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Lisuride Inhibits Temporarily Sexual Behavior in Female Rats

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HLIŇÁK, Z. *Lisuride inhibits temporarily sexual behavior in female rats.* PHARMACOL BIOCHEM BEHAV 27(2) 211–215, 1987.—The effect of lisuride (0.1 and 0.2 mg/kg IP) on the sexual behavior was studied in the adult, ovariectomized and chronically estradiol-primed female rats. The behavioral tests were done under dyadic interaction with males 60 min before and 30, 120 and 360 min after lisuride or saline injection. Lisuride induced a prompt, short-termed and dose-dependent loss of the precopulatory patterns (darting, hopping, presenting posture) while the effect on the copulatory (lordosis) behavior was weaker. A partial restoration of the precopulatory behavior was observed in the 120th min, the full restoration of the original precopulatory states was found in the 360th min. The inhibitory effect of lisuride on feminine sexual behavior is in contrast with its facilitatory effect on masculine sexual behavior in rats. The results suggest that the serotonergic system participates in the mediation of both copulatory (receptive) behavior and precopulatory (proceptive) behavioral patterns.

Female rat Sexual behavior Lordosis response Precopulatory patterns Estradiol Lisuride Serotonin

INCREASED male-to-male mounting was reported in adult rats injected with lisuride [5, 7, 27], a semi-synthetic ergot derivative. The lisuride-injected males that interacted with a sexually receptive female displayed a dose-dependent increase in complete copulatory behavior [2]. The threshold of the copulatory readiness of the lisuride-injected adult as well as juvenile males was dependent on the level of the precopulatory (proceptive, soliciting) behavior of the female partner [13,14]. The effects of lisuride were explained from the point of view of lowered behavioral threshold of the males to the specific and distinct sexual stimuli emitted by an estrous female [14]. On the biochemical level, the changes of the masculine sexual behavior induced by lisuride were attributed to impaired serotonin neuronal transmission [2,22].

Female rats injected with lisuride were observed to have more frequent masculine copulation, termed female-to-female mounting [7, 15, 16]. The only reported effect of lisuride upon lordosis behavior has been inhibitory [32]. On the basis of the results with various serotonin agonists it has been proposed that stimulation of the serotonin system leads to inhibition of the estrogen plus progesterone induced lordosis behavior (see [8,33]).

In terms of sexual behavior, the female rat has the species-typical patterns of attractive and proceptive (precopulatory) behavior [4,17]. However, there has been no systematic study dealing with the influence of lisuride on the complete feminine sexual behavior.

The effect of lisuride on copulatory posture and on precopulatory behavioral repertoire of the female rats was evaluated in the experiment reported in the present paper. The evidence on the short-term inhibitory effect of lisuride on sexual responsiveness of female rats is presented. Some results were published in the preliminary form [12].

METHOD

Female Wistar rats (Velaz, Prague), born and bred under reversed artificial 12:12 hour day-night cycle (dark period beginning at 8.00 a.m.), were used. After weaning (on the 28th day) they were kept three per cage with food and water available ad lib. At the age of 70 days the females were bilaterally ovariectomized and implanted with silastic capsules filled with crystallic estradiol-17-β. The procedure warranted that the females exhibited sexual behavior approximately at the same levels for several weeks [31].

Lisuride (lysenyl hydrogen maleate, VÚFB, Prague) dissolved in saline, in the doses of 0.1 and 0.2 mg/kg of body weight, or saline was injected to the twelve females. A balanced regimen spaced for three consecutive weeks was used. Every week always four animals received the given dosage, the interval of seven days was maintained between the injections. Lisuride or saline was injected intraperitoneally, 90 min after the onset of darkness, in volume of 1.0 ml/kg of body weight.

The sexual behavior of females was observed in the dyadic interaction with a male. The behavioral tests were made both 60 min (the 1st session) before the injection (i.e., 30 min after the onset of darkness) and 30, 120 and 360 min (the 2nd, the 3rd, the 4th sessions) after the injection. Every interaction lasted for several minutes in the course of which

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TABLE 1

THE NUMBER OF FEMALE RATS EXHIBITING COPULATORY (CB) AND PRECOPULATORY (PB) BEHAVIOR BEFORE AND AFTER LISURIDE OR SALINE INJECTION

	Time of Testing Behavior (in min)							
	Before		After Treatment					
	−60		+30		+120		+360	
	CP	PB	CP	PB	CP	PB	CP	PB
Saline	12	12	12	12	12	12	12	12
Lisuride 0.1 mg	12	12	12	8	12	12	12	12
Lisuride 0.2 mg	12	12	7	1*	12	10	12	12

For experimental design and details on sexual behavior see the Method section.
Statistical significance: Binomial test (one-tailed); *$p=0.003$ (when compared with the −60 data).

