CHAPTER I

THE GENESIS OF PERCEPTION

THE status of perception in the scheme of animal existence—its origin and rôle—might be discussed from many points of view. As a factor in the conscious life of the animal, it is pre-eminently a psychological problem. As a factor in the behaviour of the animal, it is a physiological, neurological, biological problem, or at any rate has such concomitants. Whether it be studied and analysed purely and exclusively as a problem of psychology, or whether its biological concomitants—to use a non-committal term—be also studied and analysed, may be either a simple matter of method or may depend upon the philosophical creed of the investigator.

It is, therefore, desirable that I should state my creed briefly at the outset; premising, however, that the word 'creed' thus used carries no implication of dogma or infallibility, but implies merely a carefully selected assemblage of correlated hypotheses, endowed for the end in view with the status of postulates. It is chosen because it appears to me to be the most fruitful from the scientific point of view for this and other such problems. Its hypotheses are limited to the workable minimum, and its philosophical importance will depend solely upon whether it proves useful or not.

It is essentially the creed of Emergent Evolution as set forth by Lloyd Morgan[1], stripped of metaphysical implications, which, whatever their philosophical value, appear to me to be redundant to the more limited scientific universe of discourse.

"We live in a world in which there seems to be an orderly sequence of events.... But the orderly sequence, historically viewed, appears to present, from time to time, something genuinely new. Under what I call here emergent evolution stress is laid on this incoming of the new. Salient examples are afforded in the advent of life, in the advent of mind, and in the advent of reflective thought. But in the physical world emergence is no less exemplified in the advent of each new kind of atom, and of each new kind of molecule. It is beyond the wit of man to number the instances of emergence. But if nothing new emerge—if there be only regrouping of pre-existing events *and nothing more*—then there is no emergent evolution."[2]

On the physical plane, when elements combine to form a new compound, some of the properties of which are quite different from those of either component; when a radio-active element changes into

[1] *Emergent Evolution*, London, 1923.
[2] *Ibid.* pp. 1–2.

the next product of the disintegration series; when crystallization occurs—in all such cases there is emergent evolution on the physical plane. Something new has occurred, which could not have been foretold, because it is not interpretable in terms of resultant effects calculable by algebraical summation. It is not to be attributed, in the scientific universe of discourse, to some "alien influx into nature"—force, entelechy, élan, God—but is to be accepted "with natural piety," as Alexander and Lloyd Morgan say, or as a legitimate hypothetical datum, as I should prefer to express it.

At a certain stage in evolution life emerged; at a later stage consciousness emerged. It may be that there is no life without consciousness; but, if so, consciousness at the lowest level must be very primitive.

Lloyd Morgan, in 1896, distinguished two phases of organic development;

"first, that in which consciousness is either absent or inoperative; and secondly, that in which consciousness is a co-operating factor. The first may be termed the merely organic phase; the second, the conscious-organic phase. The latter may again be sub-divided into two phases: first, that in which mental evolution is subordinate to organic evolution; and secondly, that in which mental evolution is predominant."[1]

The distinguishing feature of the conscious-organic phase is the presence of "effective consciousness," *i.e.* consciousness which enables an animal to guide its actions in the light of previous experience, and the criterion of its presence is the exercise of choice.

"Whatever the physiological conditions of the process may be, it seems clear that consciousness, as choosing and controlling, stands in a sense outside that upon which it exercises control through its power of choice. And, thus, on passing from the merely organic to the conscious-organic phase of evolution, we have to consider the development of an *imperium in imperio.*"[2]

The further argument is based on conclusions drawn from the control of the involuntary and automatic activities of man by the *cortex cerebri*. But, in dealing with origins, we just either regard these functions of choice and control as absent in the amœba, or present only in the primitive form which we should expect associated with the primitive structure. If they are totally absent, the organism is the mere sport of circumstance; its sentience is a matter of interest to itself alone and is of unknown significance as a psychological germ of evolutionary value. This appears to correspond to the anoëtic sentience of Stout. There is evidence, however, that the activities of

[1] Lloyd Morgan, *Habit and Instinct*, p. 262, London, 1896.
[2] *Ibid.* p. 265.

Protozoa do exhibit traces of choice which fundamentally differs in type from the selective properties shown by a photographic plate or other inorganic material. In fact, it is scarcely possible to accept any other view in the light of the very exhaustive observations and experiments of H. S. Jennings[1].

