# THE SIGNIFICANCE OF HEAD AND TRUNK POSITION FOR THE CORRECT DIFFERENTIATION OF AUDITORY CONDITIONED STIMULI IN ANIMALS FREE TO MOVE

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The method of the conditioned reflex has made possible a physiological study of complex forms of animal behavior [1,4,11, et al.]. P. S. Kupalov worked out the method of situational conditioned reflexes [7], and for many years undertook the study of the higher nervous activity of dogs under circumstances close to natural conditions. The work of his laboratory showed that the laws of cerebral activity established by I. P. Pavlov, who used the secretory method, can also be observed through the animal's active behavior. He also discovered some new mechanisms [5, 8, 9, et al.].

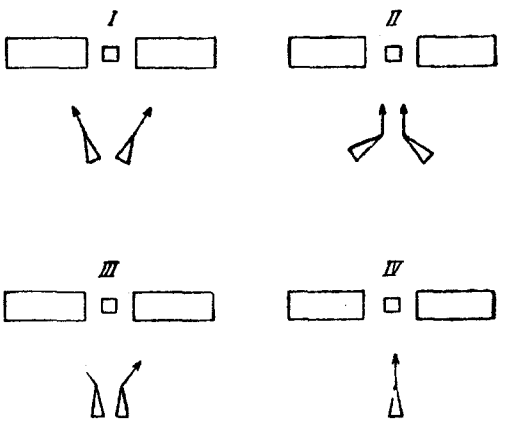


Diagram of the position of head and trunk of a dog in relation to the tables and to the conditioned stimuli. Rectangles represent the tables; square indicates the position of the conditioned stimuli; small triangle shows the position of the head, the large triangle that of the trunk; I, II, III, IV) different positions of the head and trunk of the dog in the intervals between a presentation of the conditioned stimuli.

V. V. Yakovleva found that for a long time it was impossible to get a dog to differentiate between two sound stimuli by producing the correct motor response when one sound was reinforced by food on one table and the other by food on another. Such a differentiation is not possible unless a number of accessory measures are introduced [10, 12]. It might be thought that the necessary conditions are related to particular circumstances of the experiment. Of greater importance is the activity of the visual, kinetic, vestibular, and other analyzers involved in the behavior of the animal under circumstances close to natural conditions. This was the conclusion reached by I. S. Beritov [2,3] and by P. S. Kupalov [8].

The actual factors which bring about the differentiation of the auditory conditioned stimuli under conditions of free movement of the animals had to be determined. P. S. Kupalov came to the conclusion that "the previous position of the animal in the room, its posture, the position of the conditioned stimuli, the subsequent movements of the head toward one or another table, etc., are all of importance in bringing about the correct movement of the animal toward a particular table immediately after the application of the conditioned stimulus" [8,p.463].

We have been faced with the problem of analyzing the behavior of a dog during the period of elaboration of differentiation to auditory conditioned stimuli, and to finding in what way the factors enumerated above influence the correct movement immediately after the application of the conditioned stimulus. We here present part of our results.

## METHOD

Under conditions in which the animals were free to move about the room, we developed a conditioned reflex

TABLE 1. Elaboration of Differentiation to Auditory Stimuli

| | Tone and metronome | | | Bell and buzzer | Metronomes at 60 and 120 beats/min | | Tones of 500 and 1000 cycles | |
|---|---|---|---|---|---|---|---|---|
| Number of animal | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Percent errors | 0 | 0 | 44 | 37.5 | 50 | 62 | 37.5 | 62 |
| Number of combined applications | 33 | 91 | 160 | 154 | 120 | 140 | 239 | 247 |

TABLE 2. Results of Actual Experiments

| Group of expts. | Activity of the animal while in position on the rug during the pause between the sound stimuli | Conditioned stimuli | Nature of motor conditioned response | Assessment of response | No. of expt., dog |
|---|---|---|---|---|---|
| First | Head and trunk of animal directed to table B | Metronome (table B) | Runs toward table B | Correct | 30, Hurricane |
| | The same | Tone (table A) | The same | Wrong | The same |
| | Head and trunk directed toward table A | Buzzer (table B) | Runs to table A | Wrong | 32, Gvidon |
| Second | Head directed toward conditioned stimuli, body toward table B | Tone (table A) | Runs to table B | Wrong | 30, Hurricane |
| | The same | Metronome (table B) | The same | Correct | 30, Hurricane |
| | The same | Bell (table A) | The same | Wrong | 76, Gvidon |
| Third | Head directed to table A, trunk toward conditioned stimuli | Tone (table A) | Runs to table A | Correct | 30, Hurricane |
| | The same | Metronome (table B) | The same | Wrong | 40, Hurricane |
| | The same | Buzzer (table B) | The same | Wrong | 82, Gvidon |
| Fourth | Head and trunk directed toward conditioned stimuli | Tone (table A) | Runs to table A | Correct | 30, Hurricane |
| | The same | Metronome (table B) | Runs to table B | Correct | 40, Hurricane |
| | The same | Buzzer (table B) | Runs to table B | Correct | 76, Gvidon |

Note: The letters A and B refer to tables to which the animal must run when the corresponding auditory conditioned stimulus is presented.

motor response to food. The whole setup of the room, the appearance of the table on which the animal received its food, the sound made by a tap on the drinking trough, the position of a rug in the room, all acquired conditioned feeding significance. The basic elements concerned in the feeding activity were as follows: The animal stood independently on the rug and immediately after when the auditory conditioned stimulus was presented, it ran toward a particular table. First we established a motor conditioned reflex (a run and jump on to the table) to a particular sound. After this reflex had been reinforced, we proceeded to elaborate a second reflex (a run to the second table) in response to a second sound.

