ROLE OF OVARIAN HORMONES ON HOARDING IN RATS - FEEDBACK MECHANISM

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Summary : The adult female rats hoard large quantities of food during proestrus and continue hoarding if ovariectomised at proestrus (Group I). The hoarding score is lowest in diestrus and continue to remain low if ovariectomised during this phase (Group II). The scores in Group I and Group II are reversed in intracerebral administration of Progesterone and Estradiol Benzoate respectively into preoptic areas. The significance of the response is discussed on the basis of built-in feedback mechanism for hoarding cyclicity.

Key words : ovarian hormones, hoarding score, intracerebral microinjection, preoptic areas

INTRODUCTION

The laboratory rats are known to hoard large quantities of food when kept on food deprivation (10) Female rats have been observed to exhibit cyclic variations in hoarding pattern corresponding to cyclic changes in vaginal cytology (1,2,4,5,6). The hoarding score was highest in proestrus and lowest at diestrus and it was further noted in our series that the ovariectomised animals during proestrus continued to hoard larger quantities compared to those in whom ovaries were removed in diestrus (2). The ovariectomised animals having higher hoarding score reduced the score on intramuscular administration of progesterone (2). Likewise intramuscular administration of estradiol benzoate reversed the score in those ovariectomised animals having lower score (2). The above report clearly indicated the possible role of two ovarian hormones in hoarding. The exact sites and mode of actions of these hormonal interactions were not known from the earlier studies as the doses of hormones were higher and the homrones are known to have peripheral actions besides their effects on central neural substrates when administered parenterally. The present work was planned to locate the diencephalic areas known to respond to ovarian hormones. Medial preoptic area was selected for intracranial implants of estradiol benzoate and progresterone as neurones in this area are known to have estrogen receptors on the cell membranes (11).

MATERIAL AND METHODS

Twenty seven albino rats weighing approximately 170-200 *gms* were housed in individual cages specially designed for hoarding behaviour where the animals were trained to hoard food as described earlier (1). Before ovariectomy, two normal estrus cycles of 4-5 days were studied by microscopic examination of vaginal cytology carried out at 9. A.M. every day. The hoarding scores were also determined during these two cycles in the following way. About 200 food pellets each weighing approximately 5 *gms* were kept in one compartment of the cage and animals were allowed to have free access and pick up for purpose of hoarding the pellets for 30 minutes from 9.0–9.30 A.M. The remaining pellets from the parition cage were removed after 30 minutes and the hoarded pellets counted (henceforth designated Hoarding Score). The animals were allowed to eat the food from the hoarded stock for subsequent 90 minutes while the water was available throughout the day.

After the animals had exhibited two regular vaginal cycles in which highest hoarding score was at proestrus and lowest at diestrus, 14 of them were ovariectomised in proestrus (Group I) while 13 in diestrus phase (Group II) via abdominal incision under ether anaesthesia. After one or two days post-ovarectomy hoarding scores were determined as before for 10 days. It was observed that 14 animals ovariectomised at proestrus maintained higher hoarding score while 13 of them ovariectomised at diestrus developed lower hoarding score. All the animals were then aneasthetised with sodium pentobarbitne in the dose of 40 *mg/kg* and bilateral double walled stainless steel cannulae with inner gauge 27 and outer gauge 22 were implanted stereotaxically in medial preoptic areas on both sides by using the following coordinates : antero-post 7.0 mm, lateral 0.5-1 mm. and vertical-1.5 mm. from flat surface of the skull (9).

One week later the inner cannulae were exchanged for clear 27 gauge steel cannulae through which progesterone 30 *µgm* dissolved in 2 µl of olive oil was instilled in 9 animals of Group I which developed high hoarding score while 5 of them in the same group received 2 µl of olive oil. In the Group II series with low score received estradiol benzoate 2 *µgm* in 1 µl of olive oil while 6 of them in the same group received 1 µl of olive oil with the help of micro-syringe. The post-injection hoarding scores were then determined for 8 days in both the groups of animals.