There are many levels of emergent evolution, but these can be grouped, if only for methodological purposes, into three chief levels: *A*, the physical level; *B*, the level of life; and *C*, the level of consciousness. Events at each higher level involve and depend upon concurrent events at lower levels. Physico-chemical inter-relations govern events at the level of matter *A*. Physiological inter-relations govern events at the level of life *B*, but physiological events involve and depend upon physico-chemical events. Similarly, conscious events at level *C* (mind) involve and depend upon physiological events, themselves involving and dependent upon physico-chemical events. "No *C* without *B*, and no *B* without *A*. No mind without life, and no life without 'a physical basis.'"[2]

It would also appear that we must accept "with natural piety" that, when some new kind of relatedness is supervenient, the course of events at a lower level *may* be altered.

> "Events of the kind we labelled *C* *involve* events of the kind we labelled *B*; and these in turn involve *A*-events. But in any given concrete case the specific way in which the *A*-events run their course, then and there, *depends on* the specific presence of some phase of vital *B*-relatedness; and similarly the specific way in which these *B*-events run their course—in behaviour for example—depends on such conscious *C*-relatedness as may be present"[3];

i.e. consciousness is "effective." So much for involvement (or, as Lloyd Morgan more ambiguously calls it, "involution"), dependence, and relatedness.

Similarly, there are levels of emergent evolution within the conscious level. Physical stimuli at level *A* arouse physiological responses at level *B*, by the effective inter-relatedness of which consciousness emerges (*C*). The dawn of consciousness is probably a sentiency with greater affective than cognitive tone—of which more in Chapter II. It is doubtful if a pure sensation is ever experienced in consciousness. Sensory presentations, as we experience them, invariably evolve perception, however naïve it may be, at the start: but there is no perception without sensory presentation. Similarly, there is no

[1] *Behaviour of the Lower Organisms*, Columbia University, Biological Series, No. 10, New York, 1906.
[2] Lloyd Morgan, *Emergent Evolution*, p. 15.
[3] *Ibid.* p. 16.

reflection, contemplative thought, or conception without perception. "At the level of contemplative thought, *how* perception runs its course depends on the guidance of reflective consciousness, so far as co-existent, and *how* what is given in sensory presentation takes form depends on the guidance of perception, if that level have been reached."[1]

Alexander's[2] lowest level is a Space—Time relatedness, independent of physical events. This is a metaphysical conjecture. It suffices for us, with Lloyd Morgan, to assume "that intrinsic to every minimal physical event, and extrinsic as between such events, there is (*a*) spatial here-there relatedness, and that there is (*b*) temporal now-then relatedness—always co-related as inseparably (*ab*)."[3]

Similarly, both Alexander and Lloyd Morgan conjecture that above consciousness there emerges deity, and that the nisus of all emergent evolution is towards deity. Over all and pervading all is Deity. Within the strict bounds of the *scientific* universe of discourse it does not appear to me to be necessary to accept this conjecture, even "under acknowledgment."

The chief value of emergent evolution is its function as a scientific method. Like agnosticism, it clearly segregates and labels what is known and what is unknown. It by no means follows that all emergents are unknowable; indeed, as knowledge increases, more and more emergents become known. But they are only knowable, as it were, from above. When sodium chloride dissolves in water something happens which could not have been foretold—a solution has emerged. Yet, with increased knowledge, we have learnt a great deal about solutions, and we can foretell much of what will happen when solution occurs again. Complete knowledge of an event seems to be attainable only by backstroke from a higher level, and this rule appears to hold good for every succeeding level. We can imagine a demon at each level who would know everything about every level below his own and nothing about higher levels except what was dependent directly upon the known processes of his own and lower levels. Above the top we can imagine a super-demon who would know everything.

[1] Lloyd Morgan, *Emergent Evolution*, p. 18.
[2] *Space, Time, and the Deity*, 1920.
[3] Lloyd Morgan, *Emergent Evolution*, p. 24.

