

**AN EVOLUTIONARY APPROACH TO
HUMAN BEHAVIOUR***

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SIR ROBERT PLATT (1965) has recently emphasized the sad neglect of human behaviour in the medical curriculum. There are many reasons for this, but when the emotional component of illness is as important as the organic in 27 per cent of the problems which patients bring to their general practitioners and is appreciable in a further 21 per cent of these problems (Crombie 1963) it would seem logical that human behaviour should be considered as one of the most important of the sciences basic to medical education.

The functions or behaviour as well as the structure or physical characteristics of an organism have their origin and *raison d'être* in the evolutionary past of that organism. Any analysis of the structure of behaviour will therefore be relatively meaningless if the evolutionary steps which have led to its current form are not considered. It is this fact which makes arguments about the academic respectability of teleological reasoning meaningless in the resolution of biological problems, for such problems can only be resolved by such reasoning.

The evolutionary process

The evolutionary process of man consists of two main parts, the earlier genetic or physical phase and the later cultural phase. In the earlier phase the gene mechanism was responsible for the transmission from one generation to another of all physical characteristics and also of those components of behaviour which were genetically determined.

The cultural phase consists of characteristics transmitted by two extragenetic mechanisms. The first is the structure of knowledge of the environment and the second of the non-genetically determined component of behaviour. The cultural phase could not begin until

*Adapted from the presidential address, Section of General Practice, Royal Society of Medicine, 21 October 1964.

a mechanism for two-way communication between individuals was developed. Initially, this was directly by speech but latterly at secondhand *via* visual records in the form of symbols, words, diagrams and films. Behaviour patterns are stored extragenetically in the form of laws, taboos and social mores, written and unwritten. Transmission is by various forms of teaching, explicit and implicit, made possible by a built-in genetically determined mechanism in the young for acceptance of authoritarian teaching (Waddington 1960), and in the adult as suggested here by the desire to conform to the attitudes, values and behaviour patterns of his peers.

Behaviour

All behaviour patterns are based on a genetically determined outline or code (Koestler 1964). The final expression of any behaviour pattern depends on the reaction between the coded outline, the environment which fills in the detail and other developing patterns with which it is integrated to form the final structure of behaviour. This tripartite mechanism allows the flexibility which is necessary for adaptation to a variety of environments.

The term behaviour is used for any consistent pattern of activity by an organism which involves its environment. This behaviour pattern may, however, be triggered off by a variety of afferent stimuli and requires a mechanism which co-ordinates these afferent stimuli arising in phylogenetically older and simpler mechanisms at lower hierarchic levels. The unco-ordinated activity of these lower mechanisms is usually called 'reflex'.

We have experimental evidence that rhythmic automatism, autonomy of pattern and hierarchical organization are primary attributes of even the simplest nervous mechanisms (Weiss 1951) and the initial stimulus or motivation for any form of activity or behaviour may therefore originate within the animal's brain.

A 'drive' can be defined as behaviour of a highly specified type at an even higher level than that just described. A drive results from the hierarchic activity of a central mechanism which co-ordinates a variety of afferent information from a multiplicity of sources and whose effect is to trigger off, not one behaviour pattern but appropriate co-ordinated activity in a variety of efferent mechanisms. While the aim of such a drive centre has consistency the form of its expression as behaviour patterns can be manifold. Drives are homeostatic mechanisms for providing consistency to an organism's activities and even at the lowest levels in the hierarchy of behaviour have the implication of 'motivation'.

'Emotions' are the result of specific patterns of afferent stimuli set off from centres within the central nervous system by a range of primary stimuli arising externally or from other centres. They

produce their effects within the structure of the organisms and are not expressed as external activity.

Many 'drives' or 'emotions' which we recognize biologically may not have developed as individual characteristics but are compounded from other characteristics already built in by the evolutionary process for other purposes. For instance, a 'life drive' or the concept of 'libido' is probably the conjunction of all the self-preservation drives and subdrives which have been built in during the increasing complexity and effectiveness of the organism.

