# THE PHYSIOLOGICAL BASIS OF PERSONALITY*

By G. R. Wadsworth

## INTRODUCTION

The title of this paper implies that those characteristics of a person which constitute personality are the results of certain physical properties, presumably of the brain, and natural variations which occur in them. Although this concept can be accepted in a general sense there is as yet insufficient evidence to prove it in detail. The debatable point is whether all those features of a person referable to the brain can be explained entirely on a material basis, or whether there are influences of a 'spiritual' nature affecting the brain from outside.

## DEFINITIONS

Personality has been defined as the sum of the characteristics of the individual as these are determined by the mental state; and is the habitual behaviour or attitudes of a person as they appear to others. These characteristics seem to be the composite reactions of a person to other people or particular situations. Thus, dominance in a personality sense is demonstrated by taking the initiative and by ignoring the opinions and actions of others. Timidity and apparent weakness of personality are shown by an opposite form of behaviour in social groups.

Differentiation can be made between 'character' and 'personality'. A person may suppress by will, or self-control, basic personality traits. Thus, a fundamentally aggressive person may be able to hide his aggressiveness by his wilful practices of gentle behaviour. The timid may, by force of will, assume a bold, aggressive attitude.

Psychiatrists from the study of abnormal mental states have defined different types of personality. These are:

(a) Obsessional: The person concerned is too conscientious and serious, and has an exaggerated sense of duty.

(b) Paranoid: This sort of person is mistrustful and over-sensitive to real or imagined insults; is obstinate and conceited.

(c) Hysterical: The person retains many emotional characteristics of childhood, and is over-demanding on others, and over-dramatic.

(d) Introvert: This person is more concerned with his own feelings and experiences than with those of others.

(e) Extrovert: This kind of person is completely relaxed in the company of others and responds readily to the mood of the group. He reveals readily to others his own feelings.

Although these types are those seen in exaggerated degrees in the abnormal, it can readily be appreciated that to varying extents they can be applied to everyone.

The problem under discussion is how these particular features, the various mixtures of which determine the personality of an individual have any basis in the normal structure and function of the brain.

## THE NATURE OF PERSONALITY FEATURES

The way in which a person reacts to the environment, to particular situations and to other people will be decided by various factors. One of these is the presence or absence of fear; another will be self-confidence; another whether a situation is pleasurable or not. These 'feelings', which may not, in fact, be feelings in the sense that they enter consciousness, and reactions depend upon past experience of similar situations and a knowledge that a person has at the time. Self-confidence is felt when the person possesses knowledge about topics under discussion; previous experience of similar situations may have been associated with physical or emotional unpleasantness; and so on. All this implies the existence of memory, and memory is the most important basis for human behavioural patterns.

## HUMAN BEHAVIOUR

There are three phenomena which determine how people behave in particular circumstances. Behaviour, including speech, is the 'outward and visible' sign of personality. These phenomena are:

(a) learning,

(b) habituation,

(c) conditioned reflexes.

The essential feature of learning is the acquisition of a new response, or a qualitative change in an

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G. R. WADSWORTH, M.D., Former Professor of Phisiology, University of Singapore.

The Little Cottage, Wheatley Hill, Kingsley Near Bordon, Hampshire.

existing response, to a particular stimulus. A stimulus in the context of this discussion is anything which precipitates an action or series of actions, and and the sum of these actions constitutes behaviour. The response to a willed stimulus may be to undertake a technical manouevre, for example mounting and riding a bicycle. With repetition of the procedure the response becomes more accurate and skill is acquired.

Almost the opposite of learning in the above sense is the phenomenon of habituation. Habituation consists of a gradual diminution of response as the stimulus is repeated. Suppression of reaction to certain stimuli or stimulating circumstances is essential; otherwise the effects of those many stimuli present by chance at the same time and irrelevant to an immediate purposeful response would lead to a chaotic situation.

Habituation is different to the formation of habits. Habits are responses to particular stimuli which persist when the stimuli are no longer present. Habituation is a mechanism which suppresses a response in the presence of a stimulus.

About sixty years ago in Russia, Ivan Pavlov was making observations on the digestive system of dogs, work which earned him a Nobel prize. The important feature of Pavlov's work was the application of precise measurements to physiological phenomena. Accordingly he was engaged in measuring the exact amounts of saliva and gastric juice which were formed in response to the ingestion of food. He was struck by the fact that the flow of digestive juices could be elicited in a hungry dog by the mere anticipation of food. At first his interest was directed to these 'psychic reflexes' because they interfered with the measurement of secretion evoked by specific amounts of different foods. But he and his colleagues soon realised that the phenomenon of the psychic, or conditioned, reflex was of the greatest importance in its own right. Accordingly the energies of the Pavlov team were re-directed and as a result was revealed the existence of the most important of acquired characteristics which influence animal and human behaviour.

