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Ethanol-Reinforced Performance of Rats: Effects of Brief Stimuli and Food Deprivation and Satiation

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ETHANOL-REINFORCED PERFORMANCE OF RATS: EFFECTS OF BRIEF STIMULI AND FOOD DEPRIVATION AND SATIATION[1,2]

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Abstract

Following the establishment of 8% w/v ethanol as a reinforcer for 6 rats three experiments were conducted in which ethanol-paired stimuli were presented during periods when ethanol was not available. The odor of ethanol and delivery-paired brief stimuli were presented to rats during extinction of ethanol-reinforced lever pressing. A clicker stimulus that indicated the ethanol-delivery component of a chain FI 32-min repeating FR 1 schedule was presented contingent upon lever presses during the FI component of the schedule. Despite differences in stimuli and in levels of food deprivation, response rates in the presence of ethanol-associated stimuli were greater than when the stimuli were absent. These differences in rate suggest that environmental stimuli paired with ethanol availability maintain ethanol-reinforced behavior.

Environments associated with previous exposure to a drug enhance the return to drug self-administration more than novel environments or environments associated with periods of abstinence. This has been demonstrated in rats made physiologically dependent on morphine (Kumar, 1972; Kumar & Stolerman, 1972; Thompson & Ostlund, 1965; Wikler & Pescor, 1970; Wikler, Pescor, Miller, & Norell, 1971), and in non-dependent rats and monkeys (Davis & Smith, 1974a; Schuster & Woods, 1968; Smith & Davis, 1973, 1974b). Similar findings have been found with amphetamine (Davis & Smith, 1974b). Additionally, stimuli paired with the intragastric delivery of ethanol facilitate lever pressing in rats (Smith, Werner, & Davis, 1977). The function of environmental stimuli in the maintenance and reacquisition of ethanol drinking, however, has not been examined.

Therefore, this series of experiments examined the effects of stimuli associated with ethanol on lever pressing maintained by access to an ethanol solution. These stimuli included: (a) brief-stimuli presented following lever presses, and (b) continuous stimuli such as the odor of ethanol.

EXPERIMENT I: Establishment of ethanol drinking and subsequent extinction with reintroduction of odor and brief stimulus cues.

Stimuli associated with food and water delivery increase rates of responding when presented during extinction of food or water-maintained behavior (Kelleher, 1958). The present experiment established ethanol as a reinforcer and presented ethanol associated stimuli during extinction of ethanol-maintained lever pressing.

METHOD

Animals

Six naive male albino Wistar rats (Bio-Lab Corporation, St. Paul, MN), eight months old at the beginning of the experiment, were individually housed in a constantly illuminated room at 24°C. Water was freely available, except for the initial training period. The rats were maintained at 80% of their free feeding weights determined at 8 months of age. Post-session feedings of Purina Rat Chow (usually 10 to 20 g) were given to maintain these weights. The maintenance weights for the rats were: PW-13, 437 g; PW-14, 369 g; PW-15, 418 g; PW-16, 398 g; PW-17, 448 g; PW-18, 428 g.

Apparatus

Six sound-attenuated operant chambers (Lehigh Valley Electronics model #143-25) were used. Each was equipped with two levers (LVE model #121-05), a solenoid-activated dipper (LVE model #1351), a pellet receptacle, and a feeder (LVE model #114-20). A houselight, six colored cue lights, and a Sonalert (2.9 KHz, Mallory and Co.) were also present. The levers were symmetrically located on the front panel with the food receptacle and dipper, left to right, between them. Each lever required a force of 0.3 N to be activated.

The 0.1 ml dipper cup was constantly in the up position except for the 0.8 sec refilling operation when the dipper cup descended into a 7.5 cm wide, 18 cm long and 2.0 cm high partially covered metal reservoir holding 250 ml of liquid. The refilling operation was accompanied by three distinct brief stimuli: offset of the light illuminating the dipper cup, a 0.8 sec

operation of the Sonalert, and a distinct click produced by the dipper arm striking the reservoir bottom.

Masking white noise was continuously present in the experimental room. Data recording and programming equipment was located in an adjacent room.

The 8% w/v ethanol solutions were prepared with 95% v/v ethanol in tap water at least one day before use and were kept in stoppered flasks at room temperature. All measured volumes were corrected for losses due to evaporation and spillage by subtracting mean measured losses.

Procedure

Acquisition of water-reinforced lever pressing. After 24 hr of water deprivation in home cages, the rats were placed in the operant chambers and trained to press the right lever. Each press on the right lever resulted in refilling the dipper with water. The 4-hr sessions began at the same time each day. Water was restored to the rats' home cages after three sessions of fixed-ratio 1 (FR 1) responding. Then, the rats were similarly trained to press the left lever. Each press on the left lever during the second two hr of the session resulted in the presentation of a single 45 mg Noyes food pellet. This second 2-hr component was signalled by illumination of the cue lights and offset of the houselight. Water was continuously available throughout the 4-hr session.

After two sessions an intermittent schedule of food presentation was introduced, a signalled DRL n schedule. Food availability was signalled by the offset of the houselight and illumination of the cue lights, as before. Each press on the left lever during the DRL n period delayed food

availability for n seconds. Presses spaced at least n seconds apart were followed by delivery of the food pellet, offset of the cue lights and onset of the houselight signalling a new DRL n period. One session was run with DRL values of 5, 10, and 20 sec. Rats PW-13, 14, and 15 received five sessions at DRL 40 sec; rats PW-16, 17, and 18 received 30 sessions at DRL 40 sec.

Ethanol-reinforced lever pressing. Five sessions were run under the signalled DRL 40 sec FR 1 schedule with 8% ethanol in the reservoir in place of water. Then, the food component was discontinued such that presses on the left lever, although recorded, had no programmed consequences. The cue lights were no longer used, and illumination was provided by the houselight. Subsequently, the FR requirement on the right lever was increased to FR 2, FR 4, and then to FR 8, at which value lever-pressing rates were allowed to stabilize. Next, water was substituted for the ethanol. Water was present until five stable sessions occurred, and then 8% ethanol was reintroduced. Response rates were again allowed to stabilize. Lever pressing was judged stable when visual inspection of the data revealed no steady increasing or decreasing trends over five consecutive sessions.

