THE ROLE OF THE BAR IN THE ACQUISITION OF BAR PRESS AVOIDANCE

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Edward Ren Christopherson

1965

ABSTRACT

THE ROLE OF THE BAR IN THE ACQUISITION
OF BAR PRESS AVOIDANCE

by Edward Rea Christophersen

A considerable amount of research has been devoted to the bar press avoidance situation in rats. Specifically, numerous investigations have been made in an effort to discover any variable which would account for the relatively poor avoidance performance in the bar press situation as compared to avoidance performance in a wheel-turn or shuttle bar situation.

The present experiment, based upon intensive pilot work, examined the effect, upon performance, of pairing the presentation of a retractable bar with the buzzer (CS). Three groups of six subjects were run in an automated bar press avoidance apparatus. Control group 1 resembled the typical avoidance schedule in which shocks are presented at fixed intervals unless a bar press is made, in which case the next shock is postponed. The bar, for control group 1 was always in the extended position.

The conditions for the experimental group were identical to control group 1 except that the bar was extended with the onset of the CS and retracted with the termination of the CS, i.e., the bar was present only when the CS was being presented.

Control group 2 was similar to the experimental group except that, the bar, in addition to being presented with the CS, was presented irregularly throughout the experimental session.

Subjects were said to have reached criterion performance when

they avoided 95% of the shocks two sessions in a row.

The results indicated that the pairing of the presentation of the bar with the CS yielded significantly better performance than having the bar present throughout the session. The slowest subject in the experiment group reached criterion one session before the fastest subject in control group 1. It was suggested that these results could be attributed to (1) eliminating bar-holding, (2) eliminating non-reinforced bar presses, or (3) the discriminative stimulus properties acquired by the bar thru repeated pairing with the buzzer and the shock.

A group with an intermittently presented bar was included in an effort to differentiate between the first and third possibilities. The data indicated that the introduction of the bar was a strong cue.

Approved: M. Ray Denny

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Date: Nov. 23, '65

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Psychology

1965

ACKNOWLEDGMENT

The author wishes to express his appreciation to Dr. M. Ray Denny, chairman of his committee, for guidance and assistance in conducting this research. Also he wishes to convey thanks to Drs. S.C. Ratner and J. Hunter for their helpful criticism and advice.

The author also wishes to express his sincere gratitude to his wife, Nedean, who willingly gave time and energy to the preparation of this manuscript.

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Introduction

Discrimination avoidance procedures are used extensively by the behavior scientist. In such procedures, an animal is trained to perform a response in the presence of a stimulus which signals the occurence of a noxious stimulus, such as shock, noise, wind, or a strong light. The response, which may consist of pressing a lever, or of running from one side of an alley to the other, terminates the signal and prevents the onset of the noxious stimulus, However, the reported difficulty of establishing a discriminative avoidance habit with rats in a lever-pressing apparatus severly limits the use of this favored experimental technique.

Numerous investigations have been undertaken in an effort to identify the variables which account for the poor performance in bar-press avoidance; for example: the role of the tone-shock pairing in warm up, the role of the response in warm up and the role of shock intensity in warm up (Hoffman, Fleshler, and Chorny, 1961); the length of ITI and the length of the CS-UCS interval (Meyer, Cho, and Weseman, 1960); UCS intensity (Stone 1960; Kimble, 1955; Boren, Sidman, and Herrnstein, 1959); UCS duration (Chapamn and Bolles, 1964); CS termination verses UCS termination (Kamin, Campbell, Ryan, and Walker, 1959); the effect of sensory feedback, post-response time, and reduction of the shock density (Bolles and Popp, 1964); systematic variation of the interval between the response and the onset of the pre-shock warning signal (Ulrich, Holz, and Azrin, 1964); avoidance with inescapable shock (Hurwitz, 1964). All of these studies, however,

have yielded essentially negative results.

There has to be some kind of procedural difference to account for good avoidance learning in the shuttle box or jump-out box while avoidance learning in a bar press situation remains so poor. Pilot work was conducted in an effort to find an explanation for this difference by attempting to get good bar press avoidance.

One of the findings of the pilot work was that the rats tended to hold the bar down during the response-shock interval(only the initial depression of the lever counted as a bar press response, holding counted as only one response). A search of the literature yielded a number of studies which reported this same finding. Dinsmoor, Matsuoka, and Winograd (1958) examined bar-holding specificially. Their data supported the hypothesis that holding behavior is maintained in part by its preparatory function, i.e., sequences of behavior in the escape situation indicated that animals turned the shock off more quickly on trials when they were holding the bar down at the onset of shock than on trials when they were off the bar. Anger (personal communication, 1965) has found that rats on a Sidman avoidance schedule hold the bar as much as 60% of the time.

