AN INTRODUCTION TO EDUCATIONAL PSYCHOLOGY

E. Stones

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E. STONES

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What This Book is About

This book attempts to introduce students of education to the elements of educational psychology. It also relates as closely as possible the findings of research to classroom practice. It does not attempt, however, to provide teachers with ready-made classroom techniques. Each teacher develops his own classroom techniques. On the other hand the general principles for good teaching are discussed and concrete examples given where appropriate.

In order to make clear the fundamental processes involved in psychological development, the book starts with a study of the way in which the young child adapts its behaviour to its environment. This study involves a brief consideration of some of the key aspects of physical development, mainly the central nervous system. At the same time we consider the way physical growth and psychological development are influenced by the experience of the individual.

The discussion of development is followed by an examination of the processes of learning. Lower animals are considered, as well as man, since their much simpler behaviour helps to show more clearly the basic aspects of learning which man has in common with other animals.

In the discussion of learning the general aim has been to present an integrated view of the main features of conditioning theory without attempting to go into detailed discussion of the distinctions between the various views on the subject. This has meant a certain amount of oversimplification but the reader who wishes to explore the matter further will find more precise and detailed exposition of the subject in the references given and in other standard works on the subject.

Learning characteristic of man is considered next. The view is taken that the great difference between learning in man and the other animals, stems from man's life as a social being. In particular, it is argued, language is of fundamental importance in human learning since the use of language is crucial in the development of thought.

The way in which children form ideas about the world is discussed next and particular attention is paid here to the work of Piaget. A study is also made of the categories of thinking which are likely to be of most use to children.

We then examine the processes whereby the child acquires complex habits of thought through his use of language and we see how language deficiency holds back the development of the child's thinking.

The processes of learning so far considered are now related to specific classroom subjects, and suggestions are made to help the student to apply his knowledge of these processes to the classroom. Here we also discuss the application of programmed learning to the classroom and consider the psychological principles of programming and the use of teaching machines.

A section is devoted to the tests which a teacher might use in the classroom. The weaknesses of some traditional methods of testing and marking are discussed, and suggestions made to help the teacher avoid these weaknesses. Intelligence testing is given special attention and the changing views on the nature of intelligence are explained. Suggestions are made to the teacher about ways in which he can profitably use the various types of tests including intelligence tests.

Since the majority of teachers will at some time have children in their classes who, for various reasons, are less able than the other children, we discuss the causes of backwardness and its diagnosis. We also consider the way in which the teacher can help children to overcome their disability, and what he can do to get expert help for the more difficult problems.

Children are greatly affected by the social groups to which they belong and we therefore examine the effect of group influences on the child. Particular attention is given to the influence of the class and the school on the child's learning and emotional stability.

The final chapter deals with the teacher's work. It attempts to bring together the key aspects of educational psychology that the teacher needs to consider in his work in the classroom.

A note on the organization of the book

The salient points of each chapter are brought together in a summary which may be used by the reader to obtain a preliminary overview of the content of the chapter, and as an aid to revision.

References are given in brackets in the body of the text and are restricted to those which students may be reasonably expected to be able to follow up. The references are collected at the end of the book in numerical order as they appear in the text.

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CHAPTER 1

The Foundations of Learning

Viki was a chimpanzee reared in the household of two American psychologists, C. and K. Hayes. They adopted her a few days after birth and reared her as far as was possible as they would have reared a human child. If Viki's development seemed to be deficient in any way as compared with human development, she was given special training. As a result of this unusual environment the chimpanzee developed more affinity with human babies than with other chimpanzees. She became capable of activity quite beyond the capacity of similar animals reared in more orthodox environments. She learned to dust, to wash dishes, to sharpen pencils, to paint furniture, and she could cope with psychological tests intended for children of her age so long as language was not involved. In many respects Viki made the same progress as a child of the same age; the most important difference was in language development where Viki made very little progress. The reason for this is probably that the brain of the chimpanzee is deficient in those areas which in humans we call the speech centres.

Viki was reared in an environment which for a chimp was extremely stimulating. She was continually being faced with problems to solve and she was given assistance where she had difficulty. In contrast chimpanzees in zoos have comparatively unstimulating environments and consequently develop much more limited abilities. The reverse is the usual case with children. The home itself generally provides a rich environment and the exceptional case is the child who is reared in an environment comparable to that of the chimpanzee reared in the zoo. The few existing reports which deal with such cases indicate that when the environment is grossly deficient in stimulation, the development of the child is correspondingly retarded.

One such report was made by R. A. Spitz in 1945 on the physical and psychological development of a number of children reared in a foundling home [1]. Their ages ranged from two to four years. Of twenty-one children five were totally unable to walk and only five could walk unassisted. Twelve could not feed themselves with a spoon, and only one could dress himself; none of the children was toilet trained. Six were unable to talk and only one could use sentences. Most of the children had the physical appearance of children about half their age. It should be stressed here that the children in the home were in no way maltreated. They had had excellent medical care, adequate diet, and had not been exposed to any injury or infection. The only abnormal thing in their life histories was the lack of social stimulation in the first years of life.

An extreme case of lack of social stimulation gave rise to one of the earliest attempts to apply scientific principles to the analysis, prediction, and modification of behaviour in man. Late in the eighteenth century a 'wild boy' of twelve was captured in a French forest. He was naked, walked on all fours, made unintelligible sounds, ate like an animal, and bit those who attempted to handle him. He was given to a French physician, J. M. G. Itard, to attempt to educate him. Itard thought that the child's gross deficiency was probably caused by his prolonged isolation from society. He analysed the boy's learning disabilities by a series of experiments and attempted to remedy them by a systematic programme of teaching. He was only moderately successful, one of the difficulties being that the boy probably suffered from some form of brain damage. But he did make some important progress, and his work foreshadows much modern work in education and psychology.

These investigations and experiments raise questions of fundamental importance for the teacher and the student of education. The key question is probably *to what extent can children be trained, and to what extent are physical factors which we are unable to control likely to frustrate our efforts?* The Hayeses produced behaviour in a chimpanzee quite out of proportion to the normal development of such animals. They failed to train Viki to use language probably because her brain was inadequate. On the one hand a richer environment produced much more complex behaviour, on the other hand physical deficiencies prevented the development of language despite the best efforts of the psychologists.

