BRIEF COMMUNICATION

EFFECT OF AMYGDALOID LESIONS ON OESTROUS BEHAVIOUR IN THE DEERMOUSE

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Summary. Lesions were placed bilaterally in the medial and basolateral amygdaloid nuclei of adult female deermice (*P. m. bairdii*) by means of a Radio Frequency Lesion Maker with a current of 20 μ A/30 sec. It was found that females with lesions in the basolateral amygdaloid nucleus exhibited normal cyclic vaginal smears and mating activities. However, 30% of the females exhibited hypersexuality as evaluated by excessive mating and reception of the male during dioestrus. Females with lesions in the medial amygdaloid nucleus exhibited normal oestrous cyclic activity, but did not mate during the entire 30-day period of the experiment. It is concluded that the medial amygdaloid nucleus may be involved in the nervous mechanism of normal mating.

Sexual behaviour in males of several species has been altered by amygdaloid lesions. Many investigators have found that a few weeks after bilateral ablation of the amygdala males become hypersexual (Brady, Schreiner, Geller & Kling, 1954; Fuller, Rosvold & Pribram, 1957; Green, Clemente & DeGroot, 1957; Masserman, Levitt, McAvoy, Kling & Pechtel, 1958; Wood, 1958; Anand, Malhotra, Singh & Dua, 1959; Kling, Orbach, Schwartz & Towne, 1960; Orbach, Milner & Rasmussen, 1960). Several other authors, however, have found that amygdalectomy causes a decrease in sexual behaviour (Thompson & Walker, 1950, 1951; Walker, Thompson & McQueen, 1953; Kling & Schwartz, 1961). The major effect on female behaviour following amygdaloid lesions is the disruption of maternal behaviour. In instances where an amygdalectomized monkey has given birth, the infant has a limited chance of survival (Walker *et al.*, 1953; Masserman *et al.*, 1958).

This work was conducted in order to investigate the effects of bilateral amygdaloid lesions on the oestrous cycle and mating behaviour in a wild species, the deermouse (*Peromyscus maniculatus bairdii*).

Adult female deermice (*P. m. bairdii*) with a body weight of 17 to 19 g were anaesthetized with Nembutal, placed in a standard rat stereotaxic instrument and lesioned bilaterally in either the basolateral or ventromedial amygdaloid nuclei. A Radio Frequency Lesion Maker (Grass Instruments Inc.) was used discharging 20 μ A of current for 30 sec, and producing lesions with a maximum diameter of 0.4 mm. The electrodes used for placing the lesions were made of

30 gauge platinum wire insulated to 0.5 mm of the tip with a polyvinyl plastic coating. The locations of the lesions were based on a stereotaxic atlas prepared in our laboratory for this animal (Eleftheriou & Zolovick, 1966).

All females were housed in individual new or de-scented transparent plastic cages and given unlimited water and standard laboratory rat chow throughout the experiment. After a 2-day rest period, a fertile stud male was placed in the cage with the female, and the oestrous cycle followed by daily vaginal smears. If more than twenty spermatozoa per microscope field (objective $\times 10$, ocular $\times 10$) were found in the wet vaginal smear, the male was removed and the female left alone for 10 to 15 days at which time she was killed. Location of the lesions was confirmed by histological examination.

Results indicate that bilateral lesions of the basolateral amygdaloid nucleus did not disrupt the oestrous cycle (Table 1). However, mating behaviour was altered in that 30% of these females mated and received the male while in dioestrus. This finding may indicate a hypersexual condition and if so, it would

TABLE 1

SUMMARY OF DATA ON OESTROUS CYCLIC AND MATING BEHAVIOUR IN INTACT NORMAL AND AMYGDALECTOMIZED FEMALE DEERMICE (*P. m. bairdii*)

Treatment	No. of animals	Oestrous conditions	Oestrous behaviour	Per cent mating	
				First oestrus	Second oestrus
Intact, normal	25	Cyclic	Mating	92	8
Lesioned: ventromedial amygdaloid nuclei	20	Cyclic	No mating	0	0
Basolateral amygdaloid nuclei	24	Cyclic	Mating	62	38

be the first instance in which such behaviour has been recorded in females of any species, although such lesions do produce hypersexuality in males (Brady *et al.*, 1954; Fuller *et al.*, 1957; Green *et al.*, 1957; Masserman *et al.*, 1958; Wood, 1958; Anand *et al.*, 1959; Kling *et al.*, 1960; Orbach *et al.*, 1960). No precocious ovarian stimulation following amygdaloid lesions was noted as has been reported for the rat by Elwers & Critchlow (1960).

