A CLINICAL METHOD FOR INVESTIGATING HIGHER NERVOUS FUNCTION TESTS FOR GENERALIZING ABILITY

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Clinical tests for higher nervous function are usually carried out by establishing conditioned reflexes, i.e., by associating previously indifferent stimuli with others which elicit a certain reaction. However, a feature of human reactions is that they are not limited to previously encountered stimuli associated with this or that event. A man can react adequately in new conditions in which he finds himself for the first time, i.e., he reacts correctly to new stimuli; all that is necessary is that the new stimuli should constitute a part of some group of stimuli of which he has encountered examples previously. Thus a man may react to a whole group of related stimuli in a way which was developed as a response to only certain members of the group. In this way he shows his ability to generalize from his acquired experience.

Psychological methods of investigating all aspects of generalizing ability do not allow the different experimental factors or the results to be expressed quantitatively, as in the case of a physiological investigation.

The following is a method of investigating the ability of a man to extrapolate onto a whole group of stimuli a particular type of reaction which was elaborated to some members of the group only.

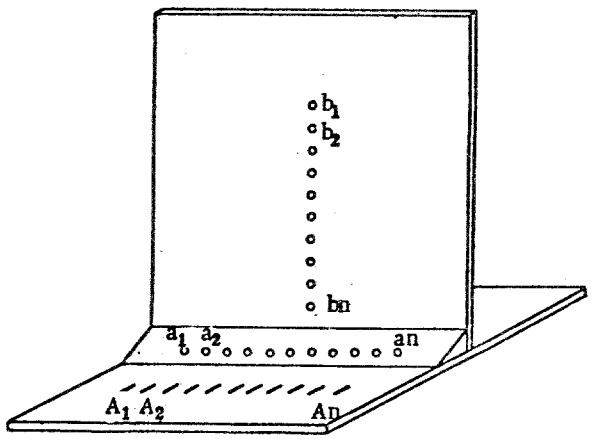

Diagram of the apparatus for investigation of higher nervous function (apparatus drawn turned towards subject).

A vertical row of lamps (b_1, b_2... b_n) is placed in the subject's field of view (see drawing). Below this a horizontal row of lamps (a_1, a_2... a_n) is arranged. Opposite each lamp of the horizontal row there is a button (A_1, A_2... A_n). The experimenter can light any lamp in either row a or row b.

The subject is told that as soon as any lamp in the horizontal row lights he is to press the corresponding button. A control lamp facing the subject indicates whether he has done this correctly or not. After the instructions have been given, lighting any lamp in a row results in the corresponding button in row A being pressed, i.e., a reaction of the type $a_i \rightarrow A_i$,* so that lighting lamp number i causes button i to be pressed, whereas lighting a lamp in row b does not lead to a button being pressed ($b_i - / \rightarrow A_i$). When the experimenter is convinced that the subject has properly understood his instructions, the experiment is started.

Before the experiment, and without telling the subject, the experimenter sets up a certain set of connections (correspondences) between rows b and a, for instance b_1 corresponds to a_1, b_2 corresponds to $a_2 \ldots b_n$ to a_n; or b_1 corresponds to a_n, b_2 corresponds to $a_{n-1} \ldots b_n$ corresponds to a_1; or b_1 corresponds to a_1, b_2 corresponds to a_n, b_3 corresponds to a_2; b_4 corresponds to a_{n-1}, etc. Any degree of complication of the connections between row b and row a is possible.

Let us consider the course of one simple experiment, the first of those described above. The experimenter switches on one of the lamps in row b for instance b_3, and immediately after it – the corresponding lamp in row a – a_3. The subject responds to this by pressing button A_3. A similar process occurs with the other lamps, and there is no regular sequence in the order in which the lamps are lit (the lighting sequence may be chosen from a table of random numbers). However not all the lamps are involved in these sequences of the type ($b_i a_i \rightarrow A_i$). The choice by the subject of the correct button is reinforced by the word "correct."

After a certain number of sequences a conditioned reflex is developed: the subject now responds to pressing the button in response to the lighting of a lamp in row b only, this lamp having been previously associated with one in row a ($b_i \rightarrow A_i$). He does not wait for a lamp in row a to light. At the same time if a lamp in row 'b' not previously associated with one in row 'a' lights, it does not cause the corresponding button to be pressed ($b_m - / \rightarrow A_m$). However after a large number of sequences of the type $b_i a_i \rightarrow A_i$ the subject will press button A_m in response to the lighting of a lamp b_m which had never previously been associated with the lighting of a lamp in the other row. Thus a reaction of the type $b_i \rightarrow A_i$, developed in response to certain of the lamps, becomes extrapolated to include the whole group. The rate at which this reaction is elaborated depends upon higher nervous function and individual characteristics as well as on a complexity of the connections between lamps a and lamps b.

The course of an experiment can be represented diagramatically as follows:

$a_i \rightarrow A_i$
$b_i - / \rightarrow A_i$
$b_i a_i \rightarrow A_i$
$b_i a_i \rightarrow A_i$
} Initial position

$b_i \rightarrow A_i$
$b_m - / \rightarrow A_m$
} Conditioned reflex developed, but no extrapolation

$b_i a_i \rightarrow A_i$
$b_m \rightarrow A_m$
} Extrapolation

The ability of the subject to generalize is indicated by the number of sequences of the type $b_i a_i \rightarrow A_i$ required before the reaction of the type $b_m \rightarrow A_m$ occurs.

When the reaction of the type $b_m \rightarrow A_m$ has been established firmly, it is possible to follow this by investigating the degree of perseverance of the subject. For this the association of lamps in row b and row a is changed in some way, for instance b_1 is made to correspond to a_n, b_2 with $a_{n-1} \ldots b_i$ with $a_{n-1+1} \ldots b_n$ with a_1. One can then find how rapidly, i.e., after how many sequences the subject stops pressing the button which

* The following abbreviations are used: a_i – lighting lamp number i in horizontal row; b_i – lighting lamp number i in vertical row; A_i – pressing button number i.

corresponds with the reaction $b_m \rightarrow A_m$ and changes to the new reaction $b_i \rightarrow A_{n-i+i}$ and therefore to $b_m \rightarrow A_{n-m+i}$. It must be realized that the stability of the reaction $b_m \rightarrow A_m$ depends also on the number of sequences $b_i a_i \rightarrow A_i$, which have been given after elaborating the reaction $b_m \rightarrow A_m$. These additional sequences $b_i a_i \rightarrow A_i$ build up a characteristic "stability reserve reaction."

Thus this method we have proposed enables the ability of the subject to generalize and to extrapolate his reaction to be determined quantitatively under the conditions of a physiological experiment.

Experiments have shown that in healthy subjects, generalization of the simplest type (sequence $b_i a_i \rightarrow A_i$) occurs after 3-6 sequences. In oligophrenics there is no generalization even after several dozen sequences.

SUMMARY

The method which is described in this paper gives the opportunity not only to trace the formation of conditioned reflexes in man but also to measure the rapidity of transfer of a correct reaction formed to several stimulants of a definite series to all stimulants of this series (generalization, extrapolation of reactions). A subject under investigation should press knob A_i when the lamp a_i is lit (look at the scheme). Then after several associations of switching on b_i and a_i lamps, a healthy individual who is examined presses the knob A_i, when lamp b_i is lit (conditioned reflex). He presses knob A_m when the lamp b_m, which was never lit before is switched on (extrapolation of reactions). The latter type of reaction could not be formed in oligophrenics.