SUBCORTICAL NEUROSIS

P. V. Simonov (Moscow)

(Received January 23, 1959. Presented by Active Member of the AMN SSSR P. K. Anokhin)

The present report represents one section of a series of investigations begun in 1954; in these, a study was made of the leukocytic reaction following the injection of various doses of sodium nucleate into animals suffering from radiation sickness and into other intact or decorticate animals in which neurosis had been induced experimentally. During the course of these investigations, we were able to examine 25 decorticate rabbits, including 7 suffering from a pathological condition of the subcortical structures, which we have named "subcortical neurosis".

When the experiment started, we had found no references in the literature to what happens when different kinds of unconditioned reflexes oppose each other in decorticate animals. Recently, we have been able to compare some of our results with those of A. S. Chechulin [1]; he experimented on two decorticate cats, and observed the breakdown of many autonomic functions after repeatedly opposing the defensive with the feeding reflex.

METHOD

Both hemispheres were removed at the same time. Subsequent examination of the brain showed that the removal had been sufficiently complete. In control animals, the skull was trepined, the dura mater cut, and then sewn up.

Unlike decorticate preparations observed by other investigators (for instance, N. Yu. Belenkov's cats), in our animals, no feeding reflexes were developed: the rabbits could not find food for themselves on the floor of the cage, or make use of it. They were kept alive exclusively by feeding with flour mixed with milk and shredded beet root placed in the mouth. In the first few days after the operation, every attempt to introduce the milk and flour mixture into the mouth of the decorticate rabbits caused a violent defensive motor reaction. Quite soon, after 4-5-6 days, the defensive reaction became weaker and lasted for a shorter time, though it was never replaced by a feeding reaction. It is scarcely possible to interpret this result as representing any primitive conditioned reflex. We appear here to be concerned rather with the phenomenon of "bahnung" and with facilitating a change to physiological dominants. It is interesting that even a short-lasting disturbance to the gastrointestinal tract, such as dyspepsia for a day, did not disturb tha balance of the dominants in favor of preponderance of the defensive reaction. On the contrary, injecting aminasine 2-3 days after removal of the hemispheres, immediately facilitated the replacement of the defensive by the feeding dominant.

A pathological condition was induced in the higher nervous centers by arranging for a conflict to occur between the unconditioned feeding and defensive reflexes; this was carried out 2-3 times per day for 2 days. The same method of opposing the unconditioned reflexes was used for both the intact and the operated animals, in the following way. While feeding the rabbit on the flour and milk mixture, a voltage sufficient to produce a motor defensive reflex was applied to the metal end of the syringe; the voltage was gradually raised until the motor response occurred. In control experiments, decorticate animals were given 6 applications in 2 days of a voltage of the same strength, but without feeding. Electrical stimulation given 1 hour before feeding did not alter the placement of the defensive by the feeding reaction either on the day which it was given, or subsequently.

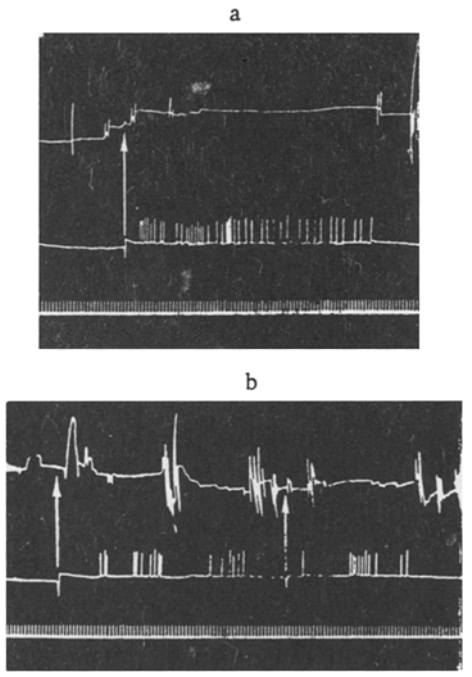

Fig. 1. Formation of an abnormally strong defensive dominant in Rabbit No. 83. a) On the day of "confusion"; b) on the fifth day after confusion. Curves, from above downwards: motor reaction, swallowing movements time marker (5 seconds), ↑ ,placing syringe in the mouth .

