

Nevertheless, the importance of his conclusions, if confirmed, is quite evident if this could be done with the above mentioned experimental defects eliminated.

In order to accomplish this all anesthetics were given intravenously, a 5 or 10 per cent. ether solution in normal salt solution being used, and this was injected at definite rates; the lecithin emulsion was also injected directly into the vein. The criteria used were the appearance and disappearance of the corneal reflex, or, when this did not occur, the loss of cutaneous pain sensation was used. Other criteria were the time when the animal first raised its head, when it first assumed the erect posture, and when all ataxia disappeared. The results obtained seem to point overwhelmingly to the following conclusions:

1. That the intravenous injection of 5 to 30 c.c. of a 5 or 10 per cent. emulsion of lecithin, depending upon the size of the animal used, does not interfere with the induction of anesthesia and that this can be accomplished as readily in animals thus injected as in controls.

2. That in the majority of experiments, lecithin has no effect upon the rapidity with which the various phenomena which indicate the animal's recovery from the effects of anesthetic appear, in fact, in most cases, it retards their appearance.

The above experiments do not seem to bear out Reicher's assumption as to the cause of the lipoidemia and the explanation of this phenomenon still remains an open question.¹

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Habit and its relations to the nervous system in the earthworm.

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This is a preliminary report of an investigation now in progress, the purpose of which is (a) to demonstrate whatever ability the earthworm may have to acquire habits of a certain order; (b) to discover the characteristics of any habits which appear; (c) to

¹ The complete report of this work will appear in the *Journ. of Exp. Med.* for February, 1913.

enumerate and evaluate the various external and internal influences on habit-formation; (*d*) to ascertain the degree of permanency of the habits and (*e*) to discover their relations to the anterior ganglia (brain).

By means of a T-shaped maze constructed from plate glass, specimens of the manure worm, *Allolobophora fetida*, were tested. The maze was placed with the stem directed toward the light. Across one of the arms a piece of sandpaper was placed and, just beyond it, a pair of electrodes. The other arm was left open so that the worm might escape to an artificial burrow. The worms were driven into the T by light and the chief motive for escape therefrom was the tendency to avoid light. It was the purpose of the test to demonstrate (*a*) any ability which the manure worm may possess to acquire a direction habit and (*b*) to associate the tactual experience of contact with sandpaper with the electrical shock which regularly followed the tactual stimulus in case the worm continued to move forward after reaching the sandpaper.

Trials were made in daily series varying in number from five to twenty. The five-trial series were found, on the whole, most satisfactory.

Referring now exclusively to the results obtained for a single worm which has been under observation since October, 1911, the following data may be presented. (1) *Allolobophora* is capable of acquiring certain definite modes of reaction. (2) Modifications appear as the result of from twenty to one hundred experiences. (3) The behavior is extremely variable because of variations in external conditions and in the condition of the worm itself. (4) There is a tendency to follow the mucous path through the apparatus but this is not sufficiently strong or constant to yield perfect results. (5) The following are the chief modifications which have been noted: (*a*) Increased readiness to enter the apparatus and to desert it for the artificial burrow; (*b*) apparent "recognition" of the artificial burrow which is used as "exit tube"; (*c*) a gradual increase in the number of avoidances of the sandpaper and of contact with the electrodes as a result of the "warning" influence of the sandpaper; (*d*) the disappearance of the early tendency to retrace the path through the stem of the T; (*e*) the similar disappearance of the tendency to turn back after progressing well

toward the exit tube. (6) The correct performance of a thoroughly ingrained habitual act, of the kind studied in this investigation is not dependent upon the "brain" (portions of the nervous system carried by the five anterior segments), since the worm reacts appropriately within a few hours after its removal. (7) As the "brain" regenerates, the worm exhibits increased initiative, its behavior becomes less automatic, more variable. (8) Within four weeks after the operation the regenerated segments appear superficially complete and the worm naturally burrows in a mixture of earth and manure. (9) Two months after the removal of the "brain," during the last four weeks of which period no training was given, the habit had completely disappeared from worm No. 2, the subject to whose responses this paper is devoted, and in its place there appeared a tendency to turn in the opposite direction to that demanded in the training. (10) Systematic training for two weeks resulted in the partial re-acquisition of the original direction-habit.

The general results which have just been stated are subject to modification in the light of additional data. To the experimenter, it seems that the particular individual which has been longest under observation is in many respects exceptional. It is perfectly clear, however, from results obtained with six individuals that important modifications in behavior appear as the result of training. It is equally certain that direction-habits are not readily acquired.

It is the purpose of the experimenter in the continuation of the investigation to pay especial attention to the relation of the nervous system to modifications of behavior.

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Preliminary note on the action of glucose upon the amount of epinephrin in the blood.

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The modern theory of experimental diabetes is that a glyco-secretory center is located in the medulla, from which impulses