

# TOTAL SIMULTANEOUS EXCLUSION OF VISUAL, AUDITORY, OLFACTORY AND VESTIBULAR RECEPTORS IN ADULT ANIMALS

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Our experiments have shown that depriving the nervous cells of the cerebral cortex of puppies three weeks to three months old of the impulses from the visual, auditory, olfactory and vestibular receptors is not accompanied by "passive" sleep. A few days after simultaneous total exclusion of the receptors mentioned the behavior of the experimental puppies does not differ from the behavior of normal animals of the same age [3].

At the same time, according to the paper by V. S. Galkin [1], in his experiments the simultaneous cutting of optic nerves (or enucleation of the eyes), destroying the cochleae and cutting the fila olfactoria resulted among adult dogs in a deep, almost comatose sleep. After the three receptors were destroyed, the dogs woke up independently only to urinate and defecate, external stimuli succeeded in waking them with difficulty, and even then they remained awake only a few seconds. As a result of extensive inhibition in the cerebral cortex, stimuli from the gastrointestinal tract did not succeed in dogs' waking due to the sensation of hunger. Therefore the dogs did not eat independently. In spite of artificial feeding the dogs lost weight and even died from emaciation.

Hence, in spite of the fact that in our experiments the cerebral cortex was deprived of a considerably great quantity of stimuli from the external environment than in the experiments of V. S. Galkin, uninterrupted sleep was not observed. The disparity between the data which we obtained and those of V. S. Galkin can be explained in the following way. First of all it must be pointed out that the method which we employed to exclude the remote receptors differed from the method used in the experiments of V. S. Galkin by a more complete cutting of the optic nerves and, especially, in the destruction of the peripheral olfactory receptors in the nasal cavity. The extracranial exclusion of receptors, moreover, prevented trauma and infection of the brain material [2]. Aside from a somewhat different method of operation, the result of the experiments may be linked with the age of the animals.

As has already been stated, V. S. Galkin destroyed the receptors of adult dogs, i. e., after the animals' brains were already fully mature morphologically and the definitive sum of the links between the organisms and the internal and external environment was established. We destroyed the peripheral divisions of the optic, auditory, olfactory and vestibular analysors of young animals at that time at which intensive processes of development were going on in their brains and links with the internal and external environment were being established. A study of the dogs' brains 4-7 months after the operation showed that, in the absence of a large number of stimuli from the external environment, on the whole the brain remains underdeveloped. Especially underdeveloped were the central termini of those brain analysors, the peripheral divisions of which were excluded by the operation [3].

Setting before ourselves the task of establishing the consequences of excluding the four groups of remote receptors in adult animals, we performed the operation on one adult dog and 30 adult cats. As in the experiment on the puppies, a few days after the operation the thoroughness of the exclusion of the receptors was checked in all of the animals. In not a single one of them was there detected excitability of the visual, auditory, olfactory and vestibular receptors. In this series of experiments a continuous record was also kept of the behavior of the

animals during the working day (from 9 AM to 4 PM), as well as an actographic recording of their movements.

The table below, in which the results of the observations of the dog subjected to the operation are compiled for a period of one month following the operation, provides proof of the fact that depriving the brain of an adult dog of a large amount of the stimuli from the external environment does not involve the animal's uninterrupted sleep. On the contrary, after the exclusion of vision, hearing, smell and the vestibular apparatus of the dog there was noted an alternation of periods of varying duration of being asleep and awake. In addition the total duration of daytime sleep fluctuated on different days within wide limits and did not differ from the sleep of normal adult dogs living under the same conditions.

The animals woke up independently in every instance, and their waking was not always accompanied by urination or defecation. At the same time the dog could easily be awakened by touching, by mild jarring of the walls of the enclosure near which it was sleeping, etc. In this respect our data are in complete agreement with the observations of N. F. Popov [4].

During the time it was awake, the duration of which in the course of a day could exceed 5 hours, the dog walked a lot, stood on its hind paws, climbed out of the enclosure over the low walls, etc. When walking in a room with a large amount of furniture, the dog stumbled over all the objects which it encountered. It by-passed some of them and crawled under others; finding itself by accident between things or in a corner, the dog always left the spot by moving backwards. On the first day after the operation it was observed that the animal had lost the feeling for the position of its body in space. In the enclosure the dog lay quietly, leaning against its wall; it did not stand up on its paws. If we attempted to place it in a free area of the enclosure where it did not touch anything, the dog jumped high in the air with its paws placed wide apart and fell on the floor, landing hard with its whole body. On the floor it threw out its paws wide and "stretched" with them until it encountered some object. After that the dog quieted down. If the object was moved away, the jump and all the phenomena following it were repeated again. All of this was accompanied by pronounced panting by the animal, which lay with its mouth open and its tongue protruding.

On the 2nd day after the operation the experimental dog was already standing on half-twisted, widely separated paws, but it did not walk. The phenomena which were observed on the first day after the operation disappeared; the dog was able to stand without touching anything, but in so doing it breathed heavily and often. The animal's excitation and panting were also noted on the 3rd day after the operation, when the dog began to walk about in the enclosure. On this day and on the following days disturbances of movement or of musculature tonus were not noted.

