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Ethanol as a Reinforcer for Rats
under Conditions of Concurrent Access
to Food and Water

by

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Ethanol as a Reinforcer for Rats under Conditions of Concurrent Access to Food and Water.[1]

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ABSTRACT

In three related experiments, dippers filled with water or an ethanol solution were presented to male Wistar rats contingent on lever pressing under a concurrent fixed-ratio 1 (water) fixed-ratio 1 (ethanol) schedule. In Experiment 1, when maintenance feedings were given during instead of following the daily 3-hr sessions, the feedings increased drinking of both 8% (w/v) ethanol and water, with 8% ethanol being consumed in greater volumes than water. In Experiment 2, which was a 28-day transitional period from the food-deprived to the food-satiated phase, continuous access to food during 3-hr sessions moderately decreased 8% ethanol intake, and increased water intake and total liquid intake (water plus 8% ethanol). In Experiment 3, concurrent water and ethanol intake of food-satiated rats were compared over two identical series of ethanol concentrations (8, 11.3, 16, 22.6, 32, and 8% retest w/v). Food was freely available both in the operant conditioning chambers and home cages. The number of dipper presentations of ethanol exceeded presentations of water for each rat at each concentration studied. Presentations of water were low in number and did not vary with the ethanol concentration. As the ethanol concentration was increased, the number of ethanol presentations decreased, while the quantity consumed (mg/100g body weight/hr) generally increased.

Lester and Freed (1972) have argued that food-deprived rats consume ethanol for its caloric value and not for its pharmacological properties. Since it is unlikely that human alcohol abuse is maintained by caloric need, they have argued that the use of food-deprived rats in an animal model of human ethanol drinking lacks "meaningfulness". However, if rats that are given continuous access to food and water consistently drink more ethanol than water, it seems likely that they would do so for reasons other than to satisfy hunger or thirst.

Previous reports (for reviews see Meisch, 1977; Myers & Veale, 1972; Wallgren & Barry, 1970) have indicated that food-satiated rats prefer water to ethanol concentrations above 6% (w/v) when given a choice between water and ethanol in the presence of an unlimited supply of solid food. These findings are in agreement with Lester and Freed's hypothesis. However, Meisch and Thompson (1973) reported food-satiated rats drank greater volumes of 8% (w/v) ethanol than of water, and showed that food-satiated rats consume ethanol concentrations of 2, 4, 8, 16, and 32% (w/v) in excess of water control values (1974a). The Meisch and Thompson studies differed from these other studies, however, in that they explicitly established ethanol as a reinforcer prior to testing and did not have food and water concurrently available with ethanol. The present study was thus conducted to determine if rats with an ethanol-reinforcement history would prefer ethanol to water, especially at high concentrations, when given continuous access to both food and water. Also, the effects of other feeding regimens on ethanol intake were examined to aid in evaluating Lester and Freed's caloric hypothesis.

Experiment 1. Within-session or post-session maintenance feedings: Effects on concurrent performances maintained by 8% ethanol and water. Freed and Lester (1970) have hypothesized that " ... the caloric value of ethanol and not its pharmacodynamic action, is a prime factor in its ingestion." A careful reading of their papers reveals that the hypothesis has never been stated in a manner that permits experimental refutation (Freed, 1972, 1974; Freed, Carpenter, & Hymowitz, 1970; Freed & Lester, 1970; Lester & Freed, 1972). One testable formulation of the hypothesis is that the ethanol intake of animals is due to a concurrent absence of their normally consumed food. The present experiment tested this formulation of the hypothesis by giving food-deprived rats their maintenance feedings either after the session or during the session.

METHODS

Subjects. Four experimentally naive male albino Wistar rats (Bio-Lab Corporation, St. Paul, MN), approximately 140 days old at the beginning of the study, were individually housed in a continuously illuminated room with the temperature at 24^{o} C. Initially, the rats were maintained at 80% of their free-feeding weight as determined at 4.5 months of age. Their 80% weights were: 342 g (SB-1); 357 g (SB-4); 388 g (SB-5); and 361 g (SB-6). During Experiment 3, when the rats were food satiated, their weights stabilized at approximately the following values: 599 g (SB-1); 583 g (SB-4); 578 g (SB-5); and 600 g (SB-6). Water was always available in the rats' home cages except during the initial training period, when lever pressing for water was being established (see following Procedure).

Apparatus. Two identical sound-attenuated commercial operant--conditioning chambers (Lehigh Valley Electronics, #1414) were equipped with two levers and two solenoid-driven liquid dippers (LVE, #1351). The levers and liquid dippers were symmetrically centered on the front panel, with the dippers placed lateral to the levers. Three colored jewel lights located above each lever provided general illumination. A 4.76-W white light was located 3.2 cm above the hole in the panels where the dipper cups were positioned when in the up-available position. Each lever press resulted in the refilling of the dipper cup with 0.11 ml liquid. The dipper was lowered into the reservoir and then returned to the up-available position. Simultaneous with the dipper cup refilling operation was the 0.8-sec sounding of a tone (Sonalert, 2900 Hz, Mallory & Co.) and illumination of the white light above the dipper-panel opening. Liquid was contained in partially covered reservoirs to minimize evaporation. White masking noise was constantly present, and an exhaust fan provided ventilation.

Programming and data recording were automatically controlled by standard electromechanical equipment in an adjacent room. The temporal pattern of responses and dipper presentations was continuously recorded by a cumulative recorder and by a counter which printed out every 5 min.

The ethanol solutions expressed in grams percent (w/v), were prepared using 95% (w/v) ethanol in tap water. The solutions were prepared at least 20 hr before use and were kept in stoppered flasks at room temperature. The volume consumed was measured at the end of each session by subtracting the volume remaining from the volume added to the reservoir, corrected for evaporation. If the volume measured by this method was greater than the product of dipper cup size (0.11 ml) times the number of dipper presentations, then this product was used for the volume consumed.

Procedure. Table 1 summarizes the training procedure for establishing concurrent lever pressing for water and 8% ethanol and the manipulations made during all experiments.