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CHAPTER II

RECEPTORS

THE fundamental characteristic of all living organisms is irritability. As seen in the lowest unicellular organisms, this is manifested in the motor response to stimulation. In the light of our own experience we conclude that irritability implies the possession of a receptor mechanism and a motor mechanism, however inextricably these may be combined in the apparently undifferentiated protoplasm of the amœba, for example. In the cœlenterates the receptor and motor mechanisms, though differentiated, form a single receptor-muscular unit. At a higher stage physiological experiment and observation have shown that differentiation leads to the structural and functional separation of the receptor mechanism from the motor mechanism, as shown in reflex action. Structurally, we find that even in the simplest reflex arc an intermediate link is interposed between the receptor and the motor neurones, and to this link highly important functions are attributable. Further evolution leads to specific differentiations of the receptor mechanism into receptors which respond only to specific types of stimuli, and these changes are accompanied by appropriate differentiations in the other links of the reflex chain.

Consciousness involves a conscious subject and an object of which the subject is conscious. The experience of the subject is primarily its consciousness of a sensory presentation. The nature of the simplest form of consciousness is an inference derived from the analysis of our own highly complex consciousness, of which alone we have immediate knowledge. In it we can discern the presence of re-presentations, attributable to the retention and recognition of previously experienced presentations, and so on. So far as we can isolate a single "field of consciousness" in the continuous stream of consciousness, we find that it is characterized by cognition endowed with more or less affective tone, and that it eventuates in a motor response or a conation which implies motor activity. From considerations of this kind we are led to the conclusion that the simplest form of consciousness, a mere sentiency, is of somewhat the following nature. Stimulation of the receptor mechanism causes the emergence of an awareness of a *change* in the environment. This awareness is tinged with affective tone, with a minimum of cognition—the situation is pleasant or unpleasant, and so far possesses meaning, to which the organism responds by appropriate motor response, positive or negative, towards or away from the source of stimulation respectively. This is consciousness on the reflex plane. As McDougall says: "it seems probable that the actions of even the lowest animals imply a vague awareness of something, together with some vague forward reference, some vague anticipation of a change in this something."[1] If so, these traces of controlled activity are the germ of conation, *i.e.* striving towards an end. It is conation in a primitive form, panoramic and unfocussed; yet it is teleological, however minimal the objective signs may be, and however slight the subjective anticipated result or pre-sentience may be. For such organisms do not cease their apparently random movements when they meet with obstacles; indeed, such opposition tends to augment the efforts. Even at this low stage there is also the germ of variation of striving in order the better to cope with the obstacle. Whether there is any germ of learning by experience or improved efficiency in dealing with a similar situation on a subsequent occasion is less easy to prove. Since this depends upon retention and recognition, the germ of memory, we should only expect to find it in its liminal form. Just as pre-sentience is minimal, so, too, we should expect recognition to be minimal.

Awareness is the primitive form of attention, and by further differentiation and integration leads to interest. This advanced evolution is the result of differentiation and integration of the sensory presentations and their accompanying complications from re-presentations, etc. The diverse simultaneous sensory presentations are integrated into perception, endowed with richer meaning than on the reflex plane. The corresponding integration of affective tones emerges in emotion. This gives rise, by conation, to an integrated motor activity, which, by backstroke, contributes to the emotional affective tone. This is consciousness on the plane of instinct.

With further differentiations and integrations, assimilation of percepts into apperception-masses by means of memory and association, the higher stage of ideation and conceptual consciousness is reached. This is consciousness on the plane of intelligence, into the details of which it is unnecessary here to enter.

If, from the vantage point of the highest stage, which man alone has reached, we attempt, so far as we can, to analyse our experience, we note in the first place that perception plays a fundamental part. No matter how complicated the differentiations and integrations

[1] McDougall, *Social Psychology*, 8th ed. p. 360.

which take place, no matter how complex the co-ordinations and modifications of the percepts resulting in the emergence of higher states of consciousness, perception, though thus modified, persists in its essential characters as the foundation stone of the edifice.

At the lowest level of life organisms appear to react chiefly, if not solely, to stimulation by contact. If they are submissible at all to radiant energy, it is by physical contact with bodies emitting such energy, *e.g.* a body at a higher or lower temperature. From all the evidence available we conclude, with some degree of confidence, that primitive sentiency is essentially tactile. It is not to be regarded, however, as immediately comparable to our tactile experience. It is probably a vague, undifferentiated touch, in which awareness of a foreign body includes mechanical, thermal and chemical elements, to which, singly or combined, there is choice only of two responses, positive or negative, characterized sensorily as pleasant or unpleasant, motorially as movement towards or movement away.

