RATE OF RECOVERY OF FUNCTIONING IN CATS WITH ROSTRAL RETICULAR LESIONS

AN EXPERIMENTAL STUDY*

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Recent studies, experimental and clinical, emphasize that damage to the rostral brain stem leads to derangement of consciousness, the site of emphasis being the mesial tegmentum of the midbrain. Earlier Bremer stressed the similarity between sleeping cats and those with cervéau isolé (midbrain transection) and attributed the former to interruption of the tonic drive propagated rostrally over the great afferent paths. The cervéau isolé preparation also showed the spontaneous spindling of the sleep electroencephalogram.

Lindsley, Bowden and Magoun added selective sections of the lemniscus to encéphale isolé (acute C1 transection) preparations. This did not convert the activation tracing characteristic of the encéphale isolé to the cervéau isolé type. However, lesions that instead destroyed sub- and hypothalamic from optic chiasm to mammillary bodies or anterior midbrain did produce a sleep tracing. Additionally, Lindsley et al. studied the effects of chronic lesions. In animals with lesions in the ponto-midbrain tegmentum, midbrain tegmentum, hypothalamus, and junction between hypothalamus and thalamus, the common behavioral result (variable in degree depending upon site and extent of the lesion) was a postoperative somnolence or lethargy in which the animal displayed little or no spontaneous activity of a purposive sort, and seemed unaware of ordinary environmental stimuli. The animal with a midbrain tegmental lesion blocking much or all of the rostral end of the reticular activating system lay on its side with eyes closed as if deeply asleep during its 21-day survival period. By contrast, in 2 animals in which the periaqueductal gray was injured an approximation of normal sleeping-waking behavior was regained. Two others, with lateral mesencephalic lesions which spared the mesial tegmentum, became able to stand and walk again and showed activation of the electroencephalographic tracing. Experiments on 9 monkeys reported by French and Magoun appeared generally to confirm these results so far as destruction of the reticular activating system and the associated behavioral deficits are concerned.

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Cairns concluded from an extensive clinical study that brain-stem lesions occasion loss of crude consciousness. Of particular interest to the locale of the present investigation is the condition of hypsomnia wherein sleep continues but can be broken into by brief arousals produced by stimulation. A variant called a kinetic mutism (Cairns et al.) shows loss of spontaneous and of most other voluntary movements but is associated with the appearance of alertness because of ocular movement and fixation in response to the movement of objects or to sound. Jefferson reported upon 6 cases in which there were disturbances of consciousness in conjunction with signs indicative of disorder of the midbrain. He concluded that obscuredness of consciousness in variable degree was caused by encroachment of the lesions upon the reticular activating system. There were no pathological controls. French found that in 3 of 5 cases in which there were profound alterations of consciousness the lesions were so situated as to destroy the reticular activating system. Penfield, commencing in 1938, has come to consider the reticular substance of the brain stem as the core of his centrencephalic system.

The experiments reported herein were designed to establish whether the procedures involved in producing brain-stem lesions and in the aftercare of the animals contribute significantly to the behavioral results. Rieser in his Principles of Neurology generalizes as follows: "In the initial stage many more regions are functionless than in the residual stage, and this explains the unanimous observation that the initial defects are much more severe" (p. 119). This suggests the importance of comparing lesions of the same size (1) produced at a single sitting and (2) by step-wise accumulation. After-care of the animals was directed primarily toward securing the maximal possible survival period and secondarily toward encouraging self-feeding and self-care.

METHOD

For the more definite experiments the cats were grouped for age and size. After preoperative still and motion-picture photography the animals of a group were divided into two sets of 3 each. In one set, a lesion (or lesions) of the desired size and position was placed at a single sitting; in the other set lesions totalling the planned size were placed step-wise in 2 or more stages, 1 to 3 weeks apart. When 2 stages were used to place bilateral lesions in the mesial tegmentum of the midbrain, each such stage was controlled by a set of 3 animals in which bilateral lesions of the same size were placed at a single sitting. The same operator set the Horsley-Clarke coordinates in each instance and the lesions were produced by a uniform technique.

Surital was used for anesthesia (1 cc./kg., intrathoracic). The lesions were made with cathodal current using a #7 milliner's steel sewing needle with tip exposure of 2–10 mm., depending upon the depth of the lesion desired. The current passed was ordinarily 4.8 MA., 50–70 sec., for each placement. For lesions localized to the mesial tegmentum a longitudinal row of electrolyses was usually placed 3 mm. from the midline. They were closely spaced enough to coalesce into a single lesion 2–3 mm. wide, 1 cm. long and 5 mm. in depth. Additionally corresponding bilateral mesial reticular lesions were placed at transverse plane A+4 in each of several cats.

To approximate a uniform recovery rate as closely as possible all animals of a