Establishment of Lever Pressing for Water. To induce drinking in the operant conditioning chambers, water bottles were removed from the rats' home cages 24 hr before the start of the first session. Daily feedings of Purina Rat Chow, sufficient to maintain the rats at 80% of their free-feeding weights, were placed in wire food hoppers in the operant-conditioning chambers to further induce drinking. During the first session, dipper presentations of water occurred at the left side for rats SB-5 and SB-6, and at the right side for rats SB-1 and SB-4. The dippers were presented noncontingently on a variable time 1-min schedule of reinforcement (VT 1-min). After the first session, the VT 1-min schedule was discontinued, and in the next 1 to 3 sessions, dipper presentations of water, at the right side for rats SB-5 and SB-6 and at the left side for rats SB-1 and SB-4, were used to shape presses on the appropriate lever. Each lever press at the side where water was available resulted in a dipper presentation, *i.e.*, each lever press was reinforced on a fixed-ratio 1 reinforcement schedule (FR 1). After the rats learned to lever press, 3 to 4 more sessions were conducted in which lever pressing was reinforced on a FR 1 schedule at the assigned side. In the next 1 to 2 sessions, the rats were shaped to lever press for dipper presentations of water at the side opposite to that on which they were initially trained

Table 1. Sequence of training and experimental phases

Phases	Home Cage Food	Home Cage Water	Operant Chamber Number of Sessions	Food	Rat	Left Side	Right Side
			Experiment 1				
Establishment of lever pressing for water	-[a]	-[b]	1	+[d]	SB-5, SB-6	VT 0%	NC[c]
					SB-1, SB-4	NC	VT 0%
	-	-	1-3	+	SB-5, SB-6	Shaping 0%	NC
					SB-1, SB-4	NC	Shaping 0%
	-	-	3-4	+	SB-5, SB-6	0%	NC
					SB-1, SB-4	NC	0%
	-	-	1-2	+	SB-5, SB-6	NC	Shaping 0%
					SB-1, SB-4	Shaping 0%	NC
	-	-	3	+	SB-5, SB-6	NC	0%
					SB-1, SB-4	0%	NC
	-	+[e]	4	+	All 4 Rats	Alternation of 0% & NC	
Establishment of ethanol as a reinforcer	-	+	2	+	All 4 Rats	Alternation of 2% & NC	
	-	+	4	+	All 4 Rats	Alternation of 4% & NC	
	-	+	6	+	All 4 Rats	Alternation of 8% & NC	
	+[d]	+	10	-	All 4 Rats	Alternation of 8% & NC	
No Food	+	+	≥10	-	All 4 Rats	Alternation of 8% & 0%	
Food	-	+	≥10	+	All 4 Rats	Alternation of 8% & 0%	
No Food (retest)	+	+	≥10	-	All 4 Rats	Alternation of 8% & 0%	

Table 1. Sequence of training and experimental phases (continued)

Phases	Home Cage Food	Home Cage Water	Operant Chamber: Number of Sessions	Operant Chamber: Food	Operant Chamber: Rat	Operant Chamber: Left Side	Operant Chamber: Right Side
Experiment 2							
Transition Phase	-	+	28	+[f]	All 4 Rats	Alternation of 8% & 0%	
Experiment 3							
Determination I: Food-satiated phase; concentration manipulations	+[f]	+	≥10	+	All 4 Rats	Alternation of 8% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 11.3% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 16% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 22.6% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 32% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 8% & 0%	
Determination II: Food-satiated phase; concentration	+	+	≥10	+	All 4 Rats	Alternation of 8% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 11.3% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 16% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 22.6% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 32% & 0%	
	+	+	≥10	+	All 4 Rats	Alternation of 8% & 0%	

[a] absence of food

[b] absence of water

[c] no consequences followed response

[d] sufficient food given to maintain rats at 80% of free-feeding weight

[e] free access to water

[f] free access to food

(*i.e.*, the right side for rats SB-5 and SB-6, and on the left side for rats SB-1 and SB-4). Next, 3 sessions followed in which lever pressing on the right side for rats SB-5 and SB-6, and on the left side for rats SB-1 and SB-4, produced dipper presentations of water. Subsequently, water bottles were permanently replaced on the home cages, and for 4 sessions the position of water was alternated daily between the left and right dippers.

Establishment of Ethanol as a Reinforcer. Within-session feedings of Purina Rat Chow continued for 12 daily 3-hr sessions. The side position of the ethanol solution was alternated between daily sessions. During the first 2 sessions 2% ethanol was present, then 4% ethanol for 4 sessions, and 8% ethanol for 6 sessions. The in-session feedings were then discontinued, and food was given to the rats in their home cages immediately following each session. During the next 10 sessions, the position of 8% ethanol was alternated daily between the left and right dippers. Throughout training, responses on the lever opposite the side of liquid availability had no programmed consequence.

Experimental Phases. Throughout the 3 phases of Experiment 1 water was concurrently available along with 8% ethanol. Each lever press produced a dipper presentation of water or 8% ethanol. Water and 8% ethanol locations were alternated daily between the sides. During the initial No Food Phase, the amount of rat chow needed to maintain the rats at 80% of their free-feeding weights was placed in their home cages following their daily experimental sessions. During this phase, no food was present in the operant-conditioning chamber. During the Food Phase, the rats' maintenance food was available each day during the experimental session in their operant-conditioning chambers, and no food was available in the home cages. During the retest No Food Phase, experimental conditions were identical to those of the initial No Food Phase. Each rat was shifted from one phase to the next following 10 consecutive sessions in which there was no upward or downward trend in the number of dipper presentations of water or 8% ethanol.

RESULTS

Figure 1 shows that within-session availability of rats' daily maintenance feedings (Food Phase) caused substantial increases in both 8% ethanol and water intake. For each rat, both ethanol and water dipper presentations were greater during the Food Phase than during the initial No Food Phase. Figure 1 also shows that during all phases, presentations of 8% ethanol exceeded presentations of water.

On retest, values of 8% ethanol and water presentations were similar to those measured during the initial No Food Phase (Fig. 1). The mean quantity consumed during the No Food, Food, and No Food (retest) phases was 1731, 2280, and 1827 mg per kg of body weight per 3-hr session, respectively.

