Social dominance in the mouse¹

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Two inbred strains of mice were opposed in measures of tube-dominance, food-dominance, and aggression, using matched pairs of individual opponents. There were stable strain differences on all three measures, and Ss within strains were highly similar to each other in performance. Results on the food-dominance and aggression measures were concordant, while performance on the tube-dominance test was negatively related to the other two measures.

While uncontrolled observation of social dominance in infrahuman animals has long been reported, there has been relatively little experimental study. In large part this has been due to the absence of sensitive and efficient measuring techniques. The present study was concerned with an examination of a relatively new measure, "tube-dominance," in relation to two other tests of social behavior. Thus, three different behavioral measures were employed: (a) a test in which hungry Ss must push against each other in a narrow tube in order to reach food, (b) a test opposing hungry Ss in an arena containing a food aperture large enough for only one S at a time to eat, (c) a test of spontaneous fighting behavior. All three tests are standardized, easy to administer, and employ objective behavioral measures. Each measure is believed on the basis of previous research to possess at least minimally adequate psychometric properties, and has been shown to possess sensitivity to behavioral differences between inbred strains of mice.

The tube-dominance test was shown in a previous study (Lindzey, Winston, & Manosevitz, 1961) to be unusually reliable and to result in very stable transitive relationships both between individual Ss within groups and between different inbred strains of mice. One means of adding to our understanding of the psychological significance of the tube-dominance measure is to observe its relation to other measures of social behavior. More specifically, in the present study we were concerned with (1) the possibility that the three tests employed might be viewed as measures of the same general trait; (2) to observe the extent to which the genetically homogeneous Ss within inbred strains would perform in the same way on these measures; and (3) to determine for each measure the stability in performance over repeated trials between individual sets of opponents.

Method

Twenty-six male Ss were employed, organized into 13 matched pairs that remained the same for all three phases of testing. One member of each pair was from strain A, the other from strain DBA/8. Pairs were matched on the basis of age. Both strains have been inbred for more than 30 generations of brother-sister mating. All Ss were weaned and housed with same-sex littermates at 23 days of age, individually housed in metal cages at approximately 42 days, and were 75-100 days of age at the beginning of the experiment.

The aggression test is a measure of spontaneous fighting between pairs of mice. The present apparatus and testing procedure is a

modification of that described by Fredericson (1950) and Hall & Klein (1942). Briefly, the test involves placing two Ss together in a neutral cage and observing whether a fight occurs within 300 sec. When a fight does occur, Ss are separated as rapidly as possible by E (in order to minimize the learning of dominant and submissive behavior patterns), and he records the latency of the fighting response, the identity of the attacker, and the identity of the S apparently winning the fight at the time of separation. There were five consecutive daily trials for each pair of Ss.

The tube-dominance apparatus and testing procedure is described by Lindzey, Winston & Manosevitz (1961). Briefly, it involves placing hungry Ss in each end of a narrow cylindrical tube through which they previously have been trained to run in order to reach food. Ss are started in the tube in such a way that they meet at the center, and the dominant S is the one that forces its opponent to retreat from the tube. On each trial E records the identity of the dominant S and the time of the trial. Here again, and in the food dominance test also, there were five consecutive daily trials.

The food dominance apparatus and procedure as used with rats is described by Uyeno (1960). Briefly, it involves training hungry S to eat wet mash from a small aperture in the center of a closed arena. Ss are then placed in the arena in pairs and the dominant S is the one spending the greater amount of time eating from the aperture during a 300 sec. trial. (The aperture is large enough to accommodate only one S at a time.) On each trial, E records the cumulative eating time for each S.

The aggression test was used first in the testing sequence for all pairs because extensive previous handling of Ss reduces their tendency to fight. During the tube and food-dominance training and testing, Ss were maintained on a feeding schedule at 85% of their normal weight. The ultimate winner of a pairing, on each of the three measures, was the S that had won a majority of the five daily trials.

Results and Discussion

Table 1 summarizes the results for all three measures. The aggression test yields two indices of dominance, fights initiated and fights won, but they apparently are closely related as indicated by a correlation between them of .857 ($p < .001$) calculated over the 13 DBA/8 Ss.

The findings provide little support for the contention that all three measures are related to the same domain. Aggression and food dominance appear positively related, with DBA/8's highly dominant on each measure. In 11 of 13 pairings, the same S, a DBA/8 in each instance, was dominant on both tests. The tube dominance test appears negatively related to the other two measures, with the dominant S in 10 of 13 pairings—an A in each instance—being submissive on both of the other measures.

Table 1.

Strain		Aggression		Tube Dominance	Food Dominance
		Fights Initiated	Fights Won		
A	Trials ^a	4	4	59.5	9.5
	Pairings ^b	1.5 ^c	0.5	12.0	1.0
DBA/8	Trials	44	57	5.5	55.5
	Pairings	11.5	12.5	1.0	12.0

^a 13 oppositions x 5 daily trials for each measure = 65 (possible).

