the microcephalic rats nevertheless decreased their error rate in a manner quite similar to that of the controls (Fig. 2). Both groups did significantly better ($P < .005$) on the second set of problems (13 to 24) than on the first (1 to 12). This suggests that both microcephalic and control animals were forming learning sets (learning how to learn). Within the seven daily trials both microcephalics and controls improved their performance significantly: the average decrease in errors from trial 1 to trial 7 was significant ($P < .005$) for both groups on both sets of problems.

After completion of this experiment, a cytotoxic effect of methlazoxymethanol on retinal neuroblasts of the rat fetus was detected (*1*). This finding indicates the need for further controls for a possible visual deficit. However, there was no difference in error scores for the first trial on the first set of problems, which suggests that there was little or no impairment of sensory-motor function in these microcephalic rats.

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3. S. Siegel, *Nonparametric Statistics for the Behavioral Sciences* (McGraw-Hill, New York, 1956). The significance levels for the differences in both the brain weights and maze errors between all microcephalics and all controls may be somewhat inflated, since a considerably larger number of more severely affected animals (females) was added to the microcephalic than to the control group. However, considering the males and females as two groups replicating the same results, multiplication of the probabilities obtained with these groups separately gives levels only slightly lower than those presented for the combined groups in Table 1.
4. G.L.L. and M.S. provided and prepared the experimental and control animals. R.K.H. and A.R. were responsible for the behavioral evaluation and the preparation of this report (supported in part by PHS grant 5-S01-FR-05558-06. We thank E. Jenney for photography, R. Dumas for assistance in the statistical analyses, and F. Bishop for his assistance in testing the animals, as well as for his excellent perfusions and brain extractions. M.P.V. was responsible for the histological, anatomical, and pathological observations.

24 October 1968

Escape from Self-Produced Rates of Brain Stimulation

Abstract. *Rats were allowed to self-stimulate while their responses were being recorded on tape. Subsequently, prerecorded patterns of their brain stimulation were "played back" to them. All subjects learned to escape brain stimulation delivered in exactly the same manner as they had previously elected to receive it.*

Bower and Miller (*1*) were the first to demonstrate that rats would work to terminate a self-initiated train of intracranial stimulation (ICS). Beer and Steiner (*2*) showed that the rate of stimulation is an important variable in determining the reinforcing properties of ICS. The subject's opportunity to control its rate of brain stimulation may conceivably be another important factor in determining the reinforcing properties of ICS.

In our experiment we attempted to separate the effects of rate of stimulation from the subject's control of presentation of a stimulus in order to determine (i) whether animals escape from recordings of rates of their own stimulation (that is, whether rats learn to escape from ICS delivered in exactly the same manner as they had elected to receive it on a previous occasion) and (ii) whether alterations in self-selected rates of stimulation change the escape behavior.

Five male albino rats (about 300 g) from the Walter Reed colony were the subjects. Rats were anesthetized with sodium pentobarbital, and then each had a bipolar, insulated, stainless steel electrode, bared at the tips, implanted in its brain with the use of a stereotaxic device. The electrodes were aimed at various hypothalamic structures that are known to yield effects of self-stimulation. After the experiment the animals were killed and perfused. Histological sections, stained either by the Weil or the cresyl violet method, were made to identify the sites of the electrodes. Electrode tips were found in the anterior hypothalamic area, the lateral hypothalamic area, and the ventromedial hypothalamic nucleus.

Rats were stimulated with pairs of biphasic rectangular pulses. Each pair of pulses consisted of two 0.2-msec waves opposite in polarity and separated from each other by an interval of 0.2 msec. Pairs of pulses were delivered at a frequency of 100 per second, and stimulus-train duration was held constant at 0.25 second. Current intensity, rate, and temporal pattern of stimulus trains were varied according to the demands of the experiment. Current, voltage, and wave form were monitored continuously on a twin-beam oscilloscope.

At least 10 days after surgery, subjects were trained to self-stimulate on one of two retractable levers in a sound-deadened experimental chamber. The range of current intensities that supported responding was explored. After stable rate-intensity functions were generated, a current intensity which maintained reliable and rapid responding was selected. The subjects were allowed to self-stimulate for 1 hour at the selected current intensity on a continuous reinforcement schedule. During this session, the exact temporal patterning of their responses was recorded on tape so that it could be precisely reproduced during a future session.

After a rest period in the home cage, the subject was returned to the experimental chamber where, for the first time, both levers were present. The lever on which the subject had previously self-stimulated (lever S) no longer affected reinforcement contingencies, but responses on that lever were counted. The animals' brains were stimulated by the previously recorded tape at the same intensity at which the subject had been self-stimulating. A response on the second level (lever E) terminated the brain stimulation for 20 seconds. The number of responses on both levers was recorded as was the latency from the onset of stimulation to the subject's first response on the escape lever (lever E).

All subjects learned to respond on lever E, which terminated their own taped rate, within the 1st hour. Escape latencies initially decreased as a function of the number of trials and then reached asymptote. During the escape condition, response rates declined on the self-stimulation lever (lever S). The initial response rate on lever S was high, but dropped to almost zero after 1 hour. Response rates on the new lever (lever E) were initially low but increased rapidly within 1 hour and then reached asymptote and remained there for the duration of the 6-hour session (Fig. 1).

