

Reviews and Abstracts.

The Present Evolution of Man. By G. ARCHDALL REID.
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Reflex Action, Instinct and Reason.

THE old time controversy as to whether animals can reason as long been settled in the affirmative, but the preliminary question of what the difference is between instinct and reason still remains an unsolved problem. Mr. Archdall Reid's offer of a solution in his recent book on Psychology appears to me unacceptable, because the basis of his definitions is unsound, their form unsatisfactory, and they do not stand the test of application to actual cases.

Mr. Reid defines instinct as "the faculty which is concerned in the conscious adaptation of means to ends, by virtue of inborn inherited knowledge and ways of thinking and acting," and reason as "the faculty which is concerned in the conscious adaptation of means to ends by virtue of acquired non-inherited knowledge and ways of thinking and acting." To regard instinct and reason as "faculties"—as separate entities—is a lingering remnant of the discarded "metaphysical" mode of treating psychological questions, which is out of harmony with current methods of thought, and is a cause of inevitable confusion. It is not possible to compare things so fundamentally different as the purely physical process of reflex action and a so-called "faculty" of reason, which is presumably mental. There is no possible basis of comparison between them. The mechanism of reflex action is as purely physical as the swing of a pendulum. It is no more possible to compare reflex action with a faculty of reason than to compare the swing of a pendulum with the working out of an equation. We may, indeed, if we can get a clear idea of what is meant by a faculty, compare the faculty of instinct with the faculty of reason, but we cannot compare either with the process of reflex action; and even if we term that process also a

faculty, we shall be no nearer to securing a basis of comparison. Mr. Reid appears to feel this difficulty, for though his chapter is devoted to reflex action, instinct and reason, and though he defines instinct and reason, he does not attempt to define reflex action. To define instinct and reason as faculties is, it is submitted, to define the unknown by the still more unknown, and so to sin against the primary canon of definition.

What we actually observe in men and animals, and can compare upon a common basis and by a common standard, are, not faculties, but acts. While we cannot compare a reflex act with a faculty of reason or of instinct, we can very easily compare reflex acts with instinctive acts and with reasoned acts; and to these acts our definitions, like our comparisons, must be limited.

No less unsatisfactory than the basis is the form of Mr. Reid's definition. A definition to be adequate must be clear; it must be intelligible. Mr. Reid's definitions are neither. Apart from the term "faculty," which conveys no clear connotation, the way in which the faculty is "concerned" in the adaptation of means to ends is left unexplained. How is the faculty concerned? The term carries the implication that there are other factors also "concerned" in the process. If so, what are these factors? If not, the definition is faulty in not stating explicitly that instinct or reason is the faculty which *actuates* the adaptation, &c. Again, the expression "by virtue of" is by no means clear, either in itself or its connections. Is it the adaptation of means to ends which is effected "by virtue of" inborn knowledge, &c., or is it the faculty which is concerned "by virtue of" this knowledge, &c.? In either case, what is the influence which this knowledge, &c., exerts on the process? Not to appear captious, I will pass over the absence of any distinction being drawn between knowledge and ways of thinking, and will note a very serious defect in the definition of reason. The term is used in the colloquial sense in which it is commonly employed when "reason" is contrasted with "instinct," and though there is much "virtue" in the term "faculty," it appears that what Mr. Reid is really dealing with under the name of reason is a certain "way of acting." If reason is to be regarded as a faculty, in accordance with the old metaphysical method of speaking of the subject, we may pass this use of the term; but in a book on Evolution, which aims at presenting the results of modern psychology, it is expedient that the term should be used in the sense recognised among modern psychologists, as connoting a mental process. Lastly, it is extremely difficult to understand

what is meant by "a faculty which is concerned with the adaptation of means to ends by virtue of inherited . . . ways of action." Is not the adaptation of means to ends "a way of acting?" and if it be, what is the meaning of a way of acting by virtue of a way of acting? The definitions appear so faulty in form as, when critically examined, to be almost unintelligible; but let us accept them as they are, and apply their provisions to actual cases, and see whether they will stand the test of application; and in order to be quite fair, let us take the instances offered by Mr. Reid himself.

He adduces the case of the young alligator or turtle instinctively seeking the water on emerging from the egg. Is it seriously maintained that the new-born turtle or alligator has a *conscious knowledge* of the difference between land and water, of the direction in which water lies, and of the fact that progression in one direction will take him towards, and in the other direction away from water? If this is not asserted, the definition falls to the ground. If it is asserted, it can be denied, and of neither assertion nor denial can proof be adduced. It might similarly be asserted that the sunflower turns to the sun by virtue of a conscious knowledge of the sun's direction.

