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INCREASED EATING IN RATS DEPRIVED OF RUNNING[1]

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Daily food intake in rats was temporarily reduced by the introduction of an activity wheel and temporarily increased by the subsequent removal of the wheel. When this outcome is coupled with the positive relation between food deprivation and running—and food deprivation is seen as a loss of eating rather than as a physiological state—there is the suggestion that the total behavior output of the organism may be regulated as such. Specifically, when the rat is deprived of a behavior that recurrently comprises a large part of its total daily activity, an increase may occur in some other behavior.

Although many studies show that depriving the rat of food increases wheel running (*e.g.*, Finger, 1951; Hall and Hanford, 1954; Richter, 1927), none appear to consider the opposite relation—the effect upon eating of depriving the rat of the activity wheel. This omission is the result of a preoccupation with the inferred consequences of food deprivation to the exclusion of its observable consequences. When an organism is deprived of food the observable consequence is that it can no longer eat. But is it feasible to consider that running increases in the food-deprived rat simply because it can no longer eat, or eat in normal amount? Yes, if it is at the same time feasible to consider that the total behavior output of the organism may be regulated as such.

When eating is characterized as a behavior, its main properties are that it (a) occupies a rather large proportion of the laboratory rat's total daily activity and (b) is recurrent over days (for operational definition of "recurrent behavior" see Premack and Collier, 1962). With free access to food, water and activity wheel, the rat appears to be active only about 6 to 7 hr per day, and the major components of this total, to the extent that they have been investigated, appear to be grooming—180 min (Bolles, 1961), eating—60 min (this figure, which is apparently not available in the literature, is taken from work in progress), running—50 min (Premack and Schaeffer, 1962), and drinking—20 min (Stellar and Hill, 1952). Thus, when the rat is deprived of all food, it is deprived of a behavior normally comprising about 17% of its total daily activity. Accordingly, the starvation-running relation suggests that when the rat is deprived of a behavior recurrently comprising a "large" part of its total daily activity, an increase will occur in some other behavior.

A nearly ideal test of this hypothesis could be made simply by depriving the rat of grooming. Grooming is reported to comprise about 40% of the daily total, more than any other one behavior, and further, its removal should not occasion food-specific internal changes. Unfortunately, we have been unable to deprive the rat of grooming without generally disrupting it. But the rat can be conveniently deprived of running, and this behavior represents about 14% of the total daily activity. In the present experiments rats were deprived of an activity wheel in order to determine the effect upon eating.

METHOD

Subjects

Twelve female albino rats, ca. 85 days old, of the Sprague-Dawley strain, were used.

Apparatus

The apparatus used was 12 standard Wahmann activity wheels, with attached cages

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in which the animals were housed. Sliding doors between the cage and wheel were used to deprive the animal of its wheel. The 12 assemblies were maintained in a continuously lighted, noise-shielded chamber. Mean daily temperature varied from approximately 73 to 78° F.

PROCEDURE

Two procedures were run using the same 12 *Ss*. First, all *Ss* were given the following three 14-day periods: no access to wheel, free access to wheel, no access to wheel. Second, the *Ss* were randomly divided into two equal groups; Group E was given free access to the wheel for 20 days, then deprived of it for 20 days; the control was kept without the wheel for the entire 40-day period. In both procedures, food and water were continuously available in each cage; food was weighed daily to the nearest 0.1 gm. Gaines dog meal was used because it facilitates recovery of spillage.

RESULTS AND DISCUSSION

Daily food intake was significantly reduced by the introduction of the wheel and significantly increased by the subsequent removal of the wheel, though in the present studies both effects were transient. The decrement lasted about seven days, the increment about twice that long. Results for procedures 1 and 2 are shown in the upper and lower panels of Fig. 1, respectively.

In the case of procedure 1, where all animals were treated alike, both a mean and median grams intake for each of the three periods was computed for each *S*. In terms of both of these measures, 11 of the 12 *Ss* ate less during the wheel than wheel-deprivation period; all 12 ate less during the wheel than no-wheel period; and 10 of the 12 ate more during the wheel-deprivation than no-wheel period. All differences are significant at not less than the .025 level by signed rank test. Group means for the no-wheel, wheel and wheel-deprivation periods were 16.6, 14.5, and 18.5 gm. per day, respectively.

The results for procedure 2 essentially confirmed those for procedure 1. Animals of Group E experienced wheel and wheel-loss for the second time on procedure 2, yet their performance on both procedures was essentially the same, indicating that the present effects can be repeated and are not limited to the naive *S*. An analysis of variance for Groups (G), Wheel-deprivation (D), and Sessions (S) showed that the main effect of deprivation was significant ($F = 27.76$, $df = 1/10$, $P < .001$), and that all the interactions except S × G attained at least the 5% level.

The increased intake produced by loss of the wheel may represent no more than compensation for the earlier decrement, and possible weight loss, produced by introduction of the wheel. This implies that if the wheel were retained for a sufficient period—greater than the present 14- and 20-day periods—no increase in intake would result when the wheel was removed. However, even for the present periods, average intake of *Ss* with the wheel approximated that of the control by wheel-day 7, and thus was on a par with control intake for about 13 days prior to removal of the wheel. The suggestion is, therefore, that the increase is not merely compensation for the earlier decrement but will continue to occur well after the initial decrement has been compensated.

