Reports

Gestation Period and Twinning in Chimpanzees

Abstract. The length of the gestation period in 118 births in a colony of chimpanzees was found to be 226.8 days, with a standard deviation of 13.3 and a range of 196 to 260 days. Six pairs of twins were born in 120 parturitions; thus the apparent twinning rate is higher than that in man.

Yerkes and Elder (*1*) reported that 20 chimpanzee births occurred in these laboratories up to 1 July 1937. Nissen and Yerkes (*2*) described an additional 29 cases, including one twin birth, for the period ending 1 April 1943. Both papers describe certain behavioral and physiological correlates of parturition. The present report (*3*) includes the data in the two previous papers and supplements them with information on births that occurred up to 1 August 1958. Among the 125 offspring obtained in these laboratories, there were 106 live single births, 6 single stillbirths, 6 pairs of twins (one pair of which was stillborn), and 1 case in which the gestation period is unknown. The number of pregnancies terminating in live or stillbirths for the 26 mothers varies from 1 to 11, with a median of 3.5. Miscarriages (defined by less than 190 days' gestation) are not included.

The estimated date of conception was calculated according to the method described by Nissen and Yerkes (*2*), who utilized the beginning of detumescence as a point from which ovulation can be determined. In the 118 parturitions (counting each twin birth only once) for which the duration of gestation period could be calculated, the mean gestation period is 226.8 days, with a standard deviation of 13.3 and a range of 196 to 260 days. Two of the cases fall more than two standard deviations above the mean; these two gestation periods are 258 and 260 days, with the next highest value being 248 days. It is possible that an error in recording one menstrual cycle for each of these animals resulted in the unusually long gestation periods. If these two cases are omitted from the computations, the mean gestation period becomes 226.2 days, with a standard deviation of 11.8 ($N = 116$). The mean gestation period for viable single births only (with twins, stillbirths, and the two doubtful cases omitted) is 227.8 days, with standard deviation of 10.6 and N of 104. No significant differences were found between male and female offspring in duration of gestation period.

Nissen and Yerkes (*2*) found that the variability among the several pregnancies of individual chimpanzee mothers was greater than the variability among the averages for the same animals, in contrast to the findings of Hotelling and Hotelling (*4*) in man and to the statement of Snyder (*5*) in his review of several species. Nissen and Yerkes attributed the discrepancy to the relatively small N on which their computations were based. The number of multiparous females has now been increased to 21 (accounting for 111 births), and the direction and magnitude of the discrepancy persist. The mean average deviation in gestation period for the 21 mothers with plural offspring is 7.8 days, while the average deviation of the means for the same animals is 5.3 days.

The duration of early pregnancies tends to be greater than that of later ones, although there is considerable variability among animals in this respect. The median gestation periods for the first six pregnancies (ten or more cases for each median) are 234, 231, 227, 228, 229.5 and 224 days, respectively.

Statistics for birth weights have not changed significantly from those reported by Gavan (*6*).

The 92 parturitions which occurred in the period from the first colony birth in 1930 until late in 1951 produced one pair of twins; this ratio leads to the conclusion that the rate of twinning in the chimpanzee approximates that of man. Since November, 1951, however, five additional pairs of twins have been born in 28 parturitions, raising the over-all twinning rate to 5 percent of the births. The reasons for the apparent increase in rate of twinning are not clear, but it is interesting to note that Breitinger (*7*) predicted in 1951, "Ich möchte glauben, dass, wenn in der Station [Yerkes Laboratories] künftig mehr und mehr ältere Weibchen mit mehreren vorausgegangenen Geburten zur Zucht gelangen, die Zwillingsgeburten eher zunehmen werden." The six pairs of twins were born to mothers ranging from 15 to 31 years of age at the time of parturition and represented the first, second, third, fourth, fifth, and eighth positions in ordinal of birth for the various mothers. An apparent increase in twinning rate in a colony of captive chimpanzees may be interpreted in light of Fischer's (*8*) theory of twinning as a newly acquired character consequent to man's "domestication" [as opposed to Schultz's (*9*) view that twinning occurs at roughly the same rate in most primates].

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References and Notes

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3. Many investigators through the years have contributed to the collection of these data. H. W. Nissen was primarily responsible for their collection and tabulation. The work has been supported in part by a grant from the National Academy of Sciences–National Research Council sex committee to Nissen, and in part by grants from the National Science Foundation, the Carnegie Corporation, and the Rockefeller Foundation.
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7 November 1958

Technique for Differential Reinforcement of Rate of Avoidance Responding

Abstract. A new avoidance conditioning procedure generates high rates of responding compared with previously used procedures. The effect of manipulation of one of the important temporal parameters in the procedure is reported.

In Sidman's initial series of avoidance experiments (*1, 2*), rats were given an electric shock through a grid floor at regular intervals unless a lever was depressed by the animal. Each lever depression reset the timer controlling the

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Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

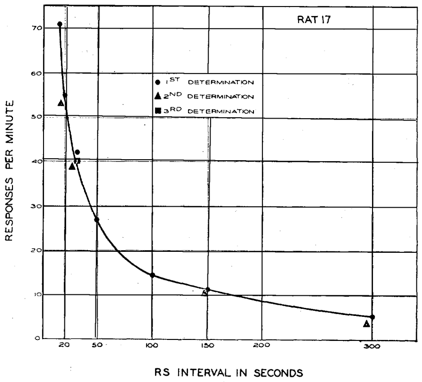

Fig. 1. Rate of avoidance responding as a function of the RS interval.

shock, thus delaying its occurrence. If, for example, each depression of the lever reset a 30-sec timer, a minimum interval of 30 sec was insured between avoidance behavior and shock. Following Sidman's usage, the time interval between a response and shock will be labelled the RS interval and the time interval between successive shocks, when no responding occurs, the SS interval.