"By what term," says Mr. Reid, "shall we designate the action of the spider when he builds his web? Does the animal not know for what purpose he constructs it?" His definition of instinct (as the faculty which is concerned in the *conscious* adaptation of means to ends, &c.) depends upon the affirmative answer to this question. But the question cannot be certainly answered in the affirmative. We know nothing about the consciousness of the spider. We can only guess what it may be by analogy from our own consciousness, and while this analogy allows us to suppose that, on the second or third occasion of constructing a web, the spider knows the purpose for which the web is being constructed, it positively forbids us to suppose that he is so aware when, without previous experience, he constructs his first web. If we say that he must know, because he constructs the web instinctively, and instinct is the conscious adaptation of means to ends, we are arguing in a circle; and there is no other ground for the statement. It is evident that when the factor of consciousness is brought into the definition, a factor is brought in of which we are almost entirely ignorant, a factor about which contradictory assertions may be made without the possibility of either being proved or refuted, and, therefore, a factor which renders the definition valueless. Mr. Reid compares the action of the spider in running

along a thread to secure his prey with that of a man running to secure a snared bird ; and that of the former cutting loose a dangerous captive with that of the latter in building a golden bridge for a flying enemy ; and asks in what respect the actions of the spider differ from those of the man. " Only," he says, " in that the actions of the spider result from knowledge that is inborn and inherited, whereas the actions of the man result from knowledge which is neither inborn nor transmissible." In this statement there are many assumptions, and if any one of them fails, the distinction is invalid. Take two of them only—first, that the spider knows what the effect of his action will be ; second, that no other difference between the acts can be found. Both are unwarranted. There is no warrant for the statement that the spider knows that the result of cutting loose a too-powerful captive will be to save his web from destruction, any more than that the ant knows, when she is hiding a pupa-sister, that she is helping to preserve the formicine body politic. We know nothing certainly about the knowledge of the spider in the circumstances, and to postulate that his act is the result of knowledge is a gratuitous assumption, opposed to what analogy we have to guide us. That there is another distinction between the acts of the spider and the man, a distinction that is not open to this objection, will presently be shown.

Precisely the same criticism applies to the stated cases of the alligator which seeks the water and snaps at an opposing walking stick ; of the nesting bird ; and of the bird which utters cries of warning ; as compared with the man who seeks a refuge and strikes an intervening enemy ; who builds a hut ; and who warns his fellow of danger. Mr. Reid's distinction fails unless we assume that the alligator and the bird respectively foresee the results of their acts, and, since he brings it forward as the only one possible, it fails also if we can find another and clearer distinction.

Almost every sentence in Mr. Reid's chapter on this subject presents obvious points for criticism, but to notice them all would be tedious. It is necessary to notice a few which bear directly upon his definitions. " Appropriate stimulation," he says, " does not cause variations and developments in reflexes and instincts," and, again, on the same page, " instinct, which, though undeviating in its promptings, is associated with consciousness, and controlled to some extent by volition, whereby the element of choice is introduced." But if instinct is controlled to any extent by volition, and if the element of choice is introduced, then appropriate stimulation *does* cause variation in instinct. For if the element of

choice is introduced, the instinct is varied, and varied to better suit the circumstances, or what is the advantage of choice? And, if varied to better suit the circumstances, then varied in obedience to the "appropriate stimulation" which the circumstances furnish.

"There is no vestige of proof that instincts are increased by stimulation, *i.e.*, that they are not only called into activity by stimulation, but sharpened by it." On the contrary, there is abundant proof that the bird with practice makes a better nest; the spider with practice makes a more perfect web. But Mr. Reid says this improvement is no longer instinct; it is reason. Then, we ask, what becomes of the absolute distinction between instinct and reason? "Instinct does not merge into reason, but is sharply divided from it. Reflex action, instinct and reason are not derived the one from any other, but each one is distinct from, and has arisen independently of, the others—is not a more or less complex form of the others." "Instinct and reason do not merge at any point."

Mr. Reid quotes Spencer as regarding instinct as arising out of reflex action, and being evolved into intelligence, and Lewes as regarding instinct as the result of intelligence, and sets them off the one against the other, and disagrees with both. No doubt, as he puts the case, the two positions are irreconcilable; and if instinct arises out of reason it seems impossible that reason can arise out of instinct; but if we alter the wording very slightly it will appear not at all inconsistent to speak of reason arising out of instinct, and sinking into instinct again.

It appears evident that such a mass of inconsistencies and contradictions in the argument points directly to a fundamental fault in the definitions upon which the argument is based; and the test of their application to actual cases confirms the impression derived from the ambiguity of their form and the unsoundness of their basis—that they do not fulfil the requirements of scientific definitions, and do not define the subjects to which they are applied.