For the next 19 days, subjects were allowed to escape their own prerecorded self-stimulation rates for 1 hour each day. After the initial decrease in escape latency, which occurred during the first

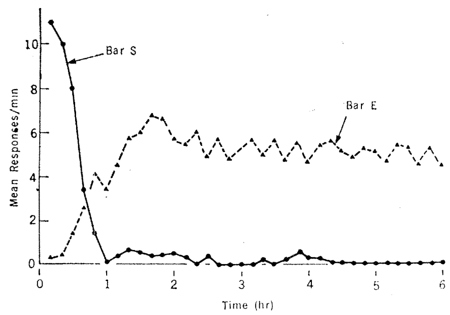

Fig. 1. Response rate (means) on both levers, collected simultaneously, are plotted as a function of time for the first escape session. Bar *S*, the lever on which the rat originally self-stimulated, is now inoperative. A response on lever *E* terminates stimulation for 20 seconds.

and only 6-hour escape session, the escape latencies for the next 19 sessions remained relatively constant (see Fig. 2).

Subsequently subjects were given the opportunity to escape ICS delivered in a regular pattern at the same average rate as their prerecorded self-stimulation. Subjects escaped with shorter latencies from the regular stimulation than from their own prerecorded pattern, which was irregular (Fig. 3). The order of presentation of these conditions was randomized. The differences in average escape latency were consistent over many days.

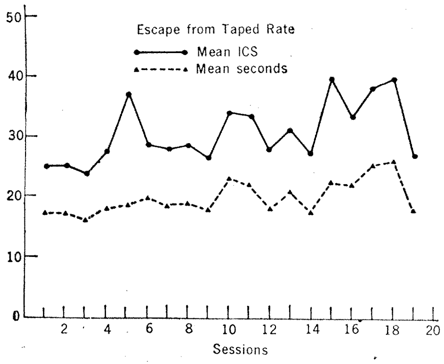

Fig. 2. Mean escape latency and mean number of intracranial stimulation (ICS) trains per trial are plotted over 19 daily 1-hour sessions.

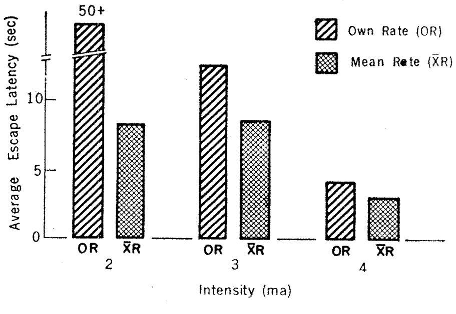

Fig. 3. Mean escape latency is plotted as a function of current intensity. Escape latencies decrease as a function of increasing current intensity. Across all intensities tested, subjects escape the average of their rate of self-stimulation at that intensity ($\overline{X}$R) with shorter latencies than they escape their prerecorded rate (OR).

Each subject was also allowed to escape stimulation presented at twice and at one-half its own taped rate. Escape behavior was not maintained when intracranial stimulation was presented at one-half the subject's taped rate, but could be reinstituted immediately when the original rate was restored. Subjects escaped with shorter latencies when brain stimulation was played at twice the taped rate.

When subjects were given an opportunity both to initiate and to terminate their own taped rate by responding on two levers, they selected an intertrial interval of approximately 4 seconds. Their average escape latencies in this condition were shorter than the condition in which the experimenter initiated stimulation after a 20-second intertrial interval. When the intertrial interval was shortened to 4 seconds, the average escape latencies were similar to those when subjects selected their own intertrial interval.

The escape behavior could not be attributed to superstitious responding. This was demonstrated in the control condition (in which rats had access to two levers) where responding on lever S dropped from a high rate to almost 0 when it no longer affected reinforcement contingencies. In contrast, animals learned to respond on the new lever which did affect reinforcement. It would appear that the escape behavior is learned and maintained because the stimulation becomes aversive (*3*).

The fact that subjects learn to escape their own prerecorded patterns of stimulation casts doubt on results of experiments in which it is assumed that the rate at which the animals take stimulation on one occasion will be rewarding on other occasions. The temporal patterns at which subjects self-stimulate may reflect some ongoing internal event, possibly subconvulsive electrical discharges. This may explain why subjects escape regularly patterned stimulation rates faster than they escape their irregular, self-produced rates of stimulation.

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11 July 1968; revised 23 August 1968

Social Status and Mating Activity in Elephant Seals

Abstract. *Individually marked male elephant seals,* Mirounga angustirostris, *observed on an island off central California participate in a social hierarchy resembling the peck order of domestic chickens. Individuals achieve status by fighting and maintain it by stereotyped threat displays. The higher the status of a male, the more readily he approaches and copulates with females. Four percent of the males inseminated 85 percent of the females.*

Patterns of social organization in vertebrates have been generally categorized as territories or social hierarchies (*1*). Many pinnipeds are territorial; a few males defend specific sites where breeding females gather in "harems" (*2*). *Mirounga angustirostris* and *M. leonina,* the northern and southern elephant seals, are exceptions. Males of these species establish social hierarchies in which the males of highest rank remain near the breeding females but do not defend specific sites (*3*). Previous studies of the hierarchies were severely limited since few animals were recognizable as individuals, and since an observer must know the members of a group individually to obtain accurate data on social order. During the 1967–1968 breeding season of *M. angustirostris* at Año Nuevo Island, San Mateo County, California, we marked virtually all of the males that landed; thus we are able to provide the first quantitative description of the hierarchy and to relate individual status to breeding success.

In December of each year male elephant seals land at Año Nuevo Island, and many of them remain there continuously until March (*4*). In January, after many males have been on land for several weeks, the adult females come ashore, give birth, suckle their