

they will improperly refuse to admit the doctrines of modern psychology, as if they were still on the old and now outworn basis. The harm which may come from attempting to tie down modern physiology to the crude notions of the old psychology may be seen from the hindrance and confusion which such conservatism has already caused in the scientific study of such related subjects, for example, as visceral sensations, emotions, instincts, subconscious processes, and personality. Dr. Nichols then elaborates somewhat these examples in the line of his theory of pain sensation, and according to the prevalent doctrines as to cœnesthesia, subconsciousness, and instinct.

These subjects, and especially personality, physiology seems to dread to investigate, lest it be thought to lay itself liable to the once more reasonable reproach that it is metaphysically speculative. In closing, Dr. Nichols expresses the following very pertinent opinion: "There is as much need that physiology shall unite now, heartily and generously, with psychology to purge the realm of the latter from primitive scholasticism, as it was, at an earlier date, for her to drive out from her own realm the false notions of physiology derived in the same manner from the same sources."

GEORGE V. DEARBORN.

Animal Intelligence: An Experimental Study of the Associative Processes in Animals. By E. L. THORNDIKE. Monograph Supplement No. 8 of the PSYCHOLOGICAL REVIEW.

In this monograph are presented the results of some experiments which I have been carrying on during two years, and some theories which these results seem to support. The subjects of the experiments were dogs, cats and chicks, and the method was to put them, when hungry, in boxes from which they could escape and so get food by manipulating some simple mechanism (*e. g.*, by pulling down a loop of wire, depressing a lever, turning a button). On the first occasion that a young animal is put into such a box, it reacts instinctively with attempts to squeeze through holes, to claw down bars, to bite through the confining walls, to claw at things outside the box as if to pull itself through. If the animal does not, in the course of such activity, hit upon the proper act by chance, it, of course, never forms the association between the sight of the interior of that box and a certain act. But if it does hit upon the proper act, the resulting pleasure stamps in that fragment of its mass of instinctive impulses and renders it more likely to come up in connection with the sense-impression of that box. The failure of all the other acts to win pleasure stamps them out.

After repeated trials, therefore, the animal will perform the act immediately on being confronted with the situation. Thus the successive times taken by one cat in a certain box were (in seconds) 160, 30, 90, 60, 15, 28, 20, 30, 22, 11, 15, 20, 12, 10, 14, 8, 8, 5, 10, 8, 6, 6, 7. Such time records were kept in all the experiments.

The first result of the work is an accurate idea of just what things a cat or dog or chick can learn, what things are easy, and how long each association is in forming. The next result is a final disproof of the theory that the acts of animals involve reasoning, comparison, inference. The disproof consists in the fact that my animals did do by chance and learn by association, representative acts (*e. g.*, using thumb-latch and button) of those which have been fancied to require reason. Further, they would, in the case of some difficult associations, happen to do the thing six or seven times, but after long periods of promiscuous scrabbling, and then forever after would fail to do it. If they had acted from inference in any case they ought not to have failed in the seventh or eighth trial. What had been inferred six times should have been inferred the seventh. Finally, in all associations, the decrease in the time taken is *gradual*. Even after doing the thing the animal does not know enough to realize what it has done and thereafter do it as soon as put in the box.

Experiments on imitation showed that these animals could not learn to do the simplest acts from seeing their fellows do them. Unless observation of the Primates has been completely mistaken, we get here a clear differentiation and advance.

The most important experiments theoretically were a series which showed that the animals could not learn to do any act from being put through it and that no association leading to an act could be formed unless there was included in the association an impulse of the animal's own. The animals, that is, did not associate the *idea of being in* the box with the *idea* of pulling the loop and with the *idea* of eating fish outside and supply the impulse to *go in*.

These phenomena, supported by general observation of the animals' behavior, lead one to suppose, as one great difference between man and the brutes, the possession of a stock of free ideas and impulses. The animal's intellectual consciousness consists of a lot of specific and, for the most part, direct connections between sense-impressions and ideas and impulses to action. Association in animals is not homologous with anything in human association except such conscious connections as a man feels in playing tennis or billiards. The essential thing in it is not the idea, but the impulse. That this sort of human associations

is homologous with the animal sort is borne out by the fact that they are, like the latter, formed *gradually* by the stamping in of successes due to trial and error, and are not able to be formed by imitation or by one's being put through them. An attempt is made to explain the origin of the distinctively human sort and to show how the stock of free ideas is a requisite for the development of higher mental processes.

Quantitative estimates of the delicacy, complexity, number and permanence of associations in these animals were derived from further experiments. The important theoretical consideration gained is that the animals possessed no memory, no realization of a situation as the same that had been encountered in the past. Their memory is only the memory of the billiard player who plays after an interval without practice.

The author's conception of mental evolution is briefly explained, and applications of his results to education, anthropology and theoretical psychology are made.

THE AUTHOR.

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