It has been pointed out that there is no common basis for comparison between a purely physical process such as reflex action, a quasi-psychological "faculty" such as instinct, and a psychological "faculty" such as reason. By reflex action is meant the physical reaction of a living body to physical stimulation. Reason is employed sometimes to connote purely mental processes, which can be observed by introspection of our own minds only; sometimes to imply the combination of this mental process with other mental processes and with conduct. It is in this latter sense that it is

understood when used in contradistinction to instinct, but the mischief is that, when so employed, the other more restricted meaning is continually creeping in and vitiating the argument. In whichever way it is employed, it can no more be compared with reflex action than a resolution passed at a public meeting can be compared with a sausage-machine. Before any mutually exclusive definition of any two or more things can be made, there must be some common standard of comparison to which they can all be reduced. In the present case, we can directly observe reflex action. Neither instinct nor reason can we directly observe. We cannot in any way compare reflex action with either instinct or reason, but we can very easily compare a reflex act with an instinctive act, and both with a reasoned act; and to these acts our definitions, like our comparisons, must be limited.

What, then, are the characteristics of a reflex act? If we touch the expanded tentacles of a sea-anemone they retract. They do not retract until touched, and when touched they retract. However long we watch the animal, we do not see its tentacles retract until they are touched, and when they are touched they never fail to retract. If we lightly touch the conjunctiva of a human being, the eyelid is convulsively closed. However long we watch the man, the lid is not so closed unless the conjunctiva is touched; and when the conjunctiva is lightly touched the lids never fail to close convulsively. If a foreign substance gets upon the sensitive surface of the air-passages, a cough is excited. The individual does not cough unless a foreign substance impinges upon the air-passages, and when such a substance touches the sensitive surface the cough never fails to occur. The two characters common to them are common to all reflex actions. Every reflex action is what its name implies—it is reflex. That is to say, it is the reaction of the living organism to a stimulus applied. No stimulus, no reflex action. And when the stimulus is applied it never fails to evoke that particular reaction and no other. When the tentacles of the sea-anemone are touched, they retract. They do not retract unless touched; and however often they may be touched they still retract and do nothing but retract. When the conjunctiva is touched, the lids close convulsively. However often it may be touched they still close convulsively. And the convulsive closure of the lids is the only action that is evoked by the stimulus. It is true that if a foreign body remains in contact with the conjunctiva the man may get up and go to a surgeon, but this act is manifestly no part of the reflex. So, too, however often the air-passages are stimulated by the contact of a foreign body, the cough never fails

to follow, and the action that follows is never anything but a cough. Allowance must be made for the differences in intensity of stimulus and for diffusion of stimulus. If the conjunctiva is wiped instead of being tickled, convulsive contraction of the lids does not follow ; but then the stimulus is different, and the contention is that the same stimulus provokes always the same reaction. So, if the irritation of the air-passages is great and persistent, the cough will be reinforced by vomiting. But these examples evidently do not vitiate the rule. A moderate irritation of the air-passages will evoke a cough, always a cough, and nothing but a cough. A more violent irritation will evoke coughing and retching, always coughing and retching, and nothing but coughing and retching. Reflex action is, then, a reaction ; it never occurs except in response to stimulus. It is unfailing ; upon application of the stimulus it never fails to occur. It is unvarying ; the same stimulus always evokes the same reaction. We may, therefore, sum up the nature of reflex action by defining it as an unfailing, unvarying reaction to stimulus ; or, better, we may combine the two first qualities in a more comprehensive term, and define reflex action as *determinate reaction to stimulus*.

Such being the character of reflex action, how is instinctive action distinguishable from it? Like reflex action, instinctive action is determinate—that is to say, in given circumstances it is unfailing and unvarying. Under given circumstances of nutrition and warmth, the bee builds comb. Every working bee without fail takes its part in comb-building, and every bee builds comb in the same unvarying way. The garden spider never fails to make a web, and always makes a geometrical web. The trap-door spiders never fail to make their webs, and always make them to line their nests and to form a trap-door over the mouth of them. The house spiders never fail to make webs, and always make their webs in sheets and festoons. Every bird, when the nesting season comes round, makes its nest ; and every species chooses a similar locality, similar materials, and a similar style of architecture. The rook always builds at the top of a tall tree, and makes its nest of live sticks. The thrush always builds in a bush, and makes its nest of grass lined with cow-dung. The kingfisher and the sandmartin always make a tunnel in the ground ; the woodpecker a hole in a tree. When the season for migration comes round, the bird never fails to migrate, and migrates to the same country, the same locality, nests even in the same tree that it had sought before. When the spawning season comes round, the salmon unfailingly seeks the river. The newly-hatched turtle and alli-

gator unfailingly seek the water; the egg-laden turtle and alligator unfailingly seek the land. The beaver never fails to make its lodge and its dam, and makes them of the same materials and in the same way as other beavers do. The rabbit always makes a burrow, the hare always sleeps in the open country, and so with all other instinctive actions. When the circumstances occur, the acts occur, and occur with unfailing, unvarying regularity. So that instinctive actions, equally with reflex actions, are *determinate*.