The animals were then sacrificed with an overdose of ether and perfused pericardially with 0.9% saline followed by neutralized 10% formalin solution. The brains were fixed in formalin and coronal sections were cut at 8 u and every 100th was stained with cresyl violet for purpose of microscopic examination.

RESUTS AND DISCUSSION

Fig. 1 indicates that intracerebral administration of progesterone into medial preoptic areas brought about decrease in hoarding score in the ovariectomised high score group. Fig. 2 displays the increase in hoarding score in rats receiving intracerebral administration of estradiol benzoate. The sham series in both high and low score groups receiving olive oil intracerebrally did not alter the score. The cannula sites in one of the rats have been depicted in Fig. 3.

The results obtained in the series studied favour the view that high estrogen levels trigger the reverberating circuit responsible for the drive for hoarding and is cyclically inhibited by its own low levels and/or increased levels of progesterone. Indeed the ovarian secretions during estrus exhibit phasic variations in which estrogen levels increase

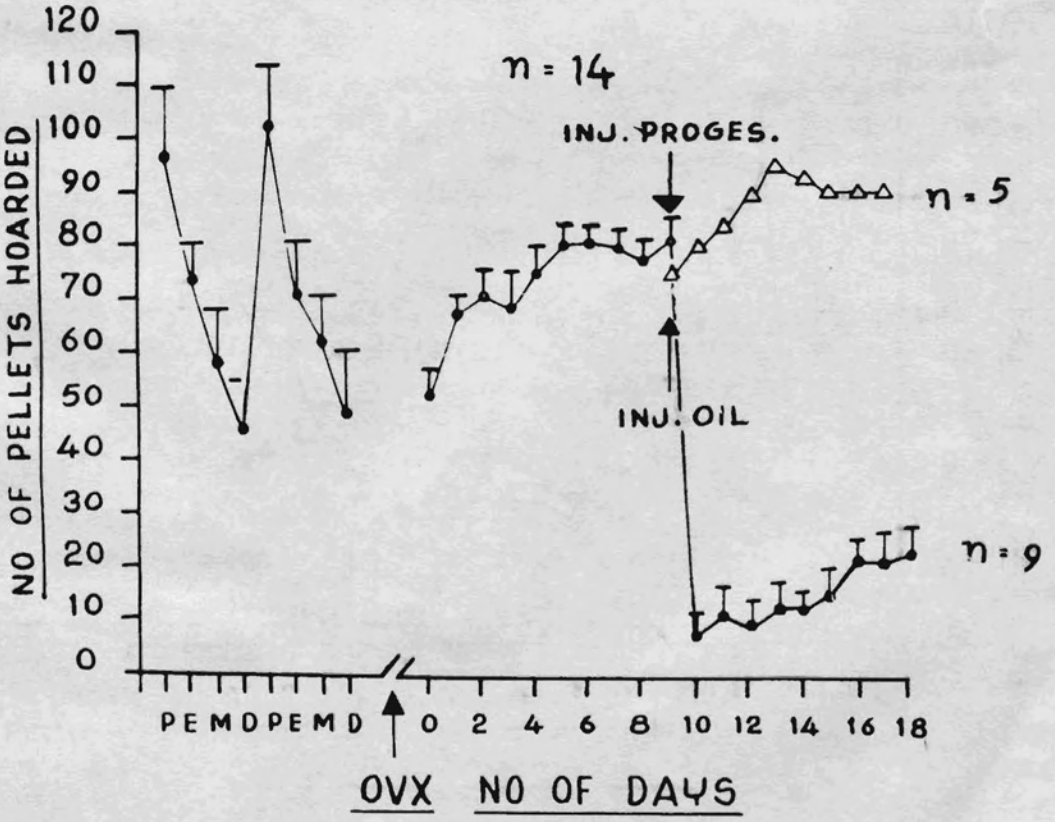

Fig. 1 : Mean and Standard Error of hoarding score of 14 rats during estrus cycles, after ovariectomy performed at Proestrus and after intracerebral administration of Progresterone (n=9) and oilve oil (n=5). The hoarding score decreased after progesterone administration ($P<0.001$).

during proestrus and decrease at diestrus and progesterone levels exhibit the reverse trend. Hoarding behaviour likewise exhibited similar phasic pattern.