Pain may have been initially a feeling of discomfort loosely associated with a limited range of afferent stimuli set off by certain aspects of the environment harmful to the organisms. The process of natural selection would strengthen this association and intensify the feeling till a balance was achieved between the maximum effectiveness in withdrawing the animal from the harmful influence and any adverse effects which undue development of the characteristic might have had on the animal. This balance once achieved would be maintained by genetic mechanisms.

Similarly in animals which derived advantages from community existence, one of the early characteristics which might have strengthened the tendency to associate could have been an uncomfortable feeling whenever behaviour was indulged in which was at variance with the acquired behaviour patterns of the community. Initially, this might have been for only one limited aspect of all such behaviour. The process of natural selection could then have extended and intensified this into what we now call guilt and shame.

Classification of behaviour

Behaviour patterns can be classified as rigid or plastic (figure 1). The former are those whose final form is constant or nearly so whatever the environment during training. These are the *rigid* or *basic patterns*, figure 1 (*a* and *b*). The rigidity follows from a relatively large genetic component and a relatively invariable feedback in the form of the training which determines its final form. Plastic behaviour patterns are those whose final form is determined by aspects of the environment which during this training period have great variability from culture to culture, figure 1 (*c* and *d*). In practice the distinction is never absolute and there is almost always some plasticity in every behaviour pattern.

Most rigid behaviour has its basis in training whose form is dictated by secondary rigid behaviour patterns in the adult animals figure 1 (*b* and *c*). Where the training process is not based on rigid behaviour, the resultant patterns may show plasticity in that they differ from those in adults of the previous generation. They may

remain immutable thereafter, figure 1 (c), or be alterable or obliterated with varying degrees of difficulty after initial establishment, figure 1 (d).

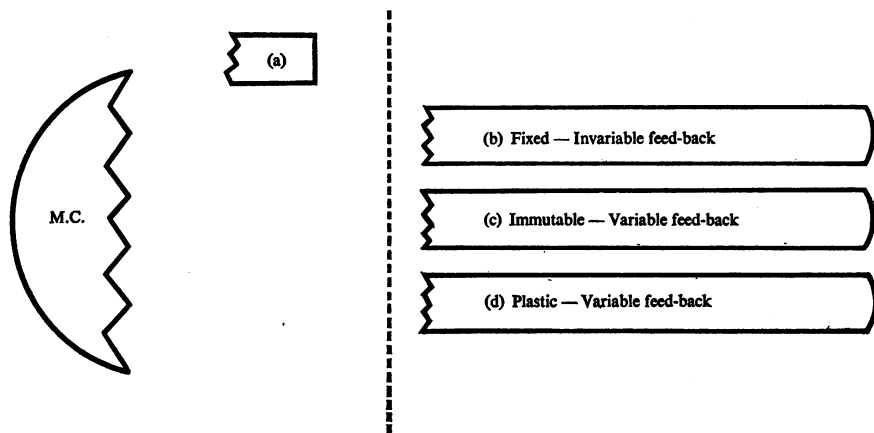


Figure 1. The structure of human behaviour.

Dotted line = Boundary between organism and environment and therefore between genetically and non-genetically determined components of behaviour.

M.C. = Motivational core (genetically determined component).

M.C. + (a) = Genetically determined behaviour patterns.

The basic values of human society are dependent on the basic or rigid behaviour patterns. Whether the basis for the rigidity of those behaviour patterns which incorporate the priority of community over individual or self-preservation needs is determined largely by a strong genetic component or by a relatively invariable feed-back in the form of teaching by parents and the herd is of no moment so long as the end-result is a perpetuation of the balance in favour of community drives from one generation to another. If a variety of social patterns are available for transmission, natural selection will eliminate communities where these priorities become reversed. This system would need to be strengthened by some mechanism operating in adults to ensure that the patterns of plastic behaviour will also maintain the priority of community values. Social conformancy is suggested here as that mechanism.

The individual and the community

Within the physical limitations set by natural (non-biological) laws, there developed variants of the first self-replicating molecule or molecular system still capable of self-replicating. As they became

more complex and sophisticated, their complexity only surviving because it had some evolutionary advantage over its simpler progenitors, they developed subsidiary characteristics other than the ability to self-replicate by asexual mechanisms. The earliest of these characteristics must have been connected with 'self-preservation', an ever-improving ability to achieve independence from and to deal with the environment (Huxley 1942). This would concern itself with two main issues: the acquisition of the necessary raw materials for survival and the avoidance of situations which might interfere with or stop the process of self-replication.