Extinction with reintroduction of ethanol associated stimuli. During this phase of the experiment, water was placed in the reservoir so that no odor of ethanol was present. For three sessions presses on the right lever had no programmed consequence. Subsequently, 8% ethanol replaced the water for three or four more sessions with presses on the right lever having no consequence. Next, the reservoir was placed to the side such that operation of the dipper produced all the stimuli originally associated with the

refilling operation without actually refilling the dipper with liquid. The dipper was scheduled to operate after the first right lever press, and then after every fourth lever press (FR 4). Daily sessions were conducted under this schedule until the rats pressed the lever less than five times in one 4-hr session.

The number of sessions at each condition for the individual rats in this and in subsequent experiments is listed in the Appendix.

RESULTS AND DISCUSSION

Substitution of ethanol for water during schedule-induced polydipsia (SIP) has been shown to quickly and reliably establish ethanol as a reinforcer for both rats and monkeys (Meisch, 1977). The present experiment replicated an SIP procedure used in this laboratory to establish etonitazene as a reinforcer for rats (Meisch & Stark, 1977), but with 8% w/v ethanol in place of etonitazene solutions.

Acquisition of lever pressing and ethanol-reinforced performance. During the DRL periods, the rats emitted many presses on the right lever, that is, they showed typical SIP behavior. When ethanol was substituted for water under SIP, the high rates of lever pressing were maintained or only slightly reduced (Table I). The reduction in 4-hr rates was accounted for by reduced rates of lever pressing in the second 2-hr SIP period (Figure 1).

There were large differences between rats in the number of SIP dipper presentations, but the subsequent levels of FR 8 dipper presentations were more uniform (Figure 1). The temporal pattern of lever pressing for all

TABLE I

Total dipper presentations during acquisition manipulations (means of five sessions ± S.E.M.). This data is also presented in Figure 1.

Rats	0% SIP	8% SIP	8% FR 1	8% FR 8	0% FR 8	8% FR 8
PW-13	158 (43)	130 (39)	110 (15)	123 (6.6)	0.2 (0.2)	149 (8.8)
PW-14	556 (51)	401 (90)	146 (33)	103 (7.3)	1.4 (0.5)	107 (13)
PW-15	667 (65)	758 (138)	225 (30)	243 (11)	1.2 (0.4)	340 (20)
PW-16	575 (49)	289 (38)	119 (25)	147 (13)	4.4 (3.7)	184 (30)
PW-17	973 (113)	356 (88)	209 (20)	346 (16)	2.0 (0.7)	270 (11)
PW-18	263 (27)	220 (26)	121 (15)	126 (42)	3.0 (1.6)	178 (11)
GROUP	532 (119)	361 (90)	155 (20)	181 (39)	2.0 (0.6)	205 (35)

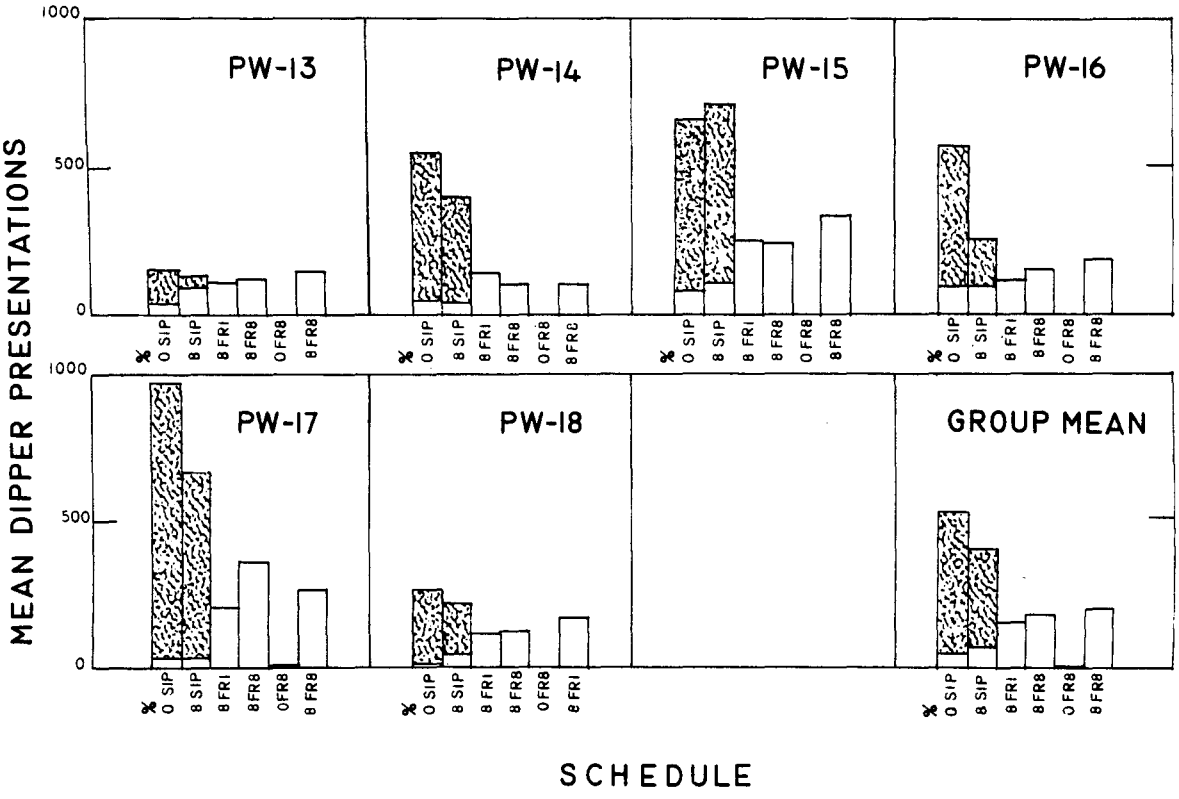

Figure 1. Mean dipper presentations in 4-hr sessions of acquisition manipulations. Each bar represents the mean of five sessions at each value. The filled portion of the bars represent dipper presentations during the second 2-hr period of the session under conditions of schedule-induced polydipsia (SIP). The open bars represent periods where food-lever presses were without consequence. The liquid in the reservoir is indicated by 0% (water) or 8% (8% w/v ethanol), and the schedule of liquid presentation is shown below each bar.