In essence a conditioned reflex is one in which the original stimulus is replaced by a new stimulus. In Pavlov's dogs the initial stimulus to the secretion of saliva was the physical presence of food in the mouth. The new stimulus could be the sight or smell of food. Substitution of stimuli can become complex. Thus, in animals salivation can be caused by a particular sound or the sight of a particular colour. In humans the reaction of fear, for example, may be brought about by a situation or stimulus which in themselves are inocuous. Such stimuli in the course of experience have been associated with, and in the end replaced, other stimuli which were true causes of fear.

Total behavioural response, and its interpretation as personality, is the 'algebraic sum' of the reactions of the brain to the multiple psychic and other stimuli impinging on a person at a particular time. The pattern of responses will vary according to the existence of learned, or conditioned, reflexes, suppression of responses through habituation and the degree of skill acquired, mainly in the formulation of verbal responses. In addition there will be contributions from inherent, genetically-determined, brain responses.

## THE LOCATION IN THE BRAIN OF THE CHARACTERISTICS WHICH DETERMINE PERSONALITY

There is now an accumulation of evidence that maintenance of normal personality depends upon the integrity of that part of the brain called the cerebral cortex. The classical case which illustrates this is that of Phineas Gage. Gage had by industry and intelligence risen to be foreman of a railway construction team in Vermont in the United States. Unfortunately on 13 September 1848 he was ramming gunpowder into a rock when the powder exploded and blew the iron ramrod through his skull. He recovered physically, but underwent a profound change in his personality becoming, it was said, "irreverent, profane and impatient of restraint", characteristics entirely foreign to his former self. He survived for about twelve years, having finally taken to an itinerant life and exhibiting himself in shows as a freak displaying his head wounds and the iron bar which had caused them. Gage's skull is a permanent exhibit in the Warren Museum of the Harvard Medical School. Examination of the wounds in the skull indicate that there must have been severe damage to both frontal lobes of the brain.

In recent times confirmation that the front part of the brain has an influence on personality has been derived from the study of patients who have undergone surgical removal of tumours in this part of the brain. Another surgical manouevre, namely, 'prefontal lobotomy' has also yielded valuable information. In this operation connections between the cerebral cortex and deeper parts of the brain are cut; the procedure is used to relieve severe symptoms of mental derangement. The results of these operations are variable, but they often lead to changes in personality. There may be, for example, a loss of initiative, the development of an unusual degree of optimism and well-being, or laziness, or loss of tactfullness; some patients lose all restraint of emotion, and may have impaired learning ability.

There are other clues which provide a basis for identifying a particular part of the brain with the mechanisms on which personality may depend, or at least be strongly influenced.

It is common experience that a particular odour can evoke a strong emotional response. For example, the smell of wooden pencils can bring back clear recall of the atmosphere of school life.

The terminal connections in the brain of the nerves which carry the sense of smell from the nose are known. There is involved a particular collection of nerve cells forming a definable anatomical structure known as the hippocampus. The hippocampus is not isolated functionally, but is intimately connected by nerve pathways to other groups of cells in the vicinity and even more widely.

Removal for surgical reasons of the hippocampal area brings about a very definite change in behavioural pattern. This is dependent upon a failure to retain memory of recent acquisition. One of the results of this is that with distraction the person affected is unable to continue to carry out a sequence of actions in which he was engaged in a way that suggests that he cannot recall what he should do next.

This and other evidence suggests that this part of the brain is involved in planning particular forms of behaviour, and is related to the execution of complex sequences of events. If it is understood that behaviour in this context includes the formulation of words and execution of speech in a logical sequence of thought, the bearing of the conclusion on the question of personality can be appreciated.

## MEMORY

The essential requisite for all the brain phenomena, be they inherent or acquired, is the storage of information. This is to say that if the initial response to an impulse changes with receipt of a second impulse the first impulse must in some way have left behind in the brain information whereby the response to the second impulse of the same kind is modified. Storage of information is a pre-requisite for learning, habituation and conditioned reflexes. If the brain remained unaffected after receipt of an impulse, successive responses to the same impulse would remain unchanged. In the case of conditioned reflexes the new, different, impulse which takes the place of the primary impulse would have no meaning in the brain unless that part of it which was involved had been changed in some way previously.

