

ALIMENTARY AND ACID AVOIDANCE
INSTRUMENTAL CONDITIONED REFLEXES IN DOGS
AFTER ABLATION OF THE ANTERIOR COMPOSITE GYRUS
(GUSTATORY CORTEX)

Bogusław ŻERNICKI and Guy SANTIBAÑEZ-H.¹

Department of Neurophysiology, Nencki Institute of Experimental Biology,
Warsaw 22, Poland

Several lines of evidence indicate that in dog the gustatory cortical area is located within the anterior composite gyrus (see Fig. 2).

1. Electrical stimulation of the chorda tympani nerve produces the evoked potentials in anterior composite gyrus (Santibañez-H. et al. 1960), and after ablation of this region the taste is clearly impaired (Żernicki and Santibañez-H. 1961).

2. Electrical stimulation of the anterior composite gyrus produces salivation, mastication and swallowing movements (Babkin and Buren 1951).

3. After ablation of the anterior composite gyrus the salivary reflexes are impaired. The conditioned reflexes are clearly more affected than the unconditioned reflexes, and the acid reflexes are more affected than the alimentary reflexes. After unilateral lesion the impairment is dramatic on the operated side (Fig. 1), and a moderate on the contralateral side. However, the reflexes improve gradually, and a few weeks after the operation they become hypernormal (Fig. 2). The following symmetrical ablation on the other hemisphere also diminishes salivary reflexes. The ipsilateral effect is stronger again, but it is much smaller than that after the first operation.

In the present report the effect of the anterior composite gyrus ablation on the instrumental conditioned reflexes elaborated on basis of gustatory reward or punishment was investigated.

¹ On leave from the Institute of Physiology, University of Chile, Santiago, Chile.

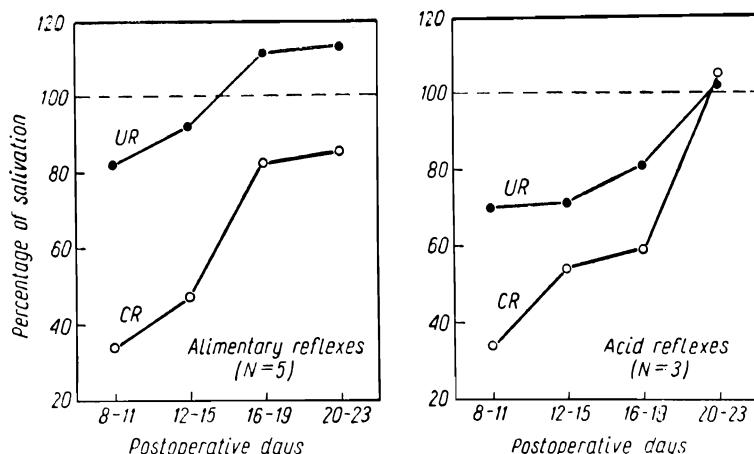


Fig. 1. The decrease of the conditioned and unconditioned salivary reflexes after ipsilateral ablation of the anterior composite gyrus. The mean values from five dogs with alimentary reflexes are shown on left, and from three dogs with acid reflexes, on right. The mean size of the reflexes during the last 10 experiments before the operation was taken as a 100% level. (Modified from Zernicki and Santibañez-H. 1961.)

METHODS

The experiments were performed on seven dogs in a conditioned-reflex chamber. In all dogs the instrumental response of the right foreleg to the sound of a metronome was elaborated. In five dogs the instrumental movement consisted in putting the leg on the feeder, and it was reinforced by a small portion of bread with broth and meat. The dogs usually put the leg back on the floor after the food was eaten. In Dogs 1, 2 and 3 the instrumental movement was reinforced by food immediately, whereas in Dogs 4 and 5 the food was presented 10 sec after the beginning of the metronome action. In addition, in Dogs 4 and 5 conditioned inhibition was elaborated. The conditioned inhibitor was the sound of a buzzer which lasted 10 sec. The interval between the buzzer and the metronome was 5 sec. In Dogs 6 and 7 the conditioned instrumental movement consisted in the lifting of the foreleg to the level of the feeder. This movement protected the dog from the introduction of 3 ml of 33% lactic acid into the mouth. The acid was given by means of a small metal tube fixed to the mouth with Mendeleev wax. In dogs with alimentary training the action of the metronome overlapped for a few seconds with the act of eating. On the other hand, in dogs with acid training the metronome was off immediately after the instrumental response had been performed. The

experimental sessions consisted of 8-10 trials. In Dogs 4 and 5 two additional trials with the inhibitory compound were given. The intertrial intervals lasted about 1 min.

