Poor results were obtained with the following: extra lard, liver or egg fat; the unsaponifiable fractions of liver or egg fat, lecithin, and extra wheat germ oil.

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Spontaneous Activity, Direct and Indirect Measures of Sexual Drive in Adult Male Rats.

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Numerous experiments[1-5] have demonstrated a significant relationship between the level of spontaneous activity in male rats, as measured by revolving drums, and the presence or the absence of the testes. Castration is followed by a marked decrease in spontaneous activity. Although the reduction is somewhat less striking when castration is performed on infantile males than when it is performed on fully developed males,[6] there is at either age a decline in spontaneous activity that may be ascribed to the loss of gonadal secretions.

A clear relationship has also been shown to exist between copulatory behavior and the presence or absence of the testes. Young male rats castrated prior to puberty seldom if ever copulate or display aggressive sexual behavior toward receptive females; furthermore, adult males, although copulating for some weeks or even months after castration,[7] soon show a measurable reduction in sexual drive as measured either by direct tests of copulatory frequency or by obstruction tests.[8] These facts indicate that reduction in spontaneous activity and reduction in quantitative expressions of sexual vigor go hand in hand in castrated males when the latter are compared with normal males. They also suggest the possibility of using the revolving drum technique to study sexual drive in normal

1 Hoskins, R. G., *Am. J. Physiol.*, 1925, **72**, 324.

2 Wang, G. H., Richter, C. P., and Guttmacher, A. F., *Am. J. Physiol.*, 1925, **73**, 581.

3 Richter, C. P., and Wislocki, G., *Am. J. Physiol.*, 1928, **86**, 651.

4 Slonaker, J. R., *Am. J. Physiol.*, 1930, **93**, 307.

5 Richter, C. P., *Quart. Rev. Biol.*, 1927, **2**, 307.

6 Richter, C. P., *Endocrinology*, 1933, **17**, 445.

7 Stone, C. P., *J. Comp. Psychol.*, 1927, **7**, 369.

8 Nissen, H. W., *Genet. Psychol. Monog.*, 1929, **5**, 451.

males; however, it should be borne in mind that an instrument that adequately registers wide variations in a given phenomenon may be wholly inadequate when fine discriminations are required. The usefulness of revolving drums in studying sexual drive in intact animals must be determined by special experiments.

In the present study, we have determined the relationships between spontaneous activity of 24 male, albino rats confined in revolving drums and their numerical scores on 2 reliable tests of sexual drive; namely, (1) frequency of their copulations in direct tests with highly receptive females, and (2) frequency of their attempts to overcome an obstruction separating them from a receptive female.[9] The males were between 6 and 7 months of age. Their average weight was 280 gm. and the range of weights was from 190 to 320 gm. They had been reared on the Steenbock diet, supplemented about twice weekly by lettuce. All were in a very fine state of nutrition and entirely free from skin parasites. When the males were approximately 5 months old they were released in a laboratory room with floor space of approximately 16 square meters. With them were placed 2 dozen adult females in order that they might have unrestricted opportunity for sexual congress. From time to time, non-pregnant females were substituted for the pregnant ones during the period of cohabitation which lasted approximately one month.

Finally, the males were transferred as a group to revolving drums made available through the courtesy of Prof. J. R. Slonaker of the Physiology Department, Stanford University. The males were kept in the revolving drums for a total of 5 weeks, one week devoted to preliminary adjustment to the new cage situation and 4 weeks devoted to the study of spontaneous activity. At the end of each week the males were shifted to different drums in order to distribute at random the unmeasured influences of possible adventitious factors such as small differences in room temperatures and air currents, the proximity of sluggish or active animals that might act as sedatives or as stimulants to certain individuals, or differences in the inertia of the cages themselves. So far as we have been able to ascertain from published reports by Prof. Slonaker, the amount of the activity of our males appears to be essentially like that of his males of similar ages that were allowed to keep the same cage for long periods of time.[10]

[9] Jenkins, T. N., Warner, L. H., and Warden, C. J., *J. Comp. Psychol.*, 1926, **6**, 361.

[10] Slonaker, J. R., *Am. J. Physiol.*, 1926, **77**, 503.

The tests* for copulatory frequency were made a few days after the males were taken out of the revolving drums. Each male was tested between the hours of 8 and 11 p.m. in his home cage with one highly receptive female. The number of copulations and the number of ejaculations were recorded during each sub-test period. The total test consisted of 4 sub-tests, each of 15 minutes duration. The first and second sub-tests came on the same evening with a 20-minute pause between tests; the third and fourth sub-tests were conducted exactly as the first pair of tests and were administered one week later. During the interim between the first and the second pair of tests the males were kept apart from the females.