For each liquid and each phase, there were no apparent side differences in dipper presentations except during the initial No Food Phase when rats SB-1, SB-4, and SB-6 had consistently more water presentations on the right. Tables 1, 2, and 3 of the Appendix list values for each rat of ethanol and water dipper presentations and quantity consumed.

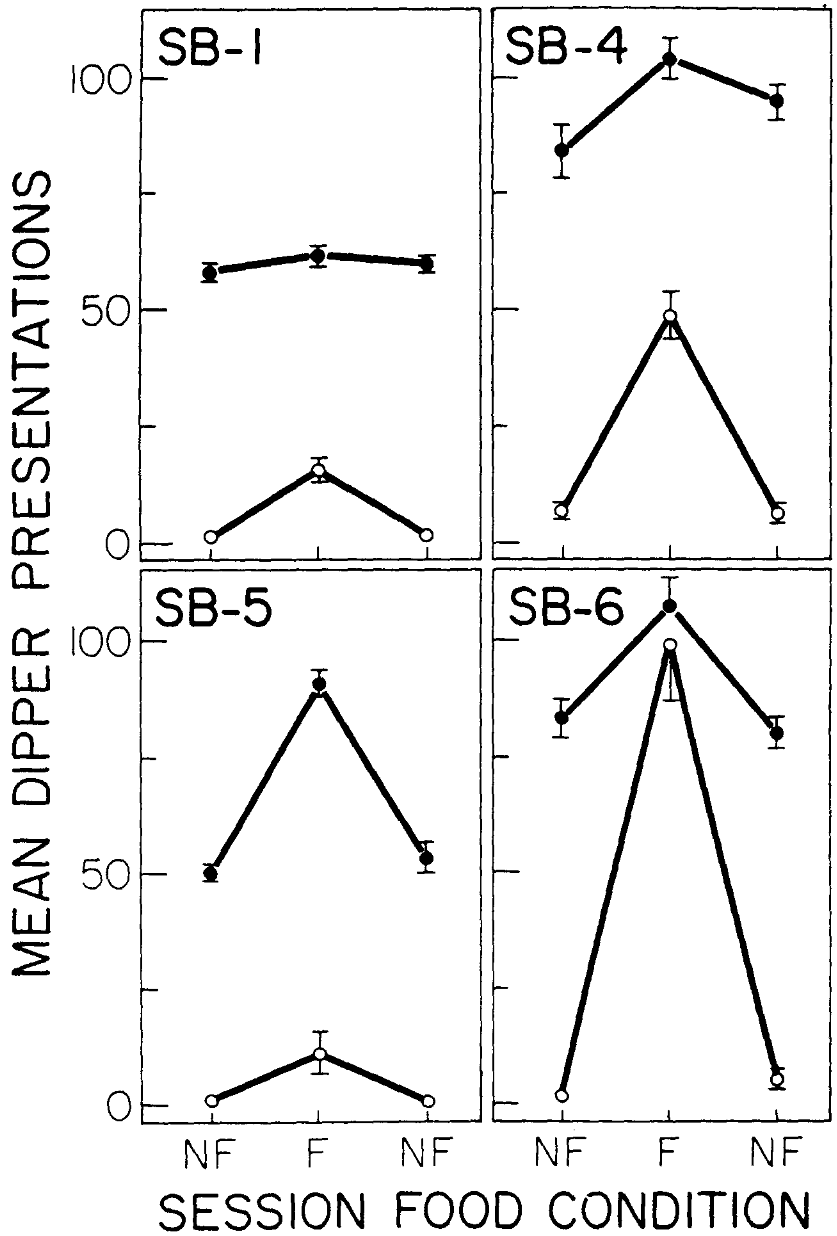

Figure 1. Water and 8% ethanol dipper presentations as a function of the presence or absence of maintenance food in the operant chamber. Filled circles: 8% ethanol presentations. Unfilled circles: water presentations. NF: no food in operant chamber. F: maintenance food available in operant chamber. Each symbol represents the mean obtained during 10 consecutive 3-hr. sessions. Brackets indicate mean standard error of the mean (n = 4; 4 rats x 1 S.E. each). Absence of brackets indicates that they fell within the area occupied by the plotted point.

DISCUSSION

The principal finding was that daily maintenance feedings given during the experimental sessions substantially increased intake of 8% ethanol. However, according to one form of the caloric hypothesis, concurrent access to normally consumed food and ethanol should have resulted in decreased ethanol intake. Other recent findings also fail to support this form of the caloric hypothesis (Henningfield & Meisch, unpublished data). In the Henningfield and Meisch study, when rhesus monkeys received their daily maintenance feedings 15 min prior to each session, the monkeys markedly increased their 8% ethanol but not their water intake.

Experiment 2. Within-session free access to food: Effects on concurrent performances maintained by 8% ethanol and water. The purpose of Experiment 2 was to slowly bring the rats to their *ad libitum* body weight while access to ethanol was concurrently maintained. A slow, regulated increase in body weight was desired because rapid satiation has proved disruptive to ethanol-maintained performance (Beardsley & Meisch, 1975). The desired free-feeding state was needed for Experiment 3. In addition, it was important to determine the effects on ethanol and water intake of providing free access to food during the experimental sessions.

METHOD

Subjects. Same as in Experiment 1.

Apparatus. Same as in Experiment 1.

Procedure. Following the final session of Experiment 1, feedings at the home cages were discontinued; instead, the rats received free access to Purina Rat Chow only during the daily 3-hr sessions. Wire food hoppers filled with the chow were placed inside the operant chambers. The rats were given 28 consecutive sessions in which the availability of water and 8% ethanol was alternated daily between the left and right dippers. Each lever press resulted in a presentation of the adjacent dipper. Other aspects of the procedure were the same as in Experiment 1.

RESULTS

For each rat, water intake was higher, 8% ethanol intake was lower, and total liquid intake (water plus 8% ethanol) was greater than during any phase of Experiment 1.