But they differ from reflex actions in being spontaneous. They are not reactions to stimulus. They are the natural spontaneous activity of the organism seeking expression in definite, stereotyped directions. They need no stimulus to evoke them. They occur under certain circumstances, but the circumstances are not necessary to evoke the actions, and although certain circumstances may be necessary to render the action possible, as, for instance, a running stream for the dam of the beaver, yet in the absence of the circumstances an effort to perform the action is still made, as when the beaver, confined in a room, makes in the corner a caricature of a dam out of boots and hair brushes; as when the dog who never wants a meal, buries his bones for a future need which will never arise. So with all instinctive actions; when the time for their performance comes round, the animal spontaneously attempts to perform them. If the necessary stimulus is not applied, no reflex action will take place. If the stimulus is withheld during the whole life of the organism, still the reflex action will never occur. But the instinctive action needs no stimulus. The young turtle turns spontaneously to the water. The bee spontaneously seeks its way out of the hive, seeks the flowers, and returns laden with honey and pollen. The spider needs no external stimulus to induce him to make his web. The stimulus comes from within. The action is spontaneous. So when the nesting season arrives, the bird is impelled by irresistible urging from within to set about building; and later is impelled by a similar craving to start on its weary migration. The changing season supplies the occasion, but no stimulus from without is needed. The stimulus arises from within. So the spawn-laden salmon seeks the river, the egg-laden turtle and alligator the land, urged thereto by no stimulus from without, but by a craving which arises within.

Instinctive actions, then, while they resemble reflex actions in their determinate character, differ from them in being, not reactions to stimulus, but spontaneous actions. They are *determinate spontaneous actions*. The difference between reasoned actions and

the two classes of actions that we have already considered is manifest at a glance. Reasoned acts are *indeterminate* acts. They may occur in response to stimulus, or they may arise out of the spontaneously-generated activities of the organism, but in either case they are indeterminate. They are uncertain. They vary. They are unpredictable. To take Mr. Reid's illustration: In what respect, he asks, does the action of the spider in running to secure his prey differ from that of the man running to secure a snared bird? In the origin, he says, of the knowledge by virtue of which the adaptation of means to ends is made—inherited in the one case, acquired in the other. But, apart from the uncertainty as to whether the action of the spider is prompted by knowledge at all, there is another and much more relevant difference. The action of the spider is unfailing and unvarying, undivertible, predictable with certainty. The action of the man is indeterminate. When a fly touches the spider's web, and by the action of its wings communicates a vibration to the threads, the spider rushes out. When another fly does the same thing, the spider rushes out again. If we imitate the vibration of the fly's wing by touching the web with a vibrating tuning fork, again the spider rushes out. As often as the web is made to vibrate, so often is the spider "drawn." Repeated disappointment does not check his promptness of action. The presence of a formidable enemy does not scare him into quiescence. His reaction to stimulus is strictly determinate. But the reasoned action of the man has no such determinate quality. When he has snared a sufficient number of birds, he sets his snares no more. In presence of a formidable enemy, he does not rush out to capture his birds, but remains concealed. And, in any case, when a bird is in the snare his attention may be diverted, he may be called off his task by an urgent message; he may follow some bigger game within his reach; he may wait, so as to refrain from scaring birds from a neighbouring snare. His action is indeterminate. So when a spider has a dangerous captive, he cuts him loose. However often a too powerful fly engages his web, he deals with it instantly and in precisely the same way. His action is determinate. But the man does not necessarily build a golden bridge for his flying enemy. He may prefer to attack, on the chance of exterminating him; he may hang upon his rear and harass him. His action is not determinate. So with the action of the alligator that seeks the water and snaps at an opposing walking-stick, as contrasted with the man seeking refuge and striking at an intervening adversary. To accept Mr. Reid's explanation we must assume that the alligator

knows that he is going towards water, and knows that his action in snapping is minatory and deterrent, which, for the first occasion on which he does so, are large assumptions. The more essential distinction is that the alligator's action is determinate, the man's indeterminate. On every occasion on which the alligator is disturbed, he makes straight for the water. Even if he has previously experienced the futility of his effort at escape, the insecurity of his refuge, he still makes the same effort, seeks the same refuge. His action is certain and unvarying. But the man may seek refuge or may determine to fight; may seek one refuge rather than another; may have recourse to various stratagems; and if he has already found the refuge to be insecure he will not seek it again. The alligator attacks the foe who intervenes between him and the water. The man may attack or may avoid him. His action is variable. The same distinction may be traced between the instinctive or reflex action and the reasoned action in the other examples given in Mr. Reid's chapter.