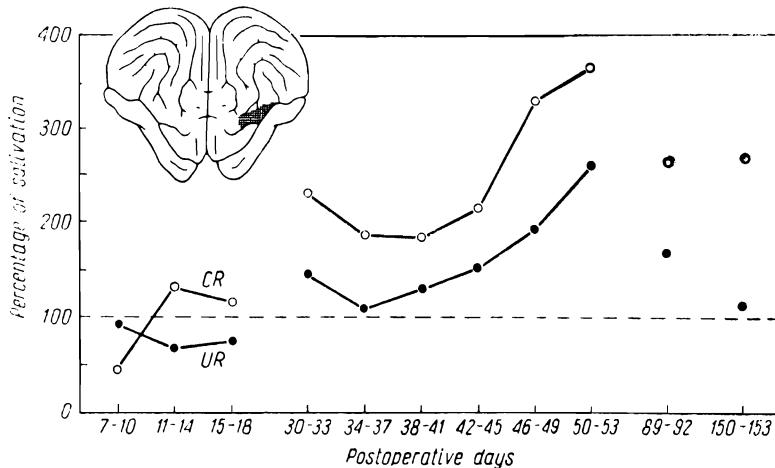


Fig. 2. The decrease and following hypernormality of the acid conditioned and unconditioned salivary reflexes after the ipsilateral ablation of the anterior composite gyrus. In this dog the increase of the reflexes was very demonstrative probably because of relatively weak salivation before the operation. The mean size of the reflexes during the last 10 experiments before the operation was taken as 100% level.

(Modified from Zernicki and Santibañez-H. 1961.)

When the instrumental movement was firmly established (the criterion was the presence of the correct movements during all trials in 10 successive sessions), the anterior composite gyrus was unilaterally ablated. In the majority of dogs the operation was on the left side, i. e. contralaterally to the movement elaborated (Table I). The experiments were resumed 1 week after the operation. In five dogs, 18-60 days after the first operation the anterior composite gyrus was removed on the second side. The experiments were resumed after 1 week, but in Dog 5 after 2 weeks. When after the operation the movement was impaired, in order to avoid massive training the experiments were performed every few days. Inadequate movements, but not small jerks, and the movements appearing after a latency of a few seconds were also reinforced by food and protected the dog against acid. Only in Dog 7 passive training of the movement was applied (see Table I).

TABLE I

The effect of ablation of the anterior composite gyrus on the instrumental conditioned reflex

Dog number	Type of instrumental movement	Delay in food presentation (in seconds)	Training of conditioned inhibition	Side of the first operation in respect to the movement	Movement after the first operation ^a after 1 week	Movement after the first operation ^a after 2 weeks	Movement after the second operation ^a after 1 week	Movement after the second operation ^a after 2 weeks	Interval between first and second operations (in days)
1	alimentary	0	absent	contralateral	+++	+++	+++	+++	40
2	alimentary	0	absent	contralateral	+++	+++	+++	+++	31
3	alimentary	0	absent	ipsilateral	+++	+++	+++	+++	60
4	alimentary	10	present	contralateral	+	++			
5	alimentary	10	present	ipsilateral	+++	++		0 ^b	21
6	acid avoidance		absent	contralateral	+	++	+	+	18
7	acid avoidance		absent	contralateral	0	0 ^d			

^a Symbols: 0 = no response; + = small jerk; ++ = inadequate response; +++ = intact response.^b During the next week poor movement appeared.^c During the next week the movement was improved.^d During the next week passive training of the movement had been applied and the movement reappeared.

RESULTS

The effects of the ablations are summarized in Table I. In Dogs 1-3 the alimentary conditioned instrumental response remained intact after both operations. In Dogs 4 and 5, in which the food was presented after 10 sec delay and the conditioned inhibition was elaborated, the instrumental movement was seriously impaired after contralateral ablation. In Dog 4 only small jerks of the leg were observed and in Dog 5 the movement was completely lost for about one week. The latter finding is in agreement with the observation of Kovalenko (1962). In his dogs, the alimentary instrumental reflexes were reinforced also after a delay of several seconds, and they were seriously impaired after ablation including the anterior composite and anterior sylvian gyri.

In Dogs 6 and 7 the avoidance reflex was seriously impaired after contralateral operation. The impairment was similar to that found for the alimentary instrumental reflex in Dogs 4 and 5.

DISCUSSION

Several lines of evidence suggest the following neural mechanism of the instrumental conditioned reflexes.

