TECHNICAL NOTE

*DEPRIVING RATS OF FOOD: A REAPPRAISAL
OF TWO TECHNIQUES*

It is universally recognized that food deprivation is an essential prerequisite for using food reinforcement. However, the manner in which food deprivation of rats has been accomplished has undergone considerable change over the last fifty years.

We believe that the prevailing method of depriving rats of food grew from a Skinnerian reaction to the Hullian analysis of drive that dominated the field 35 years ago. Moreover, this technique was originally devised for depriving pigeons, which were typically used in early research on schedules of reinforcement (e.g., Ferster & Skinner, 1957). Insofar as rats and pigeons differ in their normal feeding habits, this extrapolation should be viewed with caution. But whatever its origins, the present deprivation method gives rise to an inordinate and unnecessary amount of work. For this reason we shall propose an alternative.

Table 1 surveys the results of 100 studies involving rats, published in this Journal over the last decade. (It is worth noting that it was necessary to cover a ten-year period in order to accumulate 100 studies in which rats, rather than pigeons or primates, were used.) By far the vast majority of these studies maintained animals at approximately 80% ad lib weights by providing an individually tailored daily ration. This required the experimenter, student, or technician to weigh each animal daily and to provide an appropriate ration of food. Insofar as no formula exists for relating grams of food to body weight, this remains a hit or miss affair (cf. Kaplan, Campbell, Johnson, PapaMichael, Sparer, & Weinbaum, 1959). The situation is further confounded by the occasional use of young (e.g., 90-day-old) animals whose growth is not yet complete. Such animals might normally double their weight over the course of a 4- to 6-month period. Insistence on this regime might therefore result in harm to the animal or might necessitate establishing a new and somewhat speculative 80% estimate of ad lib weight. This is a step that is rarely reported, despite its suggestion by Davenport and Goulet (1964). These investigators maintained a group of undeprived subjects throughout the experiment and used their mean weight as a point of reference.

However, the biggest fault with the daily weighing/ration method is the amount of labor required. Ehrenfreund noted over 20 years ago that "Unfortunately it

is so time-consuming that relatively few *Es* have yet employed it" (1960, p. 339). As Table 1 indicates, times have changed. It is now the method of choice.

Early operant researchers eschewed drive as an independent variable. They accomplished this by substituting an arbitrary deprivation level (e.g., 80% ad lib weight) for a continuous independent variable specified in hours. Thus it became de rigueur for operant conditioners to maintain their subjects at 80% of ad lib body weight rather than to manipulate hours of deprivation.

We wish to advocate the return to a technique of food deprivation that has actually been in sporadic use for over 50 years (e.g., Blodgett, 1925; Tolman & Honzik, 1930). This technique deserves serious reconsideration as the technique of choice. It consists of allowing rats unlimited access to food for a specified period each day, preferably an hour or so after completion of the experimental session. No weighing of individual animals is necessary. There are several advantages to this technique. One is the obvious and considerable savings in labor. Another is that it allows experimental animals to be housed and fed communally, should this be desired by the experimenter. Because most rats will finish eating within half an hour, even the least dominant animal in the group will have ample opportunity to eat its fill.

This method is highly successful in maintaining rats within the ideal range of food deprivation. For example, Hurwitz, Stewart, and Wasservogel (1958) performed a study in which nine 120-day-old male rats were exposed to this procedure. Mean body weight for these animals was maintained at 78.4% of ad lib baseline. Similarly, Davenport and Goulet (1964) used this technique and reported that the weights of 90-day-old rats were held constant at $83 \pm 3\%$ of ad lib feeding baseline. We have recently employed this deprivation procedure in order to document the rate at which weight loss occurred, as well as to establish the stability of its terminal value. Our results are presented in Table 2. This table summarizes the results for two of six 90-day-old male Long-Evans rats. For the first 10 days, unlimited food was available on the floor of each individual home cage for a one-hour period. During this period we found it advisable to provide food bricks on the floor of the cage rather than in the food hopper. Because of the extra time and effort required to obtain the food through a wire mesh hopper, the one-hour period often resulted in additional weight loss beyond optimal levels (see Eisenberger, Masterson, & Over, 1982, for related discussion). The feeding period was changed to two hours during the next 10 days, in order to simulate standard experimental conditions in which the animal typically receives between 4 and 10 g in the test

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Table 1

Summary of food-deprivation procedures for rats reported in this Journal over period 1970 to 1980.

