A METHODOLOGICAL STUDY OF CER IN RATS WITH 'LICKING' AS THE CRITERION RESPONSE

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Two CER experiments were conducted with 'licking' as the criterion response. In Experiment I, rats' ($N=12$) number of tongue laps in a drinking box was significantly suppressed by the presentation of a CS which had been paired with electric shock previously. This suppression was not observed in the control group of 11 Ss. In Experiment II, the effect of US intensity upon CER was tested with 11 Ss using a within-subject design. The CS's of two modalities were reinforced with electric shock of two intensities in a balanced design. The Ss' drinking response was significantly more suppressed by the presentation of a CS which had been paired with stronger shock than of that with weaker shock. The results were discussed mainly from a methodological point of view.

A number of experiments have been conducted on conditioned fear using non-physiological indices. As early as 1941, Estes & Skinner introduced an excellent technique, which provided the prototype, of what was to become known as the 'CER technique' (Brady & Hunt, 1955; Hunt & Brady, 1951), for the study of conditioned fear. They demonstrated that a CS, which had been repeatedly paired with electric shock, acquired the property to interfere with a well-established lever pressing response. They thus made it possible to measure conditioned fear quantitatively in terms of the depressive effect which the CS had on an overt criterion response, namely, lever pressing. Although many investigators using the CER technique employed lever pressing as a criterion response (Libby, 1951; Hunt & Brady, 1951; Mowrer & Aiken, 1954; Mowrer & Solomon, 1954; Matsumiya, 1960; Hoffman & Fleshler, 1961; Kamin, 1963; Kamin & Brimer, 1963), any other overt response can be employed provided that the response can be inhibited by fear.

Davitz (1955) and Davitz, Mason, Mowrer, & Viek (1957) employed exploratory behavior, and Amsel (1950) and Amsel & Cole (1953) employed the consummatory drinking response. For example, Amsel (1950) trained thirsty rats to run initially from a large white compartment to a smaller white compartment to drink from a calibrated water container. After the amount of water consumed reached an asymptote, the Ss in the experimental group were shocked in the larger compartment, and on the next day tested in the original run-drink situation. The results showed a marked decrease in the amount of water consumed. With further non-shock trials, the amount of consumption gradually increased again, presumably due to the extinction of fear.

In the present experiment, the water drinking response was employed as the criterion response. But instead of measuring the water intake in milliliters, the 'number of tongue laps' was recorded. Since it has been shown that the lapping or licking rate for rats was between six and seven per second (Stellar & Hill, 1952; Davis & Keehn, 1959; Imada, 1964a), this measure of drinking behavior is likely to be a far more precise measure of drinking behavior than the amount of water in-

¹ The authors are grateful to Mr. E. Weldon and Mr. J. R. Groves (Department of Psychology, Institute of Psychiatry, University of London) for critically reading the manuscript.

take in milliliters. In addition, the present technique was closer to the technique employed in typical CER studies using lever pressing, than to that of Amsel (1950). The purpose of the present experiment was two-fold. In the first place, it was intended simply to obtain data on conditioned fear, with the 'licking' response as the criterion response. Secondly, it was planned to investigate the effects of US (shock) on conditioned fear using a within-subject design.

EXPERIMENT I

Rats were first trained to drink water from a tube in one situation. In the other situation, a CS was repeatedly paired with electric shock. Then the CS was presented in the first situation, while the tube was presented. A suppression ratio was obtained by comparing the number of times *S* lapped the tube during the CS presentation with that immediately preceding the CS presentation.

Method

Subjects. The *Ss* were 23 experimentally naive, male albino rats with a mean body weight of about 126 g at the start of the experiment. They were housed four per cage with food continuously available. For the week immediately preceding the experiment, all rats were gentled by handling, for 5 min per day, and were adapted on one-hour-per-day watering schedule. This watering schedule was maintained throughout the experiment. The temperature of the animal colony room was kept constant at approximately 20 degrees centigrade.