ratio values was consistent with previous studies: a large burst of responding occurred at the beginning of the 4-hr session followed by a period of long pauses with lower rates of lever pressing (Meisch & Thompson, 1973). The quantity of ethanol consumed varied with the number of dipper presentations, but it showed less variability between rats when calculated on a per weight basis (Table II).

When water was substituted for ethanol to evaluate the role of nonspecific liquid intake, lever pressing was not maintained (Figure 1). Because ethanol maintained more lever pressing than water at FR 8, ethanol functioned as a reinforcer.

Except for the time immediately after the food schedule was withdrawn, rates of pressing of the left lever were very low, between 0 and 10 per 4-hr session in all rats, and did not significantly change during any phase of the three experiments.

Extinction responding with reintroduction of ethanol-associated stimuli. Response rates decreased when all stimuli were withheld, but on the fourth day of extinction all six rats increased lever pressing when 8% ethanol replaced water in the reservoir (Figure 2). Increased lever-pressing rates in the presence of the odor of ethanol indicate that the odor was functioning as a discriminative stimulus. This finding confirms a previous report (Meisch & Thompson, 1973).

Figure 2 also shows that five out of six rats increased lever pressing when the brief stimuli associated with dipper operation were presented contingent upon lever pressing on the seventh or eighth day of extinction. However, lever-pressing rates were higher than baseline extinction rates for

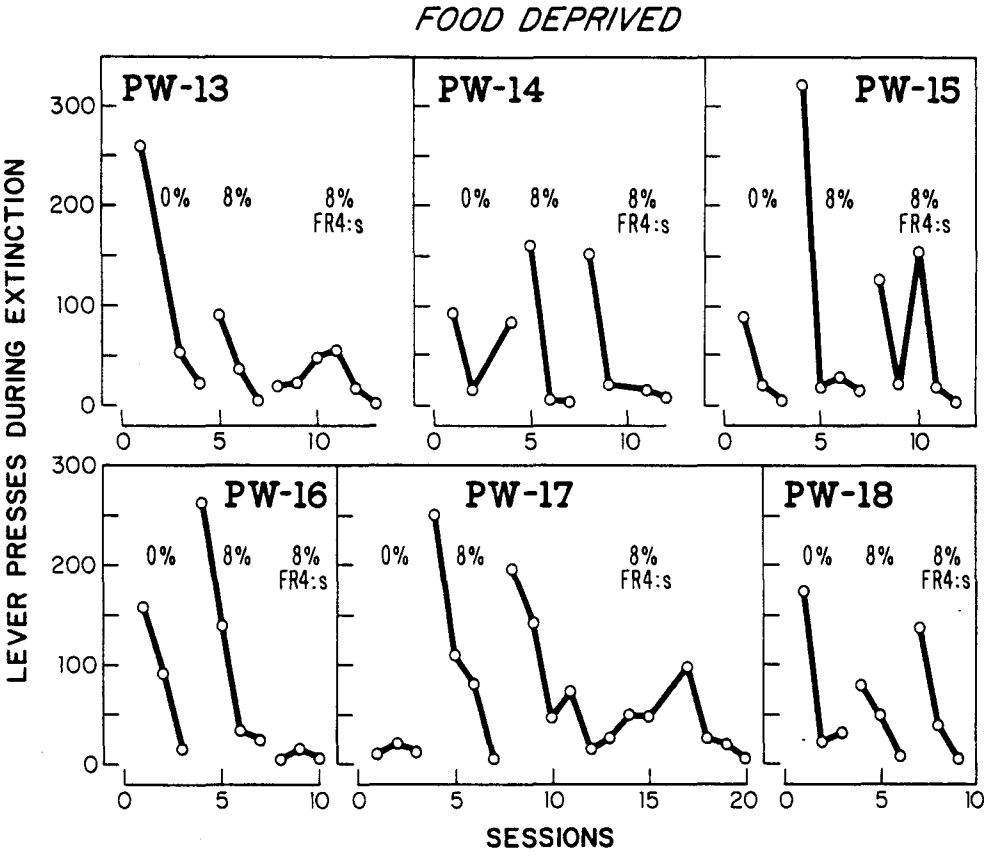

Figure 2. Lever presses emitted by each rat in consecutive extinction sessions of Experiment I. 0% indicates that the odor of ethanol was absent for the first three sessions. 8% indicates the presence of the odor of ethanol. Sessions with response-contingent brief stimuli are indicated by FR 4:s.

only a few sessions. This indicates that under these extinction conditions, ethanol-associated stimuli were insufficient to maintain lever pressing.

The failure to maintain adequate response rates is a shortcoming of procedures involving extinction baselines. However, these procedures have been successfully applied in evaluating the reinforcing efficacy of drugs, the stimulus properties of drugs, and the effects of drug antagonists (Davis & Smith, 1972, 1976; Smith & Davis, 1973a, 1973b), because direct behavioral effects of drugs are avoided (Kelleher, 1958). Extinction procedures also do not require extensive training histories.

The pattern of responding throughout all three phases of extinction was characteristic of patterns of behavior resulting from the withdrawal of more conventional reinforcers; that is, a large burst at the beginning of the session followed by a low rate during the rest of the session. Lever presses that produced brief stimuli were usually followed by bursts of responding. Pauses following stimulus presentation, characteristic of FR performance, were seldom seen.

