11702 P

Acquisition of Conditioned Reactions to Angular Acceleration After Cortical Lesions.

M. J. Oppenheimer and E. A. Spiegel.*

From the Department of Physiology and the Department of Experimental Neurology, D. J. McCarthy Foundation, Temple University, School of Medicine, Philadelphia, Pa.

Conditioned reactions (CR) to angular acceleration and discrimination of the direction of the accelerated rotation were previously demonstrated (Spiegel and Oppenheimer[1]). Experiments on labyrinthectomized dogs indicated that discrimination of direction of rotation in the horizontal plane at low acceleration is an important criterion of the analyzing function of the labyrinth. Since the changes in the electro-corticogram produced by stimulation of the labyrinth (Spiegel,[2] Kornmueller,[3] Price and Spiegel,[4] Gerebetzoff[5]) suggest that labyrinthine impulses reach the cerebral cortex, it seemed of interest to ascertain to what extent cortical centers participate in the development of these reactions, and the ability of dogs with cortical lesions (2 frontal, 2 parietal and 2 temporal lobectomies) to acquire these CR was studied. One frontal and both parietal lobectomies were performed in one stage, one frontal and both temporal lobectomies in two stages. 14-51 days after the last operation conditioning was started. The dogs were rotated as previously[1] described in clockwise or counterclockwise direction first at slow constant speed which later passed smoothly into accelerated rotation. During the counterclockwise accelerated rotation the unconditioned stimulus (electric shock) was applied, while it was omitted during clockwise rotation. The reactions of the leg and the respiration were recorded. The animals were usually tested every 2nd or 3rd day, but in some cases longer rest periods (up to several weeks) were intercalated.

In both dogs with bilateral ablation of the *parietal lobes* CR to angular acceleration were obtained in the first test series; discrimination of direction developed on the third day of experimentation

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1 Spiegel, E. A., and Oppenheimer, M. J., *Am. J. Physiol.*, 1939, **125**, 265.

2 Spiegel, E. A., *Arch. Neur. and Psych.*, 1934, **31**, 469.

3 Kornmueller, A. E., *Bioelektr. Erscheinungen d. Hirnrindenfelder*, Leipzig, Thieme, 1937.

4 Price, J. B., and Spiegel, E. A., *Arch. Otolaryngol.*, 1937, **26**, 658.

5 Gerebetzoff, M., *C. r. Soc. de biol.* (Soc. belge de biol.), 1939, **131**, 807; *Arch. internat. de physiol.*, 1940, **50**, 55.

in dog No. 506 in which conditioning was started 26 days after bilateral parietal lobectomy and somewhat later in dog No. 486 (inconstant discrimination on the fifth day, constant discrimination on the seventh day); in this dog conditioning was started 17 days after operation. After bilateral 2-stage *frontal* lobectomy (No. 593) the CR as well as discrimination were obtained in the first series of experiments, while the dog operated in one stage (No. 553) developed the CR as well as the discrimination later (on the third day conditioned respiratory reactions, on the sixth day of training conditioned leg reactions and on the same day differentiation of direction). Since the training of both animals started at the same interval (17 days) after the bilateral frontal ablation was completed, it seems that the learning abilities were less impaired by the 2-stage than by the one-stage operation. After the bilateral *temporal* lobectomies we see again a certain influence of the interval between the second operation and the beginning of the training, the animal with the longer interval (No. 584, 51 days) developing the CR in the first series of tests, the animal with the shorter interval (No. 554, 14 days) showing the first CR not before the fourth day. Discrimination of direction appeared in both animals relatively late (on the eighth day of training in No. 584, on the ninth day in No. 554).

Thus bilateral ablation of the frontal, parietal or temporal lobes does not prevent the development of CR to angular acceleration, and such reactions may appear in favorable cases without definite delay compared with normal animals. Discrimination of direction may also be obtained after these operations; there is however usually a delay in its development; only one animal (2-stage frontal lobectomy) showing discrimination on the first day of testing. This delay is the longest after ablation of the temporal lobes, discrimination appearing at the eighth and ninth test series respectively. If we compare the delay after temporal ablations with the longest delay after frontal and parietal lobectomies (Nos. 553 and 486), we have to bear in mind that in these latter animals the bilateral operations were performed in one stage, while the temporal lobectomies were 2-stage operations. Furthermore training was started in No. 553 and 486 17 days after operation, while it was started in one temporal lobectomy (No. 584) 51 days after the last operation. Thus the animals with temporal lobectomies were under more favorable conditions than the frontal lobectomy No. 553 and the parietal lobectomy No. 486 as regards operation in stages and No. 584 also as regards interval between last operation and beginning of the training. As quick a learning of discrimination of direction could have been expected in the animals with temporal lobectomies as in the most favorable

cases of frontal and parietal lobectomies, if functional differences between the lobes played no role. It is therefore perhaps not without significance that the longest delay in development of discrimination of direction was observed after the temporal lobectomies.

For an evaluation of these observations it may be recalled that a postoperative development of simple CR to sound and light stimuli is possible after decortication or after ablation of the cortical endings of the respective sensory systems and that the acquisition of such reactions is not or only slightly delayed.[6] As pointed out by Jacobsen[7] the fact that such CR may be mediated through subcortical mechanisms in absence of the cerebral cortex does not exclude the possibility that the cortex plays a role in these reactions in the intact brain, as shown by experiences on post-operative retention and forgetting of CR in cortical lesions. Experiments in this direction with CR to labyrinthine stimuli will be reported later.

11703

Effect of Denervation of Intestine on its Motor Responses at a Site of Distention.

W. B. YOUMANS.

From the Department of Physiology, University of Oregon Medical School, Portland.

The inhibition of motility at sites between 3 and 20 cm in each direction from a region of distention in the innervated and denervated intestine of unanesthetized dogs has been described.[1] The following is an analysis of responses of the small intestine at the site of distention.

Methods. Sixteen dogs with Thiry or Thiry-Vella fistulae of the jejunum as follows were used: 7 with innervated intestinal segments, 2 with both innervated and denervated intestinal segments, 3 with innervated segments that were subsequently denervated, and four with denervated segments only. Several of these animals were the

[6] Poltyreff, S. S., and Zeliony, O. P., *Z. f. Biol.*, 1930, **90**, 157; Culler, E., and Mettler, F. A., *J. Comp. Psychol.*, 1934, **18**, 291; Marquis, D. G., and Hilgard, E. R., *J. Comp. Psychol.*, 1936, **2**, 157; *Brain*, 1937, **60**, 1; Kluever, H., *J. Psychol.*, 1936, **2**, 49; 1937, **4**, 383.

[7] Jacobsen, C. F., *Physiol. Rev.*, 1939, **19**, 303.

[1] Youmans, W. B., Meek, W. J., and Herrin, R. C., *Am. J. Physiol.*, 1938, **124**, 470.