Ind. J. Physiol. Pharmac., Volume 33, Number 2, 1989

EFFECT OF STRESS ON MATERNAL BEHAVIOUR

S. D. SAHAKARI,* M. E. ABRAHAM AND J. F. MASCARENHAS

Department of Physiology,
Goa Medical College,
Bambolim, Santa Cruz P. O., Goa 403 005

(Received on September 1, 1988)

Summary : Primiparous female rats subjected to foot shock and/or immobilization stress were tested for maternal behaviour (MB) by determining the pup retrieval rate (PRR) for 5 minutes. On the third day after parturition PRR significantly decreased when foot shock was given and the fall was more pronounced after immobilization both with and without foot shock. The animals exhibited enhanced MB on the 12th day as compared to the third day, but the stressful situations produced significant decreases in MB qualitatively similar to the third day. By the 20th day when the weaning was in progress the MB decreased to the 3rd day levels. This change in the MB may be due to the changes in the pattern of prolactin secretion during the post partum period.

Key words : maternal behaviour pup retrieval rate stress
foot shock immobilization

INTRODUCTION

Primiparous rats begin caring for their newborn as soon as they are born (1, 2). The rapid appearance of maternal behaviour at parturition is accompanied by a number of hormonal changes. Three hormones in particular change drastically during pregnancy and at parturition. They are the ovarian steroid hormones, progesterone and estrogen, and milk producing pituitary peptide prolactin (3, 4, 5, 6).

Various types of stressors like foot shock (7) and immobilization (8) are known to change the pattern of hormonal release. A significant adaptation of prolactin response to foot shock or immobilization stress has been demonstrated and the speed of habituation depends upon the intensity of the stressor and the duration of each daily exposure (9, 10). A sudden acute stress markedly increases the prolactin level but a prolonged 24 hours stress results in the decline of the prolactin level to that seen in unstressed controls due to rapid habituation (11, 12).

In this study, we have attempted to examine the effects of a variety of acute stressors on the maternal behaviour of the primiparous animals. The stress paradigms chosen were foot shock, immobilization, and immobilization followed by foot shock.

METHODOLOGY

The study was conducted in 15 female albino rats reared in the departmental laboratory. The animals were isolated when pregnant and fed *ad libitum*. The study was carried out on the mothers and the pups from the first day of parturition daily for three weeks. The maternal behaviour (MB) was observed by placing the mother and the pups in two separate compartments of a cage specially designed for the

* Corresponding Author

purpose. The two compartments were linked by a narrow passage fitted with electified grid floor which could be activated when required. The intensity of the current used was 100 μ amp. The pup retrieval rate (PRR) was determined by counting the number of attempts made by the mother to cross the passage and reach the pups in 5 minutes. As soon as the mother crossed the grid to approach the pups, she was removed and placed back in her compartment.

Each experimental procedure lasted for 5 minutes. In the control situation the grid was not activated. For the next 5 minutes the floor of the passage was electrified. Later the rat was immobilized for 60 minutes in a closely fitting wire mesh cylinder, in which the rat was unable to move. At the end of 60 minutes the mother rat was released and put in her compartment of the experimental cage. The PRR was determined for 5 minutes without activating the grid and again during the ensuing five minutes with the grid activated. This was repeated daily for 3 weeks with all the 15 animals.

RESULTS

Table I shows the mean PRR with SEM computed for the 3rd, 12th and the 20th day after parturition under control and experimental situations. The PRR on 3rd day in control condition was 3.7±0.42. With the electrified grid, PRR significantly decreased to 2.1±0.46 ($P<0.05$). After immobilization, but without the activation of the grid, the PRR decreased to 1.8±0.36 ($P<0.01$). Whereas stress of immobilization followed by activation of the grid further decreased the PRR to 0.57±0.2 which was highly significant ($P<0.001$).

On the 12th day under control condition, the PRR was found to be much more than on the 3rd day i.e. 7.0±0.98 ($P<0.01$). With the activated grid the PRR decreased to 5.06±1.06 which was not statistically significant low level both with the without activation of the grid; the PRR being 2.0±0.56 and 3.3±0.85 respectively ($P<0.001$).

TABLE I : Denotes the Effect of stressors on maternal behaviour.

Day	*Control*	*Foot shock with electrified grid*	*Following immobilization for 6 min.*	*Immobilization for 60 min. followed by electrified grid*
	n=15	*n=15*	*n=15*	*n=15*
3rd	3.7 ±0.42	2.1* ±0.46	1.8** ±0.36	0.57*** ±0.2
12th	7.0≠ ±0.98	5.06† ±1.06	3.3*** ±0.85	2.0***† ±0.56
20th	4.00 ±0.81	3.00 ±0.58	2.40 ±0.62	1.46* ±0.52

Mean PRR±SEM on 3rd, 12th and 20th day after parturition under control and experimental situations.