Sexual reproduction which was a later addition, apparently had evolutionary advantages over asexual reproduction. This in its turn demanded that the behaviour pattern, desire or drive for sexual congress between male and female, necessary for the process to continue, became an associated essential characteristic.

The evolutionary development of the drive for sexual congress, if it did not result from developed community life, was probably the first step towards the evolution of the later drives associated with community living and the sharing and specialization of functions which had demonstrated advantages over individual free-living. This later and more complex system accompanied by its own specific drives was probably aided by an intermediate stage where the advantages of care of the developing young by one or both parents had evolutionary advantages over a system where the young were abandoned at birth. Compassion for the weak, destitute, dying and sick surely has its roots in the care which parents take of their children. The important point about this developing series of behaviour patterns connected with increasing complexity of community living is that they are increasingly at variance with the even more primitive drive for individual self-preservation.

During the genetic phase of the evolutionary process, natural selection should have achieved a balance between the earlier individual drives and the later community drives when they were at variance by building in suitable inhibitory processes for the former. Shame and guilt feelings, available at the onset of the cultural phase to provide the greatest variety of forms of community existence which the cultural phase made possible, are attached to behaviour patterns inculcated by parents during infancy and ensure their perpetuation. They would also supplement the social conformancy which encourages the adult to match his plastic behaviour patterns to those of his peers.

The apparent simplicity of this system dependent on the interaction of only two main groups of drives, hides a mechanism genetically endowed of great flexibility and complexity. The essential

and stable balance between the community and individual drives, with a bias in favour of the former, is maintained in cultures exhibiting practically all possible variations of behaviour patterns. For instance Brown (1963) reviewing the anthropological literature found descriptions of stable communities whose main behaviour characteristics ranged from extreme aggression through dependency to acquisitiveness and included one tribe, the Dobu, who live in such a state of persecutory suspicion that a European psychiatrist would unhesitatingly diagnose any Dobuan outside his own society as a paranoiac requiring psychiatric treatment. War is unknown amongst the Eskimos, and suicide amongst many other tribal communities. Bali, is the "unthinkable; a schizophrenic culture".

The community drives are compounded from many sources. The strongest contribution probably comes from the instincts to protect the young which evolved with family life. Another, only marginally less important, is the desire to conform to the attitudes and values of one's peers. Whether the desire for humans to seek the company of their fellows and to conform with the social mores of behaviour actually exists as a separate entity or results only from the summation of drives such as have been detailed above is of no moment. These drives act by binding the individual to a definite group of his fellow men whom he can identify as individuals. Community drives are at their strongest in such relatively small groups and are strengthened by any environmental feature including other groups of his fellow men who may threaten his own group.

Speech, intellect and problem solving

The benefits of community existence resulted not only in an intensification by natural selection of behaviour which favoured the community but also of mechanisms which improved the quality of inter-personal communication and problem solving. Traditionally, the benefits arising from tool and weapon usage have been suggested as the main driving force for this series of developments but it seems to the author that these are only one aspect of a generally increasing control of the environment.

The two main factors in the development of the cultural phase of the evolutionary process are the growth of knowledge with its ever-increasing complexity and consistency and the evolution of behaviour patterns, the changes in the latter partly resulting from and being increasingly dependent on the former. The evolution of behaviour patterns has been governed in the past mainly by a process of trial and error, unsatisfactory behaviour pattern structures being eliminated along with the societies in which they occurred.

It can be said that the evolution of the structure of knowledge

within the cultural phase of the process has used the same ingredients in the form of the conjectural and critical reasoning as the trial and error process of physical evolution. Where the gene pool constituted the memory store from which new generalizations could be created, the human memory, individually and collectively in the form of written and unwritten knowledge laws and cultural mores, fulfils the same function. In other words, Darwin's theory of evolution and Popper's (1964) concept of the growth of knowledge rely basically on the same mechanism of 'conjecture and refutation'.

