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THE EXPERIMENTAL STUDY OF THE HUNGER THERAPY*

2. EFFECT OF STARVATION UPON RETENTION OF CONDITIONED EMOTIONAL RESPONSE

By

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Assuming that such diseases as P.S.D. or neurosis is a kind of conditioned response, we have attempted to explore the mechanism of therapeutic effect of "hunger therapy" on these diseases. In order to find whether starvation directly affects the level of conditioned fear, 40 rats were first trained to press a lever for food in the Skinner-box, and then given the conditioning of emotional response (fear of shock) to 2,000 c/s tone. Following these trainings, the subjects were divided into two groups. One was treated with starvation of four days, and the other was the control group. The retention of CER after starvation was tested. The results indicated that starvation had no effect on the retention of CER, which suggested that starvation had no direct effect on the spontaneous decreasing of conditioned fear, but the extinction of fear was facilitated by starvation.

Our previous paper indicated that the extinction of avoidance response of rat was more rapid after four consecutive days of starvation (5). This finding was regarded as an experimental verification of the therapeutic effect of our "hunger therapy**" which had been adopted in our gynecologic clinic as a treatment for psychosomatic disease (P.S.D.).

As for the mechanism of this effect of starvation on extinction, the following two hypotheses could be built up: 1) starvation itself has an effect of decreasing the intensity of conditioned fear to CS; 2) it speeds up learning of some new response competing with the avoidance response (3). There are, of course, not necessarily alternative.

The present study was designed to test the former hypothesis. So far as the conditioned fear is inferred from (instrumental) avoidance response, changes in the intensity of fear itself can not be estimated precisely. In the present experiment, therefore, fear was first conditioned to CS by the technique of conditioned emotional

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** This is formerly a kind of therapy which has been employed in several countries as a treatment for some kinds of diseases (6). It was improved by Prof. Kushima and has been employed in our clinic as a new method of treatment for psychosomatic disease (2), (4).

response (CER) (1), and then the retention of CER was measured after four consecutive days of starvation.

METHOD

Subjects and apparatus

The subjects were forty male albino rats of Wister-strain with a mean age of five months. Thirteen of them were discarded because of accident in the process of the starvation.

One of the apparatus was a modified Skinner-box. Another one used as a shock-box was a wooden box ($25 \times 13 \times 20$ cm). Its walls were painted neutral grey, its floor consisted of 14 cm steel bars 1 cm apart, which were wired to an a-c transformer and performed the shock circuit. This shock circuit was powered by a 700 V a-c and the current in the circuit was $350\mu\text{a}$, which served as US in the conditioning of CER. The CS was a pure tone of 2,000c/s (about 65 db) delivered to the shock-box via a loud speaker located just above the shock-box.

Procedure

a) All subjects had first been placed on a 24-hr feeding schedule, which reduced them to about 75% of ad lib. body weight. Under 23-hr food deprivation, the subjects were trained every day to press a lever for food in the Skinner-box, every lever-pressing being reinforced with a 0.05 gm pellet of bread. When the subjects learned the lever-pressing response so completely as they pressed the lever at a constant rate, they were occasionally exposed to the tone of 2,000c/s used as CS.

b) When the subjects were habituated to the tone, fear-conditioning was carried out in the shock-box; each trial consisted of the pairing of CS with shock. The CS lasted for a total of 10 sec., and the shock was presented during the last 5 sec. of this period. On the first conditioning day, five CS-US pairings were presented. The average intertrial interval was 3 minutes.

c) On the next day, the subjects were tested for pre-starvation CER; while the subjects were responding to the lever at a constant rate, CS of 5 sec. duration was presented to them intermittently for two minutes and the suppression of lever-pressing was measured. After this test, additional two trials of fear-conditioning were given to them.

d) The subjects were divided into two groups, containing twenty rats each, matched as closely as possible for strength of CER measured by the pre-starvation test. One group was an experimental group which was to be treated with the starvation, and the other was the control group. The procedure of starvation was essentially the same as described in the previous report (5); briefly, this procedure consisted of the four-day period of complete deprivation of food followed by the four-day period of recovery. On the recovery period they were maintained of an ad libitum feeding schedule. On the other hand the control group was allowed to eat at will during eight days corresponding to those periods.

e) The post-starvation test of CER was carried out on the following day of the last recovery day by the same procedure with that of the pre-starvation test.

RESULTS

The suppression of lever-pressing response caused by CS is reported in terms of ratio. The number of the lever-pressing during two minutes immediately preceding the presentation of CS is represented as A, the number during two minutes of CS-presentation as B, and the number during two minutes immediately following the period of CS-presentation as C. Thus, B/A is a suppression ratio during CS-presentation and C/A is a suppression ratio after CS. Each of B/A and C/A has limits of 1.00 and 0.00, with 0.00 representing complete suppression of responding, 1.00 representing no effect of CS.

The mean numbers of lever-pressing are presented in Table 1. Since two groups were matched in their performance of pre-starvation test of CER, the significant difference, if any, between them in the post-starvation test would be due to the starvation variable.

Table 1 Mean number of lever-pressing response at pre- and post- starvation test of CER

CER test	Experimental Group N=14			Control Group N=13		
	A	B	C	A	B	C
Pre-starvation	13.14	2.72	5.43	14.76	2.77	9.23
Post-starvation	11.56	3.00	6.00	11.39	1.31	5.39

The two groups are almost the same in their values of A. As the CS can exert no influence upon A, this fact means that the starvation itself did not alter a level of responding. Values of B and C are smaller than A in both groups, and these low rate of responding under CS can not be expected to result only from a distracting power of 2,000 c/s tone. CS, therefore, had apparently retained a fear-eliciting characteristic through eight days of no-training.