Dramatic evidence that the hippocampal area is involved in the storage of memory has been produced by electrical stimulation of this part of the brain during surgical operations on patients under local anaesthesia. In a number of instances the patient has responded by a vivid recall of some past experience. It was as if he were actually living in the past, although the episode involved might have been of quite a trivial nature. Recall of this kind is frequently of a degree of detail much greater than that usually associated with conscious memory. During the period of brain stimulation and recall the patient remains fully aware of present circumstances.

The balance of evidence favours the hippocampal area as the location of memory; the exact nature of memory and the many problems associated with its acquisition and release at appropriate times have yet to be discovered.

## THE NATURE AND ORIGINS OF IMPULSES ON WHICH MEMORY AND BEHAVIOURAL PATTERNS DEPEND

Throughout life the brain receives continuously information from inside and outside the body. This information is in the form of physical changes, such as a change of temperature on the surface of the skin, of visceral origin, as in the beating of the heart, verbal and visual impressions, sometimes in complex form summarised, for example, in the 'attitude' of another person or group of people. So many impulses are entering the brain at a conscious and unconcious level at any time that it is essential that many of them are ignored so that there are no consequent responses. This is achieved by habituation. Often, because more than one kind of impulse or information arrives in the brain repeatedly at the same time a response may eventually come about when one particular kind of impulse arrives in the brain separate from another impulse with which it had been associated. This constitutes a conditioned response.

All individuals are exposed to conditions which lead to the entry into the brain of information which leads to particular patterns of behaviour, both physical and emotional, and hence determine to a considerable extent the type of personality. Speaking broadly overall influences, or sources of information, are termed cultural, of which there are two main categories. There is that form which is applied commonly to whole groups in the form of formal education, moral teaching and tradition. The information being stored in the brain because of this kind of culture will lead to certain uniformity in behavioural responses and personality type. The other form of cultural influence is that obtained within the family, and the result may be a type of personality different in various ways from that common to the group.

## FACTORS WHICH MAY INFLUENCE THE DEVELOPMENT OF PERSONALITY

The existence of diverse types of personality indicated at the beginning of this paper suggests a wide range in the characteristic of those parts of the brain involved.

Brain cells after an early stage of intra-uterine life do not divide and multiply. Therefore, each individual is born with the brain cells which will last for a whole lifetime. If the ability to store information and to acquire learning, habituation and conditioned reflexes depended on the number of cells in the hippocampal region, then these facilities could only be influenced during embryonic life. There is no evidence at the moment, however, that the number of brain cells is a variable factor of any consequence.

However, nerve cells continue to grow in size, particularly in the length of the projections from nerve cells called nerve fibres. With growth of nerve fibres there is also an extension of connections with other nerve cells; the extent of interconnections between nerve units may well be important in determining levels of mental ability, storage and release of information and the development of particular patterns of behaviour and types of personality.

No doubt the extent and pattern of ramification of nerve fibres are influenced genetically. Inherited influences, perhaps operating in this way or in setting levels of functional activity within nerve cells, explain the varying ability between individuals to store information.

George Bidder, who was born in 1806, at the age of nine years could answer correctly in less than one minute such questions as, "if a coach wheel is 5 feet and 10 inches in circumference how many times will it revolve in running 800 million miles?" He achieved this by virtue of his remarkable ability to store information used in making calculations in his brain. There are other examples such as this, including illiterate individuals, which demonstrate the existence of inherent variation in the brain storage mechanism.

There is much evidence, however, to show that for most people environmental influences are the chief variable in determining the acquisition of learning and memory storage. Perhaps of the greatest practical importance is the incentive given to the child early in life. The most crucial period for mental development is during early childhood; perhaps because at this time patterns of interconnections, both anatomical and functional, between nerve units are being most actively formed and can thus be most easily modified. The evidence is that this formation is not necessarily automatic but can be influenced to an important extent by factors outside the child. Full encouragement by the mother to achieve a new step in progress leads to the proper motivation of the baby to try to progress even further, for example in exploring the world around him. This implies the acquisition and storage of an ever-increasing load of information. Encouragement at this stage can only be revealed to the child by the general attitude and interest of the mother. Lack of positive interest or the exhibition of punishment for failure to achieve some objective may establish associations in the child's brain or a failure to store information which will determine, to a variable extent, the sort of person he is, that is his personality, for the rest of his life.

## CONCLUSIONS

The characteristics of a person, designated as personality, cannot be at present explained in terms of the structure and function of the brain. However, there is clear evidence that storage of information occurs and on this depends the conscious and unconscious reactions of a person to the many influences which operate on him throughout life. These reactions, or patterns of behaviour, are important in characterising an individual and to this extent are a basis for particular kinds of personality.