Tests* with the Columbia Obstruction Apparatus[9] were begun one week after the last of the direct tests for copulatory frequency. With this technique of measuring sexual drive the number of contacts with the electrified grid and the number of crossings to the incentive compartment are taken as the measures of sexual drive. The tests were conducted on 2 nights one week apart. Each night's test consisted of 2 sub-tests that were separated by a 5-minute pause. The sub-tests were of 10 minutes duration and during this time the male was given complete freedom to cross the grid separating the entrance compartment and the incentive chamber. He was returned to the entrance compartment immediately after his arrival in the incentive chamber without giving him an opportunity to copulate with the female incentive. Prior to the test proper, the males were given ample opportunity to familiarize themselves with all parts of the obstruction apparatus, to learn how to manipulate the one-way door leading to the incentive chamber, and to learn that a receptive female with which they had been given opportunity to copulate prior to the tests was in the incentive chamber.

As a measure of the spontaneous activity of each male we have used the total number of revolutions of the drum made during the 28-day period in which his records were taken. The copulatory vigor is denoted by the total number of intromissions during one hour of testing and by a composite score that was obtained by adding to the number of intromissions 10 points for each ejaculation. The obstruction test records consist of the total number of times the grid was crossed in 40 minutes, and of a combined score consisting of the number of crossings plus the number of contacts with the grid. In Table 1 will be found the raw data of each of the tests. As can be seen, there is a considerable amount of variation in the scores

* These tests are described in more detail in a forthcoming paper: Stone, C. P., Tomlin, M. I., and Barker, R. G., *J. Comp. Psychol.* (in press).

TABLE I.

Records of Each Male in the Revolving Drum, upon the Test of Copulatory Frequency, and upon the Obstruction Test.

Column 2, total numbers of revolutions for the 28-day period; Column 3, total numbers of intromissions in 4 copulatory sub-tests lasting 1 hour; Column 4, composite score obtained by adding to total number of intromissions 10 points for each ejaculation; Columns 5 and 6, respectively, total numbers of crossings of the electrified grid and sums of crossings and contacts with grid of the obstruction apparatus in 4 sub-tests which lasted 40 minutes.

Animal No.	Drum Revolutions (in 1000's)	No. of Copulations	No. of copulations + 10(No. ejac.)	No. of Crossings	Crossings + Contacts
1	10	74	144	23	61
2	201	82	122	160	192
3	119	62	92	110	166
4	109	80	140	123	173
5	114	89	149	179	193
6	141	34	44	113	174
7	17	77	147	97	138
8	111	62	122	182	202
9	168	46	66	59	118
10	25	0	0	8	9
11	158	60	110	144	203
12	73	53	93	136	203
13	196	64	104	74	94
14	49	103	183	148	156
15	25	18	18	16	20
16	215	66	126	55	145
17	29	45	45	6	20
18	233	52	82	85	133
19	48	53	113	291	300
20	86	50	120	228	252
21	93	30	30	29	38
22	94	57	137	83	100
23	91	50	70	177	187
24	24	55	145	127	152
Mean	101.25	57.50	101.67	110.42	144.17
S.D.	66.26	21.60	45.72	71.44	73.42

from animal to animal, but there is little tendency for the values from the different tests to vary together. This latter point can be verified by inspecting the correlation coefficients of Table II. In

TABLE II.

Product-Moment Correlations.

	Crossings	Contacts + Crossings	Copulations	Copulations + 10(No. ejac.)
Revolutions in drum	.084	.269	.177	.032
Crossings			.402	
Contacts + crossings				.539

this table will be found the product-moment correlations between the total numbers of revolutions made in the drums, and scores upon the other tests; here, also, will be found the correlations between the scores made on the copulation and obstruction tests.

There is no evidence of a significant relation between the number of revolutions in the drums and scores upon either the obstruction apparatus or the direct test. Applying Fisher's test of the significance of correlation coefficients[11] to the correlation between revolutions and contacts plus crossings, the largest coefficient, it appears that there is a probability of 30 in 100 that such a correlation might arise by chance in an uncorrelated population. Obviously no significance can be attached to a coefficient with such a low reliability.

In contrast to this finding, there is clear evidence of some community of function between the direct copulatory and the obstruction test scores.

The reliability of the scores denoting spontaneous activity has been determined for the present data by correlating the sums of revolutions on the odd with the sums of revolutions on the even days of the total test. This correlation is .80 and becomes .88 when the Spearman-Brown formula is used to obtain an estimate of the reliability of the total test.[12] Previously we have found that the reliabilities of the direct copulatory tests and the obstruction test are, respectively, .91 and .89. In view of the reliability of each of these tests, we may assume that the failure to obtain significant correlations between the revolving drum scores and the other tests cannot be ascribed to errors of measurement of the tests.

In conclusion, then, we find no reliable evidence that there is a true relation between the revolving drum activity of normal adult male rats and the best estimates of sexual aggressiveness now available. As experiments with castrates suggest, however, a relatively low correlation might be found if exceedingly large differences in sexual drive existed among the animals being studied.

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11 Fisher, R. A., *Statistical Methods for Research Workers*, 3d ed., Edinburgh: Oliver and Boyd, 1930, xiii+283.

12 Kelley, T. L., *Statistical Method*, New York: Macmillan, 1923, xi+390.