The suppression ratio was computed separately for each subject, and its mean values in pre- and post-starvation test are shown in Figure 1. In the experimental group both values slightly increased through starvation, while those of the control group slightly decreased.

In order to test statistically the effect of starvation upon CER, the difference of ratio between pre- and post-starvation test of control group must be taken as a control condition. Then, we computed the difference of ratio between pre- and post-starvation test separately for each subject and tested the mean difference of ratio by *t*-test. The group difference is not significant in either of B/A ($t=0.669$, $df=25$, $p>0.05$) or C/A ($t=1.162$, $df=25$, $p>0.05$).

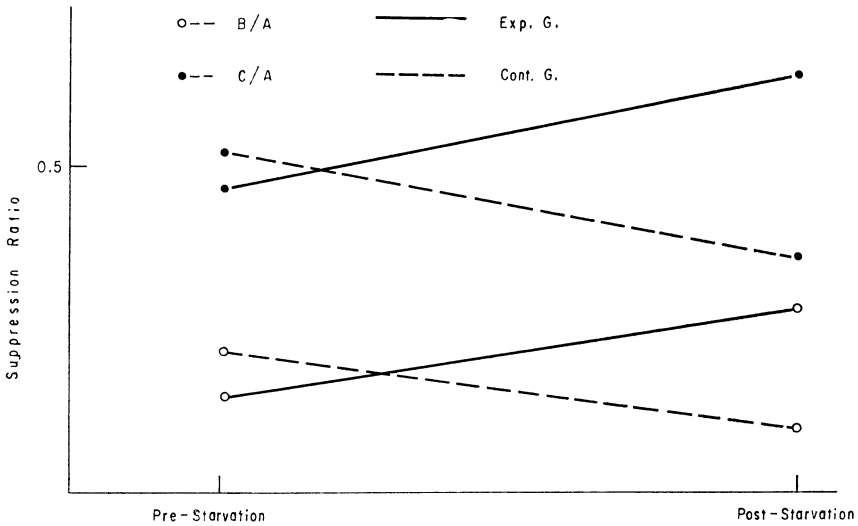


Fig. 1. Mean value of suppression ratio in pre- and post-starvation

DISCUSSION

The data indicate that the procedure of starvation had no significant effect on the retention of the conditioned emotional response. Thus, the hypothesis in the present experiment that the starvation will decrease the intensity of fear to CS must be rejected. At first sight this result seems to be contradictory to the findings, obtained in the previous experiment, that the extinction of avoidance response was more rapid after starvation. But there is no contradiction between them if we consider that what is affected here by the procedure of starvation is not the intensity of conditioned fear itself but the extinction of conditioned fear or the instrumental response mediated by the fear.

The present experiment did not measure the extinction of CER, but the retention of CER. As the procedure of measuring the retention was, however, operationally identical with that of measuring extinction except for a difference in their relative number of the presentation of CS without US, the fact that the suppression ratios in the experimental group increased slightly after starvation may be interpreted as showing a tendency of more rapid extinction of CER. This being the case, it may be concluded that the starvation does not affect the conditioned fear itself but the process of extinction of the fear, in other words, the procedure of extinction must be introduced if one wants to eliminate efficiently the conditioned fear through the procedure of starvation.

Such a conclusion coincides with our previous findings; conditioned fear is first extinguished rapidly after the starvation, which in turn results in the rapid extinction of instrumental response mediated by the conditioned fear.

Moreover the data in our previous experiment indicated that not only extinction

but also learning of avoidance response was slightly facilitated by starvation. Taken all together, these facts suggest that the starvation makes the subjects more susceptible to the operations put upon them after the starvation. If this is the case, the therapeutic effect of "hunger therapy" may be ascribed to the treatments which are given to patients during and after the period of starvation.

When the present experiment was designed, it was the main source of anxiety for the present writers if, as was already indicated by Takahira (6), the experience of severe hunger may not heighten the level of drive at the post-starvation test of CER, and thereby influences the suppression ratio of the experimental group. But as it is apparent from the values of A in the post-starvation test, hunger drive was almost the same for two groups.

The further studies are required to substantiate the above-mentioned speculation about the mechanism of "hunger therapy".

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ZUSAMMENFASSUNG

Hier haben wir den Mechanismus vom therapeutischen Effect unserer "Hungertherapie" untersucht, unter der Voraussetzung, dass die psychosomatischen Krankheiten eine Art von abnormal bedingten Reaktionen seien. Um den Einfluss des Hungers auf das Behalten der emotional bedingten Reaktion (CER) klar zu machen, wurden 40 weisse Ratten im Skinner-Köfig dressiert, den Hebel niederzudrücken und ein Stück Futter zu nehmen. Später wurden den Ratten fünf Paarungen von elektrischem Schlag und 2,000 c/s Ton gegeben. Danach wurden sie in zwei Gruppen geteilt. Eine Gruppe unterzog sich der Deprivationsprozedur von Futter während vier Tage, die andere Gruppe war eine Kontrollgruppe. Das Behalten der CER wurde geprüft. Aus den Ergebnissen folgt: 1) Die Deprivation von Futter fördert nicht spontane Erlöschung der CER, sondern experimentelle Extinktion der CER. 2) Man könnte sagen, dass schwerer Hunger Kranken zu den Behandlungen, denen sie sich unterziehen, suszeptibel macht.