TABLE 2

THE NUMBER OF FEMALE RATS CLASSIFIED ON THE INTENSITY SCALE OF SEXUAL RESPONSIVENESS BEFORE AND AFTER LISURIDE OR SALINE INJECTION

Treatment	Time of Testing (in min)	Intensity Scale of Sexual Responsiveness*							
		0	L	P	PH	H	HD	D	p
Saline	−60			4	2	4	2		
	+30			1	7	0	4		>0.20
	+120			1	5	3	2	1	>0.10
	+360				4	2	4	2	>0.05
Lisuride 0.1 mg	−60			1	8	2	1		
	+30		6	3	3				<0.01
	+120			8	3	1			<0.05
	+360			3	4	3	2		>0.30
Lisuride 0.2 mg	−60			2	5	1	3	1	
	+30	5	6	1					<0.01
	+120		2	6	4				<0.01
	+360			4	4	2	2		>0.05

*The ratio of exhibited patterns is decisive: 0 level=neither precopulatory nor copulatory behavior; L level=only lordosis postures without any precopulatory behavior; P level=presenting postures predominate; PH level=presenting postures and hoppings are balanced; H level=hoppings predominate; HD level=hoppings and darting are balanced; D level=dartings predominate (at P, PH, H, HD, D levels the lordosis postures are regularly exhibited; for details see [17]).

Statistical significance: McNemar test (two-tailed); under the given treatment the data were related to the original behavior states (−60).

each male was permitted to perform six intromissive mounts (with the aim to prevent the ejaculation). The intromissions were separated by a short interval to prevent the postcopulatory aversive state of a female which could affect the exhibition of precopulatory patterns. The behavioral procedure was described earlier [17].

The following sexual behavior of females was recorded: (a) copulatory lordosis postures performed in response to male intromissive copulations, (b) the precopulatory patterns, i.e., the presenting posture, the ritualized hopping, and the ritualized darting (the ear-wiggling was not registered because it is a part of lordosis as well as presenting postures). The behavioral effect of lisuride or saline was evaluated: (a) by the number of animals exhibiting the copulatory and the precopulatory behavior, (b) by classification of females on the intensity scale of sexual responsiveness based on the natural patterning of copulatory as well as precopulatory behavior [17]. The changes of behavioral states of the individuals following lisuride or saline administration (+30, +120, +360) in comparison with the original state (−60) were compared by means of nonparametric statistical tests. The animals served as their own controls.

RESULTS

Table 1 demonstrates the number of females exhibiting copulatory and precopulatory behavior before (−) and after

(+) lisuride or saline administration. All the saline-injected animals exhibited copulatory as well as precopulatory behavior both in the 1st sessions and in the 2nd, the 3rd and the 4th sessions (saline group). As to the copulatory behavior the 0.1 mg lisuride dose was ineffective. When the 0.2 mg lisuride dose was used the inability to respond by copulatory behavior was found in 5 females thirty minutes later. At the same time the precopulatory behavior was not found in 4 females injected with the low dose and in 11 females injected with the higher dose. In the 120th as well as in the 360th minute all the females injected with lisuride exhibited both copulatory and precopulatory behavior (with the exception of 2 animals in the 120th min, injected with 0.2 mg lisuride).

The levels of sexual responsiveness of the individual females before and after lisuride or saline injection (including the statistical significance) are shown in Table 2. After saline there is a slight shift, although statistically nonsignificant, towards more complete precopulatory patterns, characterized by hopping and darting. Apparently, the behavioral effect seems to be a consequence of repeated testing of the females. On the other hand, after both lisuride doses, there is a conspicuous shift to lose precopulatory patterns. The decrease of the sexual responsiveness was found in the females shortly (30 min) after administration of the 0.1 mg dose. Nevertheless, all the females were able to respond by lordosis posture to male mounting. The decreased levels of sexual responsiveness were also found in the 3rd session, although a recovery of the original levels is suggested; all the females exhibited any precopulatory behavior. The full restoration of the original states of sexual responsiveness is apparent in the 4th session. When the females were injected with the 0.2 mg lisuride dose, the changes of sexual responsiveness were more intensive. In the 2nd session, only one female exhibited several presenting postures, six females exhibited no precopulatory behavior (however, they responded with lordosis posture), and five females were sexually nonreceptive. The difference between the 3rd session and the 1st session is also statistically significant; nevertheless, a partial increase of the sexual responsiveness was found. The restoration of the original levels of sexual responsiveness was finished approximately in the 4th session.