The growth of knowledge and the development of the non-genetically determined component of behaviour patterns are subsystems of the earlier physical phase, in that motivation for the former depends on the problem-solving drives of man and for the latter on genetically determined authority accepting mechanisms in the developing mind (Waddington 1960) and a bias towards community rather than individual values.

Prolonged dependency

The opportunities in man for imprinting the non-genetically determined component of behaviour patterns and for acquiring knowledge of the environment at second hand by learning processes are provided by the prolonged prematuration period and dependency on maternal care. The evolution of these characteristics was, in its turn, made possible by previous arboreal existence which favours litters of one. Intrauterine competition in multiple pregnancy favours early maturation. The characteristic of prolonged dependency also leads to the increased strength of maternal instincts and the bonds binding family units (Harrison *et al.* 1964).

Knowledge and behaviour

During the last 350 years the increasing consistency of the knowledge content of the cultural component has also increasingly influenced and moulded the behaviour patterns which finally determine the quality of life. The ultimate rate at which this can take place is determined by the fact that behaviour patterns fixed at birth will largely determine the behaviour patterns imprinted by training in the subsequent generation and that only those which can be modified at all are available for rapid evolutionary change. However, major social upheavals will provide opportunities analogous to mutations in the physical phase for the alteration of behaviour patterns fixed in infancy and the pressures from the logical growth of knowledge can influence the training habits of parents even against their ingrained beliefs. A further example of cultural mutation is provided by the 'conversion' syndrome. This is characterized by the sudden reshuffling of some of the major

behaviour patterns, as happened to Paul on the way to Damascus.

In contrast to the belief that high intelligence is the essential for greater exploitation of our environment it would seem that present intelligence levels are more than adequate to power the evolution of the structure of knowledge. The quickest returns in terms of human progress would seem to lie in exploiting, *via* the social sciences, the evolution of a suitable structure of behaviour patterns and cultural system rather than concentrating on progress by genetic improvement.

In summary then, the evolution of man and in particular the cultural phase of his evolution has depended primarily on the characteristic which he shares with all other adult animals who live in herds, namely a tendency towards the suppression of his individual or selfish drives when these conflict with the community drives or interests. The other features on which his evolution has depended and which he does not share with other animals are his increasing intellectual capacity, including his problem solving abilities, allied with a prolonged learning phase, itself dependent on the ability to communicate with others by speech. The necessary adaptability to exploit these abilities has been provided by a perpetuation of the plasticity of behaviour including intense curiosity characteristic of the young of other species. The resultant evolutionary weakness of such a system which might result from the lack of homeostasis provided by the final rigid behaviour patterns of other animals is to a large extent compensated for by the adult human characteristic of conformancy with the behaviour, values and attitudes of his peers. This is also a perpetuation of the similar behaviour trait of young animals which enables any learning to take place.

Foetalization

Foetalization, or neotony as de Beer (1958) has called it, is the appearance in mature animals of features which belong to some earlier stage in their embryological or premature development. These features more often than not have never existed in any previous mature animal of the species since their evolutionary importance is as stepping stones to the mature animal. Their appearance in the adult animal results from a relatively greater retardation in the rate of the body compared with that of the reproductive organs. These features are accessible to the evolutionary process as a source of ready-made alternatives which may provide greater evolutionary advantages than can be achieved by the reshuffling of that part of the present gene pool (or from mutations acting on the same material) which controls the final structure of the mature animal only. The evolutionary process manipulates foetal features into the mature animal *via* the mechanism which controls the timing of sexual maturity in relation to some or all other characteristics of the mature