The experiments were carried out on 8 dogs. In 3 of them, as differentiation, we used a 1000-cycle tone and a metronome at 120 beats per min; in 2 others, metronomes at 120 and at 60 beats per min; in another, 2 tones of 1000 and 500 cycles; and in 1 dog we developed reflexes in response to a bell and to a buzzer. It is known that under conditions of free movement, the position of the conditioned stimuli may influence the motor conditioned response. As a rule, in order to eliminate this effect and to establish the most favorable possible conditions to differentiation with respect only to the quality of the sound, we placed the conditioned stimuli at the same distance from both tables.

## RESULTS

In 6 of the 8 dogs, despite the application of each pair of auditory stimuli more than 100 times, we were unable to develop any differentiation (Table 1).

From Table 1 it can be seen that the difficulty of elaborating differentiation to the auditory stimuli was no chance occurrence. It seems that this fact indicates a definite feature of conditioned reflex activity under conditions in which the animal is free to move.

In P. S. Kupalov and I. S. Beritov's laboratories it was shown that some positions of the head and trunk adopted during the pauses between the application of the conditioned stimuli may influence the nature of the motor conditioned response. During the differentiation we attempted first of all to find just how the direction of the conditioned response depended on the head and trunk positions.

We found that if during the pause between two auditory stimuli the animal remained on the rug so that its head and trunk were directed toward one of the tables, then, as a rule, the presentation of either sound stimulus caused it to run toward this table (see figure, I).

When the animal's head was directed toward the conditioned stimuli and the trunk toward one of the tables, the sound stimulus caused the animal to run to this table (see figure, II). If the body was turned toward the conditioned stimuli and the head alone directed to one of the tables, then in this case also the animal ran to the table (see figure, III). When the head and the trunk were directed toward the conditioned stimuli, correct motor conditioned responses occurred much more often (see figure, IV). As an illustration we give the results of several actual experiments (Table 2).

From what has been said, it can be seen that under the conditions of the experiment, the features which determined the nature of the motor conditioned response to the auditory stimuli were the direction of the head and trunk with respect to the tables. They interfere with the correct differentiation of the auditory conditioned stimuli. The kind of sound does not determine the direction of the conditioned reaction, and it remains to find the reason for this failure.

P. S. Kupalov [6] showed, in experiments in a room, that during the intervals between the presentation of the conditioned stimuli the centers to which the stimuli were directed were in a condition of heightened excitability. There is reason to suppose that the same thing occurs when the animal is free to move. Hence, it follows that while the animal is in position on the rug, the centers for which the position of the table, the tap against the feeding trough and the differentiated sounds represent conditioned stimuli are in a state of heightened excitability. When there are two tables, the center corresponding to one of them is excited, and the corresponding movement occurs.

Possibly other mechanisms are involved. During the early period of the elaboration of differentiation, the following effects may be observed: Immediately after the presentation of the conditioned stimulus, the first movement of the animal is always in the direction to which the body is pointed. It is known that straight-line motion is best manifested in decorticate animals. When such animals encounter an obstacle in their path, for a long time they are unable to circumvent it. We have observed that when the conditioned motor response is slowed down, as a rule it is replaced by a straight-line motion in the direction in which the head points. Naturally, such behavior cannot take place without mechanisms for a redistribution of muscle tone.

It seems to us that at the moment at which the auditory stimulus is presented, while such mechanisms are active, a complexly organized excitation arises in the central nervous system and embraces a number of nervous structures. This excitation may be considered preparatory. In the initial period of differentiation, the intensity of the preparatory excitation is very important, and the strength of the conditioned excitation elicited by the auditory stimulus is still relatively weak. As a result, the conditioned excitation is not able to alter the organization of the preparatory excitation, and it merely becomes added to it. Therefore, when presenting the sound stimulus, the direction of the conditioned motor response will not be determined by the quality of the sound, but by the condition of the central nervous system at the time at which the animal was on the rug.

The ideas which we have expounded account for the multiplicity of the motor conditioned responses, and emphasize that the activity of an animal under conditions of free movement is strictly determined, and susceptible to physiological analysis.

Our experiments have shown that under conditions of free activity dogs may rapidly develop a conditioned feeding reflex to a particular sound whose action causes them to run toward and jump onto a table on which a feeding

trough is placed. Differentiation may be obtained to another sound not associated with the presentation of food, and which gives no feeding motor response. However, under the same conditions it is very much harder to produce differentiation between two auditory stimuli if during one stimulus food is presented on one table and during the other it is presented on another at a distance of 3 m in the opposite direction. In other words, it is difficult to associate the action of different positive auditory stimuli with different situations of the food.

As our experiments have shown, the effect depends upon the fact that during the interval of time between the presentation of the conditioned stimuli, the animal, standing in a particular position in the room, adopts a position in which the head of the trunk are directed toward one or another table. Then, independently of whichever stimulus is presented, the animal goes to the table toward which the head or trunk was originally directed. For a long time, the conditioned stimulus acts merely to release a previously elaborated motor response.

## SUMMARY

The central nervous system of dogs was studied in terms of their behavior, by use of a method of situational conditioned reflexes. If when one sound was presented food was presented on one table, and when the second sound was made it was presented on the other, differentiation failed to occur, we were able to determine the factors which impeded this differentiation. If during the interval between the presentation of the conditioned stimuli the animal's head or body was turned in the direction of one of the tables, it went to that table, irrespective of which stimulus was presented. Thus, the direction of the motor-conditioned reaction depends largely on the nature of the excitation produced in the CNS previous to the application of the conditioned sound stimulus.

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**All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.**

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