With children similar problems arise. We might ask if young babies a few months old can be toilet trained, or if it is possible to teach the average child of four to read. The answer to the first question is clear. The child of three to six months lacks the physiological equipment to control his bladder movements, and no amount of sitting on his pot will train him to use it at the appropriate time. At best, his mother might find out the most likely moment and time her potting with the baby's evacuation. The answer to the question of teaching reading is less clear. Until quite recently many authorities would have stated that learning to read was dependent upon the child's reaching a certain stage of development, normally at about the age of six. They would say that to try to teach reading before the child was *ready* would be harmful. While it is clear that it would be impossible to teach a young baby without speech to read, it is by no means so clear that children much younger than six cannot be taught to read. It is more than likely that the waiting for the children to reach the stage of *readiness* for reading is the main factor in ensuring that they do not learn to read before six. In this case it is not so much inadequate physiological equipment as lack of stimulation and training.

What is it, we might ask, that underlies this difference between the two examples of child training we have just mentioned? To help us to find the answer to this question let us consider those aspects of our bodily make-up that affect profoundly the way in which we learn or don't learn.

Man in his environment

When an organism learns it adapts its behaviour to cope with changes in its environment. Man is an organism; more specifically he is an animal. He is undoubtedly a remarkable, and in many ways a unique, animal. Nevertheless he resembles other animals in bodily structure and functions. Because of this resemblance we can, by studying the ways in which other animals learn, gain insight into the way man himself learns. Although it is not possible to apply automatically the lessons we learn from the study of animal behaviour to human beings, there is no mysterious qualitative difference between man and the other animals which makes his behaviour inaccessible to our understanding. Many phenomena of human behaviour are still not understood, but this is probably because of inadequate knowledge rather than because the phenomena are forever inexplicable.

From the beginning of life until death, organisms are in a continuous state of interaction with their environments. In fact the term *environment* is used by some psychologists to designate the aspects of the organism's surroundings to which it is responding at a given time. This means that in the case of man he will be responding to such aspects of his surroundings as the things he can hear, see, touch, smell, taste, and feel. Such sensations may impinge upon him from his surroundings or from his internal environment, that is, from within his body.

The complexity of an organism's adaptation to its environment depends largely on the complexity of its nervous system. Thus a simple organism such as a worm with a very simple nervous system has a very low level of adaptation to its environment: that is, it is capable of only a very limited range of activities to cope with changes in its environment. Man, on the other hand, has a very complex nervous system and is therefore capable of a much greater range of activity.

The most complex nervous system would be of little use, however, if it were isolated from its environment. The nervous system of the worm receives information about the state of the soil through the worm's skin. When the soil dries, the worm burrows deeper to where the soil is damper. Man receives information about the environment through the various senses and because the channels through which he receives this information – the eyes, the ears, the nose and mouth, the skin, and the muscles – are so much more delicate and complex than the channels through which the worm receives its information, man is able to make much more delicate and complicated differentiation of the incoming information than the lower animal can do. Man has a further advantage over the worm. Not only can he take in more information and more complex information than the worm, he has the ability to deal with his environment in a more complicated way through the organs which act on the environment. The worm can act on its environment only in a limited way. It can take food and soil in through the mouth. It can excrete. It can wriggle around. Man, on the other hand, is capable of extremely delicate and versatile acts of manipulation because of the highly developed muscles and bone structure of his hands and fingers.

Ultimately, the adaptation of both man and worm will depend on the integrated activity of the organs which receive information from the environment, called the receptors. The nervous system that receives this information through nerve fibres, analyses it and passes it on to the effectors, i.e. the organs which act on the environment. In man all these organs are infinitely more complex than those of the worm hence the greater complexity of his adaptation to the environment.

If we compare man, not with a worm, but with a chimpanzee, we see that the differences are much less marked and yet man's activities are still infinitely more complex than those of the chimpanzee. What is the reason for this? Is it because one or more of man's organs are more highly developed than those of the chimpanzee? We shall discuss this at much greater length later when we shall see that physiological development is not the only thing that makes this enormous difference between the two species; however, on the physiological level there is a difference. This difference is in the level of development of the nervous system. In particular, it is the development of man's brain that provides the physiological basis for the development of the highly complex patterns of activity of which he is capable.

In very simple animals the nervous system consists of just a few nerve fibres. With a little increase in complexity the fibres increase in number and interconnect in a *neural net*. The higher up the evolutionary ladder we go the more complex this neural net until in man we find a complexity of interconnections beyond the scope of our imaginations. Judson Herrick, the neurologist, at Chicago University, has calculated that if a million of the nerve cells in the human brain were joined two by two in every possible way the number of combinations would total $10^{2,783,000}$. If this figure were written out it would take up the whole of this book. Even that would be only a fraction of the possible combinations, since every nerve cell can be linked with many more than one other, and also there are in the region of 10,000 million nerve cells in the human brain. It is this unimaginable complexity that makes for the complexity of man's behaviour.

The cortex

The cortex is the name we give to the part of the brain that accounts most for the tremendous complexity of the organ in man. Other parts of the brain are much more similar in man and the other animals. In man the cortex completely overshadows the rest of the brain and is the key factor in determining that man's behaviour is of a completely different order from that of other animals. The cortex is so important, not because of any difference in the kind of nerve cells which constitute it, but because of their enormous number and the richness of their interconnections.

Although most of the cortical cells are similar, various areas of the cortex have developed specialized functions. Some areas of the cortex are concerned with vision, with motor activity, with auditory stimulation, with speech, and so on. The detailed *maps* of the cortex sometimes given, which link with precision, areas of the brain with different bodily functions, probably give a misleading air of accuracy. It is not possible to define these areas with such precision. However, it has been discovered that when different areas of the cortex are stimulated electrically, experiences and activity specific to different bodily functions are evoked. The control by the brain of our behaviour is demonstrated vividly in these experiments as is also its role as the seat of memory.

W. Penfield, the distinguished neurosurgeon, stimulated different parts of the cortex of patients undergoing brain operations. The patients in these operations are quite conscious since the brain has no sensation and there is therefore no pain. He found that when areas of the cortex concerned with motor activity were stimulated by slight electrical discharges, movement of the limbs was caused. The patient could do nothing to stop the movement although he realized that he had not *willed* to do it. Stimulation of the area concerned with hearing cause the patient to experience sounds, and stimulation of the visual area evoke sensations of *brightness*, *colour*, and so on.*

Stimulation in other cortical areas produces vivid recollections of past events. Patients have heard music as it was originally played or sung. They will say to the surgeon that there is a man at the piano, or that the people are singing in church. In one case a patient who had been stimulated repeatedly in the same place heard the same song on each occasion and refused to believe, even in discussion later, that there was no radio in the room. All these experiments illustrate graphically how our knowledge of the world, the control of our behaviour, and the mechanisms of memory are seated in the nervous activity of the brain. One other experiment which Penfield carried out leads us to another important aspect of brain function which holds great promise for future investigations of the nature of brain mechanisms.

