trivial when there are transformation between successive levels or states, and

(3) that the characteristics of the transformations between successive levels or states are implicit in the nature of the differences between the characteristics of the observable behavioral landmarks of successive levels.

(4) Finally, I have introduced evidence indicating great variations in the ages at which infants and young children achieve the various levels of object construction which are correlated with their environmental circumstances.

I would like to close with a plea that we take the hierarchical hypothesis about the nature of psychological development seriously. I believe we have at least a first tool for investigating sensorimotor development in the ordinal scales which Professor Uzgiris and I have developed. We very much need such

scales for the preconceptual phase also. If we take the hierarchical conception of development seriously, what Piaget has termed the preconceptual phase is a portion of human psychological development about which we are abysmally ignorant. If we are to become more effective with early childhood education, we need instruments for assessment based upon this principle of sequential, hierarchical organization. We need them as tools to learn what kinds of experiences are required to foster psychological development. Moreover, only by taking this hypothesis of an epigenetic hierarchy in psychological development seriously and by determining where investigations based on it will lead, only thus can we make relics of history of the vestiges of preformation which still lurk in our theories of psychological development.

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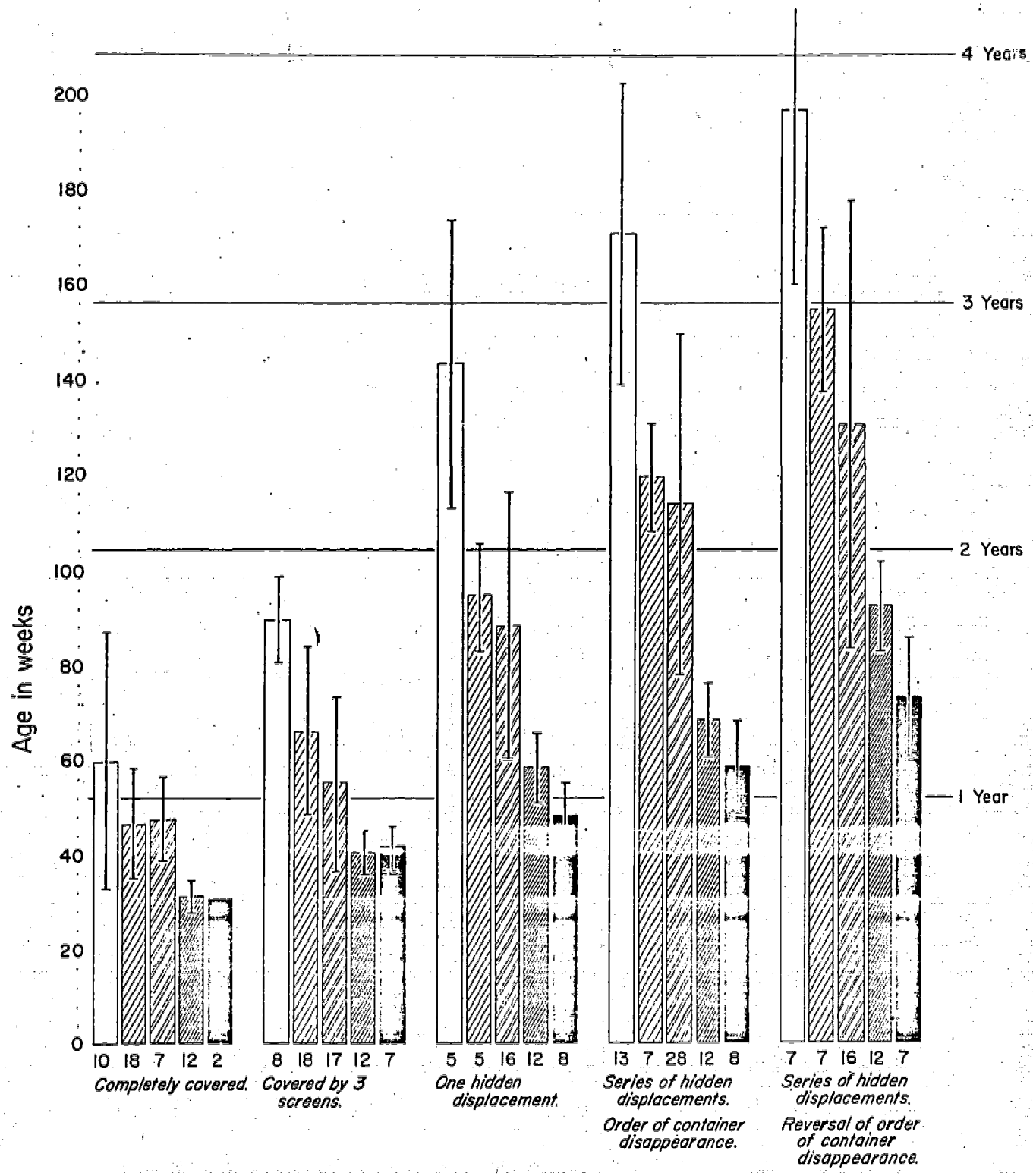
OBJECT CONSTRUCTION UNDER DIFFERING CONDITIONS OF REARING



Child searches for and obtains desired object when it is: _____

Method — Cross-sectional single examination

- Athens Orphanage - *Infant / caretaker ratio: about 10:1*
- Athens Orphanage - *Infant / caretaker ratio: about 3:1*
- Athens - *Home reared*

} from Paraskevopoulos & Hunt (1971)

Method — Longitudinal repeated examinations

- Worcester, Mass. - *Home reared - Middle class families* — Uzgiris (In press)
- Mt. Carmel, Ill. - *Parent and child center - With "badger mother-training program"* — Hunt, Schickedanz, Badger & Noe