DISCUSSION

In the present study, the following experimental design was used. The hormonal condition in female rats induced by exogenous estradiol treatment has induced sexual behavior at the maximal level of the copulatory response and in the range of various levels of the precopulatory repertoire. Then—on the basis of a preliminary study—the inhibition effect of lisuride in a sufficient range of the behavioral responsiveness could be expected and measured.

The effect of lisuride on sexual behavior of female rats can be summarized as follows:

(a) It is prompt, starting at least 30 minutes after the administration. (In an additional experiment, earlier—within 15 minutes—effectiveness of lisuride was proved.)

(b) It has an inhibitory character, the marked changes being found in the precopulatory repertoire. Ritualized darting disappeared first, followed by ritualized hopping, and finally, by presenting posture. Inhibitory effect on the copulatory lordosis posture was relatively weaker; nevertheless, it was observed especially in the female lacking precopulatory behavior.

(c) It is short-termed inhibition, lasting about two hours. The time-course of both lisuride doses was similar. The restoration of the original levels of sexual responsiveness was finished about six hours after the administration, and proceeded in the opposite order as compared with its disappearance.

(d) It is dose-dependent, with the 0.2 mg dose being more effective than the 0.1 mg dose. Not only precopulatory behavior in all females, but also copulatory response in several animals disappeared.

Two approaches in measuring the behavioral effect of lisuride proved a more sensitive evaluation based on the patterning of the whole sexual repertoire in comparison with mere division of the animals to those exhibiting copulatory and precopulatory behavior. The behavioral effects of lisuride could be differentiated using the detailed procedure. Unfortunately, considering the sexual precopulatory repertoire of the female rat and of other species, this testing procedure has not been employed routinely. In fact, all the behavioral tests used exploit only the evaluation of lordosis response.

Although gonadal hormones control sexual behavior in female rats by acting locally in the brain [10], neuropharmacological experiments suggest that concomitant participation of specific neurotransmitter systems is also effective (see [21]). The modulation of target tissues responsiveness to steroids might be an important mechanism by which neurotransmitters modify steroid-dependent processes. The operation of such mechanims provides a means for environmental, behavioral and emotional events to rapidly and selectively alter steroid effects on behavior and physiology [24]. It seems reasonable to suggest that this might be the case of lisuride, also.

Identically with other serotonin agonists used [3, 9, 19, 20, 39], lisuride inhibits lordosis behavior in the steroid-primed female rats ([32], the present paper). Despite the evidence supporting an inhibitory role for serotonin in female copulatory posture, the discovery of 5-HT receptor subtypes in the mammalian brain [25] has further complicated the question of what role serotonin plays in the mediation of female sexual behavior. It was proposed that the classical inhibitory effects of serotonin are mediated by 5-HT_1 receptors, whereas the facilitatory effects of serotonin are mediated by 5-HT_2 receptors [18,35]. The dual role hypothesis was extended in the following way: 5-HT_1A receptors mediate the inhibitory effects, whereas 5-HT_1B receptors mediate presynaptic, facilitatory effects of serotonin on lordosis behavior [19]. Indeed, the relation between serotonin role and lordosis behavior seems to be solved. However, lisuride has been reported to presynaptically inhibit serotonergic activity [28]. Because effects of lisuride upon lordosis behavior have been inhibitory in two studies ([33], the present study), an opinion that the postsynaptic lordosis-inhibitory effects of lisuride is simply dominant over any presynaptic effects [19] is supported.

Unfortunately, the participation of drugs influencing serotonin receptors was generally and merely considered from a point of view of the lordosis behavior. The question remains what is the role of serotonergic system in the mediation of the precopulatory and/or proceptive behavioral patterns. It has been demonstrated that passive lordosis response of females can be induced by the inhibition of serotonergic activity whereas the active soliciting (precopulatory, proceptive) components of female sexual behavior were not affected [38]; the authors concluded that soliciting behavior may be under the control of nonserotonergic

mechanisms. In the present study it was shown that both the active and the passive components of female sexual behavior were influenced by lisuride. Likely, any changes of the behavioral repertoire induced by drugs throughout serotonin-like effect are subjected to a sufficient estradiol priming of the neural substrate(s). This condition was not, apparently, fully accomplished in the above mentioned study [38]. Further experiments are needed to elucidate the biochemical versus hormonal versus behavioral processes in the mediation of the precopulatory patterns in the female. Also, relative importance of serotonergic and dopaminergic neurotransmitters (or the others) in the species-typical precopulatory behavior remains to be defined.