EXPERIMENT II. Effects of food satiation on ethanol-reinforced and extinction performance.

Both food and stimuli paired with food are effective in maintaining responding in food-restricted animals (Kelleher, 1961). Since the rats in Experimental I were food restricted, the caloric value of ethanol could have explained rate increases seen when the ethanol-associated stimuli were reintroduced. The purpose of this experiment was to reintroduce ethanol-associated stimuli to food-satiated rats during extinction.

METHOD

Animals

The rats were the same as those used in the previous experiment.

Apparatus

The apparatus was the same as that used in the previous experiment.

Procedure

Immediately after Experiment I, all rats were given five sessions of 8% ethanol under FR 1. They were then restricted to their home cages for five weeks with free access to Purina Rat Chow and water. Daily sessions of 8% ethanol were then resumed under FR 1, and stable ethanol-reinforced responding was reestablished. The FR requirement was increased to FR 2, to FR 4, and then to FR 8, as in Experiment I. Lever pressing was judged stable when visual inspection of the data revealed no trends or gross deviations over five consecutive sessions.

Extinction sessions were then programmed as in Experiment I, first with no stimuli present, then with the odor of ethanol present, and finally with response-contingent brief stimuli present. (Rat PW-18 received one additional session before the brief stimuli were reintroduced).

RESULTS AND DISCUSSION

In the five weeks of free access to food, the rats increased in weight: PW-13, 437 to 585 g; PW-14, 369 to 451 g; PW-15, 418 to 601 g; PW-16, 398 to 523 g; PW-17, 448 to 580 g; PW-18, 428 to 600 g.

When sessions resumed, ethanol-reinforced lever pressing was both

reduced and variable. Stable performance under FR 8 was gradually reestablished. For the food-satiated condition, dipper presentation rates and ethanol intakes were about half of the values observed in Experiment I (Table II). This decrease is consistent with that observed in previous studies at FR 8 (Meisch & Thompson, 1973). This difference in ethanol consumption could be due to many factors, such as the caloric value of ethanol or different rates of absorption or metabolsim of ethanol.

Figure 3 shows that during extinction four out of six rats increased lever pressing when the odor of ethanol was introduced to food-satiated rats, and three out of six rats showed rate increases when the response-contingent brief stimuli were presented. As in Experiment I, the rate increases were only transient. These findings suggest that the results of Experiment I are only partially explained by the calorie value of the ethanol solutions.

Like the ethanol-maintained responding, the lever-pressing rates during extinction were considerably lower in food-satiated rats than food-deprived rats (Figure 4). However, in both Experiments I and II, relative to ethanol-reinforced rates, the lever-pressing rates during extinction were comparable. Additional comparison of behavior during extinction is complicated by the fact that the rats had previously experienced extinction during Experiment I.

The pattern of lever pressing throughout this experiment was the same as observed in Experiment I; that is, nearly all of the lever presses in a session occurred within the first 10 min of each session.

TABLE II

Dipper presentations and ethanol intake (mg/100g/hr) at FR 8 (means of five sessions ± S.E.M.), food deprived (Experiment I) vs. food satiated (Experiment II).

	Experiment I: Food Deprived		Experiment II: Food Satiated	
Rats	Dipper Presentations	Intake mg/100 g/hr	Dipper Presentations	Intake mg/100 g/hr
PW-13	149.0 (8.8)	91.6 (5.5)	142.2 (19.5)	45.2 (4.8)
PW-14	106.6 (12.9)	78.6 (9.6)	34.6 (4.0)	24.3 (2.3)
PW-15	339.6 (19.8)	67.6 (4.7)	92.8 (17.2)	34.6 (7.0)
PW-16	184.4 (23.3)	68.4 (6.1)	154.2 (23.7)	65.7 (11.1)
PW-17	270.4 (10.8)	62.5 (1.4)	148.2 (11.5)	37.3 (3.5)
PW-18	177.6 (11.1)	47.6 (6.2)	82.8 (11.6)	23.6 (3.0)
GROUP	204.6 (34.8)	69.4 (6.1)	109.1 (19.3)	38.5 (6.4)