Furthermore, although in the present study no weights were taken in order to disturb the *Ss* as little as possible, a long-term study in progress has shown clearly that the increase does not depend upon subnormal body weight. Animals deprived of the wheels at a time when their weight-gain was fully normal all increased their intake. In fact, they increased to a permanently higher level in contrast to the transient increase shown by the present *Ss*, and we are engaged now in attempting to determine what factors contribute to permanent as opposed to transient intake changes.

Several writers (Amsel and Maltzman, 1950; Siegel and Brantley, 1951; Siegel and Siegel, 1949) have implicated emotionality as a factor in ingestive control; following electric shock rats temporarily increased both food and water intake. Loss of the wheel may well have been aversive to the animal, but the peak increase in intake did not occur until about 3 to 5 days after the wheel was lost and the increase would appear to be disproportionately greater than that for electric shock. Thus, neither the temporal course nor magnitude of the present intake changes favor emotionality.

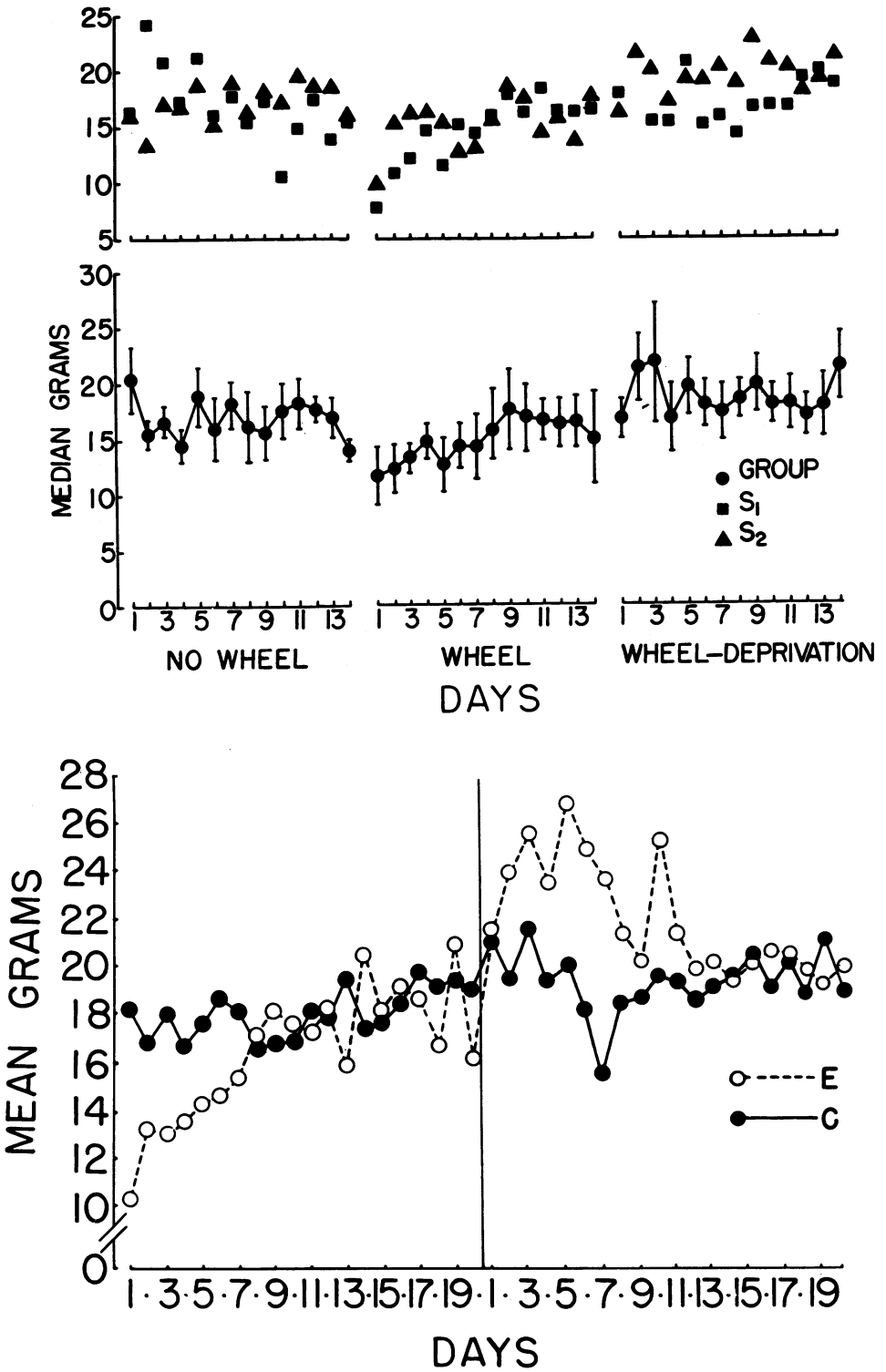

Fig. 1. Results for procedure 1 are shown in the upper two panels where median gm food intake is plotted against days for the designated periods. Individual *Ss* are shown in the top panel, group data in the middle panel; vertical bars indicate semi-interquartile range. Results for procedure 2 are shown in the bottom panel where intake is plotted against days, with separate curves for Group E and the control.

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