# DEPENDENCE OF INVESTIGATIVE ACTIVITY ON PROBABILITY OF RANDOM PERFORMANCE OF AN INSTRUMENTAL REACTION

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In the modern theory of behavioral activity much attention is paid to information-related processes of interaction between organism and environment. Behavior is regarded as a form of activity which changes the probability and duration of contact with an external object, capable of satisfying the organism's need [5, 6]. The existence of the opposite dependence can also be postulated: not only does behavior modify the probability of contact with an external object, but the initial (a priori) probability has a substantial influence on the formation of behavior.

The probability of a random correct performance of an instrumental reaction (PRCR) depends on the conditions of training and can be determined theoretically [1, 2]. Before discovery of a connection to be learned between a neutral conditioned stimulus and reinforcement, investigative reactions may appear at any moment of the experiment regardless of the conditioned stimulus (periods of receiving unconditioned reinforcement and of subsequent restoration of investigative activity, and also the time taken on performance of the instrumental reactions themselves are excluded from the calculation). In that case mathematical expectation of PRCR in time intervals linked with presentation of the conditioned stimulus is given by:

$$\text{PRCR} = \frac{\text{duration of periods coupled with conditioned stimulus}}{\text{total duration of experiment}}$$

Dependence of the rate of learning on the magnitude of PRCR, with different conditions of reinforcement, was demonstrated previously [3, 4]. However, the mechanism of this phenomenon has not previously been studied. The aim of the work was to discover the connection between the magnitude of PRCR and investigative activity during conditioned reflex formation.

## EXPERIMENTAL METHOD

Experiments were carried out on 40 noninbred male albino rats weighing 250-300 g. An instrumental defensive reflex of pressing a pedal during the action of a conditioned photic stimulus was formed. The unconditioned stimulus was electrodermal stimulation of the limbs through a wire mesh floor (20-30% above the pain threshold), for a duration of 5 sec. If the animal pressed the pedal before this period had elapsed, further stimulation was discontinued. The rats did not receive the next electrodermal stimulus if they performed correctly the instrumental reaction (pressing on the pedal during illumination of a small lamp). All the animals were divided into four groups, with 10 in each group. The experimental conditions were so chosen that the duration of intertrial intervals and (or) of conditioned stimulation were different (Table 1) for groups with equal mathematical expectation of PRCR (Table 1). Everyday 40 combinations were presented in each experiment. The durations of conditioned stimulation and of intertrial intervals were assigned as uniformly distributed random values in accordance with tables. Until discovery of a connection between conditioned stimulus and reinforcement (a uniform distribution of instrumental investigative reactions in time) the a prior probability of random pressure on the pedal during illumination of the lamp in group 1 was $\frac{3 \text{ sec}}{3 \text{ sec} + 57 \text{ sec}} = 0.05$, in the second group $\frac{3 \text{ sec}}{3 \text{ sec} + 9 \text{ sec}} = 0.25$, and so on.

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TABLE 1. Conditions of Formation of Instrumental Reflex

| Group | Mathematical expectation of PRCR | Duration of conditioned stimulus, sec | Duration of intervals between tests, sec |
|---|---|---|---|
| 1 | 0,05 | 3 | 1–113 (57) |
| 2 | 0,25 | 3 | 1–17 (9) |
| 3 | 0,05 | 1–3 (2) | 19–57 (38) |
| 4 | 0,25 | 1–19 (10) | 3–57 (30) |

Legend. Mathematical expectation of variables indicated in parentheses.

