CONDITIONED RESPIRATORY REFLEXES IN CATS

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The purpose of this work was to study, by the conditioned reflex method, the features of grey matter respiratory regulation and the functional links of the respiratory center with various analysor regions of the cat's cerebral cortex.

There are two works known to us in the literature which study conditioned respiratory reflexes in cats. A. A. Markova [2] produced conditioned respiratory reflexes and differentiations to a metronome in male cats before and after castration. N. Yu. Belenkov, G. Potoretko and R. Startseva [1] established the possibility of forming conditioned respiratory and motor reflexes to light and sound stimuli in cats from which the cerebral cortex had been removed.

EXPERIMENTAL METHODS

A total of 186 experiments were done on 4 animals (3 males and 1 female). In all of the animals, effective conditioned respiratory reflexes of short duration were formed to the light of a 40 W bulb and a bell (frequency, 3 times per second). The unconditioned, reinforcement stimulus was ammonia fumes (10-15%), which were blown from a phial through a rubber tube and funnel into the animal's nose.

The isolated action of the conditioned stimulus was continued for 5-10 seconds, and then for 5-10 seconds simultaneously with the unconditioned. In each experiment, a 5-8 combination was used with intervals of 1-5 minutes. Differentiations were produced to a "red light" bulb of 40 W and to a bell rung once per second. The respiration was recorded by pneumograph.

EXPERIMENTAL RESULTS

In all of the experimental animals, the unconditioned stimulus (ammonia) caused a clear and continuous weakening of the respiratory movements. The breathing became more rapid as well as weaker in the male cat Bars and in the female Mura.

We began the main experiments after completely eliminating the tentative motor and respiratory reactions to the conditioned stimuli.

The experimental data given in the table shows the definite differences in the behavior of the animals and in the conditioned respiratory reflex and differentiation formation dynamics, which is associated with the individual features of the highest nervous activity in the various experimental animals.

The rapid formation and fixation of the conditioned reflexes and differentiations in the male cats Pestry and Bars indicate a comparatively high force and mobility of the nervous processes. The slow, gradual formation and fixation of the conditioned reflexes and differentiations in the male cat Skripun is evidently connected with a certain inertia in the nervous processes.

In the female (weak and unstable), in contrast to the males, the conditioned respiratory reflexes and differentiations were more slowly produced and remained weakly expressed and unstable throughout the experiment.

In all of the animals, the conditioned respiratory reflex mirrored the unconditioned in the change of the amplitude and frequency of the respiratory movements. In the male, Bars, and the female, Mura, it was expressed by weakened and, at the same time, more rapid respiratory movements. See the pneumogram of the male cat Bars (Fig. 1) for illustration.

In the male cats Pestry and Skripun, the conditioned reflex was expressed by a sharp weakening of respiratory movements, but there was no change in respiration rate.

The degree to which the conditioned respiratory reflexes were expressed increased according to the extent to which they were fixed, and the latent period was reduced by 0.5-1 second.

Therefore, in contrast to A. A. Markova's data, the conditioned reflex changed the depth and rate of the respiratory movements simultaneously in two of the animals in our experiments. In the first experiments, foreign and unusual stimuli (movement of objects in the field of vision, teeth gnashing, noise, coughing) caused inhibition of the conditioned respiratory reflexes according to the type of exterior inhibition. In the later experiments, according to the degree to which the conditioned respiratory reflexes were established, these same stimuli did not inhibit but rather intensified the degree to which the conditioned reflexes were expressed in the cats. On this basis, one can suggest that the stimulation threshold, arising in the cerebral cortex to the conditioned stimulus, becomes dominant according to the extent to which the conditioned respiratory reflex is fixed.

Formation of Conditioned Respiratory Reflexes and Differentiations

Name and brief description of animal	Conditioned respiratory reflexes		Differentiations	
	to bell	to light	to bell	to light
Pestry – young male, playful and active. Weight 2,700 g	After 2nd-3rd combination; became permanent after 7th-8th combination	After the 9th-10th combination; became permanent after the 13th-14 combination	Complete and permanent after the first use	After the 14th use; became permanent and complete gradually
Bars – young male, pugnacious, active, greedy. Weight 2,600 g	After the 3rd combination; became permanent after the 7th-8th combination	After the 5th combination; permanent	Complete and permanent after the 4th-5th use	Complete and permanent after the 16th use
Skripun – male, rather inactive, agressive. Often fell asleep during the experiment; Weight 3,500 g	After the 6th combination; became permanent after the 15th-16th combination	After the 9th-10th combination; did not become fixed for a long time (until the 30th-35th combination	Incomplete from the first use to the end of the experiments	75 W bulb. After the 10th use; incomplete throughout the experiments
Mura – young female, rather inactive, timid. Took a long time to become accustomed to the cage. Weight 1,800 g	After the 8th combination; unstable and weakly expressed throughout the experiments	After the 14th-15th combination; unstable and weakly expressed	Not produced	After the 17th-18th use; incomplete and unstable

The conditioned respiratory reflexes were rather permanent. The use of the conditioned stimulus without reinforcement several times during the experiment did not remove the conditioned respiratory reflexes, nor did interruptions of 2-3 days to one month in the experiments.