In one experiment Penfield placed electrodes on the exposed cortex of a man undergoing an operation. The man was asked to 'make a fist'. As he did so the pattern of electrical discharges from the brain, which was being picked up by the electrodes, changed. From the rhythm of the brain at rest the rhythm changed to that of the active brain. This illustrated the fact that motor activity is associated with changes in the pattern of electrical discharges of the cortex; this is one aspect of the discipline of electroencephalography; the study of the patterns of electrical discharges of the brain.

The electrical activity of the brain

The electroencephalograph is an apparatus which uses electrodes fixed to the scalp to pick up electrical discharges from the brain.

* PENFIELD, W.: in MAGOUN, H. W. (Ed.): *Brain Mechanisms and Consciousness*, Blackwell, 1954.

The brain does not need to be exposed as in the case of Penfield's experiments, and there is no pain in the attaching of the electrodes to the scalp. The discharges are picked up by the electrodes and are recorded by pens on moving paper, the frequency and amplitude of the discharges being conventionally recorded as a series of wavy lines on the paper; this is the electroencephalogram or EEG. Over twenty pens record the impulses from different parts of the brain in the typical EEG. The interesting thing about EEG patterns for the psychologist is that there is evidence that they are connected with patterns of behaviour. Eventually EEG patterns may be one of the factors which link psychological phenomena with the actual activity of the brain.

EEG records show that the electrical activity of the brain conforms to certain patterns or rhythms. When the subject is at rest with the eyes closed the brain produces a slow pulsing rhythm of about ten cycles a second. This is the *alpha rhythm* which represents a synchronization of the activity of many cortical nerve cells or neurones. When the eyes are open the alpha rhythm disappears and is replaced by quicker, less regular discharges. In sleep the alpha rhythms are replaced by the *delta rhythm* which is a slower rhythm (0·5–3·5 cycles per sec.). The British scientist, W. Grey Walter, has suggested that the alpha rhythm is a form of *scanning*. The brain at rest, with few sensory inputs from the environment, seems to be searching for a pattern by scanning as you might search for a particular word by scanning the page of a book. When the pattern is found, the scanning ceases, as your eye movements would cease when you saw the word. The cessation of the alpha rhythm indicates the desynchronization of the electrical activity of the cortical neurones. These will now be receiving stimulation from the various receptors. They will have 'found their pattern' and the nerve impulses will now be engaged in dealing with the information from the environment and not with searching for it [2].

In the young baby the brain rhythms are predominantly the delta rhythms. This suggests that the child is essentially in a passive relationship with its environment. The delta rhythms are those of the sleeping adult, and although the baby is being subjected to a great number of stimuli from his environment, he lacks the cortical development to perceive or to respond to them. If we now consider the baby at the breast, we see a profound difference between his activity and that of the man who was asked to 'make a fist', in Penfield's experiment. On the one hand the alpha rhythm of the man disappeared when he made a fist: scanning activity was replaced by neural excitation connected with the physical act. On the other, the baby takes the nipple and yet still exhibits the delta rhythm of the resting brain. The sucking response is automatic; the baby does not *know* what it is doing.

Grey Walter has suggested that the lack of alpha rhythms in the young child may act as a defence mechanism for the immature brain. If the very young baby were suddenly exposed to the flood of stimulation from the environment to which adults are accustomed, the results would probably be disastrous. The cortical discharge evoked by such a barrage of stimuli would most likely overwhelm the brain and bring about a seizure or convulsions. The delta rhythm indicating indifference to outside stimulation, insulates the immature brain and shields it from the complexity of the environment.

An experiment carried out with dogs by J. Fuller of Maine seems to offer behavioural corroboration of this hypothesis.* He found that when dogs reared in isolation and deprived of stimulation through contact with different aspects of the environment were released, they exhibited behaviour very reminiscent of human psychotic behaviour. Fuller suggests the hypothesis that since the puppies were reared in conditions of stimulus deprivation while their receptors were maturing, they were, on the moment of release from their confinement, subjected to an intense flood of stimuli to which they had no developed means of adequately responding. Under normal circumstances, as with the human baby, these organs and the cerebral cortex are insufficiently developed to take in the stimuli when they are first presented. The normal processes of development, which involve the gradual adaptations of the organs to increasingly complex patterns of

* FULLER, J. L.: *Discovery*, February 1964.

stimulation, enable the young animal to come to terms with his environment gradually and without disturbance.

'Knowing' and doing

The physiological processes we have been considering are the basis of our psychological activity. We have seen how the mother cannot modify the toilet habits of her young baby before the appropriate nerve cells have developed. Other factors of a physiological nature ensure that the psychology of babies and young children is very much different from that of the adult. Mothers often find it difficult to accept that their babies could hardly be said to *know* or *understand* something of what they are doing. They consider that the baby *knows* how to suck the nipple from the very beginning. In fact, the new born baby sucks *automatically* rather as most people respond to being tickled. It will respond to stimulation inside its mouth by a sucking activity; this stimulation is usually provided by the nipple, but it can be evoked by other stimulating objects. Lacking the development of the cortex and the elaboration of the complex neural circuits, the baby cannot control its activity and it would be incorrect to say that it *understands* what it is doing. This may be seen more clearly when we consider that babies born with no cortex have exhibited sucking responses, and the cortex is the seat of our conscious activity.

The infant's smile is another factor which causes misunderstanding of the psychology of the young child. The mother often considers that the child's first smile is a smile of recognition; perhaps even of recognition of *mother*. In fact the visual apparatus is so undeveloped that the child is incapable of distinguishing the mother from other adults and will smile at a hideous mask, or even at a row of dots or a group of dots.

The brain and learning

As we have seen, the brain is of supreme importance in the regulation of the activity of organisms. Parts of the brain other than the cortex have certain functions which greatly influence the ability of the organism to learn but in man it is the great development of the cortex that has enabled him to learn the complex skills that we shall be discussing in the pages which follow. The other parts of the brain, sometimes referred to as the subcortical parts, regulate such things as our level of alertness, our awareness of basic 'needs' such as the need for food or water, and our emotions. Clearly our level of alertness has a great deal to do with learning. Unless we are alert we cannot attend effectively to our environment and the cortex will not receive the stimulation it needs to form the links necessary for us to adapt effectively to changes in the environment. The part of the brain which maintains the level of arousal of the organism is called the *reticular formation* and malfunction of this can have serious effects. Monkeys with the reticular formation removed surgically, become comatose and show little or no reaction to the environment. Some children who are mentally subnormal show irregularities in function of the reticular formation.

