Effect of Estradiol on Behavioral Responses of Sexually Immature Female Rats

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Sexually immature female rats injected with 17β-estradiol display lowered horizontal and vertical activities in the open field test and long latency of pain response in the tail flick test. These effects of the hormone are observed 4 h and 24 h after its injection. It is concluded that estradiol is involved in the regulation of motor behavior.

Key Words: *17β-estradiol; sexually immature rats; motor activity; open field tests; tail-flick test*

Genetically determined activities, such as unconditioned reflexes and instincts, and probabilistic forms of activity manifested as adaptive behavioral acts during ontogeny, constantly interact with each other [5]. Brain structures (primary those of the brainstem) are activated by environmental factors and excite the mesencephalic reticular formation neurons by modifying the neurotransmitter systems. As a result, emotional and orienting/exploratory activities are altered [1,6].

Steroid hormones play an important role in the regulation of adaptive responses. Although these hormones are the major regulators of several autonomic functions, their effects on spontaneous motor activity and on the rates of motor reactions have not been studied in sufficient detail [3,15]. The contribution of steroid hormones made to the regulation of spontaneous motor activity can be assessed by the sex-related orienting/exploratory activity [14].

The purpose of this study was to estimate the effects of the major estrogen 17β-estradiol on various behavioral responses of rats in the open field test [8] and on the latency of their pain response in the tail flick test.

MATERIALS AND METHODS

A total of 24 sexually immature (6-week-old) female Wistar rats weighing 90 g were used. They were maintained under standard illumination conditions in cages containing 6 animals each and given food and water *ad libitum*. After preliminary open-field and tail-flick tests, the rats were divided into two equal groups. Experimental rats were injected with 17β-estradiol (Sigma) in propylene glycol (daily dose 40 μg/100 g body weight, intraperitoneally, 3 days), and control rats were given propylene glycol by the same route on the same days.

The effect of 17β-estradiol was estimated 4 h and 24 h after each injection in the open-field and tail-flick tests. The open field was a glass box in which the floor (1 m^2) was divided into 25 squares. The following behavioral responses were recorded for 5 min each time: movement to various squares, rearing on hind legs, sniffing, grooming, urination, and defecation. The open field test allows one to evaluate horizontal and vertical activities by the number of squares crossed and the number of upright postures (rearing of hind legs), respectively. In parallel tests, the latency of the tail flick in response to thermal stimulation was determined using a device fitted with an infrared light source set to 56°C [10].

The results were analyzed by Student's *t* test.

RESULTS

In estradiol-treated rats, horizontal and vertical activities were significantly lower, both at 4 h and 24 h after injection (Fig. 1). They were also decreased in

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the control group (particularly on day 2, Fig. 1), presumably as a result of habituation [9]. There were no pronounced changes in other behavioral responses in the experiment. The latency of the tail-flick response in estradiol-treated rats was 3-4 times longer than in the control rats 4 and 21 h after injection (Fig. 2).

The behavior in the open field is determined by exploratory motivation and emotional state (anxiety and fear) [12]. Horizontal activity has been regarded as an indicator of emotionality and vertical activity (upright postures) and a species-specific manifestation of orienting/exploratory activity [7,11]. The open-field behavior is of a probabilistic nature, although it is structuralized to some extent. A measure of the overall orderliness of behavior is entropy [2]. The locomotor and orienting/exploratory activities of estradiol-treated sexually immature rats in the open field were reduced in parallel, which may be taken as an indication that the hormone alters the entropy of their behavior.

The decrease in motor activity and the increase in tail-flick latency caused by 17β-estradiol may be associated with its effect on the GABAergic system, which inhibits motor activity in the open field test [4]. In our study showed the hormone was active 24 h postinjection.

In view of the highly important role of endogenous opioids in the central mechanisms of nociception, the inhibitory effects of 17β-estradiol on both the motor activity and pain response of rats can be attributed to its interference with the mechanisms of positive emotions. These mechanisms probably support orienting/exploratory activity [13].

From our results it can be concluded that 17β-estradiol participates in the regulation of behavioral motor acts in sexually immature female rats, inhibiting their motor activity and prolonging the latency of the tail-flick pain response.

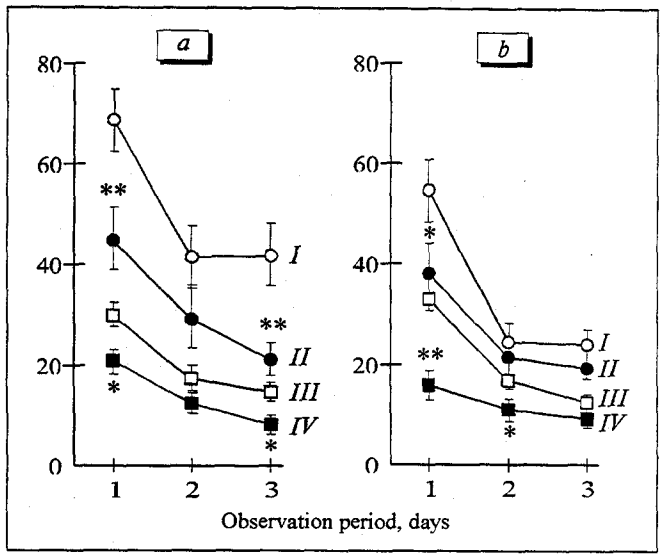

Fig. 1. Effects of 17β-estradiol on the behavior of rats in the open field test (5 min) after 4 h (*a*) and 24 h (*b*) after the hormone injection. Ordinate: number of squares crossed (horizontal motor activity) in the control (*I*) and test (*II*) groups and number of rearings on hind legs (vertical motor activity) in control (*III*) and experimental (*IV*) rats. *$p<0.05$, **$p<0.01$ compared with the control group.

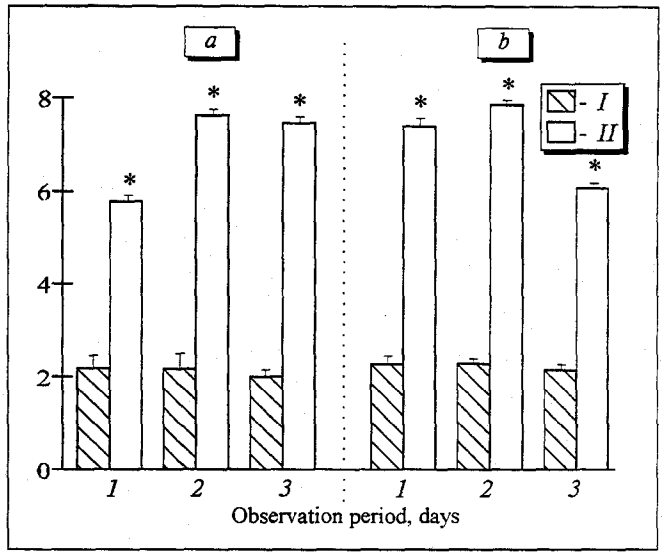

Fig. 2. Effects of 17β-estradiol on the latency of the thermal pain response (tail flick) in control (*I*) and experimental (*II*) rats 4 h (*a*) and 24 h (*b*) after the hormone injection. Ordinate: latency of response, sec; *$p<0.001$ compared with the control group.

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