Figure 2 shows mean dipper presentations of water and 8% ethanol at each side in 4 blocks of 7 consecutive sessions. Group mean presentations of water exceeded group mean presentations of 8% ethanol. Averaged across all 28 days, each rat received more water than 8% ethanol dipper presentations. There were no systematic increases or decreases across days in dipper presentations of either water or 8% ethanol. Over the 28-day period, body weight increased an average of 67 g per rat.

A preference for responding at the left side developed in rats SB-4, SB-5, and SB-6. The number of dipper presentations of a particular liquid at the left side regularly exceeded values at the right side. The reasons for the development of this preference are unknown; this side preference did not develop in rat SB-1. Although three rats

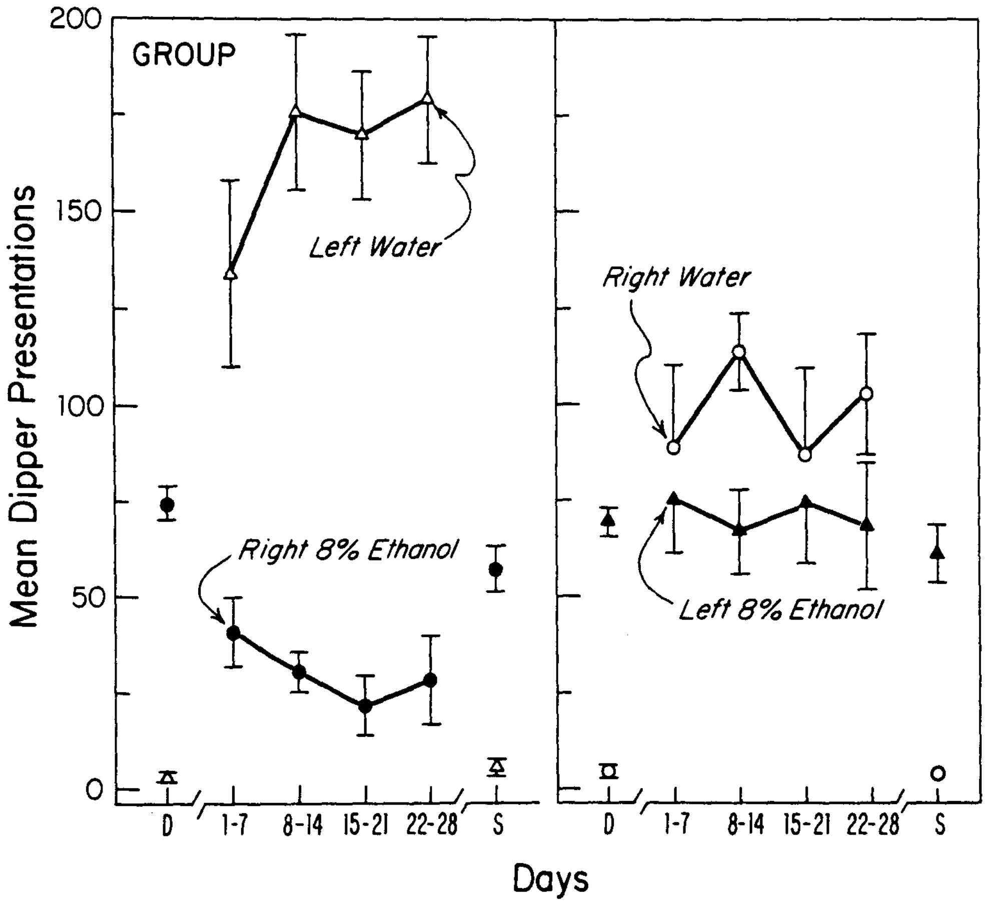

Figure 2. Water and 8% ethanol presentations during the transition from the food deprived to the food satiated phase. Filled circles: 8% ethanol presentations, right side. Unfilled circles: water presentations, right side. Filled triangles: 8% ethanol presentations, left side. Unfilled triangles: water presentations, left side. Unconnected symbols at the left side of the figure ("D" for food-deprived) represent mean water and 8% ethanol presentations during the retest No Food Phase of Experiment 1. Unconnected symbols to the right of the figure ("S" for food-satiated) represent mean water and 8% ethanol presentations during the first 8% ethanol phase of Experiment 3. Each connected symbol represents mean presentations for 4 blocks of 7 consecutive days averaged across rats. Each unconnected symbol represents the mean of 40 values (4 rats x 10 3-hr sessions each). Brackets indicate the mean standard error of the mean (n = 4; 4 rats x 1 S.E. each). Absence of brackets indicates that they fell within the area occupied by the plotted point.

developed a preference for the left side, all rats drank more water than 8% ethanol regardless of the side of availability (Fig. 2). Tables 4, 5, 6, and 7 of the Appendix specify values of the dependent variables for each rat for each session in Experiment 2.

DISCUSSION

The results of Experiments 1 and 2 seem anomalous in that *limited* access to rat chow during Experiment 1 increased drinking of 8% ethanol, but *unlimited* access to rat chow during Experiment 2 decreased 8% ethanol drinking. A number of possible explanations could account for this difference. For example, Experiments 1 and 2 differed in terms of the rats' body weights. In Experiment 1, body weights were held constant; whereas, in Experiment 2, body weights increased over the 28-day period. A decrease in ethanol intake during a period of increased food consumption that follows a period of dietary restriction, as in Experiment 2, is consistent with previous research (e.g., Aschkenasy-Lelu, 1960; Meisch & Thompson, 1974a; Westerfield & Lawrow, 1953).

Experiments 1 and 2 also differed in that Experiment 2 lasted for a *fixed* number of sessions; whereas, each condition in Experiment 1 was not terminated after a fixed number of sessions but continued until performance was stable. Perhaps, if Experiment 2 had lasted longer, ethanol drinking would have rebounded. For instance, changes in stimulus conditions often result in response decrements, and the decrease in ethanol drinking during Experiment 2 may have been due to novel stimuli (e.g., novel stimuli resulting from greater food consumption and elevated body weight). Thus, with longer exposure to these stimuli, their disruptive effect would be predicted to be less because of increased adaptation.

