STUDIES IN CHILD DEVELOPMENT

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CHILD DEVELOPMENT

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THE MENTAL GROWTH OF THE PRE-SCHOOL CHILD

INFANCY AND HUMAN GROWTH

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THE CHILD FROM FIVE TO TEN (WITH ILG)

VISION: ITS DEVELOPMENT IN INFANT AND CHILD (WITH ILG AND BULLIS)

To
The Staff
of the
Yale Clinic of Child Development

Preface

This volume is a collection of papers, prepared mostly on invitation for special occasions. The titles of the chapters, therefore, suggest a rather startling variety of subjects. But in reality these chapters all deal with a single unifying theme, namely, the characteristics and conditions of child development.

In America, the study of child development has had a double motivation—a scientific interest in growth as a biological process subject to natural laws; and a humanitarian interest in the physical and psychological needs of the growing child in home, school, and community. There is no necessary conflict between these two areas of interest. Human development cannot be divorced from the cultural setting in which it occurs.

The Yale Clinic of Child Development has functioned both as a research clinic and as a service clinic associated with a School of Medicine. A devoted, co-operative staff have made it possible to maintain a reciprocal balance between so-called basic research and applied research. Our systematic investigation has been concerned with charting the normal ontogenesis of behavior (at thirty-four progressive age levels from birth to ten years). Since development is in itself an integrating process and an integrative concept, it has been possible to study defects and deviations of maldevelopment by the same methods employed in the observation of normal behavior. In the course of years the Clinic has come into contact with an extraordinary variety of developmental manifestations—in the preschool child attending the Guidance Nursery; in the developmental supervision and survey of feeding behavior of well babies; in the study of visual functions of infants and school children; in the preadoption examination of foster children; and especially

in the diagnostic and advisory service for atypical and handicapped infants and children.

In spite of the vast diversity of symptoms, normal and abnormal, presented by children from every walk of life, we have been increasingly impressed by the lawfulness of an underlying process of development. Development is, indeed, the one inclusive function which all children share.

The task of a science of child development is to elucidate the mechanisms and the cultural goals which govern that supreme function. I hope that the present volume will reflect at least the potentialities of such a science which now is only in its first beginnings. Our emphasis on the social and medical implications will be evident.

For typographical convenience, the illustrations for various chapters are assembled in an introductory section. Part One deals with Methods of Scientific Approach; Part Two with special studies of Patterns of Growth; Part Three concretely considers Clinical and Social Applications with special reference to the developmental diagnosis of defects and deviations and the supervision of normal child development.

It is said that man needs new moral techniques and greater self-knowledge to manage a technological civilization. How can we possibly arrive at either the techniques or the self-knowledge without a deepened understanding of the laws and the very mechanisms of child development?

The most constructive cultural force that can be released in the years which lie ahead is an intensified conservation of the development of infants and young children. This must be a socialized conservation, felt and effected by the people as well as by their political leaders. This would entail vast extensions of preparental and adult education, and a more nearly universal form of developmental supervision under medical and public-health auspices. The life sciences may well have a basic cultural function in a yet more technological era.

ARNOLD GESELL

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PART THREE

Clinical and Social Applications

Introductory

CHAPTER I

"The Miracle of Growth"*

The task of science is to make the world we live in more intelligible. This world is filled with knowable realities. At one extreme is the Atom; at another extreme is the Child. In the Miracle of Growth these two extremes meet.

There are two kinds of nuclei—the nucleus of the physical atom and the nucleus of the living cell. Each contains energies derived from the cosmos through ageless processes of evolution. An atom can be pictured as a tiny solar system, composed of a central nucleus surrounded by electrons. In comparison, the fertilized human egg cell is transcendently complex, for its organic nucleus initiates the most miraculous chain reaction known to science—a cycle of growth in which a minute globule of protoplasm becomes an embryo, the embryo a fetus, the fetus an infant, the infant a child, the child a youth, the youth an adult, and the adult a parent.

With parenthood, another cycle of growth is liberated. And so it comes to pass that children, mothers, fathers, preparents, and grandparents can all behold the miracles of growth.

The exhibit which has been prepared with such imagination for your great museum is impressive, because it portrays the pageant of child development in full perspective. The central figure properly is

* Address delivered at the inauguration of an exhibit portraying "The Miracle of Growth" at The Museum of Science and Industry, Chicago, August 6, 1947.

the mother, who bears the child. But we are reminded that the child as an individual is equally derived from the nuclear chromosomes of a father. The incontrovertible importance of sound inheritance is made clear to all who wish to ponder.

Science is probing deeper and deeper into the mechanisms of heredity which underlie both the bodily and the mental growth of the human infant. Biochemists are identifying the genetic substances in the nucleus and cytoplasm of the growing cell. They have even begun to picture the possible shapes of the individual genes which determine the basic events of the drama of growth. By latest report, the genes may be likened to a curious double comb with a long row of protein teeth on one side and a row of nucleotides on the other. Simply arrange the teeth of these combs in appropriate sizes and sequences, and they will play a developmental melody. In a suitable environment, as a push-button exhibit may indicate, there will come to life a brown-eyed or a blue-eyed baby who reaches out for a rattle at six months, stands on his feet at one year, talks at two, and cuts his sixth-year molar at six. You see, it is indeed a prodigious chain reaction which deserves every possible insight that science and wisdom can bestow.