If the distinction here drawn between reasoned acts on the one hand, and instinctive and reflex acts on the other, be the true distinction, then two consequences follow. First, that so long as any action falls completely within the definition of either, so long the distinction between them is absolute; a determinate act is instinctive or reflex, an indeterminate act is reasoned. Second, that any element of uncertainty or variability that is introduced into an instinctive or reflex act imparts into that act some element of reason; and, contrariwise, any element of certainty, or, let us say, *predictability*, that exists in a reasoned act renders that act in so far instinctive or reflex. Thus it will be seen that very few acts are purely instinctive or purely reflex, and very few acts are purely reasoned; but that the two kinds of action merge into each other by an infinite series of gradations. Nevertheless, although Mr. Reid is unquestionably wrong when he states that instinctive action is sharply divided from reasoning action, and that there is no border space where the one merges into the other, yet his statement contains an approximation to the truth; for, undoubtedly, the instinctive *factor* in any act is sharply divided from the reasoned *factor* in that act—as sharply as certainty is divided from uncertainty, and sameness from variability.

The action of breathing is adduced by Mr. Reid as an example of reflex action. According to our definition, it may more properly be regarded as instinctive, since the action is provoked, not by

stimulus from without, but by spontaneous impulse from within; but if we allow it to be a reflex action, it is still not completely determinate. It is certain that the rate of breathing will be within narrow limits, the same so long as the body is at rest in the same position; that it will be increased by exercise, greatly increased by violent exercise. But, to some extent, it is modifiable. We can at will hold our breath for a season, breathe slowly or rapidly, take deep or shallow breaths. In these cases the action of breathing, usually determinate, becomes to some extent indeterminate. An element of reason is imported into it. It becomes partly reasoned. It merges into reasoned action. Another example of reflex action is coughing, and of this the same is true. Though coughing is certainly excited by irritation of the air-passages, provided the irritation is sufficient, yet, if the irritation be only slight, the cough can be suppressed. If it cannot be wholly suppressed, it may be minimised; or it may be maximised—exaggerated. Lastly, a cough may be produced spontaneously, without the stimulus of irritation. In each of these cases the ordinarily purely reflex action may have an element of reason engrafted upon it—may become in part a reasoned action. In the last case it is purely reasoned. Yet in all cases the reflex element in the action can be sharply distinguished from the reasoned element, so that, although reflex acts may and do graduate and merge into reasoned actions, reflex action and reason remain distinct.

The action of the spider in making its web is commonly adduced as a type and example of instinctive action. Yet it is manifest that although there is a general and very striking sameness in the webs of any two spiders of the same species, no two webs, even of the same spider, are precisely alike. Each individual web has certain distinctive features, which adapt it to the particular position in which it is placed, and to the relative positions and distances of its supports. Though it is certain that an *epeira diadema* will build a geometrical web, composed, first, of main boundaries attached to supports, and enclosing an irregular polygonal space; second, of radii stretching from the centre of the polygonal space to its boundaries; and, third, of two ranges of spirals, one closely set round the centre of the space, and one more widely set external to the first; yet, when an *epeira* is placed in an enclosed space, it is quite uncertain to what points it will attach the main supports of its web, or what will be the shape of the polygonal area. Although the impulse, or, if we please, the craving, to construct the web is purely instinctive,

and although the attachment of the spiral threads is a combination of pure instinct and pure reflex action, yet the construction of the main supports is only partly instinctive and is partly reasoned. The general action of making supports, of making them stronger than the rest of the web, and of enclosing a polygonal area within them, are instinctive. They are certain and unvarying. But since no two webs are made in precisely the same position, the particular action of attaching these supports to particular objects is a reasoned action, and an action involving sometimes a high degree of reason. Moreover, whenever reason is exhibited in the construction of a web, it is exhibited in the attachment of the supports, and not in any other part of the process. Thus the means by which the supports are attached to distant points are various, uncertain, and ingenious. The spider may hang by a thread, and allow itself to be swung by the wind to the desired spot; or it may run round, having first attached one end of a thread to the point of departure, and pull it taut on arriving at the destination; or it may float a thread in the air and allow it to be carried by the wind. In windy weather, spiders will attach the lowest part of the web to a hanging weight, instead of to a fixed object, and thus preserve their web from destruction. A better example of a reasoned action it would be difficult to find; yet it is a part of the action, considered typically instinctive, of web-spinning. In this instance, therefore, instinctive action does merge into reasoned action, that portion of the action which is certain and unvarying being instinctive, and that portion which is uncertain and varying being reasoned.

