

PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

AN EXPERIMENTAL NEUROSIS DUE TO LACK OF SLEEP

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As shown by the work of P. S. Kupalov and his co-workers [5], experimental neuroses may arise in animals not only in consequence of over-intensive stimulation, of extremely fine differentiation, or of conflict between excitatory and inhibitory processes, but also by the influence of the most diverse factors directly or indirectly creating difficulties and unfavorable conditions for cortical activity.

It might be expected that "the difficulty of balancing excitatory and inhibitory processes" by prevention of sleep in experimental animals, to which attention has already been drawn by M. K. Petrova [8], may also under certain conditions reach an intensity causing interruption of nervous processes.

There are reports in the literature of the impossibility of preventing sleep in man for long periods of time [7, 11], of changes in the tests of the following movements of the eye after only one period of lost sleep [3], of a "neurosis of the sleep mechanism" [4], and of changes in the cortical dynamics in children whose normal sleep pattern is upset [1].

During the investigation of experimental insomnia in animals, the vital importance of natural sleep was established [6], changes in conditioned reflex activity were discovered [2], and biochemical changes were detected in the central nervous system and the blood [9, 12].

The object of this research was to examine the course of the higher nervous activity in animals deprived of sleep, as far as possible, for a period of 2 days.

EXPERIMENTAL METHOD

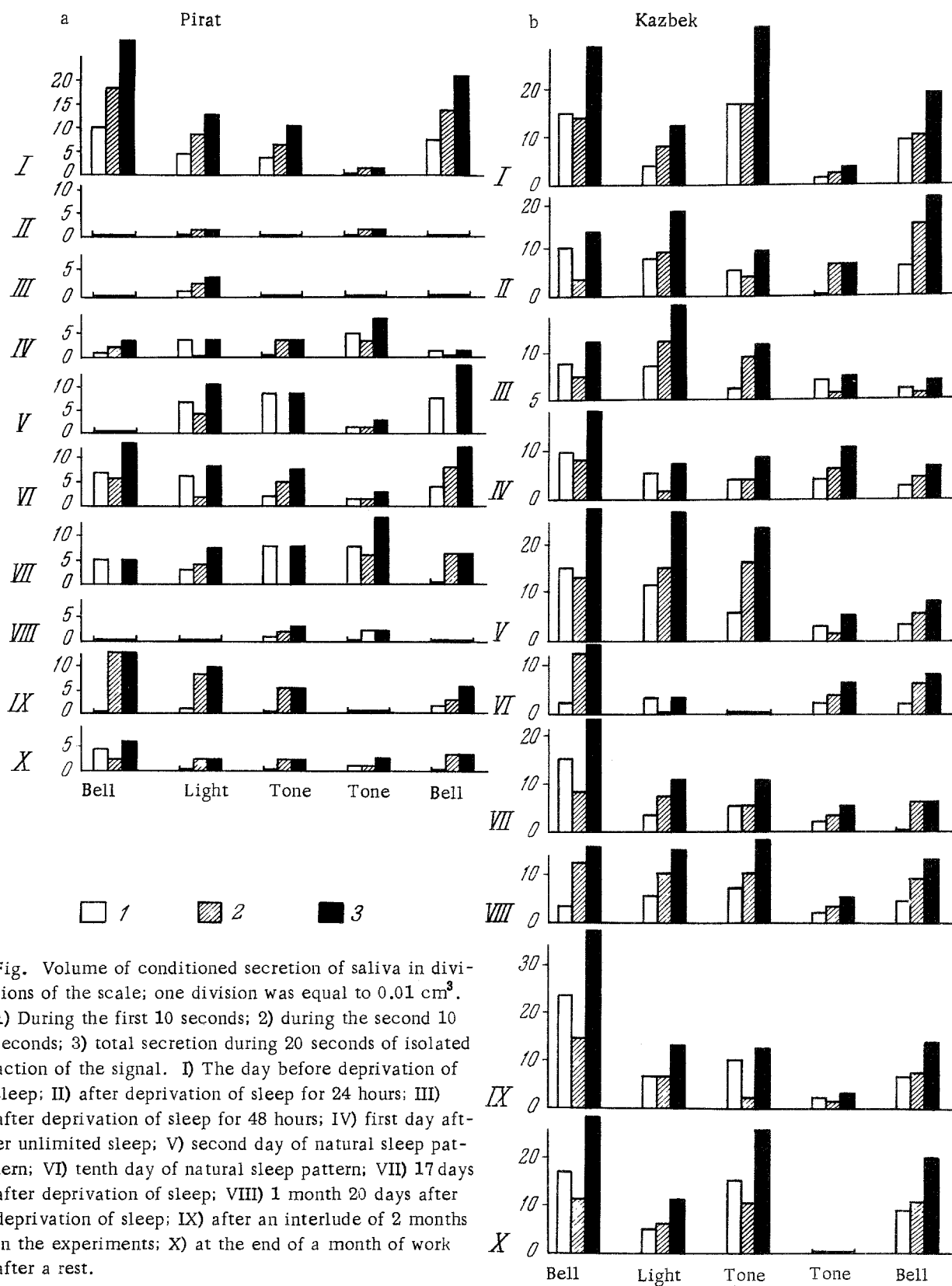
The work was carried out on two young male dogs, Pirat and Kazbek, each of which had an external fistula of the parotid ducts. The animals were distinguished from each other by their general behavior: Pirat was lively, but easily inhibited; the younger Kazbek showed signs of being of the impetuous type.

In both animals, positive conditioned reflexes were developed to a bell, a light and to the high tone (+) of a sound generator (1500 cps), and also to a differential low tone (–) (400 cps).