The part of the brain which deals with emotions can also have a great effect on learning. Malfunctioning of this, the so-called *limbic system*, could cause disproportionate reactions to environmental stimulation which would prevent learning. For example, if instead of maintaining a relatively stable level of emotionality, we exhibit uncontrolled rage or excessive fear, the corresponding activity of the limbic system would swamp that of the cortex and prevent the connections necessary for satisfactory adaptation being made. We should note in passing, however, that unsatisfactory emotionality can be learned, and need not necessarily indicate malfunction of the limbic system.

The other important functional part of the subcortical areas of the brain is called the *hypothalamus*. This makes us aware of our basic needs. We learn to adapt to our environment to satisfy our basic needs: if the hypothalamus does not function properly we may not be aware of our needs and may take no steps to satisfy them. Or, possibly, the effect is in the other direction and we find it impossible to satisfy our basic needs. On the one hand the organism would, for example, feel no need to eat and would die of starvation, on the other hand it would eat but not feel satisfied and so would continue to eat until it was incapacitated through overeating.

Under normal circumstances the subcortical regions of the brain and the cortex itself work as an integrated unit to maintain an organic equilibrium: all work together to ensure the optimum adaptation of the organism to the environment. The cortex is the essential organ in ensuring the best adaptation. It does this through the connections formed in the cortical nerve cells to which we have already referred, and these connections are the physical basis for our behaviour.

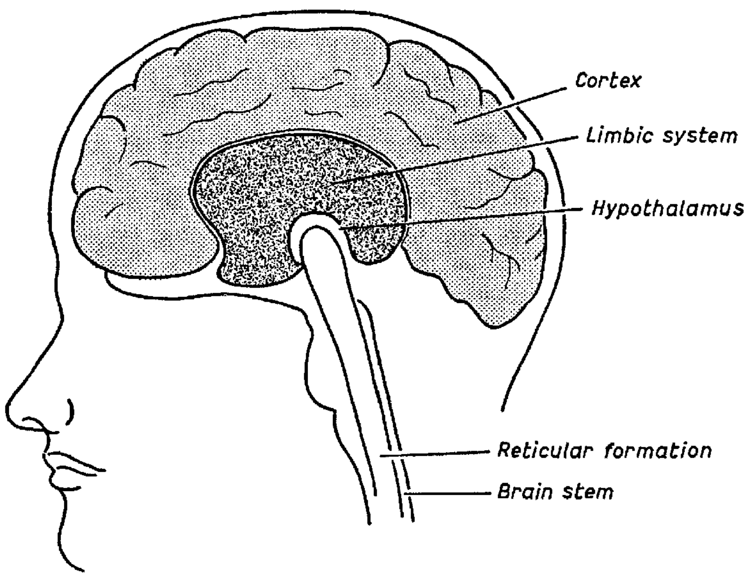

Fig. 1. Diagram of the main functional systems of the brain. Only those structures referred to in the text are shown. The diagram is not intended to be anatomical. As stressed in the text, these systems are richly interconnected and should not be considered as isolated structures.

These connections do not develop in predetermined patterns fixed at birth, but in systems of functional links depending on the stimulation they receive from the environment through the receptors. If stimulation is lacking, the links will not be formed and the patterns of behaviour will not develop. When we learn, we set up different patterns of connections in the cortex; these are real physical changes although they are not necessarily fixed once they are set up. We shall see in a later chapter how the connections are made and unmade in the process of learning.

If we consider our earlier question about the teaching of reading to young children, in the light of this discussion, it seems that the arguments about *reading readiness* have rather shaky foundations. At the age of six (average age of 'readiness') the brain is 90% of its adult size. Most of the connections with receptors and effectors are functioning and the physical apparatus to cope with reading is there. What is not there, are the cortical links which can only be formed in intercourse with the environ-

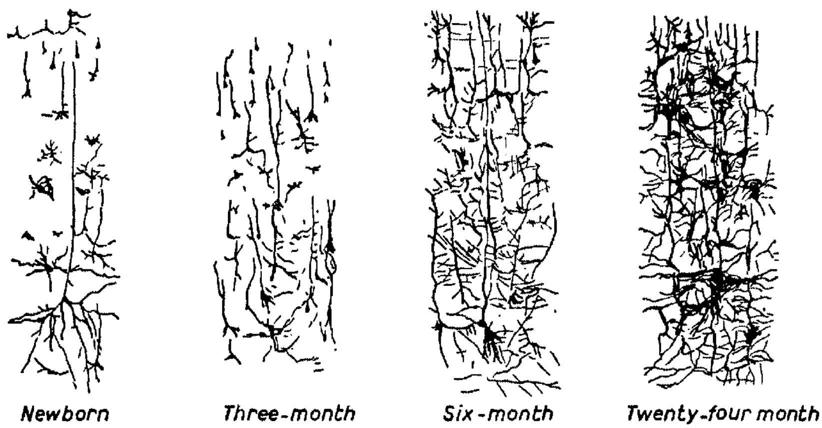

Fig. 2. Stages in the developing human brain. The increasing complexity of the baby's behaviour is very largely dependent upon the growth of the number of cortical nerve cells and the intricacy of their interconnections.

ment; in this case, with the teacher teaching reading. It seems likely, therefore, that this is an opposite example to that of the baby and the pot. The latter could not learn because the nerve cells were not fully grown; the former has all the functional nerve cells but lacks the cortical links which can only be formed through experience. No amount of experience would teach the baby to oblige; no amount of waiting without experience would bring the latter to the stage of reading. The whole question of learning to read is discussed more fully in later chapters.

The evolution of the brain

We conclude our discussion of the function of the brain in man with a brief consideration of the factors which went towards making man so much different from the other animals.

It has been said that men were walking the earth 50,000 years ago who could have conducted a symphony orchestra, or read a paper to a scientific society. This refers to the fact that the brains of such men were much the same as those of contemporary men. There seems to have been very little evolutionary development of the human brain since those times. Prior to this, man's forbears, the pre-men or hominids, had much smaller brains. In fact the brain of modern man is some three times the size of that of the hominids.

