cated by wave action, a mechanism foreign to the environment of the bathyal zone. The present drowned position they ascribed mainly to local subsidence. Thus, if the foraminiferal fauna accumulated as a limy sediment in the bathyal depths of the Early Miocene seas, the truncation of the guyot must have occurred in pre-Miocene time. There was rather widespread Late Oligocene–Early Miocene basinal subsidence in many areas of the world; the nearby California area was typical in this respect (*9*) with marked subsidence of seaways. If the truncation occurred in the Oligocene at sea level, negative tectonism of the Late Oligocene and Early Miocene could have brought about the deeper water conditions in which the upper bathyal Aquitanian faunas developed. If the truncation had occurred earlier than the Oligocene, it is likely that Oligocene and older faunas might have been preserved. None has yet been found. The interstices of the basaltic surface trapped limy sediment initially; however, after the protective pockets were filled, additional sediment was winnowed away by currents and internal waves, resulting in a surface of nondeposition in the interval from Late Aquitanian to Recent. Manganese dioxide accumulated on Erben Guyot in this interval in the same manner as on the numerous other guyots of the Pacific Ocean (*10*). Initial subsidence brought about the upper bathyal conditions within the Aquitanian—subsequent subsidence resulted in the present depth of the guyot (*11*).

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Sodium Chloride Deprivation: Development of Sodium Chloride as a Reinforcement

Abstract. *The effects of deprivation of dietary sodium chloride on operant behavior reinforced by water and sodium chloride were studied. Rats responded at high rates for sodium chloride reinforcements only after they had been fed an inadequate diet for 40 days. These effects were specific to the deprived element of the diet.*

The behavioral effects of surgical or biochemical procedures which lower the sodium chloride concentration of body electrolytes have been explored in animal studies of the specific hungers. Little is known, however, about the behavioral effects of systematic restriction of the sodium chloride in the organism's diet. Falk (*1*) has suggested that it is difficult to deplete adult animals of sodium by feeding a deficient diet because a deprived organism will strive to store its sodium and thereby avoid depletion of this element.

The present experiment studied the effects of reinforcement with sodium chloride upon the operant behavior of normal rats and rats deprived of sodium chloride. Operant conditioning techniques are used because the organism's behavior can be tested under relatively constant conditions of deprivation. The use of an interval-reinforcement schedule enables the experimenter to measure NaCl-reinforced behavior while giving the animal a minute amount of NaCl.

Twelve Wistar albino rats were used in the two phases of the experiment. In the predeprivation phase (days 1–117) the rats were allowed free access to a food free of NaCl (*2*), which was supplemented by 0.4 percent NaCl by weight. This constitutes a normal diet for rats. In the deprivation phase, which lasted 60 days, the food was no longer supplemented by NaCl. Throughout both phases of the experiment the animals were maintained on a 23-hour water-deprivation schedule. They were tested daily in an operant conditioning apparatus in which reinforcements were delivered on a 1-minute variable-interval reinforcement schedule. The reinforcements were water or NaCl for the experimental animals and water or potassium iodide for the controls. The animals were divided into three experimental groups and one control group. The three experimental groups received NaCl reinforcements (0.03 ml of 0.25-percent NaCl by weight, per reinforcement) in accordance with the following schedule: (i) the three rats in the 5-day group were reinforced with distilled water for four consecutive days and with NaCl on each 5th day; (ii) the three rats in the 10-day group received water reinforcements for nine consecutive days and NaCl every 10th day; (iii) the three rats in the 20-day group received their NaCl reinforcements only on every 20th day. The three rats in the control group were on the same reinforcement schedule as the 20-day group, but in this case potassium iodide was used as a reinforcer. Measurements were taken daily of each animal's body weight and its food and water intake.

Table 1 presents the mean response output, of the ten subjects that completed the study, during the predeprivation sessions in which NaCl (experimentals) or KI (controls) was used as

Table 1. Responding of rats to reinforcement by water or by a salt solution (NaCl or KI) under 23 hours of water deprivation. The animals were also deprived of NaCl during the period designated "Deprivation," but not during the "Predeprivation" period. The values in the "predeprivation" column are the ratios of the mean number of responses of each animal during the last two sessions reinforced by a salt during the predeprivation period to the mean number of responses of the animal during the last ten water-reinforced sessions of the predeprivation period. The values in the third column ("Water reinforcement") are the ratios of the mean number of responses during the last ten water-reinforced sessions of the deprivation period to the mean number of responses during the last ten water-reinforced sessions of the predeprivation period. The values in the last column are the ratios of the mean number of responses during the last two sessions reinforced by a salt during the deprivation period to the mean number of responses during the last ten water-reinforced sessions of the predeprivation period. (Animals Nos. 6 and 12 did not complete the study tests.)

Animal	Predeprivation: a salt* reinforcement	Deprivation	
		Water reinforcement	A salt* reinforcement
	5-day group		
1	0.98	0.98	1.02
2	.89	1.09	1.70
3	.88	.93	1.45
	10-day group		
4	1.26	1.23	5.93
5	.78	.68	3.11
	20-day group		
7	1.20	1.88	6.42
8	1.08	.55	2.12
9	1.08	1.10	3.96
	Control (KI) group		
10	1.06*	0.99	0.96*
11	.95*	1.22	.81*

* For the experimental groups the salt reinforcement was NaCl; for the control group it was KI.