P Value		
*	<0.05	
**	<0.01	Compared with control on the same day
***	<0.001	
†	<0.05	Compared to similar situation on the 3rd day.
≠	<0.01	Compared with control on the 3rd day.

On the 20th day the PRR reverted to the 3rd day levels both in the control condition and after electrifying the grid (PRR 4.0±0.81 and 3.0 ±0.58 respectively) After immobilization the PRR decreased to 2 4±0.62, and immobilization followed by foot shock while crossing the passage further decreased the PRR to 1.46±0.52 ($P<0.05$) to a significant Level.

The mean daily PRR of all the 15 animals under various conditions for 20 days, is shown in fig 1. There is a steady increase in the MB till the 12th day under control conditions. There is a downward trend thereafter though it does not reach the initial levels. The graphs under experimental conditions also show a somewhat similar pattern except the one with the activated grid alone which snows intermittent peaks with one or two of them peaking above the control levels.

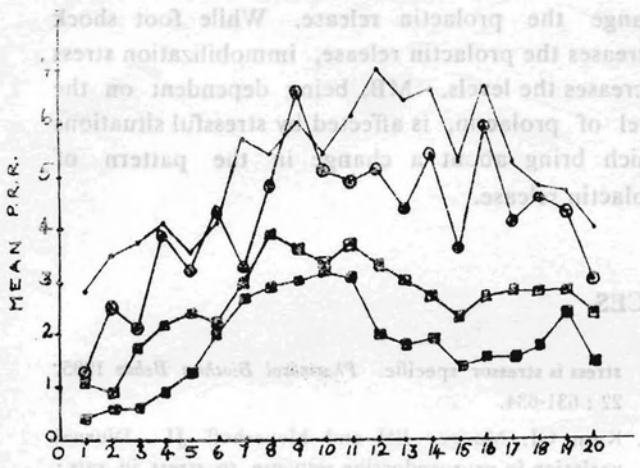

Fig. 1 : Mean daily Pup Retrieval Rate for 5 mts. (PRR) under control (●——●), electric grid activation (O——O), Immobilization (□——□), and immobilization followed by grid activation (■——■).

DISCUSSION

Appearance of maternal behaviour after parturition is due primarily to a rapid fall in the high Progesterone levels present during pregnancy and a sudden increase in estrogen levels which follows (5). Estrogen and prolactin are low during most of the pregnancy but rise near the end and peak at parturition (3, 4, 6). Prolactin which is secreted in large amount during lactation may exert a facilitatory effect on rapid appearance of maternal behaviour by acting directly on the brain (13).

Maternal behaviour (MB) was assessed by PRR under control and stressful conditions On the 3rd day the MB was found to be significantly decreased under stress, more so after immobilization followed by activation of the electric grid. The electric shock was delivered only if the animal attempted to cross over to the pups to retrieve only if the animal attempted to cross over to the pups to retrieve them; therefore it was not an inescapable shock. (MB) In this study we have observed that the female rat makes an attempt to retrieve her pups inspite o. the physical pain that she feels when she crosses the grid. It shows that the drive to retrieve the pups is strong. This drive may be due to an increased secretion of prolactin which increases the maternal instinct (13). This was reported not only when the intensity of the foot shock is increased, but also when the same intensity foot shock is delivered on consecutive days (7).

Foot shock stress increases prolactin level in the blood but a 20 minute recovery period lowers the level to normal (14). Therefore the increased prolactin level may not be carried over to the next stress session. On the other hand, the restraint stress has varied effect on the prolactin secretion. Prolonged restraint of an hour or more decreases the prolactin levels in the blood (15) and short duration (5-20 minutes) restraint increases the prolactin level (14, 8, 16). Since the duration of restraint in our study was for an hour we presume that there was a decrease in prolactin level and therefore the drive for the MB also decreased which was reflected in the much decreased PRR even without activation of the electric grid.

On the 12th day, the MB both in control as well as experimental conditions was at its peak and this could be correlated to the prolactin levels which are known to increase intermittently depending upon the stimulation of suckling (3, 17). MB declines thereafter by the 20th day by which time there is decreased tendency of mothers to nurse the pups and increased tendency of pups to eat solid food leading to the eventual abandonment of suckling (17, 18).

Constant exposure to stressors caused a more rapid habituation than repeated daily exposure of relatively short duration (15). Following 10 days of repeated (15 minutes per day) immobilization or foot shock, prolactin responses were attenuated as compared to responses to the first exposure, but a significant response to the 10th exposure was still evident (3, 9). Therefore in our study on the 12th day the response obtained was still significant.