Experiment 3. Within and between-session free access to food: Effects on concurrent performances maintained by water and a range of ethanol concentrations. Another testable form of the caloric hypothesis is that since ethanol provides calories, rats will prefer ethanol to water only if food deprived (i.e. below ad libitum weight). Thus this hypothesis predicts that food-satiated rats (i.e. rats with free access to food) will avoid ethanol and prefer water. Experiment 3 was conducted to test this form of the caloric hypothesis.

METHOD

Subjects. Same as in Experiment 2.

Apparatus. Same as in Experiment 2.

Procedure. After the final session of Experiment 2, the food hoppers at the rats' home cages were filled with Purina Rat Chow and were kept filled throughout Experiment 3. In addition, wire food hoppers, also filled with Purina Rat Chow, were placed inside the operant-conditioning chambers during all sessions of Experiment 3. This, in effect, provided the rats free access to food both during and between each daily 3-hr session. During Determination I (see Table 1), intake of ethanol concentrations of 8, 11.3, 16, 22.6, 32, and 8% (retest), in that order, was studied with water concurrently available. Determination II repeated the procedures of Determination I. A change from one concentration to the next was made following 10 consecutive sessions in which there was no upward or downward trend in the number of dipper presentations of either ethanol or water. Positions of ethanol and water were alternated daily between the left and right dippers. Other aspects of the procedure were the same as in Experiments 1 and 2.

RESULTS

In general, the number of ethanol dipper presentations decreased with increases in ethanol concentration while the quantity (mg) of ethanol consumed increased. This was the case for both Determinations I and II. Water intake remained consistently low throughout both Determinations and never exceeded concurrent ethanol intake.

Figure 3 shows that during both Determinations, presentations of ethanol generally decreased with increases in concentration; this trend is especially evident during Determination II. Dipper presentations of water remained low in number and were fewer than those of ethanol (Fig. 3). At identical concentrations (11.3% excepted) ethanol presentations were greater during Determination II than during Determination I.

Figure 4 shows that data for individual rats paralleled group data: At each ethanol concentration during Determination II, there were more ethanol than water presentations, and generally, with increases in the ethanol concentration, there were decreases in the number of ethanol presentations. In addition, with neither water nor ethanol were there apparent preferences for the left or right sides. Tables 8 through 19 of the Appendix specify values of the dependent variables for each rat at each concentration used in Determinations I and II.

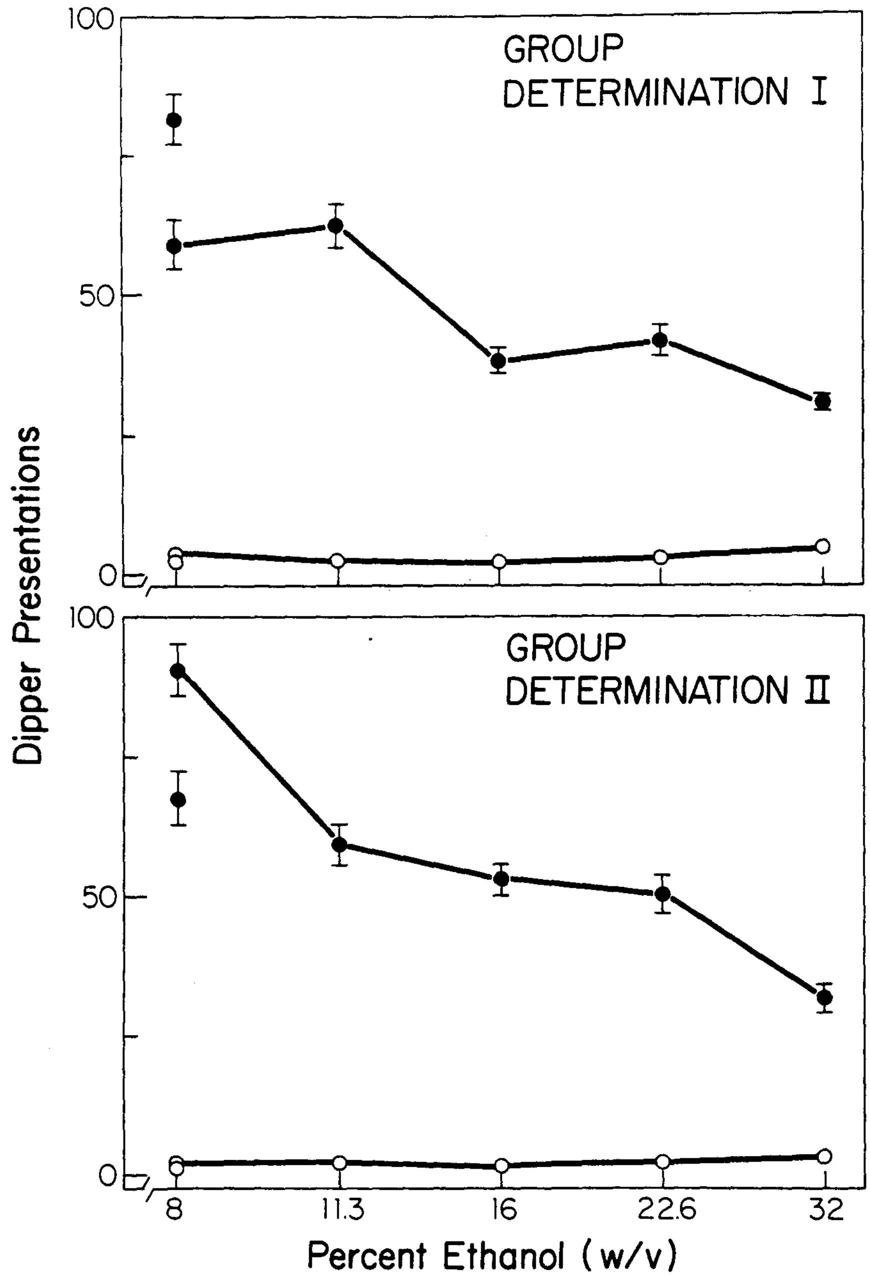

Figure 3. Ethanol and water presentations as a function of ethanol concentration during Determinations I and II. Filled circles: ethanol presentations. Unfilled circles: water presentations. At 8%, where two points are plotted, the unconnected point is the retest value. Each symbol is the mean of 40 values (4 rats x 10 3-hr sessions each). Brackets indicate the mean standard error of the mean (n = 4; 4 rats x 1 S.E. each). Absence of brackets indicates they fell within the area occupied by the plotted point.