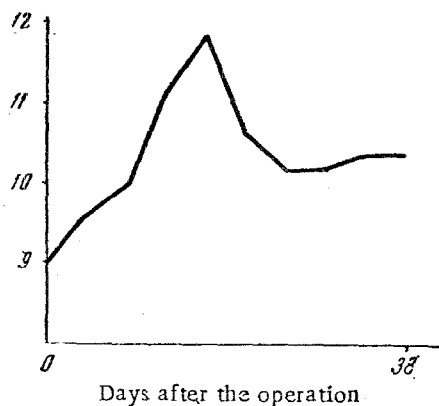


Fig. 1. The change in weight of the dog after total simultaneous exclusion of the four groups of remote receptors.

The experimental dog was already eating independently the day after the operation. Initially the correct slope of its head into the feeding trough was hindered by its strong sweeping movements from side to side. Toward the end of the day, however, the dog was taking meat from the trough just as it had done prior to the operation. On the second day after the operation the animal found the trough in the enclosure by itself and ate the food which had been left overnight. After eating the dog licked the pan frequently. While the dog ate, there was at times observed an aggressive reaction toward the puppies which approached its feeding trough. The dog's taste was fully preserved after the operation, since it always selected the pieces of meat from the trough, and only after that did it eat the bread; it gnawed bones willingly, always holding them down with its paw. As can be seen from Fig. 1, after the operation not only did it not lose weight, but even increased it considerably.

The Duration of the Dog's Periods of Being Asleep and Awake

No. of the ob- serva- tion	Date	Duration of the periods of being asleep and awake in hours and minutes														Total duration in hours and minutes	
		awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep
		asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake	asleep	awake
1	27 I	4.10	0.17	1.22	0.08	0.17	0.15	0.18	0.27	0.06	0.07	0.02	0.05	0.18	0.03	3.27	5.37
2	30/I	0.42	0.11	0.34	0.12	0.15	0.45	0.35	0.05	0.17	0.25	1.06	0.02	0.03	0.04	2.37	2.56
3	2/II		0.42	1.20	0.25	0.25	0.11	0.22	0.03	0.05	1.05	1.00	0.05	0.18	0.03	3.24	2.16
4	6/II		0.05	0.55	0.11	0.04	0.07	0.40	0.07	0.03	0.45	1.10	0.10	0.11	0.03	4.43	1.03
5	8/II	0.42	0.57	0.02	0.08	0.31	0.04	0.14	0.50	0.05	0.03	0.19	0.20	0.11	0.15	4.09	1.52
6	9/II	0.12	0.03	1.06	0.11	0.07	0.03	0.03	0.16	0.02	0.42	0.04	0.55	0.02	0.43	2.39	3.14
7	13/II	0.58	1.44	1.04	0.30	0.37	0.07	1.03	0.16	0.02	0.17	0.15	0.02	0.08	0.08	3.25	2.47
8	16/II	0.29	0.44	0.37	0.08	1.07	0.07	1.04	0.34	0.38	0.17					3.19	2.23
9	20/II	1.22	0.48	0.25	0.28	0.07	0.07	0.25	0.45	0.30	1.10					0.48	5.14
10	25/II	1.28	0.30	0.25	0.28	0.07	0.07	0.25	0.45	0.30	1.10					2.57	3.21

The behavior of the adult cats after total simultaneous exclusion of their vision, hearing, smell and vestibular apparatus was the complete opposite of the behavior of the adult dog which underwent the same operation.

In contrast to the dog, the adult cats, deprived of stimuli from the receptors mentioned, spent all the time in sleep. According to the data of Szymlansky (1920) as well as our own data, domestic cats belong to a group of polyphase animals among which night sleep predominates over that of the daytime. While normal cats are awake for most of the day and sleep only for short intervals of time, the cats with remote receptors excluded slept the whole day (Fig. 2,a). The animals deprived of vision, hearing, smell and vestibular apparatus woke up only to urinate or defecate. Their sleep was extremely deep and was with difficulty disturbed by touching or shaking the walls of the cage, etc. At the same time the animals, while asleep, performed a certain number of movements (Fig. 2,b). The time awake was of extremely short duration and did not exceed 1-2 minutes.

In contrast to the full-grown dog, the adult cats for 5-7 days after exclusion of the four groups of remote receptors did not try to get up on their paws, but rather crept from place to place. Subsequently they stood on half-twisted paws, especially while eating, and even moved about over a very small distance. Some of the animals walked on fully straightened paws, but very few. A change in the animals' positions was observed only before or after feeding if the animals were spurred on by pushing. For the first 3 days after the operation the cats slept in cages, of necessity leaning against one of the walls. In a free area they began to crawl until they touched some object, beside which they rapidly fell asleep. Among a number of the adult cats the loss of the feeling for the position of the body in space was expressed to a considerably marked degree and was accompanied by the same phenomena which were observed in the adult dog the first day after the operation. The animals' jumping into the air, however, was accompanied by a marked aggressive reaction: The animals howled loudly, bared their claws, hissed, etc. Subsequently the cats did not reveal an inclination to touch some object and could sleep peacefully in a free space.