Lesions in the medial amygdaloid nuclei did not alter oestrous cyclic activity, but females lesioned in this area were not receptive to the male. A possible explanation for this type of behaviour may be that animals lesioned in this area may have become hyperemotional although during the experiment this reaction was not measured. It is known, however, that the amygdaloid complex mediates such behavioural patterns as fear, anger, rage and alerting reactions. An alternative hypothesis may be that this area is part of a 'psychic heat' centre the destruction of which rendered the female non-receptive to the male. The causative mechanism for this behaviour, as well as plasma and pituitary levels of oestrogens and gonadotrophins, are now being investigated.

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REFERENCES

- ANAND, B. K., MALHOTRA, C. L., SINGH, B. & DUA, S. (1959) Cerebellar projections to limbic system. *J. Neurophysiol.* **22**, 451.
- BRADY, J. V., SCHREINER, L., GELLER, I. & KLING, A. (1954) Subcortical mechanisms in emotional behavior: The effect of rhinencephalic injury upon the acquisition and retention of a conditioned avoidance response in cats. *J. comp. physiol. Psychol.* **47**, 179.
- ELEFATHERIOU, B. E. & ZOLOVICK, A. J. (1966) An atlas of the forebrain of the deermouse in stereotaxic coordinates. *J. comp. Neurol.* (In press).
- ELWERS, M. & CRITCHLOW, V. (1960) Precocious ovarian stimulation following hypothalamic and amygdaloid lesions in rats. *Amer. J. Physiol.* **198**, 381.
- FULLER, J. L., ROSVOLD, H. E. & PRIBRAM, K. H. (1957) The effect on affective and cognitive behavior in the dog of lesions of the pyriform-amygdala-hippocampal complex. *J. comp. physiol. Psychol.* **50**, 89.
- GREEN, J. D., CLEMENTE, C. D. & DEGROOT, J. (1957) Rhinencephalic lesions and behaviour in cats. *J. comp. Neurol.* **108**, 505.
- KLING, A., ORBACH, J., SCHWARTZ, N. B. & TOWNE, J. C. (1960) Injury to the limbic system and associated structures in cats. *Archs gen. Psychiat.* **3**, 391.
- KLING, A. & SCHWARTZ, N. B. (1961) Effects of amygdectomy on sexual behaviour and reproductive capacity in the male rat. *Fedn Proc. Fedn Am. Soc. exp. Biol.* **20**, 335.
- MASSERMAN, J. H., LEVITT, M., McAVOY, T., KLING, A. & PECHTEL, C. (1958) The amygdalae and behaviour. *Am. J. Psychiat.* **115**, 14.
- ORBACH, J., MILNER, B. & RASMUSSEN, T. (1960) Learning and retention in monkeys after amygdala-hippocampus resection. *Arch. Neurol.* **3**, 230.
- THOMPSON, A. F. & WALKER, A. E. (1950) Behavioral alterations following lesions of the medial surface of the temporal lobe. *Folia psychiat. neurol. neurochir. neerl.* **53**, 444.
- THOMPSON, A. F. & WALKER, A. E. (1951) Behavioral alterations following lesions of the medial surface of the temporal lobe. *Archs Neurol Psychiat.* **65**, 251.
- WALKER, A. E., THOMPSON, A. F. & McQUEEN, J. D. (1953) Behavior and the temporal rhinencephalon in the monkey. *Johns Hopkins Hosp. Bull.* **93**, 65.
- WOOD, C. D. (1958) Behavioral changes following discrete lesions of temporal lobe structures. *Neurology*, **8**, 215.