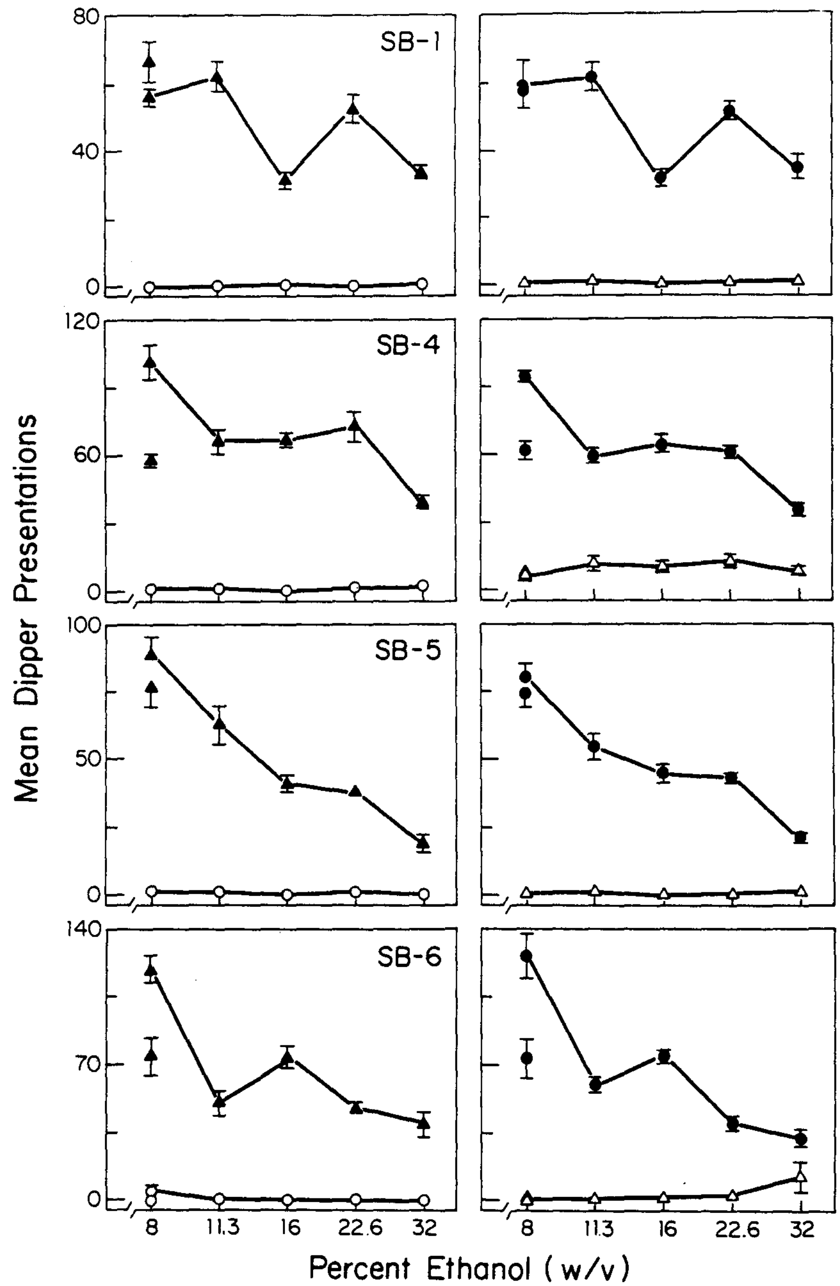

Figure 4. Ethanol and water presentations as a function of ethanol concentration and side position during Determination II. Filled triangles: ethanol presentations, left side. Unfilled triangles: water presentations, left side. Filled circles: ethanol presentations, right side. Unfilled circles: water presentations, right side. At 8%, where two points are plotted, the unconnected point is the retest value; occasionally, the retest point coincided with the original point, *e.g.*, water presentations on the right side for rat SB-1. Each symbol represents the mean obtained during 5 consecutive 3-hr sessions. Brackets indicate the standard error of the mean. Absence of brackets indicates they fell within the area occupied by the plotted point.

Although ethanol presentations generally decreased across concentrations (Fig. 3), the decreases were less than that which would cause decreases in the actual quantity consumed (mg ethanol/100 g body weight/hr). Figure 5 shows that during Determination II, the quantity (mg) of ethanol consumed per 100 g body weight generally increased with increases in concentration. This trend is particularly evident when considering consumption exclusively from the first half hour of each session where drinking was concentrated (Fig. 5).

The highest rate of ethanol drinking occurred at the beginning of each session. Figure 6 shows that most dipper presentations of ethanol during Determination II were obtained early in the session regardless of concentration; however, throughout the sessions, presentations of water remained low in number and were evenly distributed over time.

Comparisons Between Food-Deprived and Food-Satiated Drinking. Figure 7 shows that about the same number of dipper presentations of 8% ethanol occurred during the food-satiated and the food-deprived phases, with water presentations being at a consistently low level throughout all phases.

Although more presentations of 8% ethanol occurred during the food-satiated phases, quantities (mg ethanol/100 g body weight/hr) of 8% ethanol consumed during the food-deprived phases were slightly higher than during the food-satiated phases (Fig. 7). This is explained by the rats' higher body weights during the food-satiated phases. In general, the rats maintained a high level of 8% ethanol self-administration regardless of whether they were food-deprived or food-satiated.