Apparatus. Four identical shock boxes and four identical drinking boxes were used in the present experiment.

The shock box consisted of bakelite panels and a transparent sliding Plexiglas lid, which were placed over a grid-floor. Each box measured 20 cm long, 10 cm wide and 15 cm high inside. The interior walls and the tray beneath the floor grid were painted black.

This situation will hereafter be referred to as the black/grid-floor situation.

The shock box was converted into a drinking box, by replacing the box with an identical unit painted white, and covering the grid floor with a stainless steel plate. This situation will be referred to as the white/plate-floor situation hereafter. The changes outlined were made to differentiate the shock situation from the drinking situation. In the lower part of the wall at one narrow end of the drinking box, a clear Plexiglas (5 × 10 cm) rectangle was fitted, which had a hole (12 mm dia.) 4 cm above the floor, half-way along the wall of the box. An animal could gain access to a drinking tube through this hole. The Plexiglas piece was replaceable with another piece having a larger hole (15 mm dia.) which was used during the initial stage of drinking training. A metal tube (6 mm dia.) with an orifice at one end (1.3 mm dia.) was fitted to a plastic bottle by means of a rubber tube. The drinking tube could be made accessible or inaccessible to *S* by remote control from the adjoining room.

The four boxes were placed on a table in such a way that each one of the boxes was separated from the adjacent two by an equal distance. The distance from the center of the table to the nearest end of each box was 16 cm. The other end of the box, which had the hole for drinking in the white/plate-floor situation, faced outward from the center of the table.

Illumination in each apparatus was by an electric bulb located approximately 10 cm above the drinking tube. This illumination (18 lux at the floor level) remained the same for both situations. The bulb was momentarily switched off (accompanied by the sound of a click) whenever the drinking tube was moved to a position such that the *S* could drink water from the tube.

Two different kinds of CS could be employed, i.e., the light or the tone, but in Experiment I only the light was used. A 100 w electric light bulb with shade, was suspended 150 cm above the center of the table; this provided an illumination intensity of 88 lux inside the boxes.

The US was an electric shock delivered to the grid through a 300 K ohm limiting resistor

in series with *S*. The voltage across the *S* was 110 v. ac.

The experimenter sat in an adjoining room and operated a lever which controlled the availability of the drinking tubes and also pressed keys to present the CS and US. The durations of CS and US, as well as their temporal relations were automatically controlled by timers.

When *S* made contact with a drinking tube a low current circuit between the tube and the metal floor of the box was completed which activated a contact relay (Imada, 1964b) controlling an electric counter. Because contact relays 'clicked' when operating, they were placed in the third room, farthest from the experimental room, and an electric fan, located in one corner of the experimental room, served as a masking noise.

Procedure. The procedure consisted of a training phase of drinking (Days 1-14), a fear conditioning phase (Days 15-26), and a testing phase (Days 27-33). The *Ss* ran, four at a time, under approximately 23 hr of water deprivation throughout the experiment. One hour watering took place for the first 12 and the last 11 *Ss* separately, as soon as the training for the last squad of the respective group was finished.

Preceding regular drinking trials, which were given after Day 7, a tube orienting behavior was first well established. Each animal was placed in a drinking box for 10 min per day. The drinking tube was first fully inserted into the box, but was then gradually withdrawn, and by the end of Day 4 of training the tip of the tube was fixed at approximately 5 mm behind the inside surface of the Plexiglas plate. This was to prevent *S* from putting the upper jaw on the drinking tube while drinking, which would have made it impossible to count the number of laps. The Plexiglas plate with the larger hole (15 mm dia.) was used during this initial stage of drinking in order to make it easier for *S* to gain access to the drinking tube. On Days 5 and 6, the tube was withdrawn from the box and only presented to *S* at irregular intervals; this withdrawal-presentation procedure was repeated several times. From Day

7, regular drinking trials were given. A drinking trial consisted of the presentation of the drinking tube for 20-25 sec. Ten such trials were given per day, with a mean intertrial interval of 65 sec, ranging from 50 to 80 sec. In a pilot study, it was found that *Ss* were not satiated with water in 10 trials. The number of tongue laps was counted separately during two successive 5 sec periods in the last 10 sec of each trial.