animal. On the whole, therefore, foetalization must have generalized rather than specific effects. de Beer gives as examples the axolotl where foetalization is facultative only and Typhlomolge, Necturus and Proteus in which it is permanent. In a summary of the literature he has pointed out that many of the physical characteristics of adult man show foetalization. These include the relatively high brain weight, the position of the foramen magnum and the cranial flexure, the retarded closure of the sutures between the bones of the skull, the dentition, the flatness of the face, the position of the vagina, the big toe, the hairlessness of the body and the light colour of the skin. Since the direct evolutionary advantages of these features other than brain size, seem minimal, it seems likely to the author that the evolutionary driving force came from the advantages which resulted from foetalization of behaviour, as summarized above, and the physical characteristics were almost accidental. Apart from selecting behaviour which was advantageous from the evolutionary point of view, foetalization was probably also responsible for certain aspects of the behaviour of man which have always seemed paradoxical. In particular the loosening of the sex and aggressive drives, which man now indulges with the minimum of restraints, from the automatic and relatively rigid behaviour patterns with which they are linked in most other mature animals and which control and regulate their expression, is one price which man has paid for the advantages of foetalization.

On the other hand, his intense desire to conform to the attitudes, values and standards of his peers is probably the most potent force for binding humanity together and which has almost compensated for the loss of the equivalent effect produced by the more rigid behaviour patterns of all other adult animals. This desire to conform could be a perpetuation of the equivalent desire of the immature animal to copy its mature elders when laying down the final pattern of its more rigid adult behaviour.

Imprinting

The mechanism by which the genetic codes or outlines of behaviour are linked to the final patterns whose detail is determined by the culture of the organism, is called imprinting. In the lower animals the most important of these processes seem to take place very soon after birth. For instance Lorenz (1952) describes how Greylag goslings can be made to accept permanently a human being as their mother substitute if instead of a female goose he is presented visually at the appropriate time. Foetalization seems to delay until puberty the final imprintation process for much of the rigid component of human behaviour and to rely on social conformancy as the imprinting mechanism. This is evident, for example, in the

initiation ceremonies of primitive societies, religious bodies, student fraternities and secret societies. Initiation ceremonies to reinforce established patterns as well as to imprint new ones are also evident in masonry with its classes, Christianity with its weekly rituals and in all societies based on oaths of allegiance, actual or symbolic. The essential element of the imprinting mechanisms in these unusual and uncommon examples seems to be the actual or symbolic threat of rejection of the individual by his herd or group. The appropriate cultural patterns are imprinted during the ensuing emotional catharsis which follows his final acceptance.

Taboo

The power of this rejection followed by acceptance mechanism is most evident in the taboos of primitive societies, where it has been suggested (Pertinax 1965) that spontaneous death may sometimes result when an individual discovers that he has transgressed one of the basic codes or taboos of his culture.

Hypocrisy

The intense desire to conform is also expressed in the human characteristic of hypocrisy, the benefits of which are expressed in the old saying: "The hypocrite is half converted".

Ritual

Ritualistic behaviour may have its origin in the partial foetalization of the rigid structure of total behaviour of other adult animals. The diversity and even bizarre nature of the forms which shared ritual may now take in human society, and which demonstrate the strength of this conforming attitude, could have resulted from the general plasticity now allowed to all behaviour. The necessity for sharing ritual may have its origin in the desire to conform.

Personality

Personality is the chameleon-like surface for the basic behaviour patterns where the pattern of personality is adjusted according to the role demanded at any time by the culture. If this concept is correct, personality is flexible and its structure at any time determined mainly by the demands of the culture in which individuals exist. This could explain why an individual can sometimes accommodate quite happily alternative personality traits which are apparently inconsistent, for, however rapidly the cultural demands may alternate between these two inconsistent traits, they will never be both requested at the same time. The more rigid the personality structure the more restricted are the potential roles which an individual can fulfil. Personality assessment should therefore be concerned mainly with establishing the range of each separate trait which any one individual can encompass, traits in this context being the *whole* spectrum from one extreme to the other: for example, from aggres-

siveness through to submissiveness and authoritarianism through to permissiveness.

Foetalization and Freud

Freud continually referred to the warring forces in each individual which motivated his actions. Initially he referred to them as the pleasure principle *versus* the reality principle and later the libido *versus* the ego. He believed that these two polar forces represented the undisciplined urges, in which sex was believed to predominate on the one hand and on the other the disciplining factors of conscience and society. Later these became represented as Eros or life, embodying self-realization as well as sexual gratification and death.

