INFLUENCE OF EXTRIPATION OF THE SENSORIMOTOR AREA OF THE CORTEX ON THE FORMATION OF CONDITIONED REFLEXES IN RESPONSE TO A COMPLEX SIGNAL IN THE ONTOGENESIS OF THE CAT


The influence of the extirpation of the sensorimotor cortex (SMC) on the formation and maintenance of a previously developed alimentary conditioned reflex to a simultaneous complex stimulus (light+sound) with extinction of the reaction to unreinforced components of the complex signal was studied in kittens aged 39 days to 4 months. The extirpation of the SMC prior to 2.5 months of age had no influence on either the formation or maintenance of the conditioned reflex to the complex signal developed prior to the operation. The extirpation of the SMC in preliminarily trained kittens aged 3.5 months and older leads to disinhibition of the differential components when the positive conditioned reflex to the complex signal is maintained. In untrained kittens of the same age the extirpation of the SMC was manifested in the animals' incapacity to inhibit the motoric reaction to the differential signal. The question of the role of the SMC in ontogenesis during the formation of adequate forms of behavior which require the achievement of intersensory interactions is discussed.

The frontal region of the cortex is assigned a special role in the processes of the formation of different forms of adaptive behavior. This is determined by its rich afferent and efferent associations with different regions of the cortex and the subcortical structures, as well as by the presence of outputs to the executive systems [2, 3]. The existence of such associations deter-
mines the polysensory character of the majority of the cells of the frontal region of the cortex, and may provide for the polyfunctionality of one and the same signal depending upon the situation [3]. It is known that in evolution the capacity of multimodal signals for synthesis correlates with the degree of the development of the thalamofrontal system of the brain: only in the higher vertebrates, beginning with the predators, can a conditioned reflex to a complex signal develop, with extinction of the reactions to its multimodal components; extirpation of the frontal divisions of the cortex leads to the impossibility of the realization of the given reflex [2]. Investigations in kittens attests to the capacity of young animals for the synthesis of multimodal signals as early as the second month of life, but with slower extinction of the reactions to components than in adult animals [8]. However, by contrast with adult animals, extirpation of the frontal divisions of the cerebral cortex in kittens younger than 4.5 months had no influence on their capacity for the differentiation of the multimodal components of a complex signal, if training was begun 3 months following the operation [4]. An hypothesis suggesting the lesser significance of the frontal divisions, including the sensorimotor cortex (SMC) in intersensory integration at the earlier stages of ontogenesis has been advanced on the basis of these data.

The task of the present investigation was the elucidation of the role of the SMC in the formation of an alimentary conditioned reflex to a complex stimulus with active extinction of the reactions to its components in the first months of an animal's life, when the inhibitory system of the SMC, which acquires a leading role in the organization of the adaptive voluntary movements of the organism, forms [7, 10].

METHODS

The investigation was carried out in 12 kittens from five litters, aged 39 days to 4 months. The minimal age by the beginning of training was determined by the time of the animals' ability to run and jump; it coincided with the beginning of the breakup of the "nest", when the kittens shifted to independant alimentation. In addition, it is known that the development of simple forms of differential inhibition is possible animals older than a month of age [15].

Simultaneous bilateral extirpation of the SMC was carried out in four kittens aged 39-41 days; in four, 2-2.5 months; and in four, 3.5-4 months. Eight animals were operated on before training, and four, which served initially as the control for animals, were subjected to operation after training~ The operation was carried out under general nembutal anesthesia (50 mg/kg, intraperitoneally). The extent of the extirpations are represented in Figs. 1-3. Motoric disturbances were observed on the first three days following operation. During play and running the fore and hind limbs slipped along the floor and splayed out in different directions. The presence of occult motoric disturbances was checked by means of two tests: an aimed jump from one platform to another over a distance of 0.8-1.0 m, and a transit across a crossbeam. As a rule, the motoric disturbances disappeared more quickly in the animals of the younger age group than in the older animals. The animals began to be trained to the execution of a conditioned reflex task seven days after the operation. By this time the operated animals did not differ from the intact animals with respect to the performance of control tests. The operated and control animals of the same litter began training at the same time. A motoric conditioned reflex to a simultaneous complex stimulus (light+sound) was developed. Diffuse illumination (luminance 3.5 lx) of a panel of ground glass measuring 3 × 4 cm served as the light stimulus; a tone burst with a filling frequency of 1.4 kHz and intensity of 40-60 dB was used as the sound stimulus. The lighted panel and the loudspeaker were located above the food trough on the front wall of the chamber at a distance of 55-70 cm from the starting platform. The duration of action of the stimuli was 4 sec. A run toward the food trough served as the conditioned motoric reaction. The motoric reactions were recorded over the 6 sec from the beginning of the action of the stimuli. A reaction to the isolated presentation of the light and sound components was not reinforced. The time of the motoric reaction to the conditional stimuli was determined by means of a millisecond timer, triggered from the beginning of the action of the stimuli, and stopping upon the animal's approach to the food trough. The significance of the difference of the latent periods of the reactions to the complex from the latent period of erroneous reactions to the components was determined by means of the Student test [17]. Fifteen to twenty-four stimuli each with an interval of 0.5 1.0 min were presented in the experiment. The shift from the active extinction of the motoric reactions in response to unreinforced components to the equiprobable presentation of the signals according to a random number table (12 positive and 12 differential) was accomplished from the 9th-17th day from the first presentation of the differential signals at a differentiation level of not less than 45% in the two preceding experiments. Experiments with unstable reflex reactions, associated either with high motor activity or with increased somnolence in the animal, were excluded from analysis. A regression analysis of the dependence of the proportion of correct reactions on the number of presentations of the stimuli was carried out on the basis of the results of the last 10-15 experiments in order to determine the necessity for further training in the case of a low level of differentiation of the components of the complex signal.