The apparent maximum levelling off in the mean drinking curve having been achieved by the end of Day 14, the *Ss* were divided into two groups which were matched in drinking behavior of Days 7-14. The experimental group consisted of 12 *Ss* and the control group of 11. On each conditioning day, each *S* was placed in the black/grid-floor situation, where it received five CS's and five US's. The duration of the CS and US was 5.7 sec and 0.7 sec respectively. For the experimental group the CS always preceded the onset of the US by 5.0 sec. The CS and the US terminated simultaneously. The intertrial intervals varied from 100 sec to 200 sec with an average of 150 sec. For the control group the CS and US were never paired. The US's were delivered at intervals ranging from 100 sec to 200 sec. The CS's were given at various intervals ranging from 0 to 120 sec after each US presentation. The CS, however, was given at least 60 sec prior to the next US onset, in order to minimize the possible occurrence of a forward conditioning. Both groups were given shock trials in appropriate ways on every alternate day over six days, drinking training being given in the manner described previously on the other three days. In all a total of 30 fear conditioning trials were given to the experimental group, while 30 unpaired presentations of the CS and US were given to the control group.

On Days 27-33, testing was carried out in the white/plate-floor situation by presenting the CS of 5.7 sec to *S* on drinking trials. As described above, the number of laps was recorded during the last 10 sec of each drinking trial, for two successive 5 sec periods, and from a comparison of the number of laps during the two 5 sec periods, a measure called 'suppres-

sion ratio (*SR*),² was obtained. Testing occurred on two randomly selected trials each day, with the restriction that the first two trials were excluded from the selection.

Measure. In the present study the index of suppression was the ratio *SR* suggested by Hoffman & Fleshler (1961):

$$SR = \frac{A-B}{A}$$

where *A* is the number of laps in the 5 sec before the CS onset, and *B* is the number of laps in the 5 sec during the CS presentation. The ratio is unity when *B* is zero (i.e., when there are no responses during the CS presentation).

Results and Discussion

The shock treatments in the black/grid-floor situation during the second phase of the experiment had some interfering effect upon the rat's drinking response in the white/plate-floor situation. There was no significant difference in the degree of suppression between the experimental and control groups. By the end of the sixth day of the shock treatments, the drinking response of both groups recovered to the level attained before the treatments (see Fig. 2).

Fig. 1 summarizes the results of the two groups during the testing phase,² which shows evidence of the occurrence of fear conditioning and its extinction in the experimental group. In the control group there is no evidence of conditioning.

² Here, suppression ratios for each day were calculated by the formula;

$$SR = \frac{\sum_{i=1}^{12} \sum_{j=1}^2 A - \sum_{i=1}^{12} \sum_{j=1}^2 B}{\sum_{i=1}^{12} \sum_{j=1}^2 A},$$

for the experimental group and

$$SR = \frac{\sum_{i=1}^{11} \sum_{j=1}^2 A - \sum_{i=1}^{11} \sum_{j=1}^2 B}{\sum_{i=1}^{11} \sum_{j=1}^2 A},$$

for the control group. The *i* stands for the number of subjects and *j* for the number of test trials.

In order to analyze the data statistically, *SR*'s were calculated individually for the first four test trials (i.e., first two days of testing) and for the last four test trials (i.e., last two days of testing) by using the formula;

$$SR = \frac{\sum_{j=1}^4 A - \sum_{j=1}^4 B}{\sum_{j=1}^4 A},$$

where *j* is the number of test trials. For a test of significance between mean *SR*'s of the experimental and control groups in the first four test trials, a nonparametric rank test was used, because of the heterogeneity of variance. The results of the test showed a significant difference between the two groups, indicating the occurrence of conditioning of fear in the experimental group ($z=3.69$, $p<.001$). Next, simple correlated *t* tests were performed for the two groups separately, which revealed a significant extinction effect in the experimental group ($t=4.57$, $df=11$, $p<.001$). But in the control group, where there was nothing to be extinguished, no significant difference between the first and the last four test trials was obtained ($t=1.18$, $df=10$, $p>.05$).