If the concept of the evolutionary development of man's cerebral function and behaviour presented here is correct then the strife is in fact between the primitive drives for self-preservation, the selfish or individual drives on the one hand and the later community drives on the other, the aggressive or masculine elements of the sexual drives being mainly associated with the former and those concerned with care of the young and family stability, femaleness, with the latter.

In this, primary importance is given to the aggressive drives connected with individual self-preservation and only secondary importance to the sexual drives. Although this priority is reversed in Freud's original concept of emotional development and his psycho-analytical theory as it now stands, it would seem that he had modified his basic philosophical concepts in later life.

The dynamic relationship between the individuals who constitute the community and the developing cultural component of the evolutionary process resulted in an ever-increasing pressure by the cultural component through the mechanism of guilt on individuals towards intensification of those behaviour patterns which favoured the community. A main source of abnormal mental behaviour might reside in the tension created by this process as it became increasingly at variance with the individual, self-preservation behaviour.

Neurotic behaviour could then be said to result from tensions produced by behaviour patterns which are incompatible with one another but invariably set off by some common stimuli and where neither of these patterns is plastic enough to be obliterated easily. That most neurotic behaviour or at least the tension resulting from it, resolves spontaneously in about five years, suggests that this is the time necessary for this process of obliteration to take place and is a measure of the stability of human behaviour patterns.

Psychopathic personality would then be due either to congenital absence of the community drives and the ability to feel guilty or lack

of appropriate training or inculcation of the appropriate *ad hoc* community rules during the formative years.

Most psychopathic behaviour remits after the age of 40, suggesting that such behaviour is due merely to an excessive degree of foetalization. That such behaviour is much less common in women, might be explained if the origin of the basic community drives resides partly in the feminine attribute of care for the young of the species as suggested here.

Evolution and ethics

'Good' can be equated with those concepts and behaviour in which the effects of behaviour associated with the basic necessity for individual self-preservation are subjugated to those associated with the requirements of the 'community' of individuals where these two groups of behaviour patterns are at variance. 'Evil' can be equated with behaviour motivated by the innate drives associated with self-preservation where this is at variance with behaviour which favours the community or which the community has accepted as favourable.

'Evil' behaviour is basically a component of the individual's own structure. 'Good' behaviour, on the other hand, is only partly innate and partly exteriorized in the developing cultural component of the evolutionary process. It is true that the 'evil' concept has also been partly exteriorized in certain cultures and at certain times during the historical development of the evolutionary process. It is this externalization which quite apart from any element of psychological projection may have lead man to identify these important (in the evolutionary sense) concepts with the 'Devil' and 'God'. This might also provide a rational basis for the religious concept of 'Good' which traditionally requires some metaphysical outside support for the individual if he is to conform to standards which are not innate.

In this sense then 'Good' resides partly outside the individual, in that its concepts are embodied in the cultural component of the evolutionary process. For reasons already given the evolution of this component is rapid compared with those characteristics like the self-interest or 'Evil' component of behaviour which is more rigidly tied to genetic mechanisms. The more complex and more consistent the cultural component becomes and the more important relative to the constitution of any one individual then the more is the direction of evolutionary progress biased by the 'good' or community values and the quicker its progress.

Teilhard de Chardin (1959) has pointed out that the confining structure of the earth and improving communications are leading to an accelerating process of cultural convergence. This, by facilitating

the diffusion of one community concept to cover the whole of mankind and by concentrating the efforts of an increasing number of individual brains on the evolution of the cultural phase, will hasten this day without detracting from the benefits of cultural diversity at levels below those concerned with the prime community values.

There will be variations in the detailed expression of 'good' behaviour dependent on local environmental differences operating *via* suitable plastic behaviour patterns. However, these values will tend to be consistent with the absolute values which favour the community rather than the individual.

Although authority acceptance by the developing child, as described by Waddington (1960), is the basis of what he calls 'ethicizing', it is also the basis for the transmission of the whole of the non-genetically determined component of behaviour. This mechanism is ethically neutral and, alone, does not explain the basis of the ethical values of right and wrong. If the concept presented here is correct, these have their logical roots in the genetically determined bias towards community rather than individual values as expressed in the genetically determined component of behaviour.