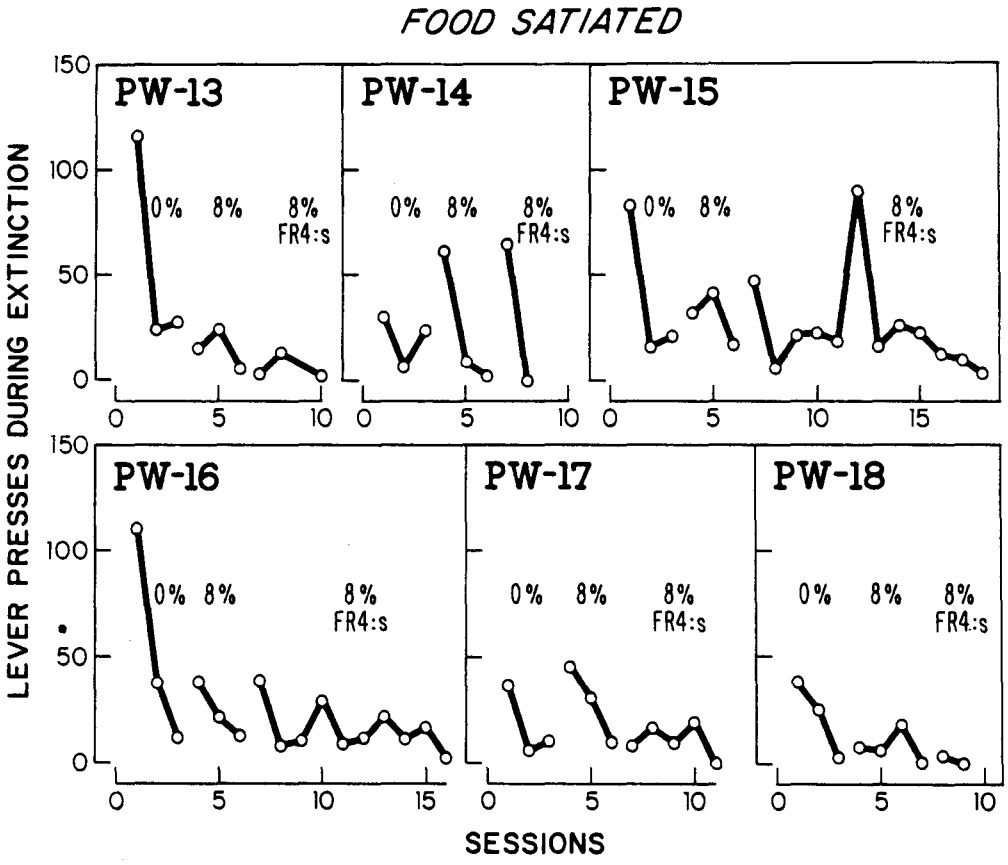

Figure 3. Lever presses emitted by each rat in consecutive extinction sessions of Experiment II. 0% indicates that the odor of ethanol was absent for the first three sessions. 8% indicates the presence of the odor of ethanol. Sessions with response-contingent brief stimuli are indicated by FR 4:s.

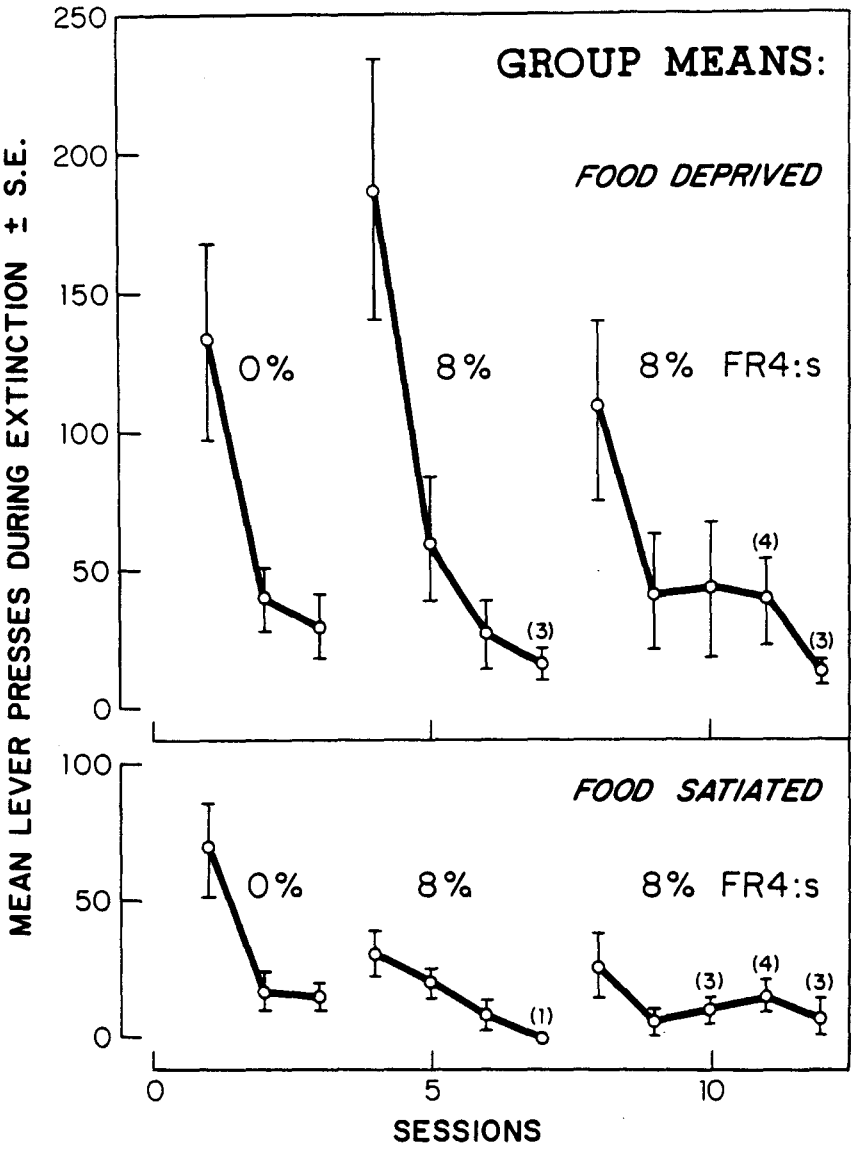

Figure 4. Mean lever presses emitted during extinction by the rats in consecutive sessions of Experiment I (upper panel) and Experiment II (lower panel). 0% indicates that the odor of ethanol was absent for the first three sessions. 8% indicates the presence of the odor of ethanol. Sessions with response-contingent brief stimuli are indicated by FR 4:s. All points represent the mean of six rats except where a numeral in parentheses indicates the size of n. Brackets indicate standard errors of the mean.

EXPERIMENT III: Response-contingent brief stimulus presentation during a 32-min fixed-interval schedule.

Introduction of the odor of ethanol and response-contingent brief stimuli produced rate increases in Experiments I and II, but the effects were only transient as ethanol was withheld. Rate increases due to response-contingent stimuli have been shown to persist in schedules which maintain pairing of the stimuli with food or water primary reinforcers (DeLorge, 1967; Kelleher, 1958; Thomas, 1969; Zimmerman, 1969). This experiment maintained pairing of a clicker with ethanol delivery during one component of a chain schedule while presenting it contingent upon responding as a probe during another component when ethanol was not available.

METHOD

Animals

Three rats (PW-15, PW-17, and PW-18) from the previous experiment were used. They were maintained at their free-feeding weights.

Apparatus

The operant chambers were the same as those used in the previous experiments. A 20 Hz modified relay clicker stimulus was added.