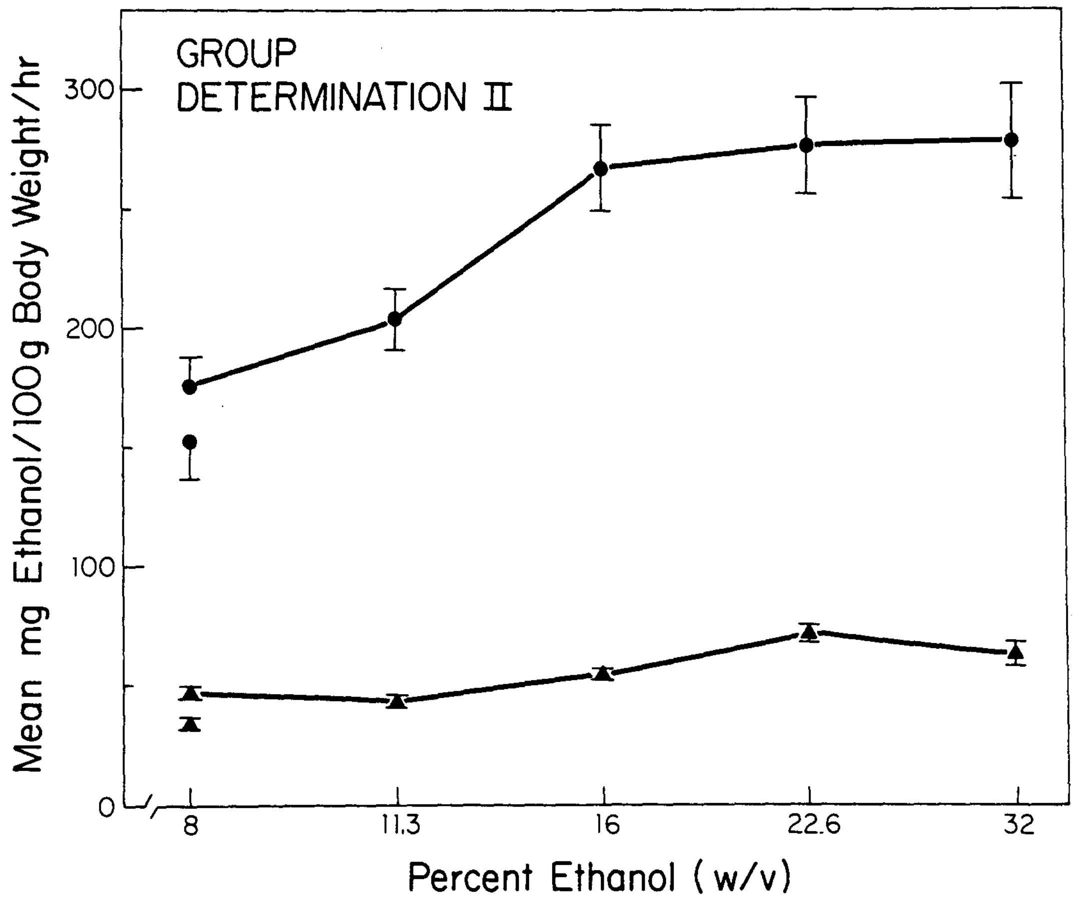

Figure 5. Quantities (mg/100 g body weight/hr) of ethanol consumed as a function of concentration during Determination II. Two measures of hourly intake are shown. Circles: data averaged from the first half--hour of sessions multiplied by 2. Triangles: data averaged across entire sessions divided by 3. Unconnected symbols represent 8% retest values. Each symbol is the mean of 20 values (4 rats x 5 sessions each). Brackets indicate the mean standard error of the mean (n = 4; 4 rats x 1 S.E. each). Absence of brackets indicates that they fell within the plotted point.