Year	Total studies	Deprivation Procedure			Target Weight Reduction			
		Daily weighing & feeding	N-hr food deprivation	Reduction to mean weight of control group	75%	80%	85%	Other
1970	9	8	1	0	2	6	0	1
1971	10	9	1	0	1	7	2	0
1972	10	9	1	0	0	8	1	1
1973	8	5	1	2	1	6	1	0
1974	10	9	1	0	0	5	2	3
1975	10	9	0	1	0	8	1	1
1976	10	9	1	0	0	7	1	2
1977	8	8	0	0	0	5	1	2
1978	10	8	1	1	0	8	0	2
1979	10	9	1	0	0	9	0	1
1980	5	5	0	0	0	4	1	0
Total	100	88	8	4	4	73	10	13

chamber before being returned to its home cage for feeding.

There are several points worth noting: (1) The largest weight loss (between 10% and 12%) occurred on the first day. (2) Weight loss rarely exceeded 2% on subsequent days. (3) All animals reached an acceptable level of weight loss (83%) within 5 days. (4) Doubling the feeding time did not appreciably affect body weight. (5) After 20 days, the weights of all animals appeared

to have stabilized at between 75% and 84% ad lib. The group mean was 78.5%.

It is obviously at issue whether this method of food deprivation, regardless of its efficiency, produced any unacceptable or atypical performance. This concern is not without merit (Eisenberger et al., 1982), although our own data clearly indicate that response rates on a variable interval (VI) 60-sec schedule were on the whole both stable and typical. To demonstrate this, we have reported performance data for two rats, selected from a group of 15 that were food deprived using the method we advocate. The results appear in Figure 1, which presents rates of response for the most stable animal in the group, the least stable animal, and the mean response

Table 2

Weight loss data for the lightest and heaviest of six Long Evans rats obtained during 20 days exposure to ad lib food-deprivation procedure.

Subject 2 (Ad lib wt. = 441 g.)			Subject 3 (Ad lib wt. = 346 g.)		
Wt.	Wt. loss or (gain)	% Ad lib weight	Wt.	Wt. loss or (gain)	% Ad lib Weight
391	50	88.6	311	35	89.9
379	12	85.9	303	8	87.6
375	4	85.0	295	8	85.3
364	11	85.5	288	7	83.2
356	8	80.7	286	2	82.7
349	7	79.1	279	7	80.6
347	2	78.7	280	(1)	80.9
354	(7)	80.3	283	(3)	81.8
349	5	79.1	279	4	80.6
348	1	78.9	277	2	80.6
343	1	77.7	276	1	79.8
345	(2)	78.2	272	4	78.6
346	(1)	78.5	277	(5)	80.1
341	5	77.3	273	4	78.9
341	0	77.3	280	(7)	80.9
342	(1)	77.6	275	5	79.5
340	2	77.1	271	4	78.3
343	(3)	77.8	271	0	78.3
347	(4)	78.7	271	0	78.3
342	5	77.6	270	1	78.0

Fig. 1. Response rates obtained during eight three-session blocks of exposure to a VI 60-sec food-reinforcement schedule. Rats were food deprived using ad lib feeding procedure described in text. Data are presented for animals with most and least stable VI rates, determined by coefficient of variation. Group mean VI rates are also plotted for reference.

rate for the group of 15. Shaping and CRF training began after one week of deprivation; VI training commenced immediately thereafter, typically within 10 days of the start of deprivation. Our estimate of variability was based upon the coefficient of variation (CV; Sokal & Rohlf, 1973), calculated during steady-state performance over the final four sessions. The most variable animal had a CV score of .32; the least variable animal scored .01. The group mean CV score was .12. To facilitate comparison, of the last 20 animals trained in our laboratory on the same VI schedule using the conventional 80% of ad lib weight deprivation technique, CV scores ranged from .02 to .41 during a comparable point in training.

Insofar as "hours of deprivation" or "hunger" are no longer variables of primary theoretical interest, our major concerns in selecting a food-deprivation technique should be practical: Does it work and is it relatively convenient? The method we have proposed meets both criteria—in fact, more so than the existing method of choice. This suggests that it is time for a reassessment of one of the most fundamental experimental techniques in our behavioral work with the laboratory rat.

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