phenomenon of a greater sensitivity to experimental manipulation in the second series than in the first is not unique to drug studies (Dewsbury, 1969). It may be related to greater variability in the first series. This phenomenon is important in interpreting studies which were terminated after the first ejaculation. With such a procedure, important experimental effects may be overlooked.

The present data remain consistent with the hypothesis that high brain monoamine levels may inhibit ejaculation.

REFERENCES

- BEACH, F. A. Cerebral and hormonal control of reflexive mechanisms involved in copulatory behavior. *Physiological Reviews*, 1967, 47, 289-316.
- CARLSON, N. J., DOYLE, D. J., & BIDDER, T. G. The effects of DL-amphetamine on runway performance. *Psychopharmacologia*, 1965, 8, 157-173.
- DEWSBURY, D. A. Copulatory behavior of rats (*Rattus norvegicus*) as a function of prior copulatory experience. *Animal Behaviour*, 1969, 17, 217-223.
- DEWSBURY, D. A., & DAVIS, H. N. Effects of reserpine on the copulatory behavior of male rats. *Physiology & Behavior*, 1970, 5, 1331-1333.
- FERGUSON, J., HENRIKSEN, S., COHEN, H., MITCHELL, G., BARCHAS, J., & DEMENT, W. "Hypersexuality" and behavioral changes in cats caused by administration of p-chlorophenylalanine. *Science*, 1970, 168, 499-501.
- FULLER, R. Sexual changes in the male rat following chronic administration of reserpine. *Nature*, 1963, 200, 585-586.
- HAGGENDAL, J., & LINDQUIST, M. Disclosure of labile monoamine-fractions in brain and their correlation to behavior. *Acta Physiologica Scandinavica*, 1964a, 60, 351-357.
- HAGGENDAL, J., & LINDQUIST, M. Brain monoamine levels and behaviour during long-term administration of reserpine. *International Journal of Neuropsychopharmacology*, 1965b, 3, 59-64.
- HART, B. L. Sexual reflexes and mating behavior in the male rat. *Journal of Comparative & Physiological Psychology*, 1968, 65, 453-460.
- JOHN, E. F., WENZEL, B. M., & TSCHIRGI, R. D. Differential effects of reserpine on conditioned avoidance responses in cats. *Science*, 1958, 127, 25-26.
- MEYERSON, B. J. Central nervous system monoamines and hormone induced estrus behavior in the spayed rat. *Acta Physiologica Scandinavica*, 1964, 63 (Supplement 241), 1-32.
- PIRCH, J. H., RECH, R. H., & MOORE, K. E. Depression and recovery of the electrocorticogram, behavior, and brain amines in rats treated with reserpine. *International Journal of Neuropsychopharmacology*, 1967, 6, 375-385.
- RAY, O. S. The effects of tranquilizers on positively and negatively motivated behavior in rats. *Psychopharmacologia*, 1963, 4, 326-342.
- SHILLITO, E. E. The effect of p-chlorophenylalanine on social interactions of male rats. *British Journal of Pharmacology*, 1969, 36, 193P-194P.
- SOULAIRAC, M. L. Etude experimentale des regulations hormononerveuses du comportement sexuel du rat male. *Annales D'Endocrinologie*, 1963, 24 (Supplement), 1-98.
- SOULAIRAC, A., & SOULAIRAC, M. L. Action de la reserpine sur le comportement sexuel du rat male. *Comptes Rendus des Séances de la Société de Biologie*, 1961, 155, 1010-1013.
- SOULAIRAC, A., & SOULAIRAC, M. L. Effects de l'administration chronique de reserpine sur la fonction genitale du rat male. *Annales D'Endocrinologie*, 1962, 23, 281-292.
- TAGLIAMONTE, A., TAGLIAMONTE, P., GESSA, G. L., & BRODIE, B. B. Compulsive sexual activity induced by p-chlorophenylalanine in normal and pinealectomized male rats. *Science*, 1969, 166, 1433-1435.