At a somewhat higher level there is evidence of response to radiation of shorter wave-length—light, and perhaps ultra-violet radiation. As soon as this occurs the germ of projicience is found. The animal is sensitive to gradations of intensity of light and moves towards or away from the light—at first, as it would appear, by random movements attaining the desired positive or negative end by a process of trial and error. Very low down in the animal scale, however, specific organs responsive to light are found, and these at a very early stage appear to be adapted to directional sensitivity. Often they are protected on one side by pigment cells.

In due course a great array of specific receptor organs is evolved[1], of which the traditional five senses are but the most obvious. According to C. J. Herrick[2], there are at least twenty sensory receptors in man.

The receptors which are found in animals may be classified into three groups according to the physical nature of the adequate stimuli, *viz.* chemo-receptors, mechano-receptors, and radio-receptors. The chemo-receptors include three classes, those of smell, the common chemical receptor, and those of taste. Those of smell include the olfactory apparatus and the vomero-nasal apparatus (Jacobson's organ) of lower animals. The common chemical sense in higher mammals is found only on mucous surfaces in close relationship

[1] See W. A. Nagel, "Die Phylogenese specifischer Sinnesorgane," *Bibliotheca zoologica*, pp. 1–42, 1894.

[2] *An Introduction to Neurology*, Philadelphia and London, 1918.

with the apertures of the body—mouth, eye, anus, etc. Its receptors respond to irritating chemical agents, such as ammonia. In lower aquatic vertebrates, *e.g.* fishes and amphibia, these receptors are scattered over the surface of the body. Phylogenetically they are very primitive, being in fact one of the earliest types of sensory receptors occurring in most invertebrates, *e.g.* sea anemone, earthworm, etc. Taste receptors, limited in man to the tongue and neighbouring buccal and pharyngeal mucous membrane, are found scattered over the surface of the body in fishes. We know little of their specific differentiation in these animals, but in man the four tastes which alone occur, *viz.* sour, saline, sweet, and bitter, have attained an independence, anatomical and physiological, which authorize their being regarded as separate chemical "senses" or receptors. On the other hand, their teleological importance in the interests of nutrition, and hence of self-preservation of the animal, has suffered partial eclipse, for in fishes, for example, taste is endowed with local signature which is lost in man. Thus, in the cat-fish, *Amiurus*, if a barbel, which is specially richly supplied with taste organs, is touched with a pledget of cotton-wool the fish turns, but does not snap at it. But if the cotton-wool is soaked in meat juice and brought to the side of the fish, it turns and snaps. The former is a tactile reaction, the latter a true gustatory reaction, unaccompanied by touch, but obviously accompanied by a local sign[1]. That these responses are really gustatory is proved by the fact that if the branch of the VIIth nerve which innervates the taste buds of the flank of *Amiurus* is cut, the responses no longer occur[2].

Phylogenetically, the common chemical sense must be regarded as the most primitive. As found in invertebrates, the neural structure is a sensory cell situated in the surface epithelium, with an axon which passes directly to the central nervous system. It differs in vertebrates, in that, like other first sensory neurones, *e.g.* those of pain, the cell body is transferred to the dorsal root ganglion, the end organ consisting of free nerve fibres amongst the superficial epithelial cells. The very primitive nature of the olfactory and vomero-nasal receptors is shown by the persistence of the most primitive apparatus, a peripheral sensory cell in the epithelium, the axon of which passes directly into the central nervous system. The olfactory apparatus in

[1] C. J. Herrick, *Bull. United States Fish Commission*, 1902.
[2] G. H. Parker, *Jl. Acad. Nat. Sc.* Philadelphia, xv, 221, 1912. See also *Smell, Taste and Allied Senses in the Vertebrates* (Monographs on Experimental Biology), Philadelphia and London, 1922.

