Optimization of Research Instrumental Activity during Exposure to a Low-Intensive Conditioned Stimulus

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Research activity of rats is determined by the intensity of conditioned stimulus and probability of initially accidental correct performance of instrumental reaction during training in an arbitrary environment. If the values of this probability are unfavorable for training, attenuation of the intensity of conditioned stimulus causes a decrease in the research activity as a result of deterioration of conditions of information. By contrast, the values of probability of accidental correct performance of the reaction optimal for training promote a higher information significance of each research reaction, this decreasing the relationship between research activity and intensity of conditioned stimulus.

Key Words: *optimization; research reactions; reflex*

According to the theory of signal detection [1], the process of instrumental training under conditions of weak (subthreshold) intensity of a conditioned stimulus is determined by two major factors: sensory (physical parameters of the active stimulus and "murmur signals", the proper "murmur" of percepting sensory system) and nonsensory (level of motivation, personality setups, degree of understanding of the proposed task, attitude to experiment, etc.). Within the framework of traditional concepts, some parameters of information interactions between the organism and environment have been neglected. This concerns the probability of accidental correct performance of instrumental reaction (PACR) estimated as a ratio between the duration of periods conjugated with conditioned signal and total duration of one cycle of experiment [3-5]. PACR determines which part of research reactions at the initial stage of training will be performed in connection with conditioned signal and properly supported.

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Previously we determined PACR values optimal and pessimal for training. The possibility of improving training efficacy during exposure to a conditioned signal of low (subthreshold) intensity by selecting a relevant PACR value is proven [5]. The mechanisms mediating this effect of PACR on the course of information interactions between the organism and environment are virtually unknown. We assessed the relationship between PACR value and research activity at different intensities of conditioned signal over the course of training.

MATERIALS AND METHODS

The methods used in this study were described in detail previously [5]. The study was carried out on outbred male rats weighing 250-310 g divided into 8 groups, 9 animals each. Instrumental defense reflex to an acoustic signal was conditioned using electrical stimulation of the skin as unconditioned stimulus. In half of the groups a strong acoustic signal was used (acoustic pressure 60 dB) and in the rest groups, a signal of subthreshold intensity (20 dB). Half of the animals were trained at PACR

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equal to 0.05, the other half at PACR 0.25 (Table 1). The experiment was automated with a Commodore-64 PC.

RESULTS

For graphic representation of the time course of research activity, five periods of training were distinguished: the total number of cycles needed for an animal to form a conditioned reflex was divided into 5 equal parts, after which the number of instrumental reactions per cycle of the respective period was counted. Only pairs of animal groups trained by conditioned stimuli of similar duration at the same intervals were compared (Fig. 1). All other combinations of probable paired comparisons of experimental groups are not informative regarding the elucidation of the effect of PACR on the time course of research activity at different intensity of conditioned stimulation, because in such cases the effects of accessory factors (absolute duration of conditioned stimulus and the interval between the signals) should be taken into consideration (Table 1). Alteration of any of the above-mentioned values can have pronounced and often ambiguous effects on the training process [7-9].