Another action usually selected as the type and example of instinctive actions is the comb-building of the bee. The domestic bee never fails to make its comb, and the comb is invariably made of hexagonal cells with pyramidal bases, composed of three rhombic plates. In an apiary of a hundred hives, each containing tens of thousands of cells, every cell answers this description. In so far, the action of the bee in building its comb is purely instinctive and reflex. But this action is subject to much variety. It is varied abundantly and continually to meet special cases, and to overcome special difficulties. Where the drone comb, built of larger cells, meets the worker comb, built of smaller cells, intermediate cells are interposed to afford a transition from the one to the other. Where a corner has to be rounded, the cells on the convex side are made with mouths larger than their bases, and those on the concave side with bases larger than their mouths. When the comb becomes heavy with its contents, its attachments

are strengthened. If a comb is torn down by its own weight, temporary buttresses are constructed from comb to comb, to hold it up until it is permanently fixed by new comb. "In places where special conditions of the situation do not otherwise permit, it may be observed that the bees, far from clinging obstinately to their plan, very well understand how to accommodate themselves to circumstances, not only in cell-building, but also in making their combs." They will pull down and rebuild repeatedly the same cell in different ways, until they have it to their satisfaction. So that the typically instinctive acts of comb-building merge into and blend with highly-reasoned acts. And the instinctive element in the action is still the determinate element, and the action is reasoned in so far as it is indeterminate.

A third typically instinctive action is the nidification of birds. The impulse to build is purely instinctive. The choice of position, of materials, of pattern, of construction, are all instinctive. That is to say, they are determinate. They are in most respects certain and unvarying, and therefore almost purely instinctive. But in some respects they are uncertain and variable, and in so far as they are thus indeterminate they lose their instinctive character and become reasoned. Thus the thrush builds its nest in a bush, and builds it of grass lined with cow-dung ; in so far the action is determinate and is instinctive. But the particular bush, and the particular branch of the bush, are not determinate. These depend upon the choice of each individual bird, and of course varies with each bird, and with the same bird from year to year. That part of the action is not instinctive, it is reasoned. It is, as already said, proved beyond doubt that the first essay of the bird at nest-building is less successful, its first nest less perfectly constructed, than its subsequent nests. It learns and improves by experience and practice, and, so improving, its action varies, and thus becomes reasoned action. In this instance, again, instinctive action merges into reasoned action. An instinctive factor and a reasoned factor enter into the composition of the act, which thus becomes composite ; and, although the two factors can be distinguished from one another upon analysis, yet in the doing they are combined and merged the one into the other.

The real nature and relationships of reflex action, instinctive action, and reasoned action cannot, however, be thoroughly understood without a consideration of the nervous mechanism by which they are severally actuated. Reflex action being determinate, is actuated by nervous structure which is fully and completely organised ; so that the ingoing current provoked by the stimulus

is restricted to certain definite paths, acts upon and discharges certain determinate cells, whose discharge flows through definite and restricted paths to the muscles, and produces the definite, determinate action. The process is determined by the physical conditions under which it occurs. The stimulus can no more produce a different action than water can leap over a bank. The action can no more occur without the provocation of the stimulus than gunpowder can explode without the spark. If, however, the stimulus is unusually intense, the more powerful current that it produces will evoke a more powerful discharge, which, being of too great volume to wholly escape by its accustomed channels, forces its way into neighbouring areas, and produces additional and allied actions. Thus an intense irritation of the air-passages will produce, not only cough, but vomiting.

Similarly, instinctive action is actuated by a fixed arrangement of nerve tissue, an arrangement which is inherited just as the arrangement of muscles and bones in a limb is inherited. Just as a bird inherits an arrangement of muscles attached to the bones of its wing—an arrangement such that the action of the muscles on the bones will produce the movement of flying—so it inherits a certain arrangement of nerve tissue, such that the action of these cells and fibres will cause the alternate contractions of the muscles necessary to produce the movements of flying. And so, too, it inherits a certain structure of nerve tissue such that it serves as a storehouse of energy, and, when replete, discharges the energy into the nervous apparatus which actuates the movements of flying. Thus the action of flying is spontaneous, because the nerve tissue become replete with energy; and this energy finds its way, through to channels already formed, in certain definite directions, from which the movements of flying result. The arrangement and nature of the tissues which determine this result are inherited by the bird, just as the nature and arrangement of the rest of its tissues are inherited; just as the shape of its beak, the number and form of its claws, and the colour of its feathers are inherited. The important thing to observe is, that what is inherited is not a "faculty," nor knowledge, nor a way of thinking, but an arrangement of tissues and organs.

What is true of the instinctive action of flying is true of other instinctive actions. The impulse to perform the acts arises from the repletion of certain nerve tissue with the energy which it is its function to store. The form of the action depends upon the arrangement and connections of the nerve tissue into which the liberated energy is discharged. The reason why the

repletion of tissue impels to one instinct rather than another is because the replete tissue is in relation with one set of viscera and nervo-muscular apparatus and not with another.