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the central nervous system of vertebrates is, however, so complicated that it may well be that the homologue of the dorsal root ganglion cell is intracerebral, a persistence of the very primitive condition exemplified by the intramedullary cells of *Amphioxus*, etc.[1] In any case the differentiation of the olfactory apparatus in higher mammals is along different lines from that of taste, for though we know little about olfaction, chiefly owing to its degraded position amongst the senses in man as compared with lower animals, it has certainly not become so specifically differentiated in man as has taste, itself somewhat similarly degraded. The less degraded position of taste is reflected in the anatomy of the apparatus, the taste buds being composed of neuro-epithelial receptor cells in synaptic relation with free nerve endings of axons which pass to unipolar cells in all respects comparable to dorsal root ganglion cells.

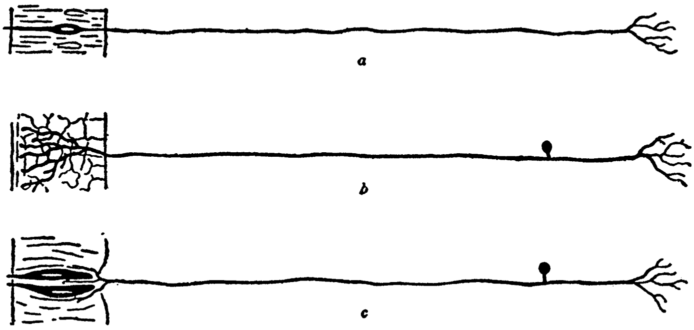

Fig. 1. Receptor system of *a*, olfactory and vomero-nasal organs; *b*, organ of common chemical sense; *c*, gustatory organ (G. H. Parker).

Physiologically, all the adequate stimuli of the chemo-receptors are substances in solution; and, judged by the molar concentration of odorous and sapid substances necessary to arouse the liminal response to olfaction and taste respectively, in man olfaction is found to be vastly more efficient than taste, or the common chemical sense[2]. The mechano-receptors can be divided into two classes, contact and distance receptors. The contact receptors include pain, touch or light pressure, temperature, and deep pressure. The distance receptors include various forms of mechanical pressure transmitted by water or air. Of these the lateral line organs of fishes and the vestibular apparatus of vertebrates are concerned in orientation, equilibration, and posture, and, therefore, belong to Sherrington's proprio-ceptive

[1] *Vide*, pp. 75, 76, 77.
[2] G. H. Parker and Stabler, *Amer. Jl. Physiol.* XXXII, 230, 1913.

group. Hearing must be regarded as a higher differentiation of this apparatus.

The radio-ceptors include temperature and vision, the adequate stimuli in each case being definite ranges of the radiant spectrum. Of them the receptors of vision are distance receptors *par excellence*. They possess the most highly developed local signature and the most accurate projicience of any receptors. In these respects temperature receptors fall far below them, being on a par with touch as regards local signature, and possessing only a vague projicience. There is no evidence that other ranges of the radiant spectrum have any corresponding receptors in man; but, as regards ultra-violet radiation, we have no definite evidence that such do not occur in lower animals.

Most of the receptors mentioned, with the exception of those of deep pressure—to which the so-called muscular and joint sense must be added—and the vestibular apparatus, which are proprio-ceptive, belong to Sherrington's group of extero-ceptors. The common chemical sense in man, olfaction and taste, belong to the intero-ceptors. Probably all the receptors have not been included in the above list. It is probable that there are receptors for hunger, thirst, etc. belonging to the intero-ceptors; but our knowledge of these is very slight. Phylogenetically, they must be very primitive, but their survival value must have been very great. Their responses in man have all the characteristics of the primitive—vague, ill-defined and undifferentiated, contributing little more than modifications of the general cœnæsthesis.

From the vantage point of man's status it is permissible to enquire what confirmatory evidence as to the evolution of receptors is derived from teleological arguments. Biologically, the fundamental ends of animal conation are (1) self-preservation, and (2) the preservation of the species. The fundamental means to the end of self-preservation are nutrition and protection. In the amœba the responses to stimulation are reduced to the lowest terms, positive and negative, and we have inferred that the conscious responses are similarly dual, pleasant or unpleasant, and are scarcely at all differentiated. It is probable that the earliest differentiation was into mechano- and chemo-receptors, of which the latter were most important for nutrition and survival. Hence the rudiments of taste and smell, probably as yet undifferentiated from each other, first arose. At a later stage smell became the distance receptor *par excellence* of nutrition, appearing first as a simple positive or negative chemotaxis. It initiated the appropriate motor response for taking