The technique permits use of the rate of responding as a continuous and direct indicator of the effects of experimental manipulations. Its usefulness for the study of more complex behavioral phenomena, however, is limited by the fact that at RS $>$ 90 sec the rate of responding drops to a very low level (*2*). In some animals a stable rate of responding cannot be maintained at such low response rates (*3*). At RS = 20 sec no rats were ever observed to emit a sustained rate of more than 20 responses per minute. This is true for any value of the SS interval or the shock level so far employed (*2–4*). The present report demonstrates that a simple modification of Sidman's original procedure can generate extremely high rates of responding. Instead of requiring only a single response on the part of the animal to reset the RS interval, a number of responses had to be made before a new RS interval was started. These responses had to be emitted within the time of the RS interval to avoid shock. The introduction of this additional contingency in the avoidance schedule made the procedure analogous to the "differential reinforcement of high rate" (DRH) schedules described by Ferster and Skinner in the case of positive reinforcement (*5*). In the present case, the lowest reinforced rate was equal to the number requirement divided by the RS interval.

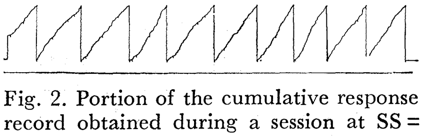

Fig. 2. Portion of the cumulative response record obtained during a session at SS = RS = 30 sec and RR = 8. An oblique pip on the record indicates the occurrence of a shock.

The data reported here were obtained from a single male hooded rat approximately 6 months old at the start of the experiment. The animal was initially conditioned at SS = 3 sec and RS = 30 sec. The shock was provided by a constant-current generator passing half-wave 60-cy current at 1.5 ma. The shock duration was 0.2 sec. The experimental space was 4½ in. wide, 10 in. long, and 7 in. high and was provided with a stainless-steel grid floor. A grid-scrambler, which alternated the polarity of each grid rod, ensured that the animal would receive a pulsating shock regardless of which rod it was standing on. A modified Switchcraft No. 3002 switch was used as a lever (*6*).

After the rate had become reasonably stable, the avoidance schedule was changed to SS = RS = 30 sec and, later, to a requirement of two depressions of the lever to reset the RS timer. During subsequent sessions the animal was gradually shifted to a higher number requirement. Each shock reset the stepper relay which programmed the number of responses required to restart the RS interval. Once the animal gave a stable performance at SS = 30 sec, RS = 30 sec and RR = 8, the RS interval was used as the independent variable of the experiment. The animal was successively run with the following sequence of RS intervals: 30, 300, 30, 150, 100, 50, 30, 20, 15, 150, 20, and 300 sec. Four 6-hr sessions were given at each value. Eight sessions totalling 48 hr were given at the final value of 300 sec. The animal was run every other day.

Figure 1 shows the rate of responding as a function of the RS interval. Each value represents the mean rate of responding during the last 4 hr of the last two successive sessions at each RS value.

As with Sidman's original schedule, where the number requirement was equal to 1, the rate of responding is a logarithmic function of the RS interval (*2*). The present data can best be described by the following equation, which was fitted by the method of least squares

$$y = 157.38 + 0.1588x - 79.84 \log x$$

in which y represents the rate of responding in minutes and x the duration of the RS interval in seconds. A cumulative record of a segment of a daily performance at SS = RS = 30 is shown in Fig. 2. The curve shows that, in spite of the number requirement's being 8, the performance is characterized by a low shock rate when compared with previously obtained data (*2, 4*). It also gives an impression of the stability of the rate of responding during a session. An important feature of the present data is that at RS = 300 sec a substantial rate of 5.6 responses per minute was still maintained. At SS = RS = 30 sec the present schedule generated a rate of 54.9 responses per minute, which is more than twice the highest rate ever observed with the original avoidance schedule. The general features of these data have been confirmed with several other animals with different number requirements.

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Biochemical Basis of Mating in Yeast

Abstract. One mating type of the yeast *Hansenula wingei* possesses a specific protein on its cell surface which is complementary to a specific polysaccharide on the cell surface of the opposite mating type. The initial phase of mating in which cells of opposite types combine is therefore analogous to a reaction between an antibody and a polysaccharide antigen.

The heterothallic microorganisms probably possess the simplest type of sexual differentiation known. In the haploid stage there are two mating types, identical morphologically and metabolically, but different in genetic composition and in their mating behavior. Mating types in heterothallic organisms are characterized by the fact that cells of one type will mate only with cells of the other type, but not with themselves. In this way they differ from homothallic organisms, in which individuals of the same genetic constitution are able to mate. There are a number of heterothallic species of yeast. These species are especially valuable for studies of the basis of heterothallism, for the haploid cells are the vegetative phase of the organism and are as well the gametes which mate. Two haploid cells of opposite mating type will fuse when they are brought into contact under appropriate conditions, and a diploid cell is formed. No good evidence