Procedure

Acquisition of baseline FI performance. Immediately after Experiment II the rats were run under an FR I schedule of 8% ethanol presentation. A 20 Hz clicker was continuously on signalling liquid availability. Next, a chain FI 15-sec FR 1 schedule was introduced such that the first lever press

after 15 sec turned on the clicker, and the following lever press activated the dipper and turned off the clicker. This schedule was systemically advanced to produce a longer FI first component and a recycling FR 1 in the second component.

Table III indicates the number of sessions each rat was run at each schedule value while the interval size and number of liquid deliveries per second component were systemically increased. The terminal schedule for each rat was chosen such that the rats entered only one FI chain per session. The terminal, or baseline schedule for PW-17 and PW-18 was chain FI 32-min 128 FR 1, and the terminal schedule for PW-15 was chain FI 64-min 256 FR 1.

Introduction of response-contingent brief stimuli. When visual inspection of the data showed no steady increasing or decreasing trends in the performance on these baseline schedules, an FR schedule of clicker-stimulus presentation was superimposed upon the FI component of the baseline schedule. During the FI component, completion of an FR 4 or FR 8 on the same right lever produced a 1-sec presentation of the clicker. The schedule during the first component of the chain schedule was a conjoint FI 32-min FR 4: brief stimulus schedule when the FR 4: brief stimulus probe was in effect (Catania, Deegan and Cook, 1966). The first response after 32 minutes (64 min for PW-15) turned the clicker continuously on and the following 128 responses (256 responses for PW-15) produced ethanol deliveries, as was the case under the baseline schedules. Ratio values of FR 4 and FR 8 were each tested and retested for ten sessions. At least ten sessions of baseline were run between each new FR value to reproduce a stable baseline condition.

TABLE III

Number of sessions for each rat during acquisition of chain FI x, N FR 1 baseline in Experiment IV

FI value	N	Rats PW-15	PW-17	PW-18
15-sec	1	9	5	5
30-sec	2	5	5	6
1-min	4	6	6	5
2-min	8	10	5	5
4-min	16	10	5	6
8-min	32	13	5	11
16-min	64	10	10	10
32-min	128	10	60*	37*
64-min	256	38*		

* Terminal baseline schedule

RESULTS AND DISCUSSION

Baseline FI performance. Lever pressing during FI component of the baseline schedule was characterized by low, constant rates of responding (Figure 6). Typical positively accelerated FI responding was not seen, possibly due to the rats' long history of FR schedules and insufficient experience with the FI schedule.

The FR 1 component was marked by a large initial burst of lever pressing followed by periods of long pauses. This pattern is identical to that seen when the rats were responding under a simple FR 1 schedule prior to the introduction of the FI chain schedule (Figure 7), and is characteristic of ethanol-reinforced responding (Meisch & Thompson, 1973). Rats never completed all the 128 or 256 FR 1 responses necessary to initiate a new FI component.

Response contingent brief stimuli. Introduction of the FR 4 or FR 8 brief stimulus contingency produced an increase in lever pressing within the first few minutes of the FI component. This initial rate increase, like that seen when stimuli were presented in Experiments I and II, rapidly diminished over two to three sessions. However, mean lever-pressing rates during the FI component with brief stimulus presentations remained higher than baseline FI rates (Table IV and Figure 5).

The distribution of lever presses during the FI component with brief stimuli showed negative acceleration in PW-15 and PW-18 and was relatively uniform in PW-17 (Figure 6). The patterning of responses throughout the brief presentations of the clicker was similar to those seen in Experiments I and II, where presentations of the dipper-associated stimuli were usually

TABLE IV

Fixed-interval lever presses (means of the last five sessions at each condition ± S.E.M.).

Rats	BASELINE		CONJOINT FR BRIEF STIMULI	
	FI 32, 128 FR 1	FI 64, 256 FR 1	FR 4:s	FR 8:s
PW-17	38.2 (15)		197 (24)	
	21.8 (6.1)		74.6 (40)	
	30.2 (16)			74.0 (29)
	22.8 (13)			
mean	28.3 (6.4)		135.8 (44)	
PW-18	13.6 (1.5)		23.8 (4.6)	
	8.0 (1.9)		23.8 (1.9)	
	7.2 (2.6)			37.0 (22)
	7.4 (3.4)			15.2 (6.9)
	6.2 (2.5)			
mean	8.4 (1.3)		23.8 (2.4)	26.1 (10.9)
PW-15		48.2 (9.1)	88.4 (31)	