Corresponding to the order of formation of the reflexes, the conditioned stimuli were arranged in the following stereotype: bell, light, high tone, low tone, and, at the end of the experiment, the bell once more. This stereotype of reflexes was firmly consolidated over a period of one year, after which the experimental insomnia was commenced.

The animals were kept under observation throughout the 24 hours, starting with the first hour of the experiment. Pirat behaved quietly during the experiment, reacting only to a new stimulus. Kazbek spent most of the time in moving about, whining and trying to get away from the apparatus.

The animals were placed in the experimental chamber for the usual time required for investigation of the conditioned reflexes. At night, the animals were taken into an illuminated yard where, from time to time they were walked around and harassed, so that they were unable to lay down their head or close their eyes.



EXPERIMENTAL RESULTS

At the beginning of the first night, the dogs were vigilant, and they quickly seized the small pieces of bread thrown to them. Toward the end of the night, however, first Pirat and then Kazbek began to try to go to sleep. They began to react sluggishly to calls, barks of other dogs and so on. In the morning, the conditioned reflexes of both dogs were tested.

In the course of the day, the dogs showed, besides an increasing tendency to sleep, a reduction in their appetite (both ate only half their ordinary daily ration of food).

In these conditions, almost continuous extraneous activity was required in order to prevent the dogs from falling asleep, and moreover they occasionally displayed an aggressive reaction.

At nightfall, on the second day, the reaction of both dogs to the surroundings was considerably decreased and their tendency to sleep was increased. If during walking about, for instance, the dog became entangled in its chain, it made no attempt to free itself, but stood still and shut its eyes.

At the end of the night Pirat could not sit up, but fell, while Kazbek, no sooner had he sat up than he hung his head down and closed his eyes. At the same time, Pirat began to show a distinctive reaction; he began persistently to lick an area of skin on the forelimb. This appeared to be a perverted form of the "therapeutic reflex" described by I.P. Pavlov in dogs during transitional forms from vigilance to sleep [10].

The results taken from the experimental records which are given below (see figure, a, b) show the changes in the stereotype of conditioned salivatory reflexes produced in consequence of forced lack of sleep.

As may be seen from the diagrams, all the established conditioned reflexes apart from the reflex to the weak stimulus – the light – disappeared in Pirat during deprivation of sleep (see figure, a-I, II), and in Kazbek the reflexes to the strong stimuli were greatly decreased but those to weak stimuli were increased, i.e., there developed an equalizing (see figure, b-II) and particularly clearly a paradoxical (see figure, b-III) hypnotic phase.

The behavior of the animals was also characteristic: refusal to eat, and sleepiness overcome with difficulty. Even when the animals were able to maintain their state of alertness in the intervals between the signals, as a result of opening the door into the chamber, cries, pretended untying their leads and other methods, during the action of the signals, and especially the differential, Pirat did nothing but fall down, while Kazbek hung on his collar, pulling at it to such an extent that difficulty in breathing appeared.

Of greatest interest, however, were the changes in conditioned reflex activity which arose after the period of forced deprivation of sleep had ended.

The conditioned salivatory reflexes remained diminished in magnitude and extremely irregular for a long time. The latent periods were lengthened 4-5 times. Phasic states developed, and equalizing (see figure, a-X and b-VIII), paradoxical and ultraparadoxical phases (see figure, a-VII, VIII) were observed.

Instead of the usual increase in salivation during the isolated action of the conditioned stimulus, it often began to fall at the moment of reinforcement (see figure, b-IX, X), and the unconditioned reflexes were altered too, as shown mainly by the more rapid fall in their magnitude at the end of the experiment.

The behavior of the animals altered correspondingly. The appearance of the food when the feeding dish was uncovered caused salivation, but movements in the direction of the feeding dish did not take place.

In a number of cases, the animals took food only during the action of the weak signal – light – or after cessation of the strong – the bell and tone. As a rule, refusal to eat from the feeding dish was observed. It was necessary to enter the chamber, raise the dish of food to the dog's nose and, only when the animal started to eat, to replace the dish in the feeding receptacle.

All these disturbances, which were signs of neurosis, were expressed much more intensively in Pirat than in Kazbek: in Pirat's behavior, a tendency to remain chained up was most pronounced, whereas Kazbek showed constant restlessness.

After a slight improvement, Pirat's conditioned reflex activity began to deteriorate, and after a month ended in total disorganization (see figure, a-VIII). Only after an interruption of two months in the work was there a

return to relatively normal behavior (see figure, a-IX). In Kazbek the neurotic disturbances began to clear up sooner, and after an interval of two months restoration of the conditioned reflexes was more than complete (see figure, b-IX).

The differing degree and form of the neurotic changes in the salivatory reflexes and the behavior of the dogs Pirat and Kazbek corresponded to the different types of nervous system of the two animals. Different relationships between the intensity of the cortical and subcortical processes, of great importance in the onset and character of the neurosis, may also have been revealed in this case (E.A. Yakovleva, [10]).

The predominance of phenomena associated with the severe diminution in the magnitude of the conditioned reflexes in the picture of the developing neurosis, the development of phasic states and so on indicated that underlying these disturbances was a weakening of the process of excitation, evidently as the result of artificial removal of the protective inhibition of sleep.

SUMMARY

The course of the higher nervous activity processes was studied on 2 dogs with the aid of the classical Pavlov's method of conditioned salivary reflexes, after they were deprived of sleep for 48 hours. Disturbances of the conditioned reflex activity (of the neurosis type) develop in these conditions, the degree and the form of which reflect the typological peculiarities of the animals.

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