Temperature variation during the estrous cycle: Active vs restricted rats

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Eight female hooded rats were divided into two groups, one active (unrestricted) and another severely restricted in muscular activity. Colonic temperatures and vaginal smears were taken daily to determine body temperature throughout one natural estrous cycle. Body temperatures for the active and restricted groups were about the same for all phases of the estrous cycle except early estrus. During this phase the restricted group, as predicted, demonstrated a much greater dip in temperature than did the active group. It was hypothesized that the increase in running activity one normally records during estrus is a temperature control mechanism rather than an indicant of increased drive.

For years workers have noted that food and water deprivation usually cause an increase in activity in the rat (Bevan et al, 1950; Finger, 1951). At the same time, muscular activity and its associated heat production is a means of maintaining body temperature (Brobeck et al, 1947). Brobeck was one of the first researchers to tie these two phenomena together in hypothesizing that the regulation of food intake is related to the regulation of body temperature (Brobeck, 1948). In 1957 Stevenson and Rixon published a unique study that tested the Brobeck hypothesis. They reasoned that rats whose muscular activity was severely restricted would be unable to use muscular exertion as a means of maintaining body temperature and would suffer a temperature decrease during deprivation. On the other hand, a restricted but free-feeding group or an active-deprived group should not experience a temperature drop, since they have food intake and muscular exertion, respectively, to achieve temperature homeostasis. To test these ideas, they divided their Ss into an active group, which was allowed to move freely, and a restricted group, in which the Ss were suspended from canvas slings to minimize muscular activity. Half of each group was then placed on a deprived food schedule

and the other half on an ad lib food schedule. As predicted, only the restricted-deprived Ss suffered a temperature drop. The other three groups were able to maintain their body temperature. The authors concluded that, in the absence of the heat-producing calories available in food, muscular activity is used to compensate for the heat deficit. "It is suggested that the increased activity during starvation is related to the maintenance of body temperature and is interrelated with food intake in this function [p. 582]."

Also for years, psychologists have noted a large increase in running activity of the female during estrus (Munn, 1950; Slonaker, 1924; Wang, 1924, 1927). Some have even suggested that this increased running is a good method of pinpointing estrus (Ericsson, 1953). A decline in body temperature immediately preceding this rise in running activity has likewise been reported (Brobeck, 1947). One might then hypothesize, along the same lines as Stevenson and Rixon for food deprivation, that this increased activity during estrus is related to the drop in temperature and serves as a means of maintaining the temperature of the animal.

Paralleling the Stevenson and Rixon study still further, might not one

Fig. 1. Mean and range of colonic temperatures for the active and restricted groups during six phases of the estrous cycle. (ED, early diestrus; D, diestrus; LD, late diestrus; EE, early estrus; E, estrus; LE, late estrus).

predict an even larger temperature decline during estrus of Ss restricted to minimize activity? The present research was designed to test this hypothesis.

SUBJECTS

Eight Long-Evans female hooded rats, weighing 220-281 g, served as Ss.

APPARATUS AND PROCEDURE

The Ss were assigned randomly to either a restricted (experimental) group or an active (control) group. The four restricted Ss were imprisoned individually in ½-in. hardware-cloth cylinders, approximately 8 in. long and 3 in. in diam. These were adjusted so as to allow minimum movement within the cylinder. These restricted Ss occupied one large (14 x 19 x 22 in.) cage, within sight and smell of each other, and remained in the cylinders throughout the experiment. The other four animals, the active group, were housed in two more large cages, with two Ss to a cage. All eight Ss remained on an ad lib food and water schedule. The Ss occupied the same room throughout the experiment, with a reversed 12-h day-night cycle. Room temperature was the same for all Ss.