In the avoidance situation, any time the bar is pressed prior to the onset of the noxious stimulus, the noxious stimulus is avoided. But what of the situation where the subject holds the bar down for two trials in a row? The first trial is counted as an avoidance response and postpones the shock, but on the second trial the subject is shocked for essentially the same response (continuing to hold the bar down). The present study was designed to see what would happen if the subject were not allowed to respond without reinforcement during the safe period

Thus, all responses which were made were reinforced. This was accomplished by using a retractable lever. The lever was in the test chamber only when a bar press could be reinforced; its introduction acted, then, as a conditioned stimulus. It was thought that the prevention of bar-holding, coupled with the discriminative properties (if any) of the presense of the bar and the prevention of any "unrewarded" bar presses, would yield significantly better bar press avoidance learning than had previously been demonstrated. Two groups of subjects were run under identical conditions except that, in the experimental group the bar was retractable and in the control group 1 the bar was present all the time. A third group was run in an effort to differentiate between bar-holding, as such, and the discriminative properties accompanying the introduction of the bar.

Method

Subjects

Eighteen male albino rats, approximately 90 days old, were housed in individual cages and allowed free access to food and water.

Apparatus

The experimental space measured (9" x 10" x 12½" high). Three sides were constructed of wood; the top and the door were of clear plastic, allowing unrestricted observation of the Ss. The top was mounted on switches so that when the subject hit the top, shock was terminated, i.e., a "top hit" served as an escape response. The floor of the compartment consisted of stainless steel rods, 3/32 in. in diameter and spaced .5 in. apart. A G.E. 313 bulb (1.7 amp) on the back wall on the enclosure illuminated the chamber during the sessions. The response lever was a Lehigh Valley Electronics Model 1405M Retractable Lever; it was located 2 in. above the grid floor. A clearly audible non-aversive buzzer served as the warning signal (CS). The CS-UCS interval was 5 sec. The experimental compartment was contained within a sound attenuating chest. A blower served as a masking noise and as a ventilator.

Direct current shocks (100 volts) 1.5 ma in intensity were delivered through the grid floor until the bar was pressed or until 5 seconds elapsed, whichever occurred first. An Applegate constant current stimulator generated the shocks through a polarity scrambling circuit of the type devised by Hoffman (1962).

Bar presses were "rewarded" by termination of the CS and UCS (if on) and also by turning on a safe light (2½in. above the bar) which denoted the "safe period", i.e., absense from shock.

Procedure

Experimental Group. During the first four sessions, the subjects (Ss) were trained to respond by placing them in the apparatus with the bar extended. After 25 sec. the buzzer was presented. If no bar press occurred within 5 sec. the shock was introduced. If no bar press or "top hit" occurred, the CS and UCS were terminated at 5 sec., 2 sec. were allowed to elapse, and the CS was presented again. When a bar press occurred, the CS or CS and UCS were terminated, the bar was retracted, and the "safe light" was turned on. The safe period duration was 25 sec., after which the bar was reintroduced, 2 sec. elapsed, and the CS was represented.

On session 5, and all later sessions, the bar was introduced when the buzzer came on, stayed in as long as the buzzer was on, and was retracted when the buzzer was terminated.

The response-shock interval of 32 sec., the shock-shock interval of 7 sec., and the 25 sec. safe light remained constant. The sessions lasted either 2 hours or until 100 shocks had been presented, whichever occurred first.

All bar presses turned on the safe light but only those bar presses occurring prior to the onset of the shock were counted as avoidance responses, i.e., if the bar were pressed while it was being retracted, there was immediate cessation of shock concurrent with the onset of the safe light.

All Ss were run until they had reached the pre-set criterion of 95% avoidance or above for two sessions in a row.

Control Group 1. The treatment was identical to the experimental group except that the bar was always extended, i.e., it was never retracted. All Ss were run until they had reached criterion; those Ss not reaching criterion by the 11th day were discontinued.

Control Group 2. The treatment was identical to the experimental group except that the bar was extended and retracted according to the schedule listed in Table 4 of the Appendix. Also, on every trial, the bar was extended with the buzzer onset and retracted with the buzzer termination. The safe period was divided into 4 sec. segments during which the bar was either extended or retracted according to the schedule.

Both the experimental and the control group subjects also had available, as an escape response, a "top hit". That is, if the subject, while being shocked, hit the top, that shock was terminated.[1]

[1] An additional experimental group was run, at a later date, without the "top hit" escape response. The rate of acquisition, however, was similar to the present experimental group. The difference between shocks prior to reaching criterion was not significant ($t = .223$, $df = 7$, $.450 > p > .40$).

Results

Figure 1 shows the mean percent avoidance $\pm$ one standard deviation for the experimental group and control group 1 (bar always extended). The entire experimental group was avoiding at least 95% of the shocks on the sixth and seventh day. Two subjects of control group 1 reached criterion on the eighth day. All other subjects from control group 1 reached criterion after the eighth session. Figure 2, a frequency polygraph of sessions to criterion, shows no overlap between the two groups. It should be noted that three of the control group 1 subjects had not reached criterion by the 11th session and were discontinued.

A t-test was run on those subjects which reached criterion to determine the significance of the difference in the number of shocks to criterion ($t=2.87$, $df= 10$, $.010 > p > .005$). (See Appendix, Tables 1 and 2). The experimental group subjects had significantly fewer shocks prior to reaching criterion.