Storage of information and the particular form of reaction to a stimulus seem to depend on the extent and pattern of the functional connections between different units of brain tissue. These connections are inherited, but there is enough evidence to show that they can be modified by environmental influences, especially during early life.

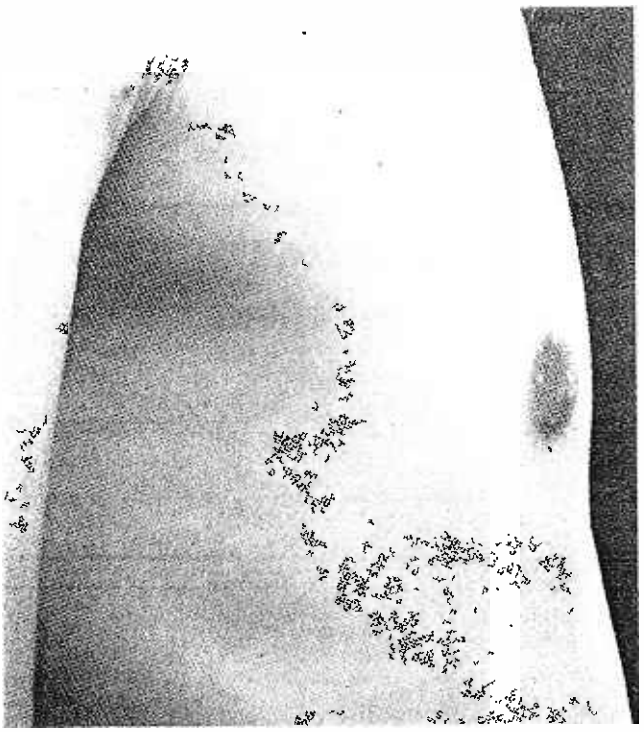

Fig. 2. Disappearance of the gynaecomastia in euthyroid state.

gynaecomastia could be detected (Fig. 2). At this stage his serum protein bound iodine was 4·0 µg/100 ml. and his 24-hour urinary 17 ketosteroid was 5·7 mg.

## DISCUSSION

Gynaecomastia is an unusual and uncommon complication of hyperthyroidism (Hall, 1969). In Singapore, the author saw 51 male patients with hyperthyroidism over a 3 year period; gynaecomastia was carefully looked for and the above case was the only one found. This differed from the experience of Becker *et al* (1968) who found 5 cases of gynaecomastia among 12 consecutive patients with hyperthyroidism; they believe that gynaecomastia occurring in hyperthyroidism is not rare, though seldom reported.

In the above case, like most reported cases, the gynaecomastia appeared during the hyperthyroid state and regressed on return to the euthyroid state, strongly indicating that the gynaecomastia is due to the hyperthyroidism and not merely coincidental. There is no convincing documentation of gynaecomastia occurring in hypothyroidism (Becker *et al*, 1968). Larsson, Sundbom and Astedt (1963) reported a patient with malignant adenoma of the thyroid gland complicated by gynaecomastia.

In the present case, both breasts are enlarged and tender with no nipple discharge. In most of the reported cases the gynaecomastia is bilateral and tender; rarely it is unilateral (Larsson, Sundbom and Astedt, 1963). Nipple discharge is rare but has been reported (Hall, 1959).

The pathogenesis of gynaecomastia in hyperthyroidism is doubtful and has been discussed at length by Becker *et al* (1968) and Hall (1969). Rosenthal and Lees (1958) showed that increased adrenocortical activity occurs in hyperthyroidism; this implies that the gynaecomastia of hyperthyroidism is the result of increased adrenal oestrogens. Another theory is based on the observation that thyroxine alters the metabolism of steroids (Fishman *et al*, 1962); the gynaecomastia in thyrotoxicosis may be due to the action of steroids on the breast tissue. Increased secretion of prolactin by the pituitary may be the cause of gynaecomastia in hyperthyroidism; Moon (1962) has shown that thyroxine increases the release of prolactin from the pituitary of ovariectomised rats.

Bauer and Goodwin (1951) reported 3 cases of gynaecomastia appearing in patients treated with radioiodine for hyperthyroidism and considered the gynaecomastia as a complication of radioiodine therapy. In 135 cases of thyrotoxicosis treated with radioiodine, there was no such complication (Cheah and Tan, 1971).

No specific therapy is needed for gynaecomastia in hyperthyroidism as it regresses spontaneously when euthyroidism is achieved. Rarely, the gynaecomastia persists, as in the patient reported by Larsson, Sundbom and Astedt (1963) and bilateral mastectomy was required.

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