Recent fossil discoveries have provided evidence of great interest and importance in this field. What has been called 'an explosion of brains', it is suggested, is not the cause of man becoming man as we know him, but that his taking to the social existence characteristic of man was the cause of the tremendous development of the brain which set man apart from pre-man. On the occasion of the one hundreth anniversary of Darwin's *The Origin of Species* Washburn and Howell at the Chicago Centennial celebration read a paper in which they said:

> The tool using, ground living, hunting way of life created the large human brain rather than the large brained man discovering certain new ways of life. [We] believe this conclusion is the most important result of recent fossil discoveries and is one which carries far-reaching implications for the interpretation of human behaviour and its origins. The important point is that size of brain, insofar as it can be measured by cranial capacity, has increased some threefold subsequent to the use and manufacture of implements. . . . The uniqueness of modern man is seen as the result of a technical-social life which tripled the size of the brain, reduced the face and modified many other structures of the body.*

We might well ask in concluding this chapter: 'Why, in fact, were there no men conducting symphony orchestras 50,000 years

* Quoted BRUNER, J. S.: in *American Psychologist*, January 1964.

ago?' The answer to this points to one of the most important aspects of human psychology and illustrates in a striking way the interdependence of man and his environment. The brain, we have seen, depends for the development of its most characteristically human feature, the cortex, on stimulation from the environment. The evolution of man has led to a progressively more complex social environment. This increasingly complex environment has provided the cortex with ever richer patterns of stimulation, which lead to more and more elaborate cortical connections. Man thus increases the complexity of his environment and this new complexity makes possible the further development of the cortex and the complicated behaviour patterns which depend on it. In other words, there were no symphony orchestras 50,000 years ago because man had only just started to create the environmental conditions which were eventually to make symphony orchestras technologically and psychologically feasible. If we could whisk a child from those times to our present day, he would probably develop in much the same way as our own children. In the absence of a time machine he must stay at his primitive level, and instead of growing up to conduct an orchestra, he grows up to hunt and gather food; no doubt adding a little in the process to the complication of the environment we have been discussing. The whole process has been admirably summed up by V. Gordon Childe in the title of his book, *Man Makes Himself*.

Summary

In this chapter we have considered the factors which determine the extent to which children can be trained. We saw that chimpanzees in a stimulating environment develop more intelligent behaviour than chimps in zoos or in the wild. Conversely, children reared in environments lacking in stimulation grow up less intelligent than other children and are backward in many other respects. We saw that the chimp did not develop speech because it lacked the necessary development of the cortex. The child was unable to control its bladder activity because the necessary neural links had not yet been set up.

Man is considered as an organism in constant interaction with the environment. The patterns of interaction are determined by the activity of the central nervous system. Information about the environment is collected by the *receptors* and transmitted via the central nervous system to the *effectors* which control bodily movement.

The brain has four basic structures. The *reticular formation* maintains the state of alertness of the organism. The *hypothalamus* registers states of organic need, the *limbic system* is concerned with states of emotion. The *cortex* is the seat of intellectual activity. These four structures work together and influence each other.

The cortex is the most complex part of the brain. It is the part of the brain most concerned with regulation of man's interaction with the environment. The cortex of the young baby lacks the network of functional neural connections of the adult. EEG patterns in young babies suggest that they are mostly unaware of their surroundings. They only gradually become aware as an increasing number of neural connections are made. That is, consciousness is built up gradually in the child. It is likely that this is advantageous to the child, since if a new-born baby were fully conscious of its surroundings, the sudden influx of stimulation to the brain would probably cause organic breakdown.

Since the nerves of the very young baby are not yet sufficiently grown to make the necessary connections, it is impossible to build up habits which depend on these connections. It is, therefore, not possible to toilet train a very young child. On the other hand, behaviour such as reading which depends on the establishing of *functional* systems of links in the brain caused by changes in the nerve cells can be built up in children once the nerves are sufficiently mature. Children in general reach this stage by four or five, and whether, in fact, they learn to read will depend largely upon whether the teacher gives them the experience to build up the necessary cortical links.

The brain of modern man is very similar to that of man living over 50,000 years ago. The fact that modern man is capable of much more complex activity is not because of any evolutionary change in brain structure, but because men's brains today develop in a much more complex environment. Cultural change has replaced evolutionary change. One of the most important aspects of the changed environment involved in ensuring that man today is not as man was 50,000 years ago is his educational *milieu.*

CHAPTER 2

The Nature of Development

From the moment of conception, when the male sperm cell fertilizes the female ovum in the uterus, to the moment of death, the organism is in a constant state of change. Early in life the changes are dramatic and obvious and this is the field which mostly concerns the student of child behaviour. The process of change starts in the uterus where, for the first part of its life, the child is shielded from the vagaries of the world outside and rocked securely in an environment of great stability. It is an environment most congenial to the foetus but it is a relatively unstimulating one, and, despite the very great changes which take place in the embryo before delivery, the new-born child is completely unequipped to cope with the enormous complexity of the world outside.

Normal foetal change consists essentially of the gradual differentiation of the specialized organs from the original fertilized ovum. This development in the womb takes the child from the stage of the single fertilized cell to something recognizably human. Its development is essentially morphological, that is, it consists mainly of the development of the structure of the organs. Post natal development continues this structural growth but, in addition, functional development now becomes significant. From now on the baby adapts to its environment mainly by refining the functions of various organs. At birth the baby's movements are gross and undifferentiated; it tends to move the whole of its body rather than individual limbs; or the whole arm rather than the hand. It is capable only of the crudest reflex actions. These reflex actions are mainly elicited by touching the skin but there is also a good deal of uncoordinated spontaneous bodily movement [3]. This activity has been observed in malformed infants without a cortex which indicates that it is truly involuntary.

Growth of the brain and other parts of the body, together with the elaboration of neural links, make for the finer discrimination of activity. One of the first results of this development is that the child acquires the ability to control the former indiscriminate activity of his limbs. Instead of making gross movements of the arms, he gradually acquires the ability to move the hands to grip, then to manipulate. Bodily movement progresses from the gross activity of the recumbent baby, through the stage of crawling, to the complex coordination and balancing of the walking child. Later development brings the increasingly complex coordination of motor activity associated with the acquisition of various physical skills. After the differentiation of control over the various organs comes the complicated synthesis of their activities into coordinated movements. The baby eventually grows into the child who is capable of riding a bicycle or manipulating a pen with accuracy. Such advances depend on the growth and development of the various organs, and also on the satisfactory growth and development of the brain, including the elaboration of the necessary cortical connections.

When the new-born baby leaves the womb it leaves an environment which supplies everything it needs to keep it alive and in comfort: the foetus needs to do nothing to maintain a stable state of equilibrium. We might say that it lacks nothing. On being delivered, its state of equilibrium is shattered. No longer is it automatically fed, warmed, and kept free of impurities and damage; these functions, from the moment of birth, start to become the baby's own responsibility. It must come to terms with its new environment.

The fact that most babies do, in fact, learn to come to terms with their environment, and do, in fact, manage to take over responsibility for their own survival, is due to a great extent to the tendency of living organisms to maintain a state of equilibrium with the environment. What it once did in the womb with no effort, the baby must now do outside, often by the setting up of extremely complex patterns of behaviour. When the current state of equilibrium is upset, the organism adapts its behaviour in some way so as to restore equilibrium again. The new state of equilibrium will not be the same as the original one since the organism will be changed in some way by the very act of restoring the state of equilibrium.