Figure 3 represents the rate of acquisition of bar press avoidance for individual subjects in control group 2. The subjects with a high level of avoidance were discriminating between the buzzer CS and the introduction of the bar. (See Appendix, Table 3). Excess bar presses were gradually eliminated, over sessions, in these subjects. However, two subjects showed little or no avoidance learning and no discrimination. Because of the high inter-subject variability, control group 2 was not compared directly with the experimental group or control group 1.

Figures 4 and 5 represent, respectively the rates of acquisition for individual subjects in the experimental group and in control group 1.

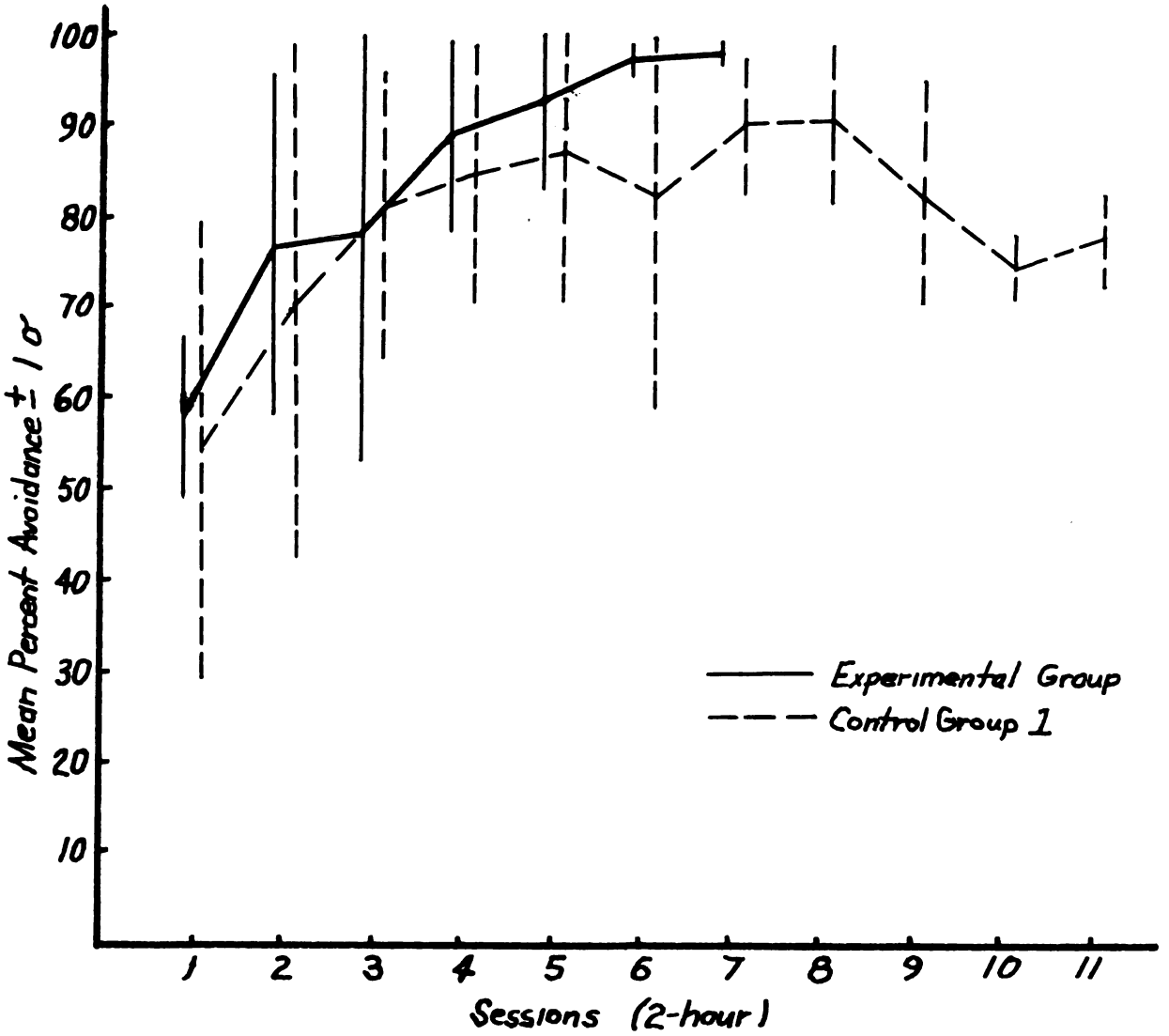

Fig. 1. A comparison of percent avoidance, mean ± one standard deviation, for the experimental group and control group 1.

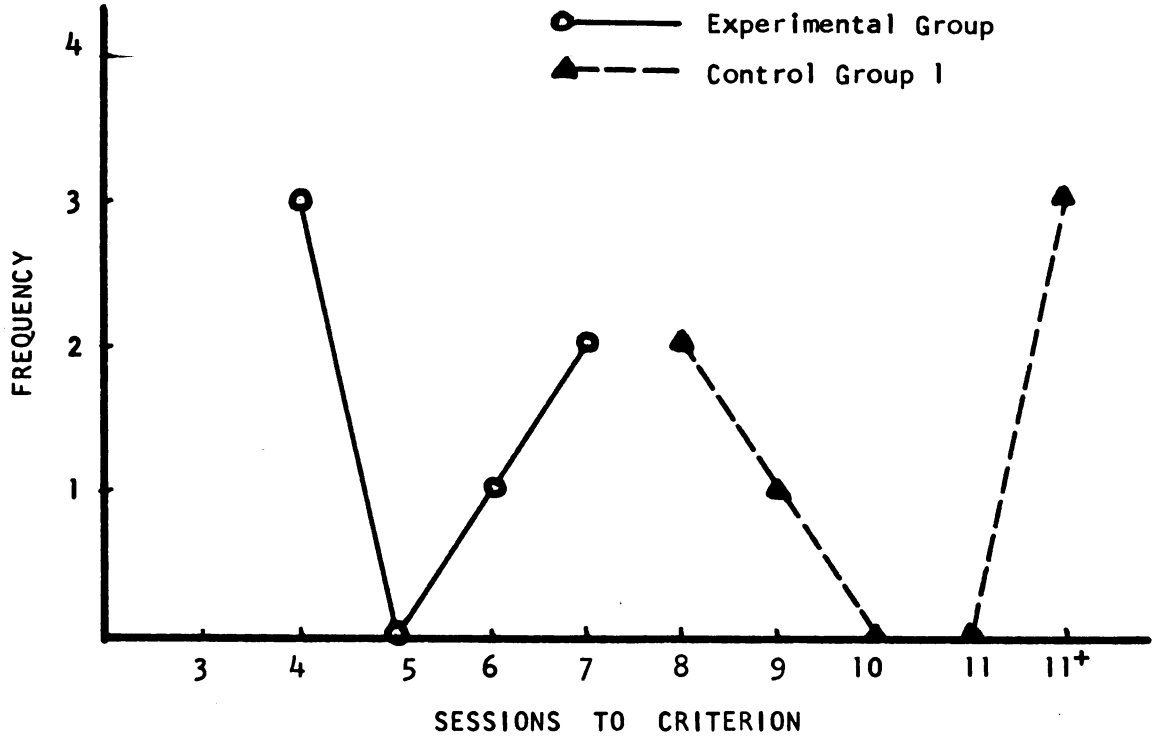

Fig. 2. A comparison of the number of sessions prior to reaching criterion for the experimental group and control group 1. Each point represents the number of subjects per respective group that reached criterion in that session.