The neural substrates like frontal cortex (8), Amygdala (3) Lateral Hypothalamus (6), Caudate-Putamen and Thalamus (7,9) are known to influence hoarding behavior. It is likely that these centers constitute the motivational system for hoarding and feeding which are the functions closely related to each other. The present work elucidates the role of ovarian hormones influencing the cyclic variations in hoarding behavior through their action on preoptic area.

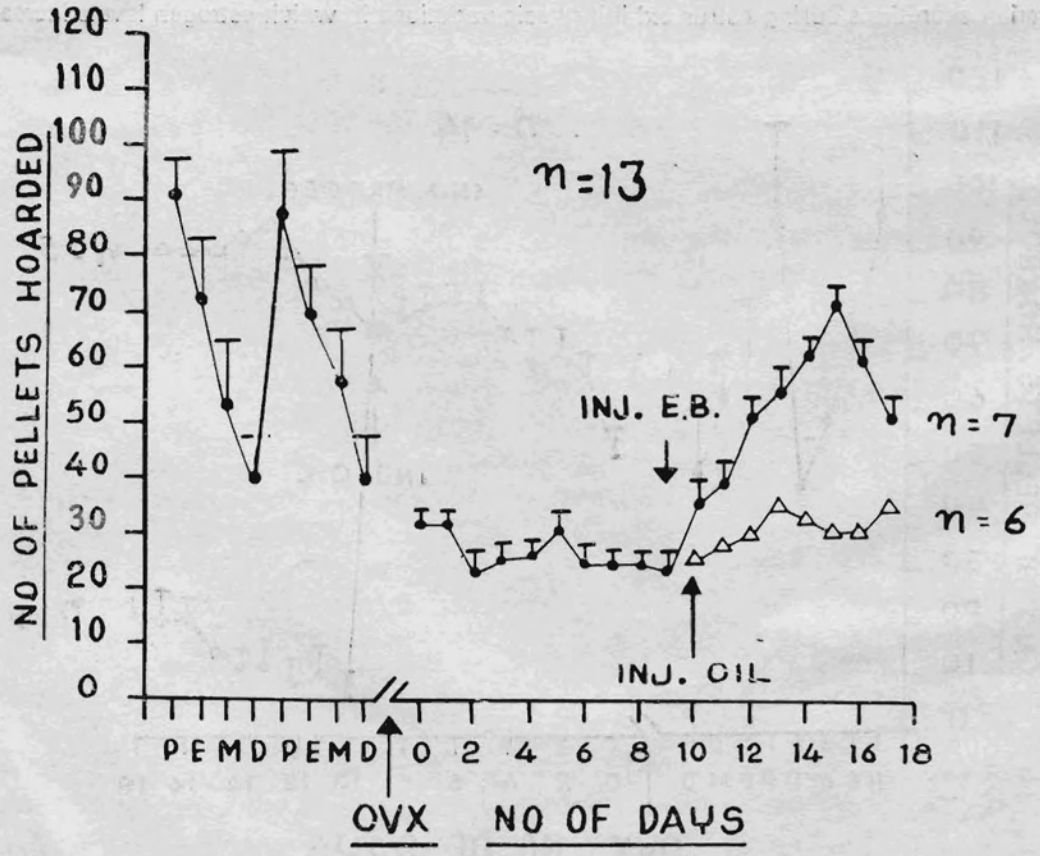

Fig. 2 : Mean and Standard Error of hoarding score of 13 rats during two estrus cycles, after ovariectomy performed at diestrus and after intracerebral administration of Estradiol Benzoate (n=7) and Olive oil (n=6). The hoarding increased after Estrogen administration ($P<0.01$).