FIG. 1. Suppression ratios of the experimental group (filled circle) and the control group (open circle) on each day of the testing phase.

Taking the above analyses as a whole, it may be concluded that the present technique is a satisfactory one for the study of conditioned fear. The results are consonant with the findings obtained by the typical CER technique using bar pressing as the criterion response.

EXPERIMENT II

If the technique used in Exp. I is comparable to the more traditional techniques employed in the study of conditioned fear, it should be possible to demonstrate that conditioned suppression of laps is greater when a stronger US is used than with a weak US as has been shown in other CER studies (Matsumiya, 1960; Annau & Kamin, 1961; Kamin & Brimer, 1963). Exp. II was designed to examine conditioned fear as a function of US intensity, using drinking as the criterion response. Unlike the studies referred to above in which a between-subject design was used to study effects of shock intensity upon CER, a within-subject design was used in the present experiment. In other words, CS's of two modalities (i.e., light and tone) were reinforced with electric shock of two intensities in a balanced design. The experiment involved, therefore, a type of discriminative conditioning (Dykman, 1965, p. 231).

Method

Subjects and apparatus. The eleven Ss in the control group of Exp. I were used. In Exp. II, the animals were treated in the white/grid-floor situation throughout (except Day 1). This set-up was a modification of the white/plate-floor situation, made simply by removing the plate-floor which covered the grid. In addition to the light stimulus used as the CS in Exp. I, a tone of 1000 cps was used as the second CS, which was given through a loud-speaker placed at the center of the table. The tone was 89 decibels when measured inside the experimental boxes.

Procedure. After the termination of Exp. I,

Ss were kept in their home cages for three days under the same water deprivation schedule as before. This was followed by 29 days of Exp. II.

On Day 1 the Ss were placed in the white/plate-floor situation and trained to drink as in Exp. I. On Day 2 the plate-floor was removed changing the situation to the white/grid-floor situation. As may be seen in Fig. 2, drinking behavior was disturbed, presumably through fear evoked by the grid-floor, which had been charged previously. Four days were required for the drinking rate to recover. After the treatment on Day 5, Ss were divided into one group of five and another group of six, matched for drinking rate of Days 2-5.

On Days 6-20, the group of six Ss had the light paired with strong shock, and the tone paired with weak shock. The other group of five Ss had the tone paired with strong shock and the light with weak shock. The CS, irrespective of the mode, which was associated with strong shock will hereafter be called CSs, and that associated with weak shock will be called CSw. These 'light-strong US/tone-weak US' group and 'tone-strong US/light-weak US' group were counterbalanced for possible differential effects of the two types of conditioned stimuli in fear conditioning. This counterbalancing was also necessary since the Ss had had previous experience of the light CS (though unpaired with shock), but not of the tone CS. Shock levels of 130 v ac and 65 v ac were used respectively for the strong and weak US's. The durations of CS's, US's, and their temporal relations, were as in Exp. I.

Sixteen trials were given per day, ten drinking trials and six fear conditioning trials. The intertrial interval was variable with an average of 65 sec as in Exp. I. Of the six fear conditioning trials, three were strong shock trials and the others weak shock trials. Fear conditioning trials were randomly interspersed among drinking trials, but with some restrictions (on every day the first and the last trials were drinking trials; fear conditioning trials were not given in succession. At least one drinking trial intervened between fear conditioning trials).

FIG. 2. Disturbance of drinking behavior by shock treatments. (Note that there were total possible number of 20 periods on each day).