Furthermore, a fuller understanding of the neural systems mediating the precopulatory patterns and systems mediating the lordosis behavior of females is desirable. For example, some evidence suggests that ventromedial hypothalamus is importantly involved in the control of both receptive and proceptive components of feminine sexual behavior [6], whereas a clear dissociation of the regulatory mechanisms between display of both behavioral components at the dorsomedial pontine tegmentum level has been reported [36]. Moreover, there is evidence indicating that serotonin may not directly act on the forebrain lordosis inhibitory system [37]. Considering the complete sexual repertoire the neural circuits of the copulatory response localized in the lower brain stem regions and reticular formation [23, 26, 29] were probably influenced by lisuride less than the structure controlling precopulatory patterns [34].

Whereas lisuride facilitated mounting behavior in the males [2, 5, 7, 13, 14] as well as in the females [7, 15, 16] the opposite effect was found both in the present study and recently [32] as to own feminine copulatory behavior. Two last studies support the hypothesis that heterotypic mating behavior in one sex and homotypic mating behavior in the opposite sex are influenced analogously by monoaminergic mechanisms [21]. While both precopulatory patterns and lordosis posture are suppressed by lisuride, the female may be able to exhibit lisuride-mounting behavior. Similarly, the question arises if the female will be able to exhibit masculine sexual mounts as the time after lisuride administration progresses, that is, in the period when her own sexual behavior is gradually restored. These possibilities were not considered and tested. Apparently, for the expression of certain behavioral components suitable situational and contextual states and/or respective stimuli emitted by the partner(s) are desirable and decisive. Therefore, under the experimental interaction, male versus female, used in the present study, lisuride-induced mounting in the female could not be found.

In behavioral studies lisuride has been shown to induce locomotor inhibition and sedation in low doses, and locomotor stimulation in higher doses (see [1]). The locomotor effects of lisuride were related to a complex action involving both dopaminergic and serotonergic mechanisms [11]. Therefore, here is a good point to accept that the short-term effect of lisuride could be explained by a reduction of the general locomotor activity and thus, by a reduction of precopulatory darting and hopping. However, there are several evidences on the separability of the general (normal) and the sexual (specific) behavioral constituents of animal locomotion following lisuride administration: (1) The locomotor activity of male rats injected with the 0.25 mg/kg lisuride dose was the same as compared with the activity of the control animals; however, the specific sniffing behavior of the estrous female scent traces, the precopulatory behavior and the copulatory readiness were increased in the lisuride males [14]. (2) In the female rats injected with the 0.025 mg/kg lisuride dose the inhibition of the locomotor activity was found, however, the stimulation of mounting has appeared under female-to-female interaction [30]. (3) While for a statistically significant increase in rat locomotor activity a lisuride dose of 0.2 mg/kg was required [5], this dose was conspicuously effective in the inhibition of the complete sexual behavior in female rats (the present study). Also, lisuride elicited frequent mounting behavior in a dose range from 0.1 to 0.78 mg/kg in the group of juvenile female rats [15]. (4) Although, in the present study, we did not measure the locomotor activity, the level did not seem to be decreased in the lisuride-injected females in comparison with the level of the saline-injected animals. (5) According to an unpublished observation (I. Krejčí, personal communication) the same doses as were used in the present study stimulated the locomotor activity of male rats over the control level at about two hours after lisuride administration; at that time the sexual activity of females (the present study) was still partially decreased. On the other hand, at the time of the full restoration of sexual behavior in females (in the 360th min) the locomotor activity levels were found to fall under the control level.

Both the lordosis and the precopulatory behavioral patterns in the female rats represent easily recognizable ovarian hormone-dependent motor actions. Moreover, these patterns are not the constituents of the normal (standard) locomotor equipment. Therefore, their inhibition cannot be satisfactory explained by the general sedation or hypomotility of animals. Thus, the different paradigm of serotonergic and dopaminergic action is safely involved in expression or suppression of different types of behavior. An attempt to compare the lisuride effect on the locomotor activity with sexual activity seems to be premature. It is not clear which brain structures are involved in the expression of the locomotor behavior induced by lisuride and how lisuride inhibits or facilitates sexual behavior. Finally, the testing procedure that is suitable for measuring the intensity of sexual behavior is not, in fact, available for measuring and evaluating the general locomotor activity of animals.

In summary, lisuride inhibited precopulatory as well as copulatory behavioral patterns in estradiol-primed female rats. Several hours later, the original levels of sexual behavior were restored.

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