The conflict between the two different unconditioned reflexes was introduced 2 weeks after decortication. The time appeared optimal because , on the one hand, at this period the direct aftereffects of the operation have disappeared and on the other, compensatory changes induced by the loss of cortex have not yet appeared, nor have degenerative processes in the subcortical structures yet taken place.

Naturally, in order to determine the functional condition of the subcortical cerebral structures which develops as a result of opposing the unconditioned reflexes, it was important first of all to determine what changes occur in the feeding and defensive reactions directly involved in the conflict. It appeared that on the day of the "conflict" and one hour after it, there was no disturbance of the defensive dominant; for this reason we cannot interpret the phenomena which will be discussed below as being due to the laboration of a conditioned defensive reflex. Only 3-5 days after the "conflict" of the reflexes (an not immediately!) did an over-developed defensive dominant develop: the animals hurled themselves about the cage, struggled free from being held, and it was extremely difficult to feed them at this period (rabbits No. 54, 73, 74, 83, etc.).

Much less frequently (rabbits No. 57, 58, and 85) we found that the feeding dominant was stable: the rabbit continued to "chew the air" , and chewed inedible objects such as cottonwool, if they were placed in the mouth; even pricking caused no defensive reaction, but increased the strength of the chewing movements. It was noted that the preponderance of the feeding dominant was found in Rabbit No. 57 before "conflict" of the unconditioned reflexes. Only the comparatively strong pain stimulation during feeding caused this animal to change over from the feeding to the defensive reaction. We may suppose, therefore, that the changeover of the unconditioned reflex activity toward a stable defensive or feeding dominant is to some extent determined by the relative strength of these dominants before the "conflict" .

The formation of an abnormally strong defensive dominant is illustrated by the kymograms for rabbit No. 83 (Fig. 1, a and b). A stable feeding reaction developed on the 4-5th day after the operation. Three electrical stimulations given on the 8-9 day did not interfere with the feeding reaction when the animal was fed one hour after stimulation; the same result occurred on subsequent days. The feeding reaction remained unchanged even on the days of the "conflict" (see Fig. 1, a). However, a marked change occurred subsequently: when the syringe was put into the mouth , the animal developed a desperate defensive reaction, swallowing was continually interrupted, and the defensive reaction dominated the situation (see Fig. 1, b). During this period, and sometimes later, there was a disturbance of autonomic function: the animals lost weight, and the fur was shed; there was a gastrointestinal upset, and postmortem examination of rabbit No. 73 showed erosion of the gastric mucosa.

A careful study was made of the leukocytic reactions (LR) to the injection of small and large doses of sodium nucleate (NaN). A subcutaneous injection of 1 or 3 ml of a 5% solution of NaN was given into the back. Blood from an ear vein was taken immediately before the injection, and 1, 3, and 6 hours afterwards, and a further sample was taken the next day. The interval between successive injections into one animal was, as a rule, 1-3 days. If the number of leukocytes found 1, 3 and 6 hours after the NaN injection even once exceeded the initial level, the reaction was taken as positive; if in all three test the leukocyte count was below normal, the reaction was ranked as inhibitory. Variations of less than 1000 in the leukocyte count were ignored.

The results of investigating the LR in rabbit No. 74 are shown in Fig. 2.

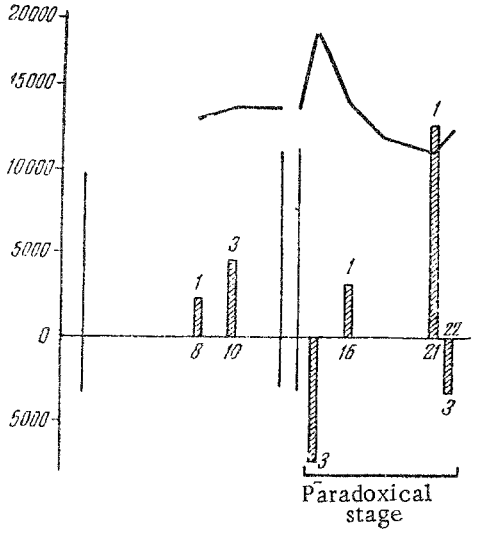

Fig. 2. Change in the leukocytic reaction in rabbit No. 74 induced by injecting 5% solution of sodium nucleate. ——— Initial level of leukocytes on days of experiments Columns show the difference between the maximal increase or decrease in the number of leukocytes after injecting sodium nucleate and the initial value. The figures over the columns indicate the volume in ml of injected solution. The scale shows the numbers along the horizontal axis represent the time, in days, after the decortication.

