THE EFFECT OF MEDIAL AMYGDALA LESIONS ON INSTRUMENTAL SEXUAL RESPONSES IN MALE RATS

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Abstract. In male rats bar press responses reinforced by the contact with estrous females were established during the preoperative training. Bilateral electrolytic lesions of the medial amygdala nuclei caused an impairment of copulatory behavior manifested by the appearance, during male-female contacts, of exploratory behavior or body investigation instead of copulatory behavior. In all subjects such noncopulatory contacts occurred alternately with those when the copulations took place. The latencies of instrumental responses immediately following the contacts during which intromissions took place remained unchanged. It is suggested that the medial amygdala exerts excitatory and regulatory influences on sexual arousal mechanisms in male rats.

Many papers indicate to the role of the amygdaloid complex in the regulatory mechanisms of sexual behavior. Hypersexuality, homosexual and interspecies sexual behavior after amygdala lesions were observed in various species (7, 18, 19). The influence of amygdala lesions on sexual drive in male rats was investigated by Rasmusen et al. (16), who observed a decrease of sexual drive in male rats manifested by a marked decrease of crossing the electrical grid in order to reach the female. Furthermore, the decrease of sexual behavior after amygdala lesions was observed by other authors: a prolongation of inter-intromission intervals and post-ejaculatory intervals (3, 8), a prolongation of the
ejaculation latency and a decrease of the number of ejaculations (6), an avoidance of contacts with the female (15). On the other hand Schwartz and Kling (20, 21) observed, after amygdala lesions, a hyper-sexuality in male rats, manifested by spontaneous ejaculations occurring in the presence or absence of the female. They observed also a tendency to avoid contact with the female. However, a more precise localization of the sexual function inside the amygdala is yet unknown. It ought to be mentioned that in female rats lesions in the anterior part of the corticomedial amygdala decreased the frequency of lordotic responses (14). The medial part of the amygdaloid complex was proved to play an excitatory role in the motivation of alimentary behavior (15). It was also shown that in rats medial amygdala lesions impaired the instrumental performance reinforced by food or water (9, 10, 11). The purpose of the present work was to investigate the influence of the medial amygdala on basic motivational mechanisms underlying sexual behavior in male rats.

Six male F1 (Wistar × August) rats were the subjects of this study. The 12 h reversed day-night cycle was maintained, food and water were available ad lib. The rats were housed 3–5 per cage. The experimental sessions were performed 4–7 h after the beginning of the dark period. The apparatus for the investigation of instrumental responses consisted of two compartments, dimensions 30 × 40 × 40 cm and 60 × 40 × 40 cm, connected by an opaque guillotine door. In the front wall of the smaller compartment a 5 × 8 cm bar was installed 7 cm above the floor. The transparent front walls of both compartments allowed the observation of the subjects.

During the session the subject was placed in the smaller compartment equipped with the bar and the estrous female used as a reward was in placed the larger one. The instrumental responses consisted of three bar presses. When the male performed the instrumental response, the door separating him from the female was opened, enabling the contact between the animals. After each contact, during which intromission, mounting, ejaculation, body investigation or exploratory behavior had taken place, the male was forced back into the smaller compartment, and the door separating him from the female was immediately closed. The contacts were allowed during 15 s unless the intromission or ejaculation accured earlier. In these cases contact was interrupted 1–2 s after the termination of the item. Before the operation the sessions were ended with the first or second ejaculation, or lasted up to 10 trials if the subjects did not copulate. After the surgery the sessions were ended with the first postejaculatory intromission or lasted up to 20 trials if the rats did not copulate. During the preoperative
training the subjects were tested every two weeks and one a week after the surgery. The response latency (the time between the closing of the subject in his compartment and the first bar press) was recorded on the phototape. In each subject three sessions immediately preceding the surgery were compared with six postoperative sessions. The postoperative sessions were divided into two experimental blocks. Block 1 involved session 1–3. Block 2 — sessions 4–6. Both blocks covered a period of 6 wk. The postoperative testing started 2 wk after surgery.

