Sexual motivation and medial preoptic self-stimulation in male rats

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Self-stimulation and sexual behavior of male rats with electrodes implanted in the medial preoptic area were studied in an experiment in which the animals were castrated and subsequently treated with testosterone propionate. The rewarding effect of an electrical stimulus in this area proved to depend upon the presence of testosterone. The results of this study provide additional evidence for the importance of the medial preoptic area in the motivational aspects of male sexual behavior.

The importance of the preoptic area for the neural regulation of sexual behavior has been shown recently by several lines of experiments.

Bilateral destruction of the medial preoptic area in the male rat abolished sexual behavior without concomitant atrophy of the gonads and the accessory sex organs (Heimer & Larsson, 1966-67). Testosterone treatment could not restore this decline in sexual behavior. Electrical and chemical stimulation of the preoptic area can bring about high levels of sexual behavior in male rats (Fisher, 1956; Vaughan & Fisher, 1962; van Dis & Larsson, 1971). Hillarp et al (1954), in an earlier experiment, made electrolytic lesions in the preoptic area in rats. Some of their animals, both male and female, exhibited intense masculine copulatory responses during a short period after the operation. This short-lasting effect may suggest an electrochemical irritative stimulation of nervous structures in the vicinity of the lesion.

Preliminary experiments in this laboratory showed a strong reinforcing property of an electrical stimulus in the preoptic area of male rats, and it was easy to induce self-stimulation in this area. Olds (1958) observed that the rate of self-stimulation in some areas of the brain (septal area and lateral posterior area of the hypothalamus) decreased after castration and increased again after subsequent androgen treatment. Recently, evidence was reported for a linkage between sexual behavior and self-stimulation in the posterior hypothalamus (Caggiula & Hoebel, 1966; Caggiula, 1970).

The present study investigates the influence of androgens upon the rewarding effect of electrical stimulation in the medial preoptic area. In order to find further evidence concerning the role of this area in the motivational aspects of sexual behavior, special attention was given

to the temporal relations between alterations in sexual behavior and in self-stimulation following castration and subsequent testosterone treatment.

METHOD

The Ss were three sexually experienced male Wistar rats, individually caged and maintained under a 12/12-h diurnal cycle. Bipolar twisted electrodes, made of stainless steel wire (150-micron diam) were unilaterally implanted in the medial preoptic area. In preliminary tests the animals stimulated themselves at frequencies above 600 barpressings/hour. The electrical stimulus selected was a sine wave train (50 cs) lasting 0.3 sec following each barpress. The stimulus intensity was adjusted separately for each animal in order to assure a convenient response level, and was then kept constant during the whole experimental procedure. The self-stimulation tests consisted of an initial period of adjusting the current for each animal. After this adjustment period, the self-stimulation rates were recorded for 15-min periods three times weekly.

Females for the mating tests were brought into behavioral estrous by means of i.m. estrogen (50 micrograms) injected 30 h before testing, and progesterone (1 mg) 4-6 h before testing. Only highly receptive females were used. The mating tests were performed during the end of the dark period. Mounts, intromissions,

and ejaculations were recorded as described earlier (Larsson & Essberg, 1962). Sexual behavior tests were discontinued when (1) no intromission occurred after a 15-min period of observation, (2) no ejaculation occurred within 25 min after the first intromission, and (3) the animal ejaculated.

Each animal was tested five times weekly, i.e., two sexual behavior tests and three self-stimulation tests on alternating days. The control period consisted of nine self-stimulation and six mating tests. Thereafter, the animals were castrated under ether anesthesia. If the animals failed to have mounts in at least three consecutive mating tests, they were treated with testosterone propionate (150 micrograms/animal/day) until ejaculations occurred in three consecutive mating tests.

RESULTS

After castration, all sexual behavior disappeared in 1½, 3, and 4½ weeks, respectively. Ten days of testosterone treatment restored the sexual behavior in all three animals.

Table 1 summarizes for each animal the self-stimulation results of: (1) the last three precastration tests, (2) the last three postcastration tests during which no mounts occurred in the parallel mating tests, and (3) the first three tests following testosterone treatment corresponding to mating tests in which the animals once again ejaculated. The response rates are given as the mean $\pm$ SEM of the three consecutive tests.

Figure 1 shows the results for Animal No. 283, in which all self-stimulation was abolished 4 weeks after castration. The gradual decline in the self-stimulation rate closely paralleled the decline in sexual behavior. Testosterone injections reinstituted the self-stimulation several days before the sexual behavior reappeared.

Animal No. 285 showed a gradual decline of self-stimulation after castration but not a complete abolishment. Testosterone injections restored the behavior to the precastration level. Animal No. 287 showed only a slight but

Table 1
Current and Rates of Self-Stimulation (Per 15 Min) in the Precastration Period, the Postcastration Period, and After Testosterone Treatment*

Animal Number	Current in μ A	Precast-ration Rate	Postcas-tration Rate	Testos-terone	Pre vs Post	Post vs Testos-terone	Pre vs Testos-terone
283	300	338 $\pm$ 34	0 $\pm$	306 $\pm$ 38	< .05	< .05	n.s.
285	175	532 $\pm$ 42	71 $\pm$ 36	488 $\pm$ 158	< .05	< .05	n.s.
287	200	727 $\pm$ 102	403 $\pm$ 110	1028 $\pm$ 178	n.s.	< .05	n.s.

*Mean and SEM are calculated for three consecutive tests. Differences are tested with the randomization test (Siegel, 1956).

Fig. 1. Self-stimulation frequencies $\pm$ SEM and sexual behavior of Animal No. 283. C = castration; TP = initiation of treatment with testosterone propionate; M = mounts were recorded in the parallel mating tests; I = intromissions were recorded; E = ejaculations were recorded.

Fig. 2. Histological control of the electrode tips according to the atlas of König & Klippel (1963).

nonsignificant influence of castration, but the testosterone treatment did give a significant increase in the self-stimulation rate.

The electrodes of all three animals were located in the medial preoptic area, as shown in Fig. 2.

DISCUSSION

The results of this study indicate that the rewarding effect of electrical stimulation in the medial preoptic area can be influenced by castration and subsequent androgen treatment. Although higher current intensities were tried during the postcastration phase in Animal No. 283, when all self-stimulation had disappeared, it was impossible to restore the self-stimulation behavior in this particular animal. In Animal No. 285, on the other hand, it was possible, by using a sufficiently increased current, to restore the self-stimulation level to the precastration value. With regard to such individually different reactions of

the animals to the experimental procedure, the question remains as to whether these might be due to small differences in the current spread within the tissue surrounding the electrodes or to other uncontrolled factors. The same holds true for other experiments (Vaughan & Fisher, 1962; van Dis & Larsson, 1971), in which hypersexuality was found in only 10% of the animals. The temporal relationship found in this study between sexual behavior and self-stimulation, both during the period of their decline and during that of their subsequent restoration, is an important additional argument for a relationship between the strength of sexual motivation and the rewarding effect of stimulation in the medial preoptic area. The present results increase the likelihood that the medial preoptic area is of central importance for the motivational aspects of male sexual behavior.

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