^b 13 oppositions or matches between individual Ss.

^c Decimals reflect the occurrence of ties.

Table 1 shows that in the aggression and food tests, the superiority of the DBA/8 strain is nearly complete, while in the tube test the A strain attains nearly complete dominance. This one-sidedness supports previous results indicating that each of the measures is highly sensitive to strain differences, and is congruent with strain difference findings reported by Ginsburg & Allee (1942), Scott (1942), and Fredericson & Birnbaum (1954), all using mice in studies of fighting and aggression. While not surprising, such a finding does highlight the potential usefulness of these measures for research in behavior genetics. In addition, it indicates the Ss within the respective strains were highly consistent with each other in their behavior on all three measures. Since Ss within each strain are genetically homogeneous and were reared in controlled laboratory environment, this observed behavioral similarity is evidence for the reliability of the measures. For example, 10 of 13 A's made zero attacks in five trials on the aggression test, while 2 initiated one and 1 initiated two. The figures are precisely the same for A's in regard to fights won. Nine of their 13 DBA/8 opponents initiated four attacks, 2 initiated three, and 2 initiated one. Eleven of 13 DBA/8's were dominant in all five tube dominance trials, and another was dominant on four. Twelve of 13 DBA/8's were dominant on either four or five trials in the food dominance test.

Stability over repeated trials can be estimated by the percentage of pairings in which knowing the outcome of the first trial leads to a correct prediction of the ultimate winner. These percentages are 81% and 88% for the aggression and tube tests. Since DBA/8's characteristically ate very little during the first trial on the food test, predictive accuracy was calculated on the basis of the second trial (only), and the result was 100%. In the comparison between A and DBA/8 Ss knowing an S's performance on any one of the three measures would lead to a correct prediction of its performance on both of the other two measures in 77% of the pairings, compared with a chance expectation of 25%; simply knowing an S's strain would lead to a 77% correct prediction of its performance on all three measures. Odd-even correlations were calculated on the outcomes of the individual trials within pairings, and Spearman-Brown coefficients for tube-dominance, aggression, and food-dominance are .96, .78, and .41. Correlations calculated on such homogeneous Ss tend to be low, but the present coefficients do appear to indicate satisfactory reliability

particularly for the measure of tube dominance. These findings contradict those reported by Candland & Bloomquist (1965) and Seward (1945), neither of whom observed stable dominance orders in rats with their measures. Grant & Chance (1958) did observe stable relations with rats, however, as did Lindzey et al (1961) with mice.

Consistent results were obtained in five comparisons (pairings) using the same three measures with the DBA/8 strain and another inbred strain, C3H/Bi. These results are almost identical to the present findings, indicating high concordance between the aggression and food dominance measures and high discordance between each of these and the tube dominance test.

The two measures yielding concordant results are both conducted in test situations that permit Ss great freedom for movement as well as considerable opportunity to behave aggressively, e.g., biting and scratching, even when, as in the food test, the measure is not intrinsically concerned with "activity" or "aggression." The tube measure, in which opportunities for free movement and aggression behavior are extremely restricted, yields nearly opposite results.

References

- Candland, D. K., & Bloomquist, D. W. Interspecies comparisons of the reliability of dominance orders. *J. comp. physiol. Psychol.*, 1965, 59, 135-137.
- Fredericson, E. The effects of food deprivation upon competitive and spontaneous combat in C57 black mice. *J. Psychol.*, 1950, 29, 80-100.
- Fredericson, E., & Birnbaum, E. A. Competitive fighting between mice with different hereditary backgrounds. *J. genet. Psychol.*, 1954, 85, 271-280.
- Ginsburg, B. E., & Allee, W. C. Some effects of conditioning on social dominance and subordination in inbred strains of mice. *Physiol. Zool.*, 1942, 15, 484-506.
- Grant, E. C., & Chance, M. R. Rank order in caged rats. *Anim. Behav.*, 1958, 6, 183-194.
- Hall, C. S., & Klein, S. J. Individual differences in aggressiveness in rats. *J. comp. Psychol.*, 1942, 33, 371-383.
- Lindzey, G., Winston, H. D., & Manosevitz, M. Social dominance in inbred mouse strains. *Nature*, 1961, 191, 474-476.
- Scott, J. P. Genetic differences in the social behavior of inbred strains of mice. *J. Hered.*, 1942, 33, 11-15.
- Seward, J. P. Aggressive behavior in the rat. II: An attempt to establish a dominance hierarchy. *J. comp. Psychol.*, 1945, 38, 213-224.
- Uyeno, E. T. Hereditary and environmental aspects of dominance behavior in the albino rat. *J. comp. physiol. Psychol.*, 1960, 53, 138-141.

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