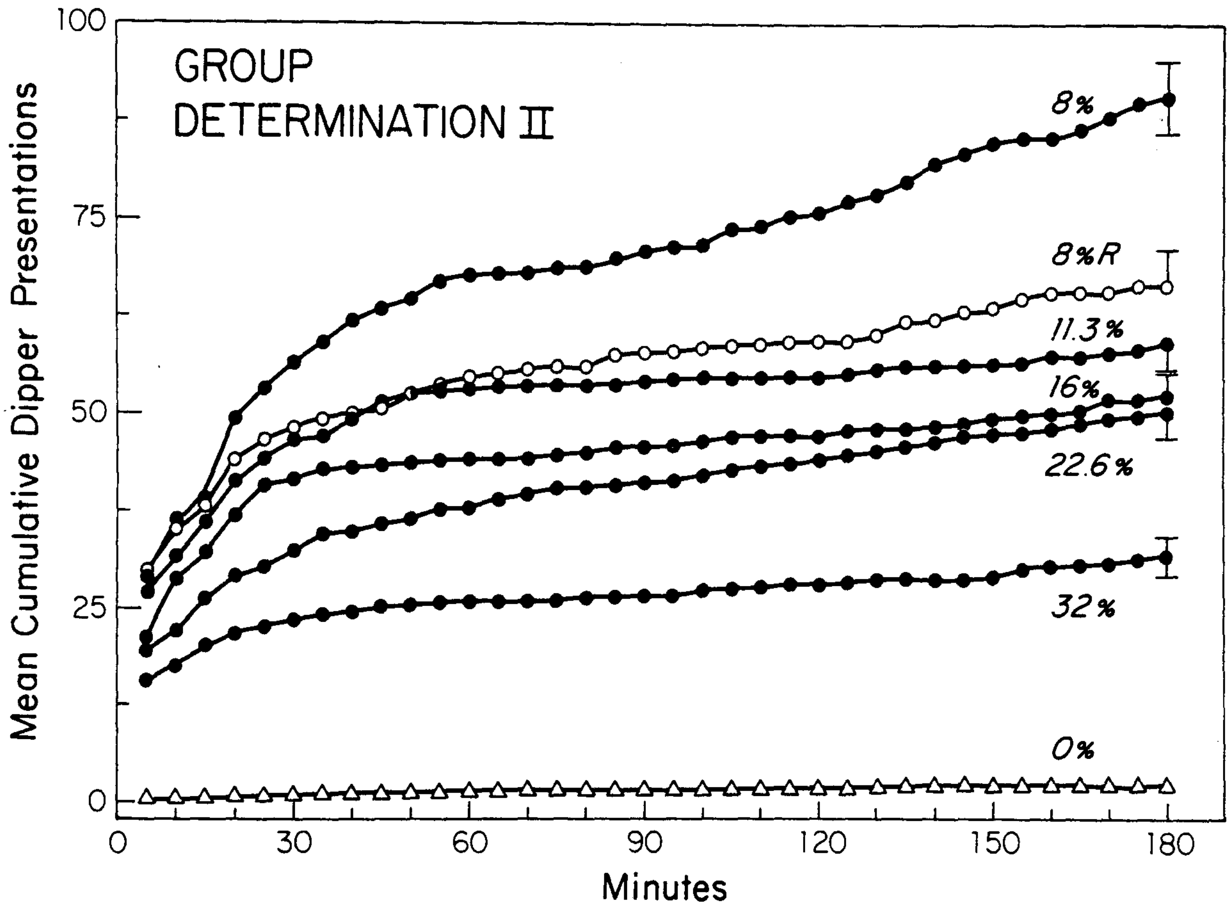

Figure 6. Mean cumulative dipper presentations as a function of ethanol concentration for Determination II. Unfilled circles represent 8% retest values. Each point is the mean, based on observations from 40 sessions (4 rats x 10 3-hr sessions each), except for those points at 0% which are the means of 240 sessions (4 rats x 6 conditions x 10 3-hr sessions each). Brackets indicate the mean standard error of the mean (n = 4; 4 rats x 1 S.E. each). Absence of brackets indicate that they fell within the area occupied by the plotted point.

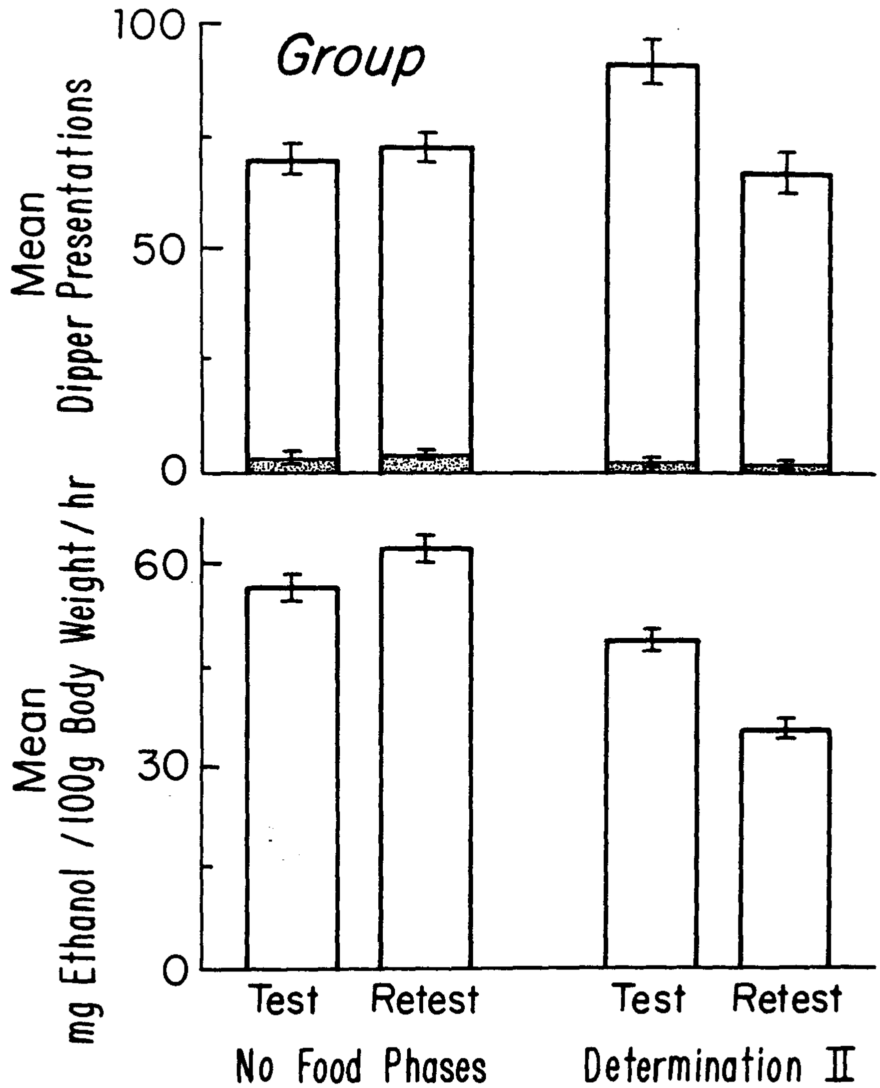

Figure 7. Intake of 8% ethanol and water under conditions of food-deprivation and food-satiation. Bars from left to right represent results from the initial and retest No Food Phases of Experiment 1 (food-deprived condition) and from the 8% test and retest phases of Determination II, Experiment 3 (food-satiated condition), respectively. Upper panel: mean dipper presentations (n = 40; 4 rats x 10 sessions each). Total height of bars represents 8% ethanol presentations whereas striped portion represents water presentations. Lower panel: mean quantity consumed in mg ethanol per 100 g body weight per hr. Brackets indicate the mean standard error of the mean (n = 4; 4 rats x 1 S.E. each).

DISCUSSION

These results show that ethanol concentrations as high as 32% (w/v) will maintain lever-pressing behavior of food-satiated rats when water and food are concurrently available. Additionally, more ethanol than water is consumed, and more lever pressing is maintained by ethanol than by water. Previously, it has been shown that food-satiated rats would consume ethanol concentrations as high as 32% (w/v) at levels exceeding water control values (Meisch and Thompson, 1974a). However, in this earlier study, food and water were not available in the operant chamber at the same time ethanol was present.

Throughout Experiment 3, during which the rats were always food-satiated, the number of dipper presentations of ethanol decreased with increases in concentration, but generally, the quantity (mg/100 g body weight/hr) of ethanol consumed increased with increasing concentration. This result is consistent with results of previous studies with food--satiated rats (Meisch and Thompson, 1974a) and with food-deprived rats (Meisch and Thompson, 1974b; Meisch and Beardsley, 1975).

Also during Experiment 3, the temporal pattern of