We may illustrate this by reference to one of the most fundamental states of disequilibrium. An organism needs food for growth and energy. When food is lacking the state of equilibrium of the organism is upset; it cannot replace the energy it is consuming or continue any processes of bodily growth. All organisms whose equilibrium is upset in this way will do what they can to obtain food so as to restore equilibrium. The term *needs* is sometimes used to designate the state of organic disequilibrium. The organism engages in behaviour to reduce its needs. A need is some deficit within the individual. In the case of lack of food the need may be referred to as hunger, although it must be said that some psychologists dislike the use of the term since it does not really explain anything although it may name it.

Neural connections between the hypothalamus and the limbic system link needs with *affect* (which is the general term used to refer to emotion). Thus the restoration of the equilibrium of the organism, through the ending of a state of need, results in a state of positive affect; for example, a mild pleasure after a meal, or the feeling of satisfaction after solving a problem. In addition, the cortex is linked with the hypothalamus and with the limbic system. Thus we are aware of needs and of our affective state. At the same time the cortex can influence the other centres. We eventually learn, with varying degrees of success, to 'control our emotions'. We learn also to satisfy our needs in conventional socially acceptable ways. Both these would be impossible without the integrated activity of the whole brain.

The affective states of the organism have their correlates in the autonomic nervous system. This is the system concerned with the control of our basic bodily functions such as heartbeat and the digestive system. Thus negative affect, such as is associated with what we term the emotion of fear, involves such physiological changes as increased heartbeat, dilation of the pupils of the eyes, the secretion of adrenalin into the bloodstream, and the inhibition of digestive processes. These physiological changes have survival value. They all help to enhance the physical capabilities of the organism to deal with an emergency. In adults, we can identify many emotions; fear, anger, hate, joy, and so on, but the young baby lacks these differentiated affective states. Instead he exhibits only positive and negative affect. Like much of the baby's development and activity, his affective life is gross and undifferentiated. Movement towards maturity brings the finer differentiation of affective states, so that we are eventually able to distinguish between behaviour associated with anger and fear, whereas in the young baby these would have been identifiable only as negative affect. The same applies, of course, to other emotional states.

From the first moments the behaviour of the new-born baby is *motivated* by the tendency towards the restoration of equilibrium. Behaviour which restores this state of equilibrium will be found satisfying or 'pleasant' so that the baby will be likely to repeat the behaviour on a future occasion. When the baby takes the nipple on the first occasion through reflex activity on having his mouth stimulated, the state of disequilibrium existing because of the need for food will be ended, and the sucking will be accompanied by positive affect. This behaviour is the prototype of the behaviour of the adult who goes to a restaurant and carefully consults the menu and then makes his choice of meal.

Thirst is another basic need. The organism deprived of water cannot survive and therefore is impelled to behaviour aimed at ending the state of deprivation.

Most animals are motivated at times by the need for sexual activity. This is another of the basic needs. The mature organism is stimulated by secretions from the sexual glands. Satisfaction of the need is provided by copulation. In primitive animals the activity which ends the state of need caused by the stimulation from sexual glands is largely automatic, but in more highly developed animals, as we have seen, while the need develops with the development of the organism, the manner of its satisfaction has to be learned.

For the organism to survive it must avoid damage to its tissues. Hostile environmental conditions such as intense heat, or intense cold, or direct physical damage, are all inimicable to survival and produce a state of organic disequilibrium which the organism will seek to end. As with other needs there is a link between this and the affective side of behaviour. Tissue damage stimulates the connections to the limbic system producing negative affect, that is, sensations which we refer to as pain. The ending of the noxious situation ends the threat to the organism and thus removes the factors which disturb its equilibrium. The organism then returns to its normal state; the strong negative affect also ceasing. Were there no connection between the affective centres and the receptors signalling tissue damage, we should feel no pain on being cut or burned. This would mean that we should be in considerable danger of serious organic injury of which we would be unaware.

The needs so far discussed are those clearly connected with the survival of the organism, or in the case of the need for sexual activity, with the survival of the species. These needs may be regarded as the outcome of a long evolutionary process. Two other needs, which are basic to the survival of some organisms and which provide the motivation for much of their behaviour, are also of evolutionary significance, although less obviously apparent than the ones so far mentioned. One of these needs has been identified in recent years by H. F. Harlow who has conducted extensive experiments on the behaviour of monkeys. This is the need of the young mammal for contact with the mother or a substitute for the mother. Newly born monkeys will react by clinging to any surface which is placed in contact with the surface of the body. This reaction is similar to the automatic action of the baby's mouth when the nipple is presented. Its strength is strikingly demonstrated by one experiment in which very young monkeys who had shown no signs of being able to move around, followed a piece of cloth which was placed against the face and then gradually withdrawn. The animals automatically followed the cloth, sometimes even quite rapidly. In nature the evolutionary value of this behaviour is apparent; the monkey that did not cling to its mother would fall and die.

The baby kangaroo is born in a very immature state; it is little more than a foetus. On delivery it clings to the mother's skin and climbs upwards to her pouch. Eventually it reaches the pouch and attaches itself firmly to the nipple within and there it stays until mature enough to fend for itself. Any other pattern of activity would be disastrous for the young animal. It would, however, be wrong to say that the animal *knows* that it is climbing to safety. Kangaroos are not particularly intelligent when adult; the immature animal is a very much simpler organism and the activity can only be described as reflex.

The experiments which Harlow carried out demonstrated that the need for what has been called *contact comfort* was not dependent upon the need for food as might have been surmised. He devised substitute mothers from wire frameworks, one of which he covered with towelling. The other frame carried the feeding bottle. To obtain food the monkey had to climb up the wire *mother*. Despite this arrangement, the young monkeys developed an attachment to the towelling mother very similar to that normally formed to the real mother. They even clung to it in anxiety-producing situations, for example, when a strange object was put in the cage. Monkeys reared only on the wire frame did not cling to that in the presence of danger, but clutched themselves or rubbed themselves on the side of the cage until the danger was over [4].

One other basic motivator of behaviour is the need to know the environment. This is generally referred to as the *orienting reflex*. The orienting reflex is evoked when new stimuli enter the environment. An unknown stimulus in natural conditions may represent danger until it is thoroughly explored and seen to be harmless. When the new stimulus first appears, the equilibrium of the organism is upset by the change in the environment. Equilibrium is restored when the stimulus is thoroughly explored. The organism is then said to be *habituated*. Orienting activity is linked with the activity of the reticular formation. Work with the EEG suggests that the effect of the reticular formation is to increase the significance of stimuli for the organism so that the organism orients to these stimuli. Habituation is accompanied by a dying away of the discharge from the reticular formation.