On Days 21 and 22 recovery training consisting of ten normal drinking trials on each of the days was given. Testing procedure (Days 23–29) was identical with that in Exp. I, except that one test was with CSs and the other with CSw. The tests were presented on randomly selected trials, but never on the first trial of each day. The order of presentation of CSs and CSw was varied from day to day.

Results and Discussion

As shown in Fig. 2, the drinking response was heavily suppressed by the superimposition of fear conditioning trials in the drinking situation. The initial drinking response level had not recovered after 15 days of further drinking training. This was quite in contrast with the relatively quick recovery of drinking response observed in Exp. I (see extreme left of Fig. 2), in which fear conditioning took place in a different situation from the drinking one. Because of this slow recovery of drinking in Exp. II, Ss were given recovery training for two days, in which only drinking trials were given in order to stabilize the level of the 'to-be-suppressed' behavior. As may be seen in the extreme right of Fig. 2, this procedure worked satisfactorily.³

FIG. 3. Suppression ratios to CSs and CSw on each test day.

The results of Exp. II are presented in Fig. 3 and Fig. 4. The suppression ratios were calculated as in Exp. I. Fig. 3 clearly shows a greater suppressive effect for CSs than for CSw. Fig. 4 represents the

³ Drops of base line response rate of bar pressing due to introduction of fear conditioning trials have been reported by Annau & Kamin (1961), Brimer & Kamin (1963) and Seligman (1968).

FIG. 4. Suppression ratios of the two counter-balanced groups for each modality of CS separately.

results for each CS separately, demonstrating that the tone was consistently more effective as a CS than the light, regardless

of the shock intensity with which it was paired.

In order to analyze the data the *SR*'s for the combined trials of the first two days and those for the combined trials of the last two days were calculated, for each *S* and for each CS separately. In Table 1, the data for the first two test days (i.e., the data on two test trials with CSs and two test trials with CSw) are given for each *S*.

A $2 \times 2 \times 2$ analysis of variance was carried out, in which the two counter-balanced groups formed a 'between' factor (Groups); the two stages of extinction (Extinction) and the two US intensities (US) formed two 'within' factors. The results of the analysis are summarized in Table 2. Both the main effects of US and Extinction were significant ($p < .001$). The first order interaction of $US \times$ Groups was also significant ($p < .05$), which represents a differential effect of US intensity upon two groups. Graphically, this is represented in Fig. 4 by the difference in differences of

TABLE 1

The number of laps and *SR*'s in the first two CSs test trials and the first two CSw test trials for each *S* (Exp. II)

Group	<i>S</i>	CSs			CSw		
		$\sum A$	$\sum B$	<i>SR</i> †	$\sum A$	$\sum B$	<i>SR</i>
Light-Strong US/ Tone-Weak US	1	67	2	.970	70	9	.871
	2	27	0	1.000	30	1	.967
	3	68	2	.971	66	40	.394
	4	75	5	.933	75	63	.160
	5	62	2	.968	60	21	.650
	6	64	20	.688	76	1	.987
		Mean <i>SR</i> = .922,		<i>SD</i> = .106	Mean <i>SR</i> = .672,		<i>SD</i> = .307
Tone-Strong US/ Light-Weak US	1	67	5	.925	66	62	.061
	2	69	0	1.000	68	40	.412
	3	66	1	.985	68	37	.456
	4	66	1	.985	68	15	.779
	5	59	10	.831	60	56	.067
		Mean <i>SR</i> = .945,		<i>SD</i> = .063	Mean <i>SR</i> = .355,		<i>SD</i> = .269

† $SR = (\sum A - \sum B) / \sum A$

TABLE 2
Summary of analysis of variance (Exp. II)