We have seen that, although the distinctive quality of instinctive action, as compared with reasoned action, is its determinate character; yet no instinctive action is wholly determinate. There is, in every such action, some variable factor, some element of reasoning. Even in an action to all appearance so wholly instinctive as flying or walking the direction is variable, the time of starting and arrest, the direction and speed are variable. No action, however greatly instinctive, is wholly instinctive. So, too, the arrangement of nerve tissue which underlies instinctive actions, definitely and fixedly organised though it be for the most part, yet is always to some extent plastic, modifiable, subject to disturbance and rearrangement. It is inherited with its main features, indeed, organised, but it is never completely organised throughout, or instinctive action would be as unvarying as pure reflex action.

Lastly, together with the wholly fixed, definite, stereotyped, unchangeable, completely-organised nervous arrangements that actuate reflex action, and the, in great part, fixed, and nearly completely-organised nervous arrangements that actuate instinctive action, there is inherited a quantity of nervous tissue which is still in plastic condition, still modifiable, and subject to rearrangement under the action of incident forces and of its own escaping energy. It is this portion of nervous tissue that actuates reasoned actions—actions whose indeterminate character represents the as yet incomplete organisation of the nervous arrangements to whose activity they are due. This portion of nervous tissue is, of course, inherited just as much as are the portions which actuate instinctive reflex action. The distinction is that in the last case the arrangements are inherited ready made, completely fixed; in the second they are in great part ready made, but in part subject to modification by the experience of the individual, and in the first case they are only “roughed out,” and although the individual derives much assistance, and is saved much labour by the inherited tendency of this tissue to develop and organise in certain definite ways, yet, in the absence of the guidance of experience, that is, of stimulation by circumstances, it will only slowly, slightly and imperfectly so develop.

By regarding the inherited factor in conduct, not as faculty, but as arrangement of nervous tissue, we have a trustworthy guide through the perplexing tangle of the genetic relationships of the three sets of actions with which we are dealing.

When it is stated that instinct and reason do not merge at any point, as they would were the one derived from the other, there is a confusion of thought involved in the statement, which becomes obvious when we deal, not with instinct and reason as faculties, but with instinctive action and reasoned action. Obviously an act cannot be, in the same respects, both determinate and indeterminate, and if we call the determinate portions of the act instinct, and the indeterminate portions reason, then, of course, instinct and reason do not and cannot merge into one another. But if we regard the action as a whole, and find that certain portions of it are determinate and certain other portions are indeterminate, that indeterminate action may become determinate and *vice versa*, as in the cases examined above of the web-making of the spider, the comb-building of the bee, and the nest-building of birds; then, undoubtedly, an action may partake of the nature of both instinct and reason, and in this sense the two do most undoubtedly merge into each other; so that this argument against the origin of one from the other falls to the ground.

But, says Mr. Reid, I define instinct as depending on inheritance, reason as wholly acquired, and, since acquired traits are never inherited, instinct cannot be derived from reason; nor, since reason contains no element of inheritance save the power to be acquired, can reason be derived from instinct. If reason and instinct be regarded as faculties, and if acquired traits are never inherited, and if Mr. Reid's definitions are correct, this reasoning is no doubt sound. But if we deal with instinct and reason in terms of the acts which display them, and if we regard these acts as depending on nervous structure, we shall see reason to doubt his conclusions. Pure reflex action is actuated by a nervo-muscular mechanism, which is completely organised, that is to say, which has its parts disposed in an arrangement so fixed and determined, so shut off from the possibility of interference from without, that the action follows the stimulus as surely as the discharge of the gun follows the pull of the trigger. But it is quite in accordance with our knowledge of the arrangement of the nervous system to suppose cases in which, although the mechanism is completely organised throughout most of its extent, yet there is in some part of the circuit a breach through which modifying currents can find admission; and, correspondingly, we find that there are reflex actions, which are not purely reflex, but admit of modification and inhibition. Thus, although we cannot check or interfere with the convulsive closure of the eyes that follows a

light touch on the conjunctiva, we can modify and check the cough that follows a slight irritation of the air passages. Once allow that reflex actions can be modified—that the nervo-muscular circuit, well and deeply organised, as for the most part it is, yet in part of its course is incompletely organised, and retains some plasticity—and it is immediately apparent that the degree to which the fixity of organisation may be imperfect, and plasticity of action may be retained, is indefinite. It may be, in some cases, little or none, in others much; and hence we shall find actions, such as that of the eyelids, or the contraction of the pupils on the stimulus of light, that are purely reflex; others, like that of coughing, that are slightly modifiable; others, like that of withdrawing an injured limb, that are more modifiable, until we arrive at actions like that of undressing, or winding the watch, or crocheting when the materials are placed in the hands, or writing when a pen is put between the fingers, whose reflex character is so little apparent, is so swamped by the intelligence with which they are usually guided, that it only becomes apparent in certain morbid states of the nervous system, when the normal interference of parts of the nervous system outside of the special nervo-muscular circuit is abolished by disease.