There is evidence to suggest that organisms seek to maintain the input of stimulation through the senses at a relatively high level. Reduction of the input results in activity which continues until the sensory input is returned to the optimum level. The reduction of input of stimulation to a very low level can have deleterious effects for the organism.

In one investigation designed to examine the effects of stimulus deprivation, the experimenters paid college students to lie on beds in lighted cubicles for twenty-four hours a day. Sounds were kept at a minimum. Vision was controlled by goggles. The arms were placed in cardboard tubes which restricted the input through touch. Under these conditions mental skills deteriorated and emotional disturbances appeared. The students seemed dependent for their mental health on a continuing stream of stimulation from the environment.

In another experiment rhesus monkeys were given a discrimination problem to learn, the only reward being the opportunity to look out through a window for thirty seconds. The fact that the monkeys learned to solve the problem with this reward suggests that the need for stimulation is basic to the organism.

The suggestion is, therefore, that the need to know the environment is basic. It may be regarded as one of the important motivators of behaviour and one which is very important for the teacher. Applied to the classroom this suggests that we should maintain orienting activity related to current learning by ensuring that new elements are introduced before habituation takes place and the child loses interest. The point to bear in mind is that when the child is investigating new stimuli (new material or novel activity initiated by the teacher) he is in a greater state of arousal than when he is in a monotonous situation in the classroom. This means that the child's receptivity to the learning situation as a whole is heightened when controlled orienting activity is maintained.

The needs we have been considering have been related to simple, or even primitive patterns of behaviour. It is obvious, however, that the patterns of human behaviour are far from simple or primitive. But human behaviour patterns are, to a large extent, founded on these basic needs through the processes of learning that we shall take up in the next chapter. Before leaving the subject, however, we should note a potential difficulty. It is possible, and only too easy, to postulate a need appropriate to any observed behaviour. We could, for example, 'explain' the habits of the dipsomaniac or the chain smoker, in the one case by referring to a 'need' for alcohol and in the other to a 'need' for tobacco. This explanation is obviously spurious if we are using the expression *need* in the way we have previously used it. We do not really explain, we merely describe. Needs such as that for food or for drink can be founded on the physiological facts of tissue requirements and brain activity. Thirst and hunger have both been evoked in rats by electrical stimulation to the brain. Sexual activity has also been found to have its appropriate centres. A number of experiments in electroencephalography suggests that behaviour resulting from the orienting reflex has a physiological correlate which can be recorded by the electroencephalograph. Needs that can be demonstrated to be innate and based upon physiological foundations may be accepted as being real, others must await further evidence before they can be accepted with the same certainty as such things as hunger.

The needs that we have identified, either in their basic or highly developed forms, underly the processes of development which we are considering, and in the constant seeking for a state of equilibrium the organism will be motivated by these factors and the associated affect. Thus, as organic development proceeds, the patterns of behaviour which are related to the satisfaction of the basic needs evolve in intimate conjunction with that development.

Maturation and experience

The process of organic growth towards maturity is generally referred to as *maturation*. Maturation has figured large in our discussion of the child's adaptation to his environment, for we have talked about such things as the elaboration of neural links and the growth of the various organs. But this is only one side of the coin. The child's increasingly elaborate adaptation to its environment is dependent on the processes of growth and the pressures of the outside world. We have already mentioned the fact that at birth the child exchanges a congenial and extremely stable but relatively unstimulating environment, for an environment which is in comparison, unstable and extremely stimulating, and which, but for the intervention of adults, would be hostile. The new environment is stimulating *because* it is unstable, and it offers great possibilities to the baby *because* it is so potentially hostile. If a mammalian foetus could be transferred from the womb to a replica of the womb, which could cope with any increase in size, it would be safe from the vicissitudes of the outside world but it would never become anything resembling the adult animal. The new-born baby demonstrates dramatically its dependence on new experience for adaptive development, when it takes its first breath, not because it *knows* it must breathe air, but in response to the drastic change in its environment caused by the transition from life in a warm liquid to life in the relatively colder air. Sometimes, of course, the stimulus that produces the first essential reaction, the baby's cry, which fills its lungs with air, is the midwife's smack. The key to the production of the first breath seems to be the sudden increase in sensory input from the environment, whether it be chemical or physical. From the first moment we owe our existence to environmental stimulation. From this moment on, the development of the child is the result of the two forces of maturation and experience and it is quite impossible to determine which is the most potent factor at any one time [5].

This point may be made clearer by considering some of the ways in which fundamental human abilities develop. Visual ability is one of the most important of these and is one which is extremely limited in the young baby. The new-born baby is unable to focus his eyes for any length of time, and, as we have seen, he is unable to distinguish between different faces for the first few months. The eventual emergence of the ability to distinguish among various visual patterns may be ascribed to the maturation of the nervous connections with the cortex in conjunction with experience of using the visual apparatus. It is difficult to get a meaningful picture of the extent of the contribution of experience to the development of visual ability from the young baby, but investigations into the reactions of congenitally blind adults given their sight by operation has given us some idea of the importance of experience. Such adults have had great difficulty in progressing from the most simple visual discrimination. They have been able to distinguish a figure from its background and have been able to name colours after a little practice, but only rarely have they learned to identify simple geometric figures and read separate letters and numbers. One woman, who was attended for six months after her operation by two surgeons, was unable to tell one from the other at the end of the period [1]. Another patient who had learned to tell the time using a braille watch could not tell the time from the hospital clock but had to feel it on his watch.

Experiments with animals have given us further indications of the importance of protracted experience for normal visual abilities. Young chimpanzees reared in the dark until sixteen months of age were unable to fixate objects with their eyes, although normal animals are well able to at this age. They did not respond visually to their feeding bottles, although they were readily responded to by touch. They did not blink when a blow to the face was threatened. Other chimpanzees reared in the dark for seven months were unable to pick out a large yellow and black striped disc which gave them a mild electric shock, and took over two weeks to show any sign that they were connecting the disc with the shock, whereas other animals which had been allowed ninety minutes of light a day learned to avoid the disc after receiving one or two shocks.

Other experiments have shown that non-visual behaviour is also dependent upon experience. Chimpanzees, reared under conditions which precluded their being able to use their hands or feet, grew up incapable of many of the normal abilities of these animals. Experiments investigating the maternal and sexual behaviour of rats have shown their dependence upon adequate experience. Female rats deprived of the experience connected with nest building, do not construct such nests when they have litters and are very lax in the general care of the young. Rats reared in isolation and brought together at the height of sexual development exhibit a high degree of sexual excitement but a very low level of sexual competence. Such animals are so deficient in the skills of mating that males rarely reached the sexual climax. Chimpanzees reared in similar conditions are incapable of engaging in complete sexual relations.