The bilateral electrolytic lesions of the medial amygdala were performed under Nembutal anesthesia (50 mg/kg) by passing anodal direct current of 2 mA per 10 s through the tungsten electrode 0.5 mm in diameter, insulated with enamel except for 0.2 mm of the tip.

After the experiment had been completed, the subjects were sacrificed. Their brains were removed, fixed in a 10% formalin solution and sectioned at 15 μm frontal slices.

A histological verification revealed that the lesions in all subjects were localized mainly in the medial amygdala (Fig. 1).

Before the surgery all the subjects displayed mating behavior during all sessions, however, during some of them they failed to ejaculate. During the contacts usually mountings or intromissions took place. The contacts when only exploratory behavior or body investigation were displayed, occurred very seldom usually during the trials immediately following the ejaculation.

In the first postoperative session mating behavior was completely abolished in two subjects whereas other four subjects displayed mating behavior, but did not ejaculate. Furthermore in the course of the experiment the sessions during which ejaculations were achieved occurred alternately with the ones when the subjects failed to ejaculate. During all these sessions 1 to 3 contacts during which instromissions or mountings were displayed (the copulatory contacts) occurred alternately with 1 or 2 noncopulatory contacts, when only exploratory behavior or body investigation took place. The noncopulatory contacts appeared after the copulatory ones significantly more often during the first postoperative block (Fig. 2) than during the preoperative sessions ($\chi^2 = 29.55$, $p < 0.001$) whereas the difference between Block 2 and Block 3 was nonsignificant ($\chi^2 = 1.76$, $p > 0.05$).

The median latencies of the instrumental responses immediately following the copulatory contacts before operation were 25.5 (14.5–46.0), during the first postoperative block 25.0 (15.0–41.0) and during the second block 22.0 (10.5–33.0). The analysis of the response latencies immediately following the copulatory contacts between the preoperative sessions and both postoperative blocks performed with Kolmogorov-Smirnov test revealed no significant differences.
No evident differences were observed between the particular subjects' behavior related to small differences in the localization of the amygdala lesions.

The data indicate that bilateral lesions of the medial amygdala

![Fig. 1. Reconstructions of amygdala lesions (black areas).](image)

![Fig. 2. Percent of noncopulatory contacts after instrumental responses immediately following copulatory contacts. Open bar—before operation, stripped bar—3–5 wk after operation, dashed — 6–8 wk after operation.](image)
produce an impairment of mating behavior, manifested mainly by the appearance of contacts in which only exploratory behavior or body investigation were observed alternately with the contacts during which copulatory behavior was manifested. The appearance of such noncopulatory contacts after some contacts with mounting or intromissions seems to be caused by the prolongation of decreased sexual arousability observed normally after each intromission or mounting. This suggestion may be supported by the fact that in normal rats such noncopulatory contacts are often observed in trials immediately following the ejaculations (2, 17). It is also known that the post-ejaculatory interval, as well as the interintromissions interval, depends on the decrease of the sexual arousal mechanisms (1, 17).

Beside this explanation, also another one should be taken into account. In earlier studies it was established that the lesion of the medial amygdala increases the motor activity (10, 11, 13) and exploratory responses (12). Then it is possible that the increase of exploratory behavior after intromissions may have a competitive character in relation to sexual behavior as a result of amygdala lesions. It is not clear however, at this stage of the study, why the response latencies immediately following the copulatory contacts were not affected by the surgery.

In conclusion, our results seem to indicate that the medial amygdala nuclei are involved in the maintenance of the function of sexual arousability in male rats. On the other hand, the lack of differences between the response latencies immediately following the copulatory contacts during the preoperative sessions and both postoperative blocks seems to indicate that the medial amygdala is not involved in the modulation of rewarding values of copulatory events.

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