1. The center of the conditioned stimulus is connected with the center of the instrumental movement "directly", and "indirectly" through the intermediary of the drive center (Wyrwicka 1952). The latter connection has a facilitatory meaning. Only in the presence of the joint operation of direct and indirect connections is the conditioned instrumental movement elicited.

2. The alimentary instrumental reflex is facilitated by appetite and hunger drives, whereas the avoidance reflex only by fear drive (see Żernicki 1972).

It is probable that after gustatory cortex ablation the intensity of fear and appetite drives becomes smaller. In other words, the indirect pathway between the centers of conditioned stimulus and instrumental response is less effective. In the process of retraining, which was moderate under our experimental conditions, this deficit cannot be easily restored, because the punishing and rewarding values of the unconditioned stimuli are also diminished. In that context it would be interesting to know the effect of electrical stimulation of the anterior composite gyrus in the unanesthetized dog on a previously elaborated instrumental response.

Under our experimental conditions the hunger drive was probably more important than the appetite drive. The dog came to the experimental chamber without morning meal, whereas the attractiveness of food presen-

ted during experimental session was moderate. Therefore, although after the operation the appetite drive was impaired, the hunger drive itself could protect the alimentary instrumental reflex. The hunger facilitation was unsatisfactory, however, when the movement was fragile due to the delay in food presentation and the presence of the conditioned inhibition. In view of this hypothesis it would be interesting to investigate the effect of the ablation on the alimentary instrumental reflex under conditions of the appetite drive predominance, i. e. the dog would be rather satiated and tasty food presented during the experimental session.

Recently Ellison and Konorski (1965) have reported that there exists some antagonism between instrumental and salivary alimentary reflexes, and Konorski claims that the pathways for these two types of reflexes are basically different (Konorski 1967, Konorski and Gawroński 1970). It is interesting, therefore, that after ablation of the anterior composite gyrus there is some similarity in the intensity and the duration of the impairment of the instrumental and salivary reflexes (see Table I and Fig. 1, and Kovalenko 1962). This problem needs obviously further investigations. It would be useful to know the effect of the gustatory cortex ablation in an animal, in which the instrumental and salivary reflexes were elaborated to different conditioned stimuli.

SUMMARY

After ablation of the anterior composite gyrus the contralaterally elaborated acid avoidance reflex was impaired. The contralateral alimentary instrumental conditioned reflex was impaired in dogs, in which it was fragile due to the delay in food presentation and the presence of conditioned inhibition. It is assumed that (i) the impairment of the instrumental reflexes was due to the impairment of fear and appetite drives, and (ii) the less impairment of the alimentary reflex was due to its protection by hunger drive.

We are greatly indebted to Mrs. Janina Rokicka for her excellent technical assistance.

REFERENCES

BABKIN, B. P. and BUREN, J. M. 1951. Mechanism and cortical representation of the feeding patterns. *A. M. A. Arch. Neurol. Psychiat.* 66: 1.

ELLISON, G. D. and KONORSKI, J. 1965. An investigation of the relations between salivary and motor responses during instrumental performance. *Acta Biol. Exp.* 25: 297-315.

KONORSKI, J. 1967. Integrative activity of the brain. An interdisciplinary approach. Chicago Univ. Press, Chicago. 531 p.

KONORSKI, J. and GAWROŃSKI, R. 1970. An attempt at modelling of the central alimentary system in higher animals. V. Instrumental conditioned reflexes. *Acta Neurobiol. Exp.* 30: 397-414.

KOVALENKO, V. N. 1962. The effect of bilateral ablation of the orbital and anterior sylvian gyri on the salivary and instrumental alimentary reflexes in dogs (in Russian, English summary). *Zh. Vyssh. Nerv. Deyat.* 12: 508-516.

SANTIBAÑEZ-H., G., TARNECKI, R., ŻERNICKI, B. and KONORSKI, J. 1960. Cortical representation of the chorda tympani nerve in dogs (in Polish). *Acta Physiol. Pol.* 11: 882-883.

WYRWICKA, W. 1952. Studies on motor conditioned reflexes. 5. On the mechanism of the motor conditioned reaction. *Acta Biol. Exp.* 16: 131-137.

ŻERNICKI, B. 1972. Higher reflexes: an attempt at comprehensive classification of neuro-behavioral activity. *Acta Neurobiol. Exp.* 32 (in press).

ŻERNICKI, B. and SANTIBAÑEZ-H., G. 1961. The effects of ablations of "alimentary area" of the cerebral cortex on salivary conditioned and unconditioned reflexes in dogs. *Acta Biol. Exp.* 21: 163-176.

Received 20 February 1971