In conclusion, one may note that MB makes a rapid appearance soon after parturition and three hormones are responsible for its appearance which include an increased secretion of prolactin at the time of parturition. Prolactin is released in bouts in the succeeding days stimulated by suckling, reaching a peak by the 12th day. Stressful situations change the prolactin release. While foot shock increases the prolactin release, immobilization stress decreases the levels. MB, being dependent on the level of prolactin, is affected by stressful situations which bring about a change in the pattern of prolactin release.

REFERENCES

1. Rosenblatt JS and DS Lehrman. Maternal behaviour in the laboratory rat. In : Maternal Behaviour in Mammals, edited by H. L. Rheingold, *New York : John Woley Press*, 1963; 8-57.
2. Weisner BP and Sheard NM. Maternal Behaviour in the Rat. *Lond : Oliver and Boyd* 1933.
3. Leong DA *et al.* Neuroendocrine control of prolactin secretion. *Ann Rev Physiol* 1983; 45 : 109.
4. Morishige WK, Pape GJ and Rothehild I. Serum Luteinizing hormone (LH), prolactin and progesterone levels during pregnancy in the rat, *Endocrinology* 1973; 92 : 1527-1530.
5. Rosenblatt JS, Siegel HI and Mayer AD. Progress in the study ofmaternal behaviour in the rat : Hormonal, sensory and developmental aspects, In : Advances in the Study of Behaviour, Vol. 10, Edited by J. S. Rosenblatt, R. A. Hinde, C. Beer and M. Busnel, New York : *Academic Press* : 1979; 223-310.
6. Shaikh AA. Estrone and estradiol levels in the ovarian venous blood from rats during the estrous cycle and pregnancy. *Biol Reprod* 1971; 5 : 297-307.
7. Benjamin HN, Ottenwaller HE, Pitman D and Tapp D. An Assessment of Prolactin's value as an index of stress. *Life Sc* 1988; 42 (17) : 1587.
8. Mueller GP, Twohy GP, Chen HT, Advis JP and Meltes J. Effect of L-tryptophan and restraint stress on hypothalamic and brain serotonin turnover, and pituitary TSH, and proclactin release in rats. *Life Sc* 197 ; 18 : 715-724.
9. Kant GJ, Bunnell PN, Mougey EH, Pennington LL and Meyerhoff JL. Effects of repeated stress on pituitary cyclic AMP, and plasma prolactin, corticosterone and growth hormone in male rats. *Pharmacol Biochem Behave* 1983; 18 : 967-971.
10. Kant GJ, Eggleston T, Landman-Roberts L, Kenion CC, Driver CC and Meyerhoff JL. Habituation to repeated stress is stressor specific. *Pharmacol Biochem Behav* 1985; 22 : 631-634.
11. Kant GJ, Mougey EH and Meyerhoff JL. Diurnal variation in neuroendocrine response to stress in rats : Plasma ACTH β-endorphin, β-LPH, corticosterone and prolactin and pituitary cyclic AMP responses, *Neuroendocrinology* 1986; 43 : 383-390.
12. Kant PJ, Leu JR, Anderson SM and Mougey EH. Effects of chornic stress on plasma Corticosterone, ACTH and prolactin. *Physiol Behav* 1987; 40 (6) 775-779.
13. Ganong WF, Endocrinology and Metabolism. In : Review of Medical Physiology, edited by Ganong WF, Lange Medical publication, California 1985; 94022 : 342-375.
14. Paris JM, Lorens SA, Van LD, Kar DC, Urban JH, Richardson - Morton KD and Bethea CL. A comparison of acute stress paradigms : Hormonal responses and hypothalamic serotonin. *Physiol Behav* 1987; 39 (1) : 33-43.
15. Morehead MH and Richard R. The lack of a Physiologic effect of the stress induced decrease of the proestrous prolactin surg in the rat. *Life Sciences* 1987; 41 (21) : 2355-2362.
16. Lenox RE, Kant GJ, Session GR, Pennington LL, Mougey EH and Meyernoff JL. Specific hormonal and neurochemical responses to different stressors. *Neuroendocrinology* 1980. 30 : 300-308.
17. Rosenblatt J. Maternal behaviour In : Tne Oxford Companion to animal behaviour, edited by D. McFarland. Oxford : *Oxford Univ. Press*, 1981; 359-364.
18. Thiels E, Cramer CP and Alberts JR. Behavioral Interactions rather than milk availability determine decline in milk intake by weaning rats. *Physiol Behav* 1999; 42 : 507-515.