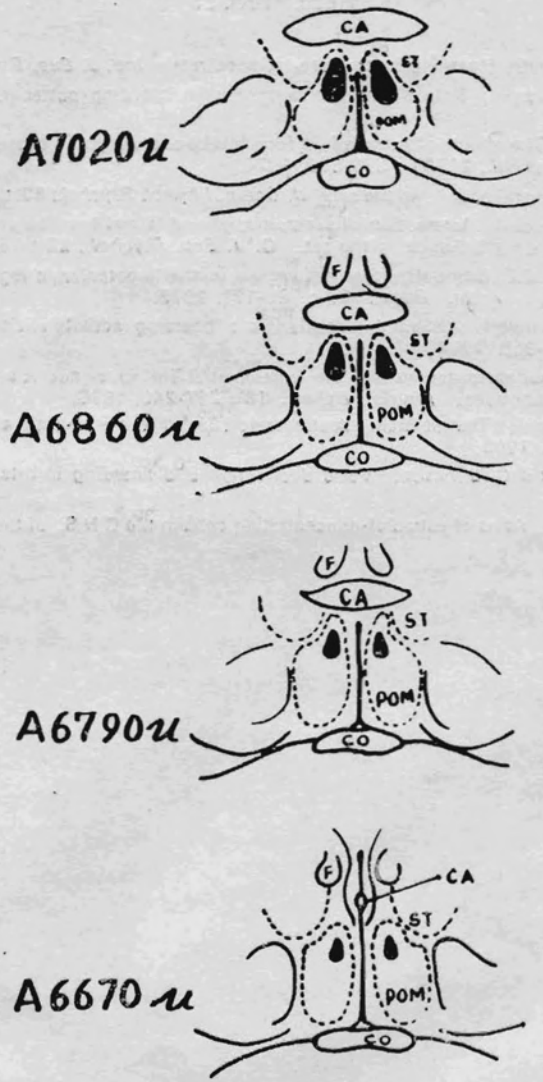

Fig. 3 : Reconstruction of a typical cannula placement in preoptic areas in four coronal sections of the rats brain. The sites are shown in black. At the left side of each section the figures specify the planes approximately corresponding to the section of König and Klippel Sterotaxic atlas.

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REFERENCES

1. Borker, M.G. A.S. and Gogate. Hoarding in caudate-lesioned rats. *Ind. J. Exp. Bio.*, **18** : 690-692. 1980.
2. Borker, A.S. and M.G. Gogate. Role of ovarian hormones in hoarding patterns. *Ind. J. Physiol. Pharmac.*, **28** : 115-120, 1984.
3. Cox, V.C. and J.M. King. The effects of estradiol on food intake and weight in ovariectomised rats with amygdaloid lesions. *Physiol. Psychol.*, **2(3A)** : 371-375, 1974.
4. Finger, F.W. Estrus and general activity in the rat. *J. Comp. Physiol. Psychol.*, **69** : 461-463, 1969.
5. Herberg, L.J. and J.E. Blundell. Interaction of ventromedial and lateral hypothalamic mechanisms in the regulation of feeding and hoarding behavior in the rat. *Q. J. Exp. Psychol.*, **22** : 133-141, 1970.
6. Herberg, L., J.G. Pye and J.E. Blundell. Sex differences in the hypothalamic regulation of food hoarding : Hormones versus calories. *Anim. Behv.*, **20** : 186-191, 1972.
7. Herberg, L.J. and J.E. Blundell. Lateral hypothalamus : hoarding activity elicited by electrical stimulation. *Science, N.Y.* **155** : 349-350, 1974.
8. Kolb, B. Studies on the caudate putamen and the Dorsomedial Thalamic nucleus of the rat. Implications for mammalian frontal lobe functions. *Physiol. Behav.*, **18** : 237-240, 1976.
9. Konig, J.F.R. and K.A. Klippel. The rat Brain : A sterotaxic atlas of the Fore-brain and lower parts of the Brainstem. Baltimore : Williams, 1963.
10. Morgan, C.T., E. Stellar and C. Johnson. Food deprivation and hoarding in rats. *J. Comp. Psychol.*, **35** : 275-295, 1943.
11. Pfaff, D.W. and M. Keiner, Atlas of estradiol-concentrating cells in the C.N.S. of the rat. *J. Comp. Neur.*, **151** : 209-242, 1973.