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Post-Parturitional Heat Responses of Newborn and Adult Guinea Pigs. Data on Parturition.*

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When newborn male and female guinea pigs are stroked on the posterior part of the back, they give a response which is similar to if not identical with that given by adult females at the time of heat.[1, 2] This behavior has been studied in order to ascertain the percent of newborn which give the response, the interval between birth and the time at which the response can be elicited, the length of time the response can be obtained, the effect of ovariectomy of the mother prior to parturition on the response and if the response is comparable with that displayed by the mature female.

The investigation required day and night observation of a large number of adult females at the time of parturition. Since little was known about the post-parturitional heat in the adult except that it is of frequent occurrence, data were collected bearing on the percent of animals which display post-parturitional heat, its length, the interval between the end of parturition and the beginning of heat, the ovarian condition in post-partum females which have not come into heat and the effect of ovariectomy prior to the end of pregnancy on the post-parturitional heat.

In addition the time required for parturition measured from the time of birth of the first young to that of the last, the interval between delivery of members of a litter and the time of day parturition occurred were recorded.†

The "heat response" of newborn animals. Animals in 84 litters composed of 93 females and 123 males were observed. Of these, 92 females and 121 males exhibited lordosis when fingered.

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1 Young, W. C., Dempsey, E. W., and Myers, H. I., *J. Comp. Psychol.*, 1935, **19**, 313.

2 Young, W. C., Dempsey, E. W., Hagquist, C. W., and Boling, J. L., *J. Lab. and Clin. Med.*, 1937, **23**, 300.

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TABLE I.
Length of Interval Between Birth and Time the First "Heat Response" Was Obtained in Newborn Animals.

Time	92 females	121 males
Less than 15 min.	44	67
15 to 30 "	22	31
30 to 60 "	25	15
1 hr to 1.5 hr	1	7
2.5 "	0	1

The response was elicited almost immediately after birth (Table I), and, as in adult females, its intensity is greatest at the beginning of the period during which it can be obtained. This period averaged 2.4 hours in males, range 1.0 to 5.0 hours; and 2.8 hours in females, range 0.5 to 5.5 hours. Subsequently, it frequently can be obtained for several hours, but only if the animals are covered by the mother.

In order to determine if ovariectomy of the mother affects the behavior, 15 pregnant females were ovariectomized between the 50th and 55th day of gestation. Eight gave birth to normal litters between the 67th and 69th days of gestation. The 14 young of both sexes responded normally. Furthermore, normal responses were elicited from 13 young born to 5 females which did not come into heat or ovulate at the time of parturition.

Whether the response in young animals is true heat behavior stimulated by a hormonal action to which newborn are subjected *in utero* is not known. Quantities of injected estradiol benzoate (Progynon-B)‡ sufficient to cause a growth and differentiation of the vaginal epithelium similar to that described by Courrier,[3, 4] did not always induce the heat response. Of 22 spayed and normal animals injected with from 125 to 264 R.U. on the second or third day, only 12 gave the heat response when fingered. Furthermore, the 10 which did not display heat behavior following estradiol benzoate injections were subsequently injected with 0.4 I.U. progesterone (Proluton)‡ and did not respond to this hormone, although 20 R.U. estradiol benzoate followed 48 hours later by 0.1 I.U. progesterone is effective in 20-day animals. Obviously, procedures which induce heat on the twentieth day are ineffective in very young animals and until the "heat response" can be stimulated in newborn young with the regularity which is shown normally, we shall not know how to regard this post-partum behavior.

Post-parturitional heat in adult females. Fifty of 78 animals

‡ Supplied by Dr. Erwin Schwenk of the Schering Corporation.

[3] Courrier, R., *Compt. Rend. Soc. Biol.*, 1929, **99**, 24.

[4] Courrier, R., *Proc. Second International Congress for Sex Research*, 1930, 352.

which were observed came into heat. This occurrence of heat post-partum in about two-thirds of the cases is less frequent than in non-pregnant animals. Thirty-one of the experimental animals had been observed during 124 reproductive cycles prior to pregnancy and heat occurred during 107 or 86.3%.

Post-parturitional heat was shorter than normal heat. For 50 animals the length averaged 3.5 hours, range 0.5 to 10 hours. This compares with an average of 8.6 hours, range 4 to 15 hours, for 76 heat periods displayed prior to pregnancy.

The interval between the birth of the last young and the beginning of the post-parturitional heat is shown in Table II. In general, it was so short that a close correspondence between the beginning of parturition and the beginning of heat is suggested.

TABLE II.

Length of Interval Between the End of Parturition and the Beginning of Post-parturitional Heat in Adult Females.

Interval between end of parturition and heat in hours	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
No. of animals	13	17	6	4	3	2	1	3	0	1

The ovarian condition in animals which came into heat post-partum was determined by ovariectomy 20 to 45 hours later, and in 12 animals which did not come into heat by examination 24 to 44 hours post-partum. In the former ovulation had occurred. In 7 of the latter ovulation also had occurred, but in the remaining 5 it had not. The volume of the largest follicles in these ovaries was similar to that of follicles in non-pregnant animals immediately prior to ovulation,[5] but it is doubted that they would have ruptured because all showed signs of atresia and no evidence of luteinization was seen. These animals probably would not have come into heat until a new set of large follicles had developed.