Free-will

This concept also leaves 'free-will' as a natural function of man, in the sense that ultimately every man decides his actions in ethical matters partly by mechanisms within the brain whose responses have been determined by evolution and training, but also partly as a result of the external pressures from his culture. These may include any brand of shared belief or dogma, rational or irrational, based on logical premises or on absolute values as provided by revelation and which he is free to accept or reject. He is placed in no different position with respect to 'free-will' whether he rejects the revealed absolute values of Christianity or the cultural norms of his society as described here and which have their logical roots in the evolutionary process.

'Free-will' is to some extent related to the high proportion of plastic behaviour patterns compared with those which are rigid or fixed. It is paradoxical that the high proportion of plastic or secondary behaviour patterns in man is due to foetalization. However, this is not, strictly speaking, a reversion to a more primitive mechanism in the evolutionary sense. It is this increased plasticity of behaviour which causes the problems for man, in that he has to rely more on the direct action of the basic motivational mechanisms which lie behind behaviour rather than, as in the adult forms of

the lower animals, on a rigid pattern of final behaviour.

Conclusions and summary

In this short paper it has only been possible to deal with the most fundamental components of human behaviour. The first link in the evolutionary chain which led from the previously most advanced form of biological life to what de Chardin called the 'phenomenon of man' was the removal of intra-uterine competition which resulted from tree living, since arboreal existence favoured litters of one. Without this foetalization, neotony or paedomorphosis as it is variously called, which underlies the phenomenon of man would never have been possible. Foetalization achieved this by enormously increasing the learning period, by leaving man perpetually curious, by allowing the brain growth which was necessary for speech and the other intellectual powers necessary to take advantage of this long maturation process, by enabling man to develop his problem solving abilities and the growth of knowledge which resulted from this, by loosening the bonds between the genetically determined motivational component of his behaviour from the final patterns of behaviour, by enabling the authority acceptance of childhood to be extended into adult life as a desire to conform to the attitudes and values of his peers and by enabling this mechanism to provide the link between motivation and a behaviour structure which is determined by his culture and not directly by his genetic endowment. The ultimate evolutionary importance of the foetalization of man was that it freed him from the almost complete dependence on his genetic endowment which characterizes all other higher forms of life and enabled man to benefit from the extragenetic endowment of his ever-increasing knowledge of the universe now embodied in the cultural phase of his evolution. The apparent paradox of man resides in this very freedom.

The two components of the cultural phase of human society, the growth of knowledge and the development of behaviour patterns, have their own evolution. The growth of knowledge has its origin in the problem solving and conjectural abilities of man. It has powerful evolutionary tendencies in that application of critical reasoning in the form of logic and scientific method to primary intuitive conjectures is resulting in models or descriptions of the universe with ever greater complexity, consistency and explanatory power.

Our patterns of behaviour, whose primary evolutionary purpose is to provide the maximum of adaptability to our changing environment, have for this very reason weak evolutionary tendencies, yet the potential benefits accruing from the growth of knowledge can only achieve their effect in the further evolution of man and his

culture *via* their influence on his behaviour patterns. As yet there is no fixed or rigid behaviour pattern which would lead man automatically to mold his behaviour on the logical conclusions which can be drawn from his accumulating knowledge of the universe. This has been of little moment so far for man has not as yet gained sufficient insight into or knowledge of the control of his own behaviour mechanism for this to be appropriate, but that time is rapidly approaching. On the other hand, his knowledge of the physical world has advanced, relatively, at an enormous rate. Whatever may be the final evaluation of the use to which he has so far put this knowledge, its development at least to present levels was necessary for the production of mechanical intelligence and associated aids to problem solving. It is only from the hierarchic structure which will result from the interaction and association of such aids with the brains of human beings and which will constitute the next phase in the 'phenomenon of man' that we may create ever more appropriate cultural systems and extract the maximum from the potential of human achievement and satisfaction. The possible effects of these systems will be explored indirectly without subjecting man himself to the hazards of the trial and error mechanism of the evolutionary process by which he has reached his present evolutionary position.

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