Evidence about the effect of limited experience in children comparable to that we have observed in animals is lacking for obvious reasons. The investigation carried out by Spitz referred to in Chapter I is one of the few studies on the subject. The essential thing about the environment of the children in the foundling home was that they suffered from most severe social deprivation. As babies, all they saw was the ceiling above their cots except when the nurse's head appeared at feeding time. As toddlers the children had no toys and got no stimulation from adults. It was an environment unlikely to be paralleled in many homes, and the extreme retardation in physical and psychological development was ascribed by Spitz to unfavourable environmental conditions. Corroboration of this point of view was found by Spitz in a parallel investigation with children of similar physical and intellectual endowment early in life, who were reared in a nursery attached to a women's prison. Here the children were with their mothers for many hours a day and received a good deal of affectionate care and attention. In addition, there were toys to play with. The development of these children progressed normally while that of the children in the foundling home fell away, until as we have seen they were retarded in many ways. They even suffered from seriously decreased resistance to disease and the mortality rate of the group was extremely high.

As we have seen, the chimpanzee Viki reared in an extremely stimulating environment developed skills quite foreign to the normal development of these animals. This phenomenon can also be seen when these animals in the wild are compared with those in experimental laboratories. Chimpanzees in a beneficent habitat, where food is plentiful and the climate mild, have few problems to solve in order to survive. Few demands are made on them to learn new skills. In the laboratory, the reverse is usually the case and here the chimp has to solve different problems before he can eat. The result is that the laboratory animal is generally a far more intelligent animal than his opposite number in the wild.

The development of the school child

What is the significance of the findings from these experiments and investigations for the teacher and student of child behaviour? One of the most important is the fact that children do not just *unfold* inevitably as it were. Charts of child development and indices of child attainment such as are given in texts concerned with child development should be regarded in this light. They do not represent absolute levels of development, rather they refer to the *average* child of a given age, and also to the environmental *norm* of such children. Both these conceptions, in our case, are drawn from West European or American cultures. They cannot be carried over automatically into other cultures and they are unlikely to remain the same even in our culture. This can be seen clearly on the physical side where higher standards of living are radically changing the patterns of growth and development. Thus a child of five today is as big and as physically mature as a child of six thirty years ago. At school, children are capable of arithmetical calculations beyond the majority of adults of a hundred years ago; or of handling ideas in certain areas of science which would be out of the grasp of the teachers who taught their grandparents.

If children do not just *unfold* what are we to make of the statement that: 'Just as a child learns to walk and talk when he reaches the proper development for these activities, so he arrives at readiness for reading in his own time' [6]. This is a point of view commonly held until very recently. It was generally held that the average age at which a child *could* learn to read was about six and a half. At this age, it was said, the average child had developed the necessary physical and mental skills to cope with the complex behaviour involved in reading. The emphasis was almost entirely on maturation and the term *reading readiness* was used to indicate that state at which the child was capable of

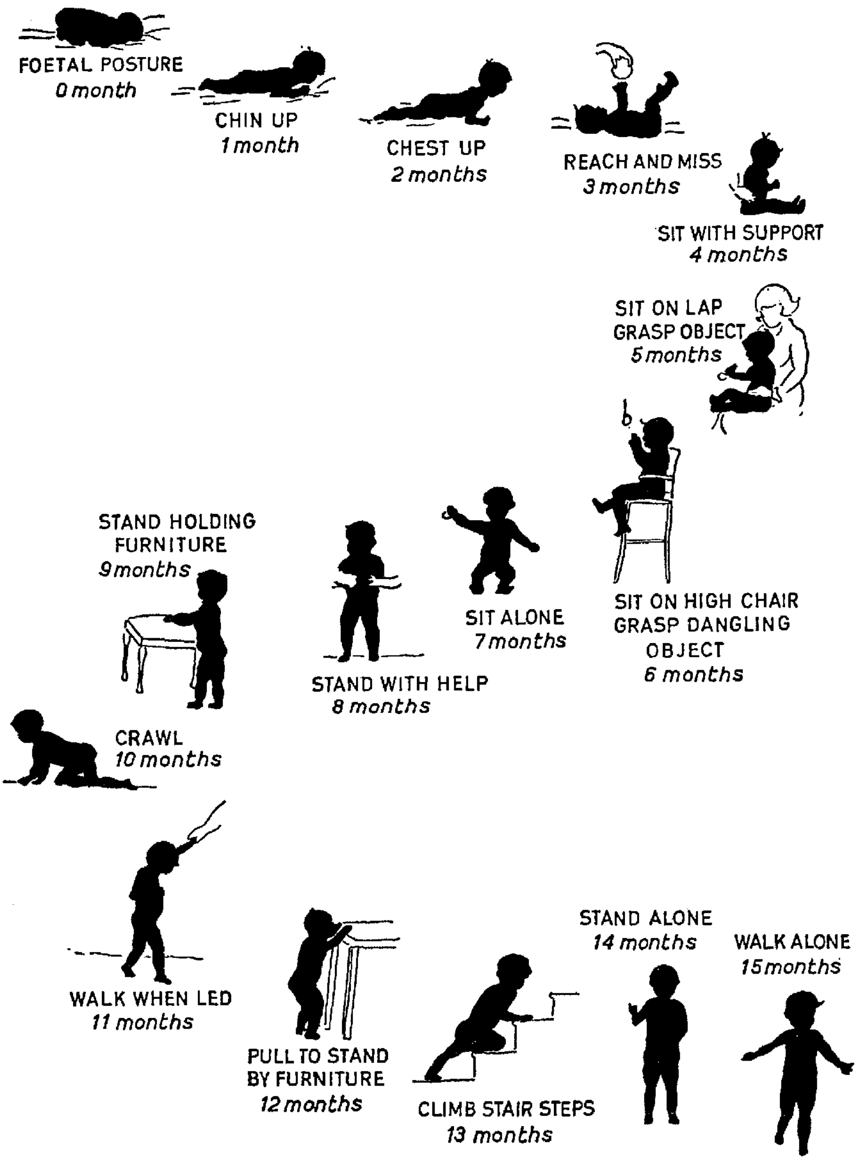

Fig. 3. This is a well-known chart showing a sequence of stages of child development. This sequence cannot, however, be considered to be the *natural* or *inevitable* sequence; it will be the sequence appropriate to a specific environment. Children deprived of stimulation, such as those described by Spitz, not only do not pass through the same stages at the same time, but do not pass through some of the stages at all.