Purely instinctive action is similarly actuated by a fixed, definite, organised arrangement of nerve tissue. But, as in the case of reflex action, the whole complexus of this arrangement is seldom organised with such completeness as to prevent the incursion, at some point, of interfering currents from without its own area. Whenever such incompleteness of organisation exists, the actions admit of modification. They become indeterminate. They partake of the nature of reason. They exhibit intelligence. Now, it is certain that incompletely organised arrangements of tissue are as freely transmitted from parent to offspring as completely organised arrangements. For instance, the majority of bones are more completely organised cartilage, yet not only bones but cartilages are inherited. Many inherited tissues are partly bone and partly cartilage, and some such tissues become in the course of life completely organised into bone. Hence there is nothing unusual, or incongruous with other instances of inheritance, in the transmission from parent to offspring of either the completely organised arrangement of tissue that actuates purely reflex action, or the well-organised, but in part incompletely organised, arrangements that actuate impure reflex action and instinct; and the point is, that not only is that part of the arrangement inherited which actuates the instinctive portion of

the action ; but that part also of the arrangement which actuates the reasoned portion of the action is likewise inherited. This latter part of the nervous arrangement is, it is true, plastic, modifiable, educable. It is inherited, not as a completely organised arrangement, but as an arrangement incipiently organised, and thus in some sense justifies Mr. Reid's description of reason that what is inherited is not reason itself, but only the power of acquiring reason. It is obvious, however, that to regard what is transmitted as nervous tissue rather than as "power of acquiring reason" is a great advance in the definiteness and clearness of knowledge.

As with reflex acts, so with instinctive acts, the proportion of unorganised or incompletely organised tissue that enters into the construction of the nervous arrangements that actuate them varies greatly in different cases, and, correspondingly, the amount of the reasoned element that is combined with the instinctive action varies, some actions being almost purely instinctive, others being almost purely reasoned, and having their motive only in instinct.

This being so, the final question, whether instinct can be evolved into reason, or whether reason can sink into instinct must be stated anew in the terms, not of faculty, but of action. It becomes the question whether reflex or instinctive action admits of modification so as to become reasoned, and whether reasoned action can become stereotyped so as to become instinctive or reflex. That the first of these questions can be answered in the affirmative we have already seen. In every instinctive action, and in nearly all reflex actions there is an element of reason. The question becomes whether this element can increase and take a larger and larger share in the action. Without adducing examples, it will be evident to those who are acquainted with the facts of animal psychology, and even from the facts already adduced, that this does occur, and that instinctive actions may and do become modified into reasoned actions.

As to the reverse change, the attainment of fixity and invariability by reasoned actions, we have the universal experience of mankind in its favour. Of the nature and mode of working of nervous processes we know little, but this fact is established beyond doubt, that nervous processes are established and organised by repetition. When a novel process occurs in the plastic, and comparatively unorganised nervous tissue, it brings about a partial and tentative re-arrangement of the tissue elements. If the process is not repeated, the new arrangement becomes partially or completely dissipated, and a mere trace, or no trace, is left.

But if the process be repeated, the disturbed nervous elements are thereby confirmed in their new disposition ; and with every repetition they become more firmly fixed, more stably compacted, more completely organised. So that it is a matter of common, of universal experience, that actions become easier by being practised. At first purely reasoned, they gradually lose their reasoned character and become more and more determinate. Although, in the lifetime of an individual, reasoned acts rarely become purely reflex, yet they often become so largely determinate that the application to them of the term "reasoned" becomes inappropriate, and they are called, in the less advanced stage "habitual," and in the more advanced stage "automatic." The response to command may become so fixed in the nervous organisation of the old soldier, that if he is suddenly called to "attention" when carrying his dinner, he will jerk his arms to his sides and let his meat and potatoes go rolling in the street. In this case, the transformation of a reasoned action into a reflex has become complete in the lifetime of a single individual. To examine the question whether the reflex thus acquired may be wholly or in part transmitted to the offspring is beside the question.

Although, therefore, we cannot refute the position that "reason and instinct do not merge into one another," since the instant an act becomes instinctive it ceases to be reasoned, and the instant it becomes reasoned it ceases to be instinctive; yet, if we deal with acts, we find that, beyond the shadow of a doubt, instinctive and reflex actions do merge into reasoned actions, and reasoned actions do merge into instinctive and into reflex actions.

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