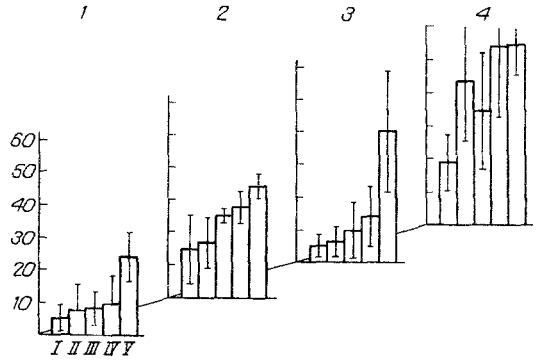


Fig. 1. Frequency of correct responses during different periods of training of rats. 1) Group 1, PRCR = 0.05; 2) group 2, PRCR = 0.25; 3) group 3, PRCR = 0.05; 4) group 4, PRCR = 0.25. Abscissa, training periods (I-V); ordinate, correct performance of instrumental reactions relative to their total number in corresponding training periods (in %). Significance of mean values indicated by confidence intervals (p = 0.05).

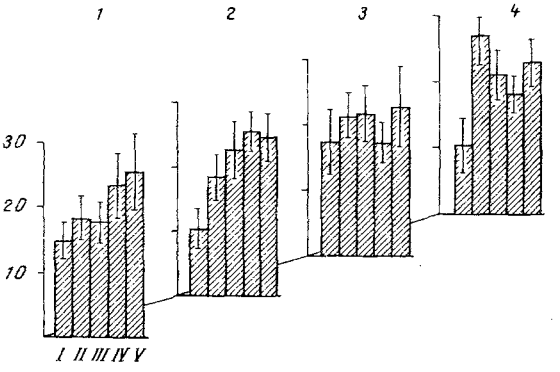


Fig. 2. Time course of investigative reactions at different periods of training of rats. Ordinate, instrumental reactions during corresponding training periods relative to their total number (in %). Remainder of legend as to Fig. 1.

When, in the course of the experiment, the duration of the conditioned stimulus and of the intervals between the conditioned stimuli was determined, no attention was paid to the time of pressing the pedal or the time of electrodermal stimulation and the period of 2 sec thereafter (necessary in order to terminate the chaotic movements of the animal and to restore investigative activity). The reflex was considered to have been formed if there was a statistically significant ($p < 0.05$) increase in the number of correct responses compared with the a priori level of their random performance [2].

## EXPERIMENTAL RESULTS

To facilitate graphic representation of the time course of conditioning five training periods were distinguished (I-V). For this purpose the total number of combinations required by each animal to form the reflex was subdivided into five equal parts, after which the percentage of correct realizations in each of them was calculated. It will be clear from Fig. 1 that in all the groups, during 60-80% of combinations the frequency of pressing on the pedal during the action of the conditioned stimulus coincided (allowing for confidence intervals) with mathematical expectation of PRCR. This confirms the validity of the formula given above for calculating the value of PRCR, based on the assumption that the distribution of investigative instrumental reactions is uniform in time.

The time course of performance of the instrumental reactions during the five training periods thus distinguished is particularly interesting. It will be clear from Fig. 2 that an increase in investigative activity was observed in the animals of all groups during training. In groups 2 and 4 the frequency of investigative reactions was significantly increased as early as after period II (PRCR = 0.25, $p < 0.05$). Conversely, in the case when PRCR = 0.05, no significant increase in the frequency of pressings on the pedal compared with period I was observed (group 3), or such an increase took place only at the very last stage of training (group 1). The rule thus discovered is independent of variation of the durations of conditioned stimulation and (or) of intertrial intervals (Table 1), if the value of PRCR remained unchanged. We know that each of these parameters separately significantly affects investigative activity [7, 8]. Evidently it is not the absolute time intervals that has a decisive influence on the dynamics of the training process, but relative values (PRCR). The ratio of the duration of the periods during conditioned stimulation to the total duration of the cycles determines the a priori probability of random performance of the instrumental reactions, for investigative reactions were uniformly distributed in time. In the course of investigative activity this value has a significant effect on the number of positive and negative reinforcements obtained. At values of PRCR optimal for training (in our case 0.25) the effectiveness of investigative instrumental activity is increased, and this leads to its stimulation even in the early stages of training. This may be a mechanism of the accelerated process of formation of conditioned-reflex connections, described previously, at the PRCR = 0.25 level [3].

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