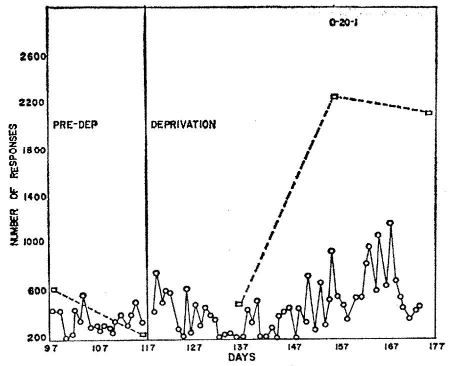

Fig. 1. Responses per hour of an animal in the 20-day group. The data to the left of the perpendicular line are for the predeprivation period; the data to the right, for the deprivation period. The circles connected by a solid line represent responding on the water-reinforced days; the squares connected by a dashed line trace the NaCl-reinforced behavior.

a reinforcement and the deprivation sessions in which the reinforcements were water or NaCl for the experimental groups and water or KI for the control group. The scores are expressed as ratios, as explained in the heading of Table 1. This ratio compensates for the different response levels of the rats during the predeprivation sessions.

These data show that near the end of the predeprivation period the hourly response rates of all of the subjects during the water-reinforced operant sessions were rather similar to their response rates during the sessions reinforced by a salt. At the end of the deprivation period, however, the response rate during the NaCl-reinforced sessions was greater than the response rate during water-reinforced sessions of the predeprivation period. This increase was less for the subjects in the 5-day group than for those in the 10- and 20-day groups. In fact, subject 1 of the 5-day group did not show this change. The responses of rats in the 10- and 20-day groups were roughly the same.

The use of potassium iodide as a reinforcement did not appreciably alter the behavior of the subjects in the control group. During the predeprivation period the KI-reinforced behavior of these animals was similar to their water-reinforced behavior.

Figure 1 shows the data obtained on a typical animal in the 20-day group. It should be noted that the increased NaCl-reinforced responding occurred after the 40th day of deprivation and that this increased rate is unique to those days on which NaCl was used as a reinforcement.

The increased responding during the NaCl test sessions seems to be specific to NaCl reinforcement, since only small changes occurred in the water- or KI-reinforced behavior. The change in the NaCl-reinforced behavior that occurred during the deprivation period can be related to Lewis's data (*3*). She found that a group of normal water- and salt-satiated rats would not respond in an operant conditioning apparatus when a 1-percent NaCl and water solution was used as reinforcement. A group of adrenalectomized rats, however, learned to press a lever under identical conditions. Thus NaCl deprivation appears to be necessary in order for NaCl to act as a reinforcing agent for a bar-press response.

The KI control was used to investigate the effects of NaCl deprivation in a situation in which the reinforcement contains ions that were adequately provided in the NaCl-deficient diet. The animals in this group reacted to the deprivation regime in the same fashion as their experimental counterparts: all subjects lost about 5 percent of their predeprivation body weight during the deprivation period. The control animals, however, did not show increased responding during the KI-reinforcement test sessions. This indicates that the increased response rate, which was characteristic of the animals deprived of and reinforced with NaCl, was not due to this weight loss. It is, of course, possible that the deprived animals would react differently if another salt solution were used as a control reinforcement. In this case the use of KI reinforcements did not change the behavior of the animals during the predeprivation period, and thus seems to produce a situation that was similar to the predeprivation NaCl test sessions.

During the deprivation period of the experiment the animals had access to two sources of NaCl: (i) that contained in the standard diet consisting of 4×10^{-4} percent NaCl, and (ii) that contained in the reinforcements provided during the NaCl test sessions (0.25 percent NaCl). Since the deprived animals ingested around 20 g of food each day, they consumed approximately 8.0×10^{-5} g of NaCl if we assume that all of the sodium appeared as NaCl. Sixty NaCl reinforcements contain 4.5×10^{-3} g of NaCl. Since all of the animals received the same food during deprivation, the only difference between the groups is the amount of NaCl they received during the test sessions. The 5-day group had one more salt test period than the 10-day group every 10 days. This gave them an average advantage of 4.5×10^{-4} g of NaCl per day. Despite the small differences in NaCl intake among these groups, the 5-day animals failed to show the deprivation effects as severely as the 10-day animals. These differences indicate that very small changes in the amount of NaCl deprivation can alter the subject's behavior.

The results of the present experiment clearly indicate that the effects of NaCl deprivation can be studied through the use of operant conditioning techniques. The sensitivity of this measure also indicates that the technique may be useful in the analysis of the dietary needs of organisms.

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Cardiovascular Responses of the Chicken to Seasonal and Induced Temperature Changes

Abstract. *Blood pressure and cardiac output decline as ambient temperature rises in birds acclimatized to both seasonal- and induced-temperature changes, in contrast to the response usually observed in unacclimatized mammals. The decline in chickens is due to a lowered vascular resistance and blood volume. These circulatory adjustments may be related to the fact that excess heat in birds is dissipated through the respiratory system rather than through the skin.*

Most studies of circulatory responses to changes in ambient temperature have been short-term experiments of a few hours or a few days which is insufficient time for long-term adaptative processes to develop such as may occur under seasonal influences.

Weiss, Ringer, and Sturkie (*1*) first observed a seasonal change in blood pressure of chickens (higher levels in the winter), and further work substantiated their findings (*2*). Seasonal changes have also been studied in man (*3*) and other animals (*4*), but observations have been limited to blood pressure, blood volume, and heart rate.