Accordingly, the experimental embryologist has brought the problems of organic growth into the laboratory where he is systematically analyzing the mechanisms of development. With the aid of microscope, staining methods, and recording devices, he boldly explores the growth processes of tadpole, salamander, sea urchin. He manipulates the conditions of growth to determine the effect of surgical and environmental alterations. He modifies the temperature and the nutriment of the organism, or he bombards it with X-rays to ascertain the developmental forces at work. He transplants tissue from one part of the organism to another part, or even transfers tissue from one species to another—all for the purpose of probing more deeply into the concealed miracles of growth. He transplants a regenerating amphibian tail into the eye chamber of a frog larva and discovers that the potential tail transforms

into a crystalline lens, a man-made miracle, based however on natural law.

In a growing system the components are in a state of labile equilibrium. One component has the capacity to *induce*, probably by some bio-electric mechanism, a new shape or arrangement in another component. The latent energy of the genes issues into patterned forms.

The medical scientist is especially interested in the harmonies and disharmonies of growth—disharmonies like cancer, and developmental anomalies such as retrolental fibroplasia which may blind the eyes of a human infant too prematurely born. Not without reason, the investigation of the physiology of development has become a major occupation of the life sciences. This investigation embraces plant and animal, human and subhuman, normal and abnormal manifestations.

Do all these varied laboratory studies throw light on the nature and needs of child development? Indeed they do, because we may be sure that the profoundest laws of development are universal and apply alike to the growth of tissues, to the growth of organs, of functions, and of human behavior.

From the standpoint of development, body and mind are indivisible. The child comes by his mind as he comes by his body, through the organizing processes of growth. Consider, for example, the embryology of *eyes and hands and brain*. These three are inseparably interlinked, both somatically and psychologically.

As early as the fifth week after conception (the embryo is but ¼ inch in length), the eyes emerge as optic cups, the hands as limb buds, the brain as rudimentary cerebral hemispheres. The growing cells multiply at an extraordinary rate. Cells invade the diminutive limb buds and cause them to elongate. The outer segment assumes the shape of a paddle. Five lobes appear on the edge of the paddle, which in another month transforms into a five-fingered hand. Muscles and tendons attach themselves to the skeleton of arm and hand. Nerve fibers penetrate the muscular tissue. Nerve endings ramify into the joints. End organs by the thousands establish themselves in the sensitive skin. Thus the hand

becomes a patterned structure, elaborately connected with the central nervous system, including the brain. Presently, some of the structures are ripe enough to react. Arms and fingers make their first spontaneous movements. About the third month of gestation the eyeballs move in their sockets beneath fused lids, the fingers flex, open and close. These are patterned movements, embryonic behavior patterns. The mind has begun to grow.

There are six hundred paired muscles with billions of contractile fibrils in the human fetus. The fibrils are supplied by multibillions of neuron fibrils. The growing mind is part and parcel of this vast network of living filaments. The mind grows because tissue grows. Neurons have prodigious powers of growth. They multiply at a rapid rate in the embryonic and fetal period when the foundations of behavior are laid. The 5-months-old fetus is already in possession of the final quota of twelve or more billions of nerve cells which make up the nervous system. These cells continue to grow and to organize throughout the cycle of growth.

One may think of the child's mind as a marvelous fabric—a growing, functional fabric. Functionally the mind consists of propensities and patterns of behavior. If you should ask whether a newborn baby has a mind, the baby might well answer, "Look at my behavior patterns and watch them grow."

Note how *eyes and hands and brain* co-ordinate during the first year of life. The newborn baby can breathe, can suckle, can sleep. In the early weeks his hands remain fisted most of the time, but presently he opens his eyes and begins his psychological conquest of the physical world. He seeks the light of the window. At the age of 2 months, his eyes follow a moving person. At 3 months, he can look at his own hand which now is opening. At 4 months he can pick up a tiny object with his eyes, but not yet with his hands. At 6 months he can pick it up on sight. His grasp at first is crude and pawlike, but at 10 months he extends his index finger and picks up a crumb on his highchair tray by a precise pincer prehension. This extension of the index finger is an

important event in the story of growth. It represents a refinement and specialization of the child's action system.

At this age the New Haven infant, and I believe also the Chicago infant, is under an irrepressible compulsion to poke and to pry and to probe. He uses his index finger as though it were a tool. He uses it as an awl to thrust, as a lever to push. His prehension and manipulation are no longer pawlike. He has made a neurological advance toward adult levels of skill, and he is discovering the mysteries of container and contained, and of the third dimension. He continues to progress from one level of skill to another, not altogether because of specific training or instruction, but primarily because he is richly endowed with natural powers of growth, which bring eyes, hands, nerve cells into increasingly complex co-ordinations.

By the age of one year his brain has sufficiently matured so that he is capable of inhibiting his grasp and of exercising voluntary release. Give him a dozen cubes. He picks them up one by one and then drops them one by one to exercise this new-found power of release. He disposes the cubes in random array, but at 18 months he uses them as though they were building stones and erects a tower of three blocks. At 2 years he builds horizontally, arranging the blocks into a wall. At 3 years he can rearrange the three blocks to construct a bridge. This is a lawful sequence determined by the intrinsic growth of the relationships between eyes and hands and brain.

Similar sequences determine the later progressions of behavior. The 3-year-old can draw a circle; the 4-year-old a square. The 5-year-old uses eyes and hands to mold objects with clay. The 6-year-old can use a pencil or crayon as a tool, printing capital letters. Seven-year-old boys begin to use hammer and saw; girls color and cut out paper dolls. The 8-year-old draws action figures in good proportion, and puts perspective into his drawings. The 10-year-old can build complex structures with an erector set, and he uses handwriting as a tool with freedom and facility.

This sketchy summary of the eye-hand-brain relationships indicates