The data suggest that post-parturitional heat in the adult is dependent on ovulation and is similar in this respect to heat in non-pregnant animals. An attempt was made to obtain critical evidence by observing the 8 females spayed between the 50th and 55th day of gestation which subsequently delivered normal litters. Of these, 4 were observed for post-parturitional heat without further treatment. Three did not come into heat. The fourth, however, displayed a normal heat of 4.5 hours' duration which began 4.5 hours after parturition. After heat the animal was killed, but no ovarian tissue was found. Heat in this case cannot be accounted for unless

[5] Myers, H. I., Young, W. C., and Dempsey, E. W., *Anat. Rec.*, 1936, **65**, 381.

estrogens circulating in the blood were responsible or unless ovarian tissue was overlooked when the animal was killed.

The former possibility is questioned because of results obtained from a test applied to the remaining 4 spayed animals. Within 45 minutes after parturition they were injected with 0.2 I.U. progesterone. None came into heat during the 11 to 25 hours they were observed. Had they been under the influence of estrogen, the progesterone should have induced heat.[6]

The possibility that ovarian tissue was overlooked is considered more likely, because of the failure of the above test and other observations. If no ovarian tissue was left behind in this animal, it was only one of 13 post-partum individuals in which heat occurred without ovulation. Furthermore, in none of 101 non-pregnant guinea pigs was heat without ovulation encountered.[7] Nevertheless, the doubtful case cannot be explained and until additional experimental animals can be established, the conclusion that the post-parturitional heat of adults depends on the presence of the maternal

TABLE III.
Length of Interval Within Which Parturition Occurred.

Length of interval during which birth occurred	No. of litters	Size of litters
45 min*	1	1 of 4 young
Less than 30 min	14	1 " 5 " 7 " 4 " 4 " 3 " 2 " 2 "
" " 20 "	10	2 " 4 " 5 " 3 " 3 " 2 "
" " 15 "	30	5 " 4 " 13 " 3 " 11 " 2 " 1 " 1 "
" " 10 "	16	1 " 4 " 6 " 3 " 6 " 2 " 3 " 1 "
" " 5 "	9	1 " 3 " 3 " 2 " 5 " 1 "

*30 minutes elapsed between the birth of the 3rd and 4th young. This was 14 minutes longer than the next longest of 44 recorded intervals and is not included in the averages shown in Table IV.

[6] Dempsey, E. W., Hertz, R., and Young, W. C., *Am. J. Physiol.*, 1936, **116**, 201.

[7] Young, W. C., Dempsey, E. W., Myers, H. I., and Hagquist, C. W., *Am. J. Anat.*, 1938, **63**, 457.

TABLE IV.
Length of Interval Between Birth of Members of a Litter.

Order of young	No. of cases	Average interval and range in min
1st and 2nd	18	8.8, range 2 to 16
2nd " 3rd	16	6.8, " 2 " 13
3rd " 4th	9	5.5, " 1 " 12
4th " 5th	1	14 min
Summary	44	7.4, range 1 to 16

TABLE V.
The Time of Day Parturition Occurred.

Time of day	12 mid.-1 a.m.	1 a.m.-2	2 a.m.-3	3 a.m.-4	4 a.m.-5	5 a.m-6	6 a.m.-7	7 a.m.-8	8 a.m.-9	9 a.m.-10	10 a.m.-11	11 a.m.-12 noon	12 noon-1 p.m.	1 p.m.-2	2 p.m.-3	3 p.m.-4	4 p.m.-5	5 p.m.-6	6 p.m.-7	7 p.m.-8	8 p.m.-9	9 p.m.-10	10 p.m.-11	11 p.m.-12 mid.
Number of births	4	2	4	4	6	2	3	5	3	7	4	7	4	3	4	7	3	4	2	6	5	5	3	2

ovaries and ovulation must be advanced with reservations.

Data on parturition. The interval within which delivery of the young occurred was ascertained from observations of 80 litters (Table III). In Table IV the length of 44 intervals between the births of individuals are tabulated. The data are not sufficient to give significance to the progressive decrease in the average length of the interval between the birth of individuals, but the possibility of such a decrease is suggested.

The time of day parturition occurred was obtained for 99 animals and is summarized in Table V. The approximately even distribution throughout the 24 hours is surprising in view of the predominant nocturnal occurrence of heat.

Summary. Ninety-two of 93 newborn females and 121 of 123 newborn males displayed a response when fingered which is similar to the heat response of adult females. The behavior is independent of the post-parturitional heat in the adult and does not depend on the presence of the maternal ovaries. In the adult post-parturitional heat was displayed by a smaller percent of animals and was shorter than normal heat. The preponderance of evidence suggests that post-parturitional heat is induced by factors associated with ovulation in the maternal ovaries. The interval between delivery of the first and last members of a litter was less than 30 minutes in 79 of 80 cases. The time of parturition in 99 animals was distributed about evenly throughout the 24 hours of the day.