

CHANGES IN CARDIAC CONDITIONED REFLEXES IN DECORTICATE CATS

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There are numerous references [6] to the fact that decorticate dogs are capable of developing defensive conditioned responses. The same reaction has been developed in decorticate cats [5]. Recently it has been possible to develop and to study feeding as well as defensive conditioned reflexes in such animals [1, 2]. Further, it has also been possible to elicit conditioned reflexes associated with respiration [4].

The aim of the present work has been to form temporary connections affecting cardiac activity in decorticate cats.

METHOD

Three cats were used. In 2, Blanche and Panther, the cortex of the cerebral hemispheres (neocortex) was removed in two stages with an interval of one month between the operations. In a third cat, Pepper, the formation of cardiac conditioned reflexes was begun before decortication was complete, at the stage when the right hemisphere had been removed. Extirpation was made by the method described by N. Yu. Belenkov [3]. Work on developing the conditioned reflexes was begun one month after the last operation.

A 1000 c/s sound was used as a conditioned stimulus. Ammonia vapor was the unconditioned stimulus, and was conveyed from the bottle to the animal's nose by a glass funnel. The conditioned stimulus was applied for 5 seconds. For the next 5 seconds the sound and the ammonia vapor were both given together. In each experiment, 5-6 combined applications were given at intervals of 3-5 minutes.

The electrocardiogram was recorded using an EKP-4 apparatus. Respiratory movements were recorded simultaneously on the kymograph.

RESULTS

It is known that ammonia vapor slows the heart beat. Thus, for instance, in Blanche the normal heart rate was 171 per minute, but inhalation of ammonia vapor lowered the rate to 136 (Fig. 1, a). In Panther, the normal heart rate was 222, and after ammonia -- 169.

A check was made that the conditioned stimulus itself (the sound) caused no change in the electrocardiogram.

It was found that it was possible to establish a conditioned cardiac reflex in the decorticate preparations. The first conditioned reflex bradycardia was observed in Blanche at the 30th application of the stimuli, and in Panther the same effect occurred on the 20th occasion. Reinforcement of the reflex was applied after 90-100 applications. In Blanche, the rate was reduced by from 16 to 30 beats per minute (Fig. 1, b), and in Panther it fell from 12 to 20 beats per minute. There was also a conditioned reflex reduction in the amplitude of the respiratory movements.

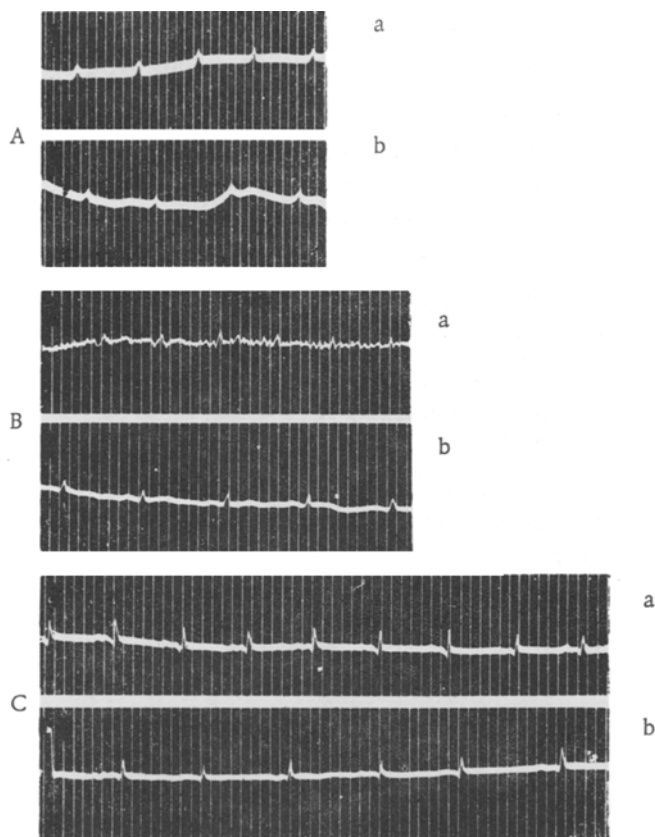


Fig. 1. Cat electrocardiograms. A) effect of ammonia vapor on the heart in Blanche. a) Normal; b) during inspiration of ammonia vapor. B) Conditioned reflex reduction in the heart rate in Blanche. a) Normal; b) during the action of the conditioned stimulus (1000 c/s sound). C) Conditioned reflex response to the first application of the conditioned stimulus after complete decortication, cat Pepper. a) Normal; b) during the action of the conditioned stimulus.