In the majority of the adult cats upon which we operated, disturbed swallowing was noted during the first 1-3 days after the operation. Subsequently the swallowing reflex was restored, but with the exception of a single cat the animals did not eat independently and it was necessary to feed them artificially. Therefore the cat which began to eat independently a week after the operation kept its weight on the preoperative level for the entire 69 days of its life after exclusion of the receptors (Fig. 3,a). Among the other animals, in spite of the force applied, we were

not successful in keeping their weight on the preoperative level (Fig. 3,b,c). The cats never woke up by themselves in order to eat and did not look for the feeding troughs, even in those instances in which they had not been fed for 2 days. Among many of the animals for 12-20 days after the operation an aggressiveness was observed, detected especially during feeding. It was characteristic that, during a strong irritation which was unpleasant for them, the adult cats which were deprived of the most important aspects of reception never localized the irritation. In response to strong irritation, in the region of the sacrum for example, a cat would hiss furiously, show its teeth, bare its claws, beat its tail, etc., but it would not turn its head to the side of the irritation, or try to catch the hand of the person irritating it, or even make an attempt to crawl away from the site of the irritation. One of the characteristic features of the adult cats following the exclusion of their vision, hearing, smell and vestibular apparatus was the loss of a feeling for cleanliness, which lasted, as a rule, for 2-3 weeks. During this time the cats did not "wash themselves", did not lick their coats and did not crawl away from a wet place.

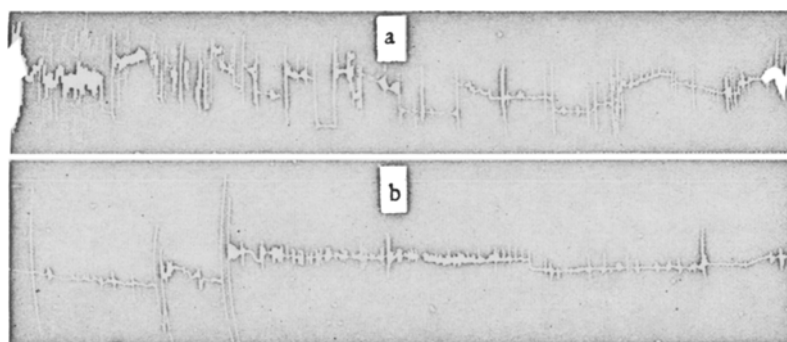


Fig. 2. Actograms of the motor activity of adult cats in the course of a day.  
a) Normal cats; b) experimental cats 1 month after exclusion of the four groups of remote receptors.

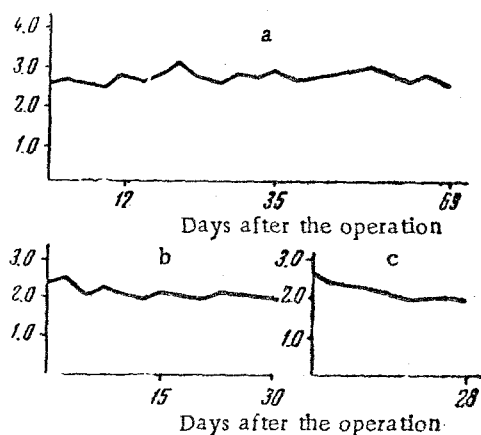


Fig. 3. The change in weight of adult cats after total simultaneous exclusion of the four groups of remote receptors. 1) Days after the operation; a) cats which lived 69 days after the operation; b) cats which lived one month; c) cats which lived 28 days.

Thus the experiments showed that a period of uninterrupted sleep is not observed as a result of simultaneous total exclusion of visual, auditory, olfactory and vestibular receptors in adult dogs, just as it is not among puppies three weeks to three months old. Among these animals sleep alternates with periods of being awake. Waking occurs independently or can easily be produced by contact; the periods of being awake are active. On the other hand among cats deprived of the same receptors a shut-down of deep sleep ensues. Independent waking occurs only in connection with urination and defecation and lasts for not more than 1-2 minutes.

The data obtained by us require further examination in order to shed light on the causes of the different behavior of the adult dogs and cats deprived of the four groups of remote receptors.

## SUMMARY

The visual, auditory, olfactory and vestibular receptors of one adult dog and 30 adult cats were excluded on both sides during the same operation by a procedure elaborated earlier by the same authors. The paper describes the dog's behavior and data on the duration of sleep and wakefulness observed for 7 months after operation. It was demonstrated that exclusion of the receptors mentioned in adult dogs is not followed by uninterrupted sleep. Sleep and wakefulness succeeded one another and the duration of daytime sleep did not differ from normal. Awakening occurred spontaneously or was easily caused by touch.

Cats, on the contrary, deprived of the same receptors, developed profound sleep inhibition. Spontaneous awakening occurred only for urination and defecation and did not last longer than 1-2 minutes. The behavior of the cats after the operation is described.

## LITERATURE CITED

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\* In Russian.