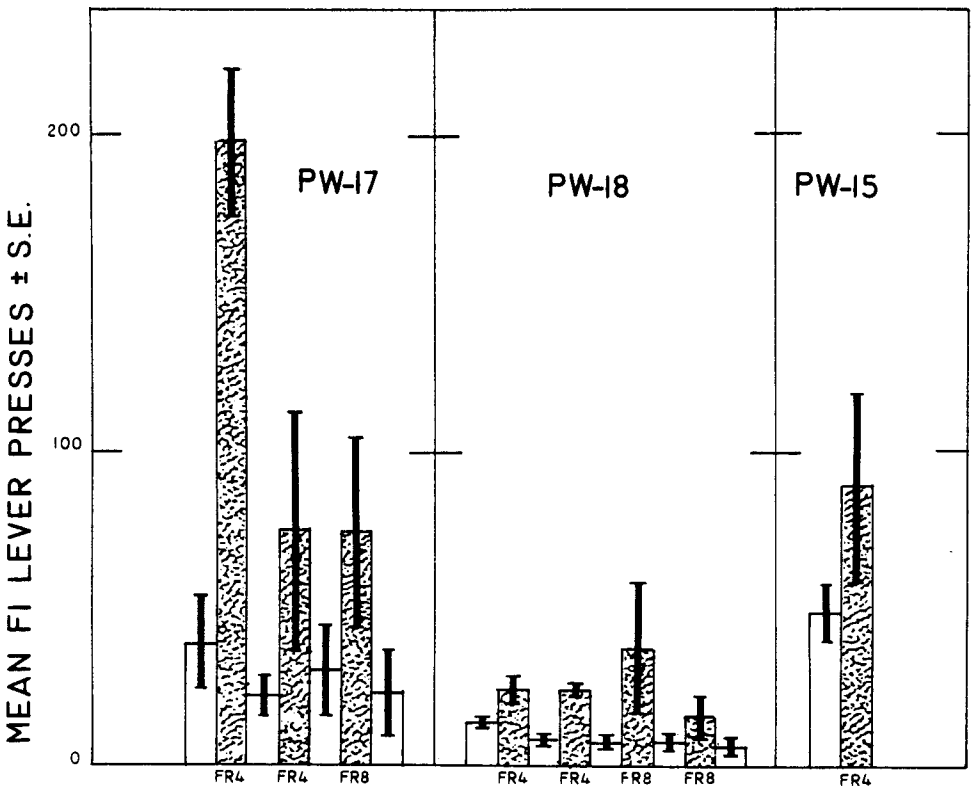

Figure 5. Mean lever presses during the FI component of the terminal schedules of Experiment III. Each bar represents the mean of the last 5 days at each condition. Open bars indicate the baseline FI. The filled bars indicate sessions where the clicker stimulus was presented briefly following completion of conjoint FRs during the interval. The magnitude of the FR value is indicated at the base of each bar. Brackets indicate standard errors of the mean.

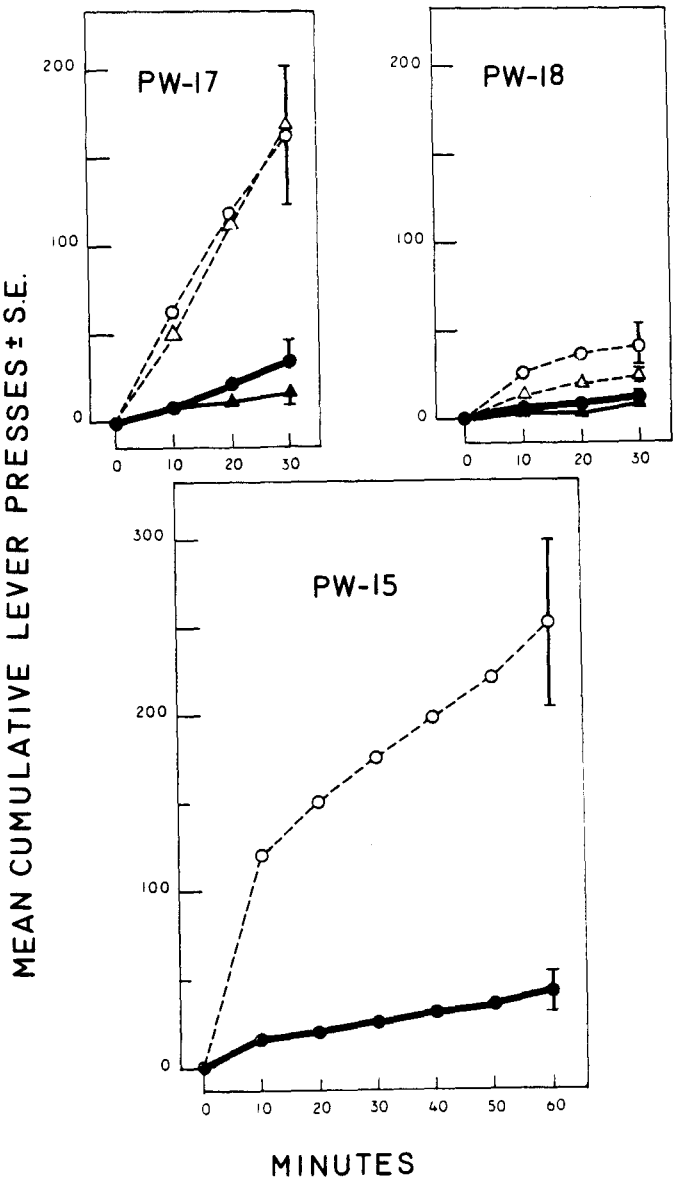

Figure 6. Cumulative lever presses during the FI component of Experiment III. Filled circles represent the means of the last 5 days at the baseline schedule before the first introduction of the brief stimulus. Open circles represent the means of the first 5 days with the brief presentations of the clicker. Open triangles represent the means of the next 5 days with the brief stimuli. Filled triangles represent the means of the last 5 days following the return to the baseline schedule. Each point was obtained by cumulating 10-min printouts and taking the mean across 5 consecutive days. Standard errors of the mean for the last point are indicated by the brackets, except where they fall within the area occupied by the plotted point.