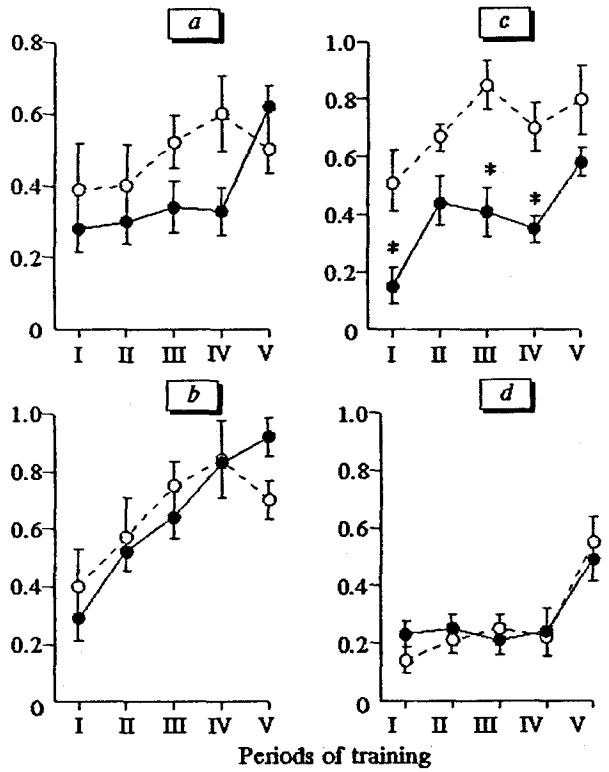

Fig. 1. Time course of research activity in different periods of training of animals with different probability of accidental correct performance of an instrumental reaction at different intensity of conditioned stimulus. *a*) groups 1 and 2; *b*) 3 and 4; *c*) 5 and 6; *d*) 7 and 8 (estimated value of probability of accidental correct performance of reaction 0.05 and 0.25, respectively). Ordinates: mean number of instrumental reactions per cycle, $p<0.05$ between paired groups. Solid line: 60 dB; broken line: 20 dB.

Figure 1 shows that alteration of the intensity of conditioned stimulation differently affected the research activity of animals and depended on the PACR value. At PACR equal to 0.05 attenuation of the intensity of conditioned signal markedly enhanced the research activity. Comparison of groups 5 and 6, particularly at the beginning of training, demonstrated it very well. Similar results were observed in groups 1 and 2, coinciding with the findings of other scientists [11,12]. This regularity is based on decreased information significance of research instrumental reactions under conditions of insufficiently reliable perception of a weak conditioned signal. It is noteworthy that PACR equal to 0.05 is the pessimal for training [5], impeding the process of information interactions between the trained subject and the environment.

A qualitatively different regularity was observed at PACR equal to 0.25. Paired comparisons of groups 3 and 4 and 7 and 8 showed that variations in the intensity of acoustic stimulus did not lead to universally directed essential changes in research activity. A higher research activity was observed during several training periods at subthreshold intensity of conditioned signal and in other cases at suprathreshold values. PACR equal to 0.25 can be considered as the optimal for training [5]. The information significance of each research reaction under such conditions is apparently increasing just to decrease the unfavorable effect of the low intensity of conditioned stimulus. This result does not depend on variations in the duration of conditioned stimulation and/or intervals between the signals if PACR value is constant (Table 1). The relative PACR values, but not absolute time intervals, exert the primary effect on the course of training process. This concept is in line with the opinions of many authors [2,10] indicating the significance of relative parameters in variations of the duration of absolute values of conditioned stimulation and intervals between the stimuli.

Comparison of the findings with the results of previous experiments [4] in which research activity was studied at different regimens of unconditioned support (intensity of conditioned stimulus was suprathreshold) was of special interest. At PACR=0.25, a 4-fold decrease in the rate of support of correct reactions did not cause the changes in research activity which were observed at PACR=0.05. This agrees with our findings that the intensity of conditioned stimulus varies at constant 100% support. In a conditioned reflex experiment, the degree of

TABLE 1. Conditions of Formation of Instrumental Reflex

Group	Mathematically expected PACR	Duration of conditioned signal, sec	Duration of intervals between tests, sec	Intensity of conditioned signal, dB
1	0.05	2	38	60
2	0.05	2	38	20
3	0.25	10	30	60
4	0.25	10	30	20
5	0.05	4	76	60
6	0.05	4	76	20
7	0.25	4	12	60
8	0.25	4	12	20

subjective indefiniteness of the environment, which may depend on the intensity of conditioned stimulus and the value of unconditioned support probability ("partiality"), may be decisive for the trained subject [6].

Thus, research activity of animals is largely determined by PACR. PACR determines which part of instrumental reactions will be initially performed after the conditioned signal and will be adequately supported. This, in turn, affects the information interactions with the environment, the degree of animal stress during the reflex formation, etc. At PACR values unfavorable for training, the increase in subjective indefiniteness of the environment (subthreshold intensity of conditioned stimulus, probability of unconditioned support) sharply decreases the research activity because of deterioration of conditions of information. By contrast, PACR values optimal for training favor an increase in information significance of each research reaction, leading to attenuation of the relationship between research activity and intensity of conditioned stimulus and its other parameters affecting the subjective indefiniteness of the environment.

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