Here it can be seen that extirpation of the hemispheres does not by itself disturb the normal strength relationships. After "conflict", a paradoxical stage with reversal of the LR occurred: small doses of NaN (1 ml) caused a marked increase in the number of leukocytes from 2500 to 14,000, while large doses (3 ml), on the other hand, actually reduced the number by 2500-6000.

Stimulation with a current of the same strength without feeding, caused no reversal of the LR. After the "confusion" the LR was inverted as in the narcotic, equalizing, paradoxical and inhibitory stage. Also, in intact and decorticate animals with experimental neurosis, we observed particular kinds of distortion of the LR consisting of disturbances of the strength relationships concerned in inhibitory reactions (reactions in which the number of leukocytes was reduced), whereas a large dose of NaN reduced the number of leukocytes to the same extent or even less than did a large dose (equalizing-inhibitory and paradoxical-inhibitory stages). We never once encountered these stages in radiation sickness, because in this disease, the inhibitory stage shows normal strength relationships right down "to zero": the greater the dose of NaN, the greater is the fall in the number of leukocytes.

Total exposure of rabbits with subcortical neurosis to a dose of 400 r (RUM-3; 180 kv; 15 ma; F— 50 cm; Cu 0.5 + 1 Al; 20.3 r/minute) induced a particularly acute form of radiation sickness, and the animals died after 4-5 days (rabbits No. 57 and 58). After exposure to a total irradiation dose of 400 r, decorticate animals which had not been "confused" did not die until the 11-17th day, while control irradiated rabbits recovered.

It remains to enquire in what way subcortical neurosis in decorticate rabbits differs from the corresponding condition in intact animals. First, in intact animals, we never succeeded in observing the over-development of the defensive and feeding dominants after "conflict". In these animals, the conditioned defensive reaction which arose became rapidly transformed into the usual feeding reaction. The effects of "conflict" in intact animals are shown chiefly in autonomic disturbances, and not in their "everyday" behavior. Secondly, conflicts between the defensive and feeding reflexes in the decorticate animal lead to reversal of the LR immediately after the "conflict". In intact animals, the greatest autonomic LR disturbance develops by the 5-8th day after the "confusion".

It is very intesresting that in five rabbits which had recovered from experimental neurosis, and in which the change in the LR to increased amounts of NaN had become quite normal, decortication produced a second reversal of the LR. Decortication of rabbits which had recovered from radiation sickness does not cause this inversion, if the normal relationship of the LR to strength of dose has been reestablished.

Our conclusion is that the experiments demonstrate the important part played by subcortical structures in the pathogenesis of neurosis. The severity of the condition in decorticate as compared with intact animals, and the return after decortication of a neurosis from which the animal had previously recovered demonstrate the important part played by the cortex in compensation of function lost as a result of the neurosis. In this respect, our findings and conclusions agree with those of A. S. Chechulin.

SUMMARY

Subcortical neuroses, which is a condition affecting subcortial structures, was induced in decorticate rabbits by producing a conflict between the food and defensive unconditioned reflexes. A stable dominant, usually of the defensive type, is developed, and there is a disturbance of autonomic function with a reversal of the leukocytic reaction induced by injecting various doses of sodium nucleate. Decortication of rabbits which

had recovered from an experimentally induced neurosis of this type caused a second reversal of the leukocytic reaction.

LITERATURE CITED

[1] A. S. Chechulin, The Effect of Partial and Complete Extirpation of the Cerebral Cortex on "Mechanical Secretion" of Gastric Juice* . Dissertation (Moscow, 1958).

* In Russian