After the conditioned respiratory reflexes had been fixed, differentiations were produced to stimuli similar to the conditioned ones. In the male cats, the differentiations formed rather quickly – to the bell in the very

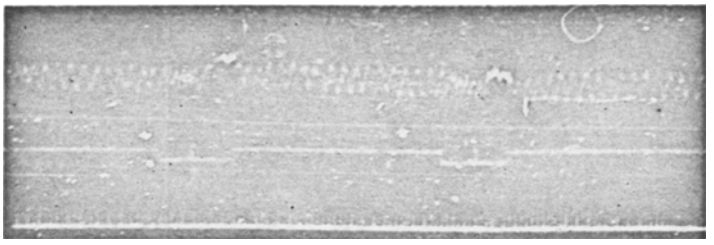

Fig. 1. Pneumogram of respiration in the male cat Bars. Conditioned respiratory reflex during the 7th and 8th combination of the stimuli. Key to tracings (from top to bottom): pneumogram; indication of conditioned stimulus (bell); indication of conditioned stimulus plus unconditioned (ammonia); indication of time (in 1 second marks).

1st experiment at the 1st-4th use and a little later to the light of the red bulb; in the 2nd-3rd experiment after the 11th-15th use of the conditioned stimulus alone, without the reinforcement.

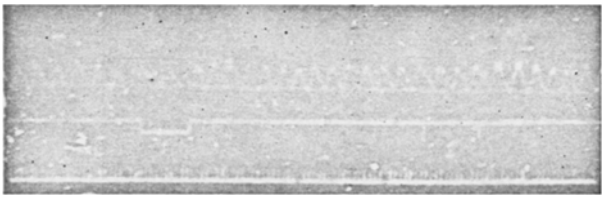

Fig. 2. Pneumogram of respiration in the male cat Pestry. Tracings the same as in Fig. 1. 1) Conditioned respiratory reflex during the action of a positive stimulus (white light); 2) absolute differentiation to the light of a red bulb. Tracings mean the same as in Fig. 1.

The differentiations rapidly acquired absolute meaning in the male cats Pestry and Bars. For example, the pneumogram of the male cat Pestry (Fig. 2) shows a marked weakening of respiration during the action of the positive stimulus (1 – white light of a 40 W bulb), but no change in respiration after the 27th use of the differentiation stimulus (2 – red light).

The formation of absolute differentiations to a red light is probably not caused so much by the difference in color as by the difference in the intensity of the light.

A different differentiation was produced in the male cat Skripun than in the other experimental animals – a differentiation to the light of a 75 W bulb, but this differentiation never acquired absolute meaning throughout the experiments.

The differentiation stimuli first (2-3 seconds) caused a slight weakening in the respiration, which then returned to normal during the stimulation period. The phenomenon of successive inhibition was observed in two of the males, Pestry and, especially, Bars.

The use of the positive stimulus 10-30 seconds after the differentiation stimulus did not cause a conditioned respiratory reflex. See the pneumogram of the male cat Bars for illustration (Fig. 3).

The respiration became uneven in depth and frequency in all of the experimental animals during the mating period (period of sexual excitation).

Both the positive and inhibitory conditioned stimuli often caused the animal to give a strong motor reaction and to cry out. The conditioned respiratory reflexes and the differentiations were disturbed, and the positive reaction to the bell remained only in the male cats Pestry and Bars. The biologically more important, dominant sexual reflex removed the temporary links between the respiration center and the cortex of the cerebral hemispheres and destroyed the normal interrelation between the processes of stimulation and inhibition. After the mating period, even breathing was restored, and the conditioned respiratory reflexes and differentiations returned as before.

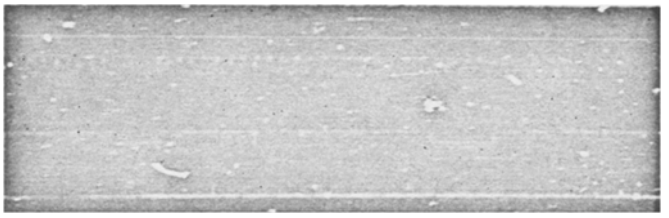

Fig. 3: Pneumogram of respiration in the male cat Bars. 1) Conditioned respiratory reflex during the action of a positive conditioned stimulus (40 W white light); 2) absolute differentiation to conditioned stimulus (40 W red light); 3) inhibition of the conditioned reflex to a positive stimulus used 30 seconds after the differentiation stimulus (successive inhibition). The tracings mean the same as in Fig. 1.

Works conducted in the I. P. Pavlov laboratories indicate that conditioned reflexes (motor, secretion) in dogs are more quickly formed to sound stimuli than to light stimuli.

This fact proved to be true in our experiments also, as the conditioned respiratory reflexes and differentiations to the sound stimulus were formed and became permanent and stable more rapidly in all of the experimental animals than those to the light stimuli.

On this basis, one can propose that the functional links of the respiratory center (both positive and negative) with the auditory analysor are more stable and permanent in cats than the functional links with the visual analysor. We make this proposal on the basis of the theory developed by M. V. Sergievsky [3] that "the different regions of the cortex are not equal in respect to respiratory regulation in the higher mammals and in man; The respiratory center of the medulla oblongata has more stable links with some regions of the cortex than with others. These stabler links are determined by the whole character of the analysor and synthetic activity of the given cortical region:".

SUMMARY

Four cats (3 male) were under investigation. Conditioned respiratory reflexes and differentiation to light (40 w lamp) and sound (a bell of various frequencies) stimuli were established and reinforced by ammonia (unconditioned stimulus).

A rate and stability of established conditioned respiratory reflexes and differentiation differed and depended on the individual properties of the animal's higher nervous activity.

The quality of conditioned respiratory reflexes was the same as the unconditioned and when firmly established acquired dominant properties. All animals established conditioned respiratory reflexes and differentiation more readily to sound than to light stimuli.

* In Russian.

In two animals phenomena of successive inhibition were noted. During the mating period conditioned respiratory reflexes and differentiation disappeared, but were subsequently restored.

LITERATURE CITED

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