Sources of variance	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>
Between Subjects				
Groups (G)	.036	1	.036	—
error	1.448	9	.161	
Within Subjects				
US (U)	1.686	1	1.686	19.835**
Extinction (E)	.751	1	.751	26.821**
U × E	.003	1	.003	—
U × G	.440	1	.440	5.176*
E × G	.094	1	.094	3.357
U × E × G	.013	1	.013	—
error 1	.764	9	.085	
error 2	.248	9	.028	
error 3	.167	9	.019	
Total	5.650	43		

* $p < .05$, ** $p < .001$

the curves of CSs and CSw for two groups. Although this indicates an apparent superiority of the tone over the light as a CS, this should not be taken at face value. It should be remembered that in Exp. I, the Ss had been exposed to the light CS repeatedly but not to the tone CS, and this might have caused the difference in efficiency between the two modes of the CS in Exp. II. In this connection it is of interest to note that Seligman (1968) found that experience with one stimulus randomly interspersed with a US retarded the association between that stimulus and the US, once pairing of the two stimuli was begun.

The present experiment has clearly shown that CSs evoked greater fear in S than CSw. This is in line with the results of the CER studies, in which the effects of US intensity were studied using a between-subject design and bar pressing as the criterion response (Matsumiya, 1960; Annau & Kamin, 1961; Kamin & Brimer, 1963).

There is at least one methodological advantage in a within-subject design over a between-subject design in CER studies

concerned with the effects of US intensity. In a within-subject design, each animal experiences both strong and weak shock associated with different CS's. Therefore, a given amount of basal emotionality is assumed to be persisting in all Ss. A differential effect of the CSs and CSw on triggering off emotional response is tested on the ground of this basal emotionality level. In a between-subject design, in which different shock intensities are given to independent groups of Ss, not only is fear aroused specifically by CS, but also basal emotionality levels are assumed and shown to be different (Annau & Kamin, 1961). There is no guarantee that this difference in the basal emotionality level does not lead to a differential degree of suppression of the criterion response, even when the CS's given have equal fear evoking property. Therefore, from a methodological point of view, control groups (in which US's are not paired with CS in any systematic way) corresponding to each of the experimental groups of different US intensities have to be included in any experiment in which effects of the US in-

tensity on CER are studied using a between-subject design.⁴

A final point should be made about the nonsignificant US×Extinction interaction effect. The gradients of the two extinction curves in Fig. 3 did not differ at any acceptable level of significance. This fact is contrary to expectations based on the notion of counterconditioning. Nelson (1966) writes:

*The procedure of feeding (or watering) an organism in a fear-producing situation has been traditionally viewed as having a fear-reducing effect. The interpretation of this method of extinguishing fear, called counterconditioning, has been that fear is reduced by conditioning to the fear-producing stimuli the incompatible emotional responses associated with eating (or drinking) (p. 208).*⁵

If this is true, fear should have been more quickly extinguished for CSw. Specifically, since rats drank more during presentations of CSw than during presentations of CSs, it seems more reasonable for counterconditioning to have taken place with CSw than with CSs; hence this should have led to a more rapid extinction for CSw than for CSs. This was not the case in the present experiment, which provides further evidence of the adequacy of the present technique in the study of conditioned fear and its extinction.

⁴ In the Kamin & Brimer (1963) study, in which three different shock intensities were used (0.28, 0.49 0.85 ma.), there were no control groups corresponding to each of the experimental groups. In another study, however, Kamin (1963) has demonstrated, with US of 0.85 ma., a marked conditioned suppression in a forward conditioning group but no conditioned suppression in a backward conditioning group. This backward conditioning group may be regarded as a control group. On the other hand, in his differential conditioning study on CER, Ayres (1968) observed a suppression in the negative CS, which was not paired with shock, when the positive CS was paired with 1.9 ma. shock.

⁵ Parentheses added by the present writers.