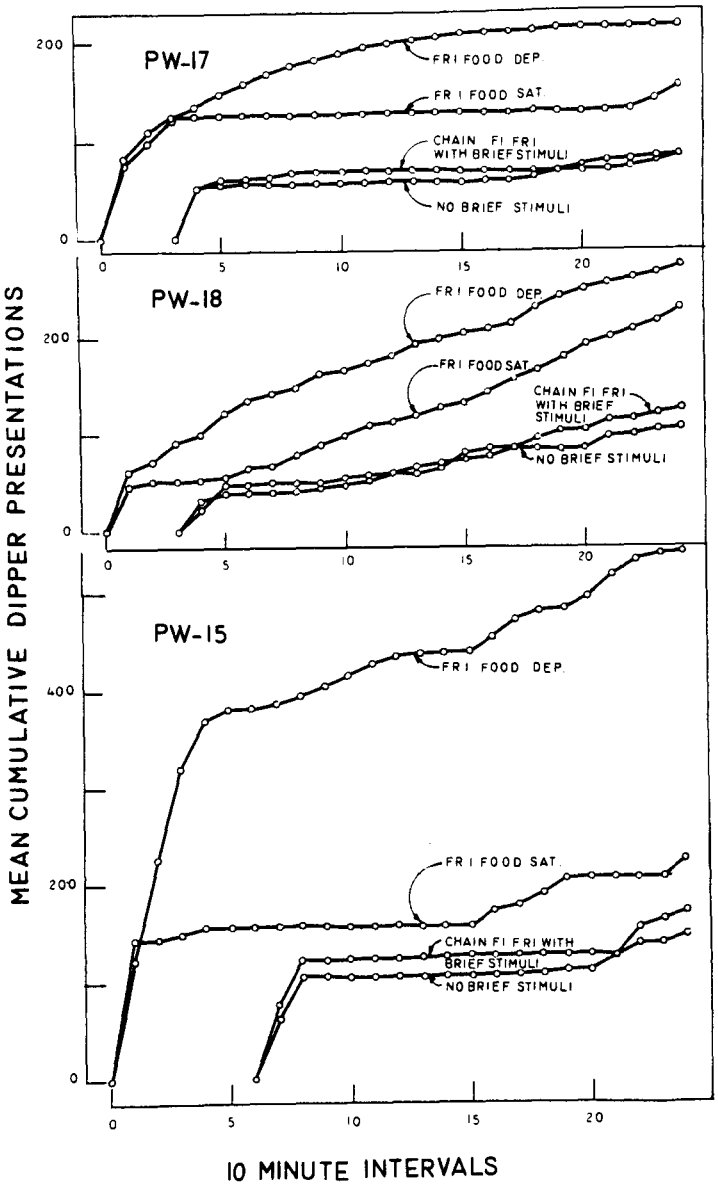

Figure 7. Cumulative dipper presentations for the three rats of Experiment III during various phases of all three experiments. Each point was obtained by cumulating 10-min printouts and taking the mean across 5 consecutive days. The curves labelled FR 1 FOOD DEP are the means of the five sessions immediately following Experiment I. The curves labelled FR 1 FOOD SAT are the means of the five sessions immediately following Experiment II. The curves labelled NO BRIEF STIMULI are the means of the last five sessions of the terminal schedule of Experiment III immediately preceding the first introduction of the brief stimulus. The curves labelled CHAIN FI FR 1 WITH BRIEF STIMULI are the means of the first five sessions of the terminal schedule of Experiment III during the first introduction of the brief clicker stimulus.

followed by a burst of lever pressing. The presence of the brief stimuli in the FI component had no effect on the ethanol-reinforced lever pressing in the second component (Figure 7).

SUMMARY

In this series of experiments: (1) ethanol was established as a positive oral reinforcer for rats; (2) the odor of ethanol functioned as a discriminative stimulus; (3) response-contingent presentations of stimuli paired with ethanol delivery increased rates of lever pressing in extinction; (4) ethanol-associated stimuli increased lever-pressing rates beyond that attributable to pairing with the calories in ethanol; and (5) the maintenance of the higher lever-pressing rates produced by response-contingent brief stimuli required the continued pairing of stimuli with ethanol. These findings extend to ethanol the generalization that stimuli associated with drug delivery can continue to exert control over an organism's drug-seeking behavior during periods when the drug is not available.

Other variables may affect stimulus facilitation of ethanol-reinforced lever pressing, but were not systematically studied in these experiments. The nature and duration of the brief stimuli, and variables concerned with the pairing of the stimuli with ethanol were not examined. Additional study of these and other variables could determine the conditions which control the resistance of ethanol drinking to extinction and the likelihood of resumption of ethanol drinking following abstinence.

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APPENDIX: Experimental histories of PW-rats:
Number of sessions in each manipulation

EXPERIMENT 1.	PW-13	PW-14	PW-15	PW-16	PW-17	PW-18
initial water training	8	8	8	7	7	7
initial food training	2	1	2	1	1	2
DRL 5-sec	1	1	2	1	1	1
DRL 10-sec	1	1	1	1	1	1
DRL 20-sec	2	1	1	1	1	3
DRL 40-sec	5	6	5	29	34	32
DRL 40-sec 8%	6	6	6	6	5	5
FR 1 8%	11	11	10	5	16	12
FR 2 8%	2	2	1	2	2	2
FR 4 8%	10	3	3	3	3	3
FR 8 8%	14	21	26	44	43	40
FR 8 water	9	8	15	7	6	9
FR 8 8%	17	10	14	59	12	13
extinction	3	3	3	3	3	3
extinction + odor	3	3	4	4	4	3
extinction + FR 4:s	6	4	5	3	12	3
EXPERIMENT 2.						
FR 1 8%	7	11	12	7	8	15
free feeding in H.C.	41	41	41	35	41	41
FR 1 8%	43	63	50	31	59	76
FR 1 8% + saccharine*	48	68	40			37
FR 2 8%	23	20	14	6	31	13
FR 4 8%	17	14	17	6	5	15
FR 8 8%	18	31	29	14	7	18
extinction	3	3	3	3	3	3
extinction + odor	3	3	3	3	3	4
extinction + FR 4:s	3	2	12	10	5	2
EXPERIMENT 3.						
FR 1 + clicker		12	5	21	13	6
FI 15-sec FR 1			9	5	5	5
FI 30-sec 2 FR 1			5	5	5	6
FI 1-min 4 FR 1			6	6	6	5
FI 2-min 8 FR 1			10	5	5	5
FI 4-min 16 FR 1			10	5	5	6
FI 8-min 32 FR 1			13	3	5	11
FI 16-min 64 FR 1			10		10	10
FI 32-min 128 FR 1			10		60	37
FI 64-min 256 FR 1			38			
FR 4:s			8		12	10
no stimuli					8	8
FR 4:s					10	8
no stimuli					42	11
FR 8:s					11	10
no stimuli					14	15
FR 8:S						8
no stimuli						14

* 0.65-2.6 mg/ml Na Saccharine was added to ethanol solutions as part of another experiment.