Vaginal smears and colonic temperatures were taken daily midway through the dark period of the alternating cycle. The Ss were tested in

random order during the testing time, with each smear taken immediately after the temperature was recorded. An electrical thermometer, manufactured by the Yellow Springs Instrument Co., was used to measure temperature to the nearest 0.1° F. Colonic temperatures were taken by inserting the lubricated probe 2-2½ in. into the rectum of the S. Vaginal smears were taken and prepared daily according to the method described by Zarrow et al (1964), except that cotton swabs soaked in physiological saline were used to obtain the mucus. Care was taken to avoid altering the Ss' cycle by rough smearing (Nicholas, 1967). Each smear was then rated according to the phases described by Mandl (1951) as early diestrus (ED), diestrus (D), late diestrus (LD), early estrus (EE), estrus (E), and late estrus (LE).

RESULTS AND DISCUSSION

As may be seen in Fig. 1, the range of temperatures and the overlap between groups was extensive for all phases of the estrous cycle except EE. At this phase there was minimal variation within groups, as well as between, and, as predicted, the restricted Ss suffered a much more severe temperature drop than did the active Ss. These findings are taken as a new line of support for the behavioral

thermoregulatory theory of activity, which was first applied to the increased running activity during food and/or water deprivation (Brobeck, 1948; Stevenson & Rixon, 1957; Weiss & Laties, 1961). Although subsequent investigators have questioned whether increased activity during food deprivation is actually triggered by hypothermia (Campbell & Lynch, 1967, 1968), the present data suggest that a similar thermoregulatory explanation might be applied to the increased running one obtains during estrus. That is, the increased activity is in response to a lowered body temperature rather than to general sexual agitation.

REFERENCES

- BEVAN, W. JR., LEWIS, G. T., BLOOM, W. L., & ABESS, A. T. Spontaneous activity in rats fed with amino acid-deficient diet. *American Journal of Physiology*, 1950, 163, 104.
- BROBECK, J. R. Food intake as a mechanism of temperature regulation. *Yale Journal of Biology & Medicine*, 1948, 20, 545.
- BROBECK, J. R., WHEATLAND, M., & STROMINGER, J. L. Variations in regulation of energy exchange associated with estrus, diestrus, and pseudopregnancy in rats. *Endocrinology*, 1947, 40, 65-72.
- CAMPBELL, B. A., & LYNCH, G. S. Activity and thermoregulation during food deprivation in the rat. *Physiology & Behavior*, 1967, 2, 311-313.
- CAMPBELL, B. A., & LYNCH, G. S. Influence of hunger and thirst on the relationship between spontaneous activity and body temperature. *Journal of Comparative & Physiological Psychology*, 1968, 65, 492-498.
- ERICSSON, S. L. A study of the activity of the female rat for experimental purposes. *Jornal Brasileiro de Psiquiatria*, 1953, 2, 231-242.
- FINGER, F. W. The effect of food deprivation and subsequent satiation upon general activity in the rat. *Journal of Comparative & Physiological Psychology*, 1951, 44, 557.
- MANDL, A. M. The phases of the oestrus cycle in the adult white rat. *Journal of Experimental Biology*, 1951, 28, 576-584.
- MUNN, N. L. *Psychological research on the rat*. Boston: Houghton Mifflin, 1950.
- NICHOLAS, J. S. *The rat in laboratory investigation*. (2nd ed.) New York: Hafner, 1967.
- SLONAKER, J. R. The effects of pubescence, oestrus, and menopause on the voluntary activity of the albino rat. *American Journal of Physiology*, 1924, 68, 294-315.
- STEVENSON, J. A., & RIXON, R. H. Environmental temperature and deprivation of food and water on the spontaneous activity of rats. *Yale Journal of Biology & Medicine*, 1957, 29, 575.
- WANG, G. H. A sexual activity rhythm in the female rat. *American Naturalist*, 1924, 58, 36-42.
- WANG, G. H. The relation between spontaneous activity and the oestrus cycle in the white rat. *Comparative Psychology Monograph*, 1927, 2, 6.
- ZARROW, M. X., YOCHIM, J. M., & MCCARTHY, J. L. *Experimental endocrinology*. New York: Academic Press, 1954.
- WEISS, B., & LATIES, V. G. Behavioral thermoregulation. *Science*, 1961, 133, 1338-1344.