REFERENCES

- AMSEL, A. 1950 The effect upon level of consummatory response of the addition of anxiety to a motivational complex. *J. exp. Psychol.*, **40**, 709-715.
- AMSEL, A., & COLE, K. F. 1953 Generalization of fear-motivated interference with water intake. *J. exp. Psychol.*, **46**, 243-247.
- ANNAU, Z., & KAMIN, L. J. 1961 The conditioned emotional response as a function of intensity of the US. *J. comp. physiol. Psychol.*, **54**, 428-432.
- AYRES, J. J. B. 1968 Differentially conditioned suppression as a function of shock intensity and incentive. *J. comp. physiol. Psychol.*, **66**, 208-210.
- BRADY, J. V., & HUNT, H. F. 1955 An experimental approach to the analysis of emotional behavior. *J. Psychol.*, **40**, 313-324.
- DAVIS, J. D., & KEEHN, J. D. 1959 Magnitude of reinforcement and consummatory behavior. *Science*, **130**, 269-271.
- DAVITZ, J. R. 1955 Reinforcement of fear at the beginning and end of shock. *J. comp. physiol. Psychol.*, **48**, 152-155.
- DAVITZ, J. R., MASON, D. J., MOWRER, O. H., & VIEK, P. 1957 Conditioning of fear: a function of the delay of reinforcement. *Amer. J. Psychol.*, **70**, 69-74.
- DYKMAN, R. A. 1965 Toward a theory of classical conditioning: cognitive, emotional, and motor components of the conditioned reflex. In B. A. Maher (Ed.), *Progress in experimental personality research*, Vol. 2. New York: Academic Press.
- ESTES, W. K., & SKINNER, B. F. 1941 Some quantitative properties of anxiety. *J. exp. Psychol.*, **29**, 390-400.
- HOFFMAN, H. S., & FLESHLER, M. 1961 Stimulus factors in aversive controls: the generalization of conditioned suppression. *J. exp. anal. Behav.*, **4**, 371-378.
- HUNT, H. F., & BRADY, J. V. 1951 Some effects of electro-convulsive shock on a conditioned emotional response ("anxiety"). *J. comp. physiol. Psychol.*, **44**, 88-98.
- IMADA, H. 1964a "Vigor" of water drinking behavior of rats as a function of thirst drive. *Jap. psychol. Res.*, **6**, 108-114.
- IMADA, H. 1964b An apparatus for the measurement of "vigor" of water drinking behavior of rats. *Ann. Anim. Psychol.*, **14**, 31-34.

- KAMIN, L. J. 1963 Backward conditioning and the conditioned emotional response. *J. comp. physiol. Psychol.*, **56**, 517-519.
- KAMIN, L. J., & BRIMER, C. J. 1963 The effects of intensity of conditioned and unconditioned stimuli on a conditioned emotional response. *Canad. J. Psychol.*, **17**, 194-200.
- LIBBY, A. 1951 Two variables in the acquisition of depressant properties of a stimulus. *J. exp. Psychol.*, **42**, 100-107.
- MATSUMIYA, Y. 1960 The effects of US intensity and CS-US pattern on conditioned emotional response. *Jap. psychol. Res.*, **2**, 35-42.
- MOWRER, O. H., & AIKEN, E. G. 1954 Contiguity vs. drive-reduction in conditioned fear: variations in conditioned and unconditioned stimuli. *Amer. J. Psychol.*, **67**, 26-38.
- MOWRER, O. H., & SOLOMON, L. N. 1954 Contiguity vs. drive-reduction in conditioned fear: the proximity and abruptness of drive-reduction. *Amer. J. Psychol.*, **67**, 15-25.
- NELSON, F. 1966 Effects of two counterconditioning procedures on the extinction of fear. *J. comp. physiol. Psychol.*, **62**, 208-213.
- SELIGMAN, M. E. P. 1968 Chronic fear produced by unpredictable electric shock. *J. comp. physiol. Psychol.*, **66**, 402-411.
- STELLAR, E., & HILL, J. H. 1952 The rat's rate of drinking as a function of water deprivation. *J. comp. physiol. Psychol.*, **45**, 96-102.

(Received June 23, 1969)