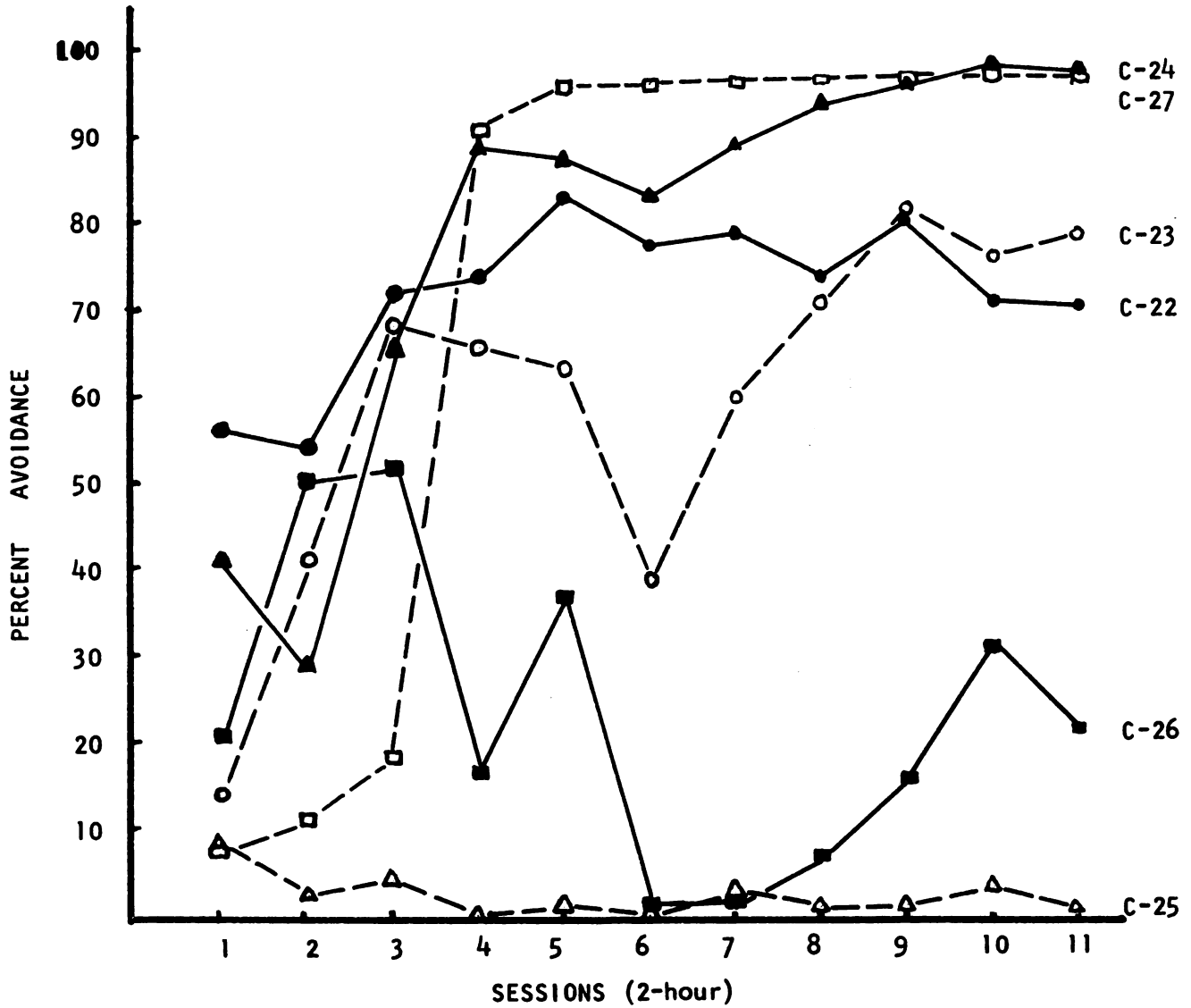

Fig.3. Rate of acquisition of bar press avoidance for each individual subject in Control Group 2.

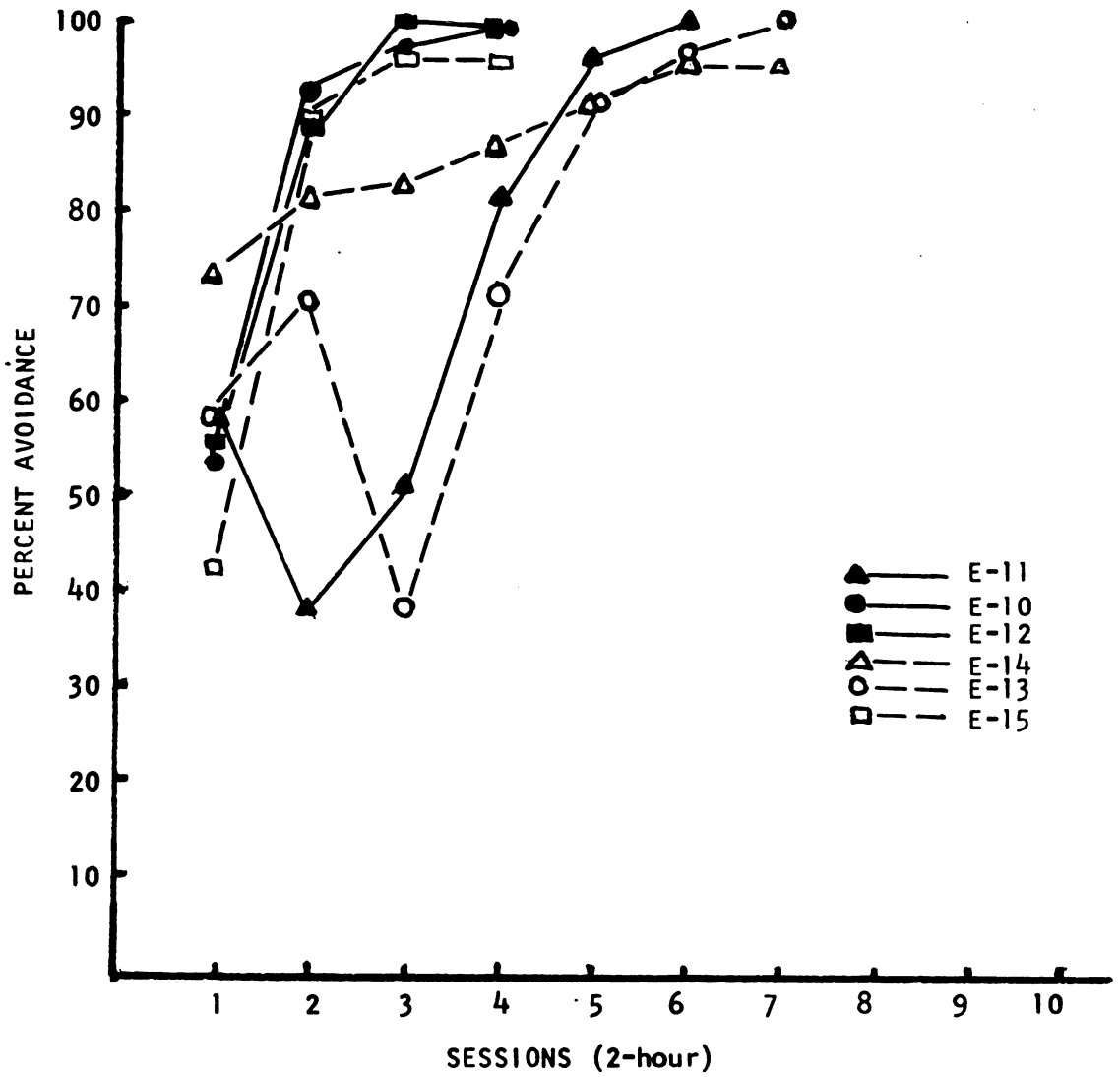

Fig. 4. Rate of acquisition of bar press avoidance for each individual subject in the experimental group.

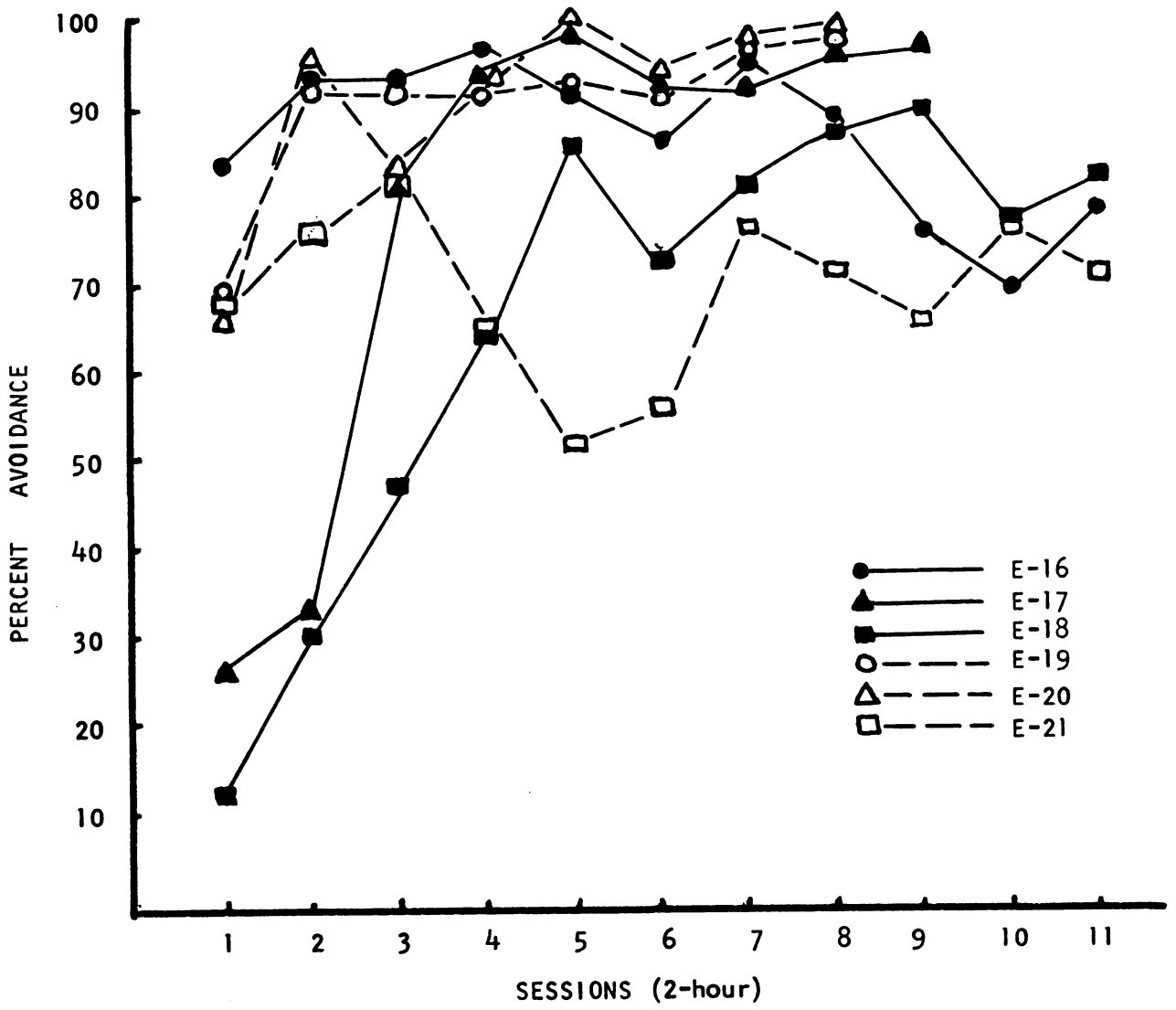

Fig. 5. Rate of acquisition of bar press avoidance for each individual subject in control group 1.

Discussion

The data reported here have demonstrated that it is possible to achieve a high percentage of avoidance in the bar press situation. The control condition in which the bar was always extended was similar to previous work with bar press avoidance. The method and the apparatus were meant to reflect previous findings that resulted in better bar press avoidance. For example: Myers (1962) demonstrated superior learning with a buzzer warning signal over a light or a tone; Ulrich, Holz, and Azrin (1964) found that the use of a warning signal reduced the number of shocks received; Chapman and Bolles' (1964) data argued for shock durations longer than brief shocks of .2 to .3 sec., hence the present study incorporated a 5 sec. maximum duration; Dinsmoor, Hughes, and Matsuoka (1958) found that learning was better if the subjects were required to released the bar, i.e., holding did not count as a response on the next trial, this was incorporated in the present work; Boren, Sidman, and Herrnstein (1959), found that acquisition of the avoidance response was facilitated by using shocks levels above 1.2 ma hence the present use of 1.5 ma. An additional variable, the "safe light", was suggested by the findings of Ulrich, Holz, and Azrin, 1964. All of the above mentioned procedural variables were included in control group 1.

The experimental group was identical to control group 1 except that the bar was extended with the warning signal and retracted when the warning signal terminated. This manipulation clearly facilitated the acquisition of the bar press response in an avoidance situation. This facilitation can be attributed to several possibilities: (1) eliminating bar-holding as a competing response, (2) eliminating non-

reinforced bar pressed, i.e., those bar presses that occur outside of the CS-UCS interval, and (3) the discriminative stimulus properties acquired by the bar thru exclusive pairing with the buzzer and the shock.

The group with the intermittently presented bar was included in an effort to differentiate between the first and third possibilities. The data didn't shed much light on possibilty (1), but did indicate that the introduction of the bar was a strong cue. Further consideration of the discriminative properties of the bar led to the examination of the training procedure for the group that had the bar extention paired with the buzzer. The warning signal came on and the bar was extended. When 5 sec. elapsed without a response, the shock was delivered. The bar remained extended until it was pressed; when pressed, the bar was retracted and the safe light was turned on for the safe period. The bar, in this situation, is used in a way similar to the way Ulrich, Holz, and Azrin (1964) used the warning stimulus, i. e., the warning stimulus stayed on (the bar was in) until the response had been made so that, in agreement with Azrin, Holz, Hake, and Ayllon (1963), the safe period was made contingent upon a specific response and the safe period was selectively associated with the absence of shocks.

The data from the present investigation are handled nicely by elicitation theory. In terms of elicitation theory (Denny and Adelman, 1956) conditional fear or anxiety results from the consistent fashion with which the autonomic responses accompany the attempt to escape. Cessation of the aversive stimulation, in this case, the bar press, elicits a relaxational - approach response which is incipiently

conditioned to the immediately preceding stimuli of the bar press and the warning stimuli. With continued trials the relaxational-approach response is consistently elicited and thereby strongly conditioned to the stimuli accompanying the bar press. The animal is not allowed to relax for sufficient time to allow extinction to occur because the relaxation cues come to be associated with the safe light. On those trials where the subject continues to relax after the termination of the safe light, relaxation is punished by the onset of the warning stimulus and the introduction of the bar. The present procedure allows the subject to relax, during the safe light but terminates the relaxation with the beginning of the next trial.

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APPENDIX

SESSIONS	E-10			E-11			E-12			E-13			E-14			E-15		
	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.
1	128	58	54.7	122	50	59.2	148	64	56.1	53	22	58.3	89	23	74.3	66	37	43.9
2	245	18	92.7	166	100	39.1	124	14	88.9	258	77	70.2	195	37	81.0	192	20	89.6
3	251	7	97.2	133	65	51.2	222	0	100.0	164	100	39.0	151	25	83.4	196	7	96.4
4	266	2	99.7	61	11	81.2	243	1	99.5	232	66	71.5	247	32	87.0	147	5	96.6
5				204	7	96.6				226	20	91.1	231	17	92.6			
6				223	0	100				203	5	97.5	221	10	95.5			
7										167	0	100.0	169	7	95.8			

TABLE 1. Experimental Group. The number of trials, the number of shocks, and the per cent avoidance per subject, per session.

C-16			C-17			C-18			C-19			C-20			C-21			SESSIONS
Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	
234	39	83.3	138	100	27.5	116	100	13.8	245	76	68.98	224	74	66.98	246	80	67.48	1
258	13	94.9	152	100	34.2	145	101	30.3	251	15	94.0	264	13	95.07	248	56	77.4	2
249	13	94.7	240	44	81.7	191	101	47.1	236	15	93.6	238	37	84.45	234	43	81.6	3
231	5	97.8	234	13	94.4	218	79	63.7	224	14	93.75	184	11	94.0	197	69	64.97	4
206	15	92.7	211	2	99.0	178	24	86.5	207	14	93.2	254	4	98.4	208	100	51.9	5
238	33	86.1	258	23	93.0	236	60	74.6	287	19	93.3	223	15	93.3	228	100	56.1	6
236	9	96.1	240	16	93.3	243	42	82.7	256	10	96.1	243	12	95.1	251	56	77.7	7
238	25	89.9	252	10	96.0	252	29	88.5	256	7	97.3	252	5	97.0	245	67	72.6	8
230	55	76.1	258	4	98.4	253	25	90.1							238	81	66.0	9
239	71	70.8				247	57	76.9							247	57	76.9	10
241	50	79.3				248	40	83.9							258	75	70.9	11

TABLE 2. Control Group1. The Number of Trials, the Number of Shocks, and the Percent Avoidance per subject, per session.

C-22			C-23			C-24			C-25			C-26			C-27			SESSIONS
Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	Trials	Shocks	% Av.	
213	94	55.8	118	101	14.4	170	101	40.5	109	100	8.2	126	100	20.6	109	100	8.2	1
201	92	54.2	171	100	41.5	141	100	29.0	103	100	2.9	205	100	51.2	113	100	11.5	2
218	60	72.4	193	60	68.9	233	81	65.2	104	100	3.8	211	100	52.6	124	100	19.3	3
233	57	74.4	203	70	65.5	236	24	89.8	100	100	0	120	100	16.6	247	24	90.2	4
191	32	83.2	234	85	63.6	114	14	87.7	101	100	.9	159	100	37.1	252	10	96.0	5
226	51	77.4	117	71	39.3	240	38	84.1	100	100	0	101	100	.9	250	9	96.4	6
222	46	79.2	238	95	60.0	238	24	89.9	103	100	2.9	102	100	1.9				7
234	60	74.3	225	65	71.1	254	13	94.8	101	100	.9	108	100	7.4				8
210	41	80.5	241	45	81.3	249	7	97.2	104	100	.9	120	100	16.7				9
220	62	71.8	240	56	76.6	250	1	99.1	100	100	0	147	100	32.0				10
221	64	71.0	241	50	79.3				100	100	0	130	100	23.1				11

TABLE 3. Control Group 2. The number of trials, the number of shocks, and the per cent avoidance per subject, per session.

1	2	1	1	1	1
2	1	2	1	1	1
1	1	1	2	1	2
2	1	1	2	1	1
1	2	1	1	2	1
1	2	2	1	1	2
1	2	1	2	1	1
1	2	2	1	2	2
1	2	1	1	1	1
1	2	2	1	2	1
2	2	1	2	1	1
2	1	1	1	1	2
2	1	2	1	2	2
2	1	2	1	2	1
1	1	2	2	1	1
2	2	1	1	2	1
1	1	1	1	1	1
1	1	2	1	2	2
2	2	2	1	2	1
2	1	1	1	1	2
1	2	1	2	1	1
1	1	1	2	2	2
1	1	2	2	1	2
1	1	2	1	1	1
1	1	1	2	1	2
1	1	1	2	2	2
1	1	2	1	1	1
1	1	1	1	1	2
2	2	2	2	2	2
1	1	2	1	2	1
2	2	1	2	2	2
2	1	2	2	2	1
2	2	2	2	2	2
1	1	2	1	2	1
1	2	1	2	2	1
1	1	2	1	2	1
1	1	1	1	1	1
1	2	2	2	1	1
1	2	2	1	1	1
2	1	2	1	2	2
2	2	1	1		
1					

TABLE 4. Schedule of Bar Presentations for Control Group2. A continuously revolving tape was programmed according to this schedule. The schedule reads from top to bottom, left to right. Each number represents a 4 sec. interval, 1 = bar extended and 2 = bar retracted.

Sessions	E-10		E-11		E-12		E-13		E-14		E-15	
	Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses
1	128	193	122	194	148	287	53	90	89	147	66	103
2	245	328	166	314	124	396	258	421	195	216	192	410
3	251	267	133	341	222	262	164	225	151	315	196	361
4	266	284	61	212	243	267	232	296	247	301	147	354
5			204	235			226	261	231	375		
6			223	280			203	210	221	234		
7							167	173	167	198		

TABLE 5. Experimental Group. Number of bar presentations and number of bar presses per subject, per session.

Sessions	C-16 Bar Presses	C-17 Bar Presses	C-18 Bar Presses	C-19 Bar Presses	C-20 Bar Presses	C-21 Bar Presses
1	465	222	151	416	308	414
2	410	314	252	298	317	380
3	280	321	322	273	271	365
4	253	306	293	254	199	301
5	232	248	238	238	260	256
6	287	307	300	338	256	279
7	258	281	286	295	261	295
8	259	286	297	285	264	290
9	272	298	296			247
10	330		347			277
11	328		303			272

Table 6. Control Group 1. Number of bar presses per subject, per session.

C-22		C-23		C-24		C-25		C-26		C-27		SESSIONS
Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses	Bar Present	Bar Presses	
529	759	234	138	408	279	252	159	201	88	267	158	1
512	840	410	414	355	285	247	183	468	554	219	116	2
528	801	440	344	561	783	259	165	503	680	282	217	3
547	816	475	487	542	777	241	152	285	335	542	618	4
464	745	547	463	249	239	250	140	377	362	535	413	5
523	740	286	216	535	430	247	139	253	226			6
542	793	531	399	525	355	262	130	237	259			7
542	583	504	285	548	284	250	114	271	283			8
495	740	541	358	547	264	249	137	296	266			9
526	731	541	326	546	258	212	153	350	465			10
539	755	540	298			87	288	306	387			11

TABLE 7. Control Group 2. Number of bar presentation and number of bar presses per subject, per session.