conditioned reflex bradycardia could still be elicited after a three-month interval.

After 136 applications of the combined stimuli, the second (left) hemisphere was removed. One month after this operation, the animal was again tested. It was found that the previously developed temporary connection affecting the heartbeat was still present, and even at the first application of the conditioned stimulus, a typical conditioned reflex bradycardia developed, the heart rate falling from 187 to 136 beats per minute (Fig. 1, c).

Naked eye postmortem examination of the brains of the two cats (Panther and Pepper) showed that the whole of the cerebral cortex had been removed except for a small portion (part of the gyrus preceus) in Pepper.

SUMMARY

Experiments were performed on 3 decorticate cats. Cardiac conditioned reflexes were developed by applying a combination of a 1000 c/s sound and the smell of ammonia vapor twenty or thirty times in succession. The reflex consisted in a decreased frequency of heartbeat in response to the conditioned signal alone. The elaborated conditioned reflexes were stable, and were maintained even after a three-month interval. It was possible to establish a crude differential response in the decorticate animals. In one hemidecorticate animal, the conditioned reflex established was maintained when the second hemisphere was removed.

The temporary connections formed were very stable. After a three month interval, the conditioned reflex bradycardia could still be elicited. Thus in Blanche the reduction was then 9 beats per minute, and in Panther 12. The original extent of the reduction was then restored after a few further stimuli.

The conditioned reflexes which had been developed, were then extinguished by the usual methods. In Blanche, the first indications of extinction occurred after 16 applications of the conditioned stimulus without auditory reinforcement, and after 40-46 such stimulations there was no response at all to the conditioned signal (Fig. 2). The conditioned respiratory reflex disappeared at the same time as the cardiac. Conditioned reflexes inhibited in this way were easily restored. On the day following the extinction, the first application of the conditioned signal induced a bradycardia.

Having shown that cardiac conditioned reflexes could be established in Blanche, we then attempted a differentiation. The negative stimulus was a 500 c/s sound, and the positive stimulus a sound at 1000 c/s. The positive and negative signals were presented alternately, 7 negative and 5 positive stimuli being given in each experiment. After 14 days, during which 106 negative stimuli were given, differentiation was obtained, which was shown by the fact that there was no change in heart rate during the action of the unreinforced negative signal. The differentiation also occurred in the respiratory responses.

Experiments were also carried out on the hemidecorticate cat Pepper. Conditioned reflex bradycardia developed at the 5th combined application of the stimuli, and had become much stronger by the 15th. The reflex was very stable. The

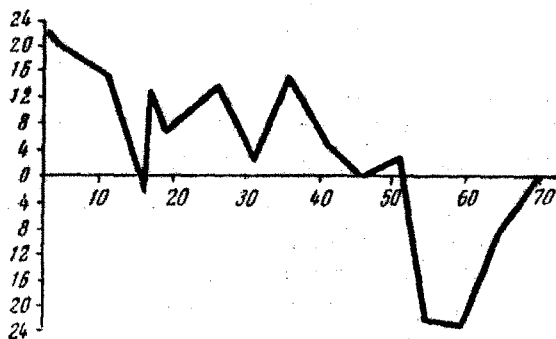


Fig. 2. Extinction of the cardiac conditioned reflex. The figures on the abscissa indicate the number of times the stimulus has been applied. The ordinate indicates the difference between the heart rate before and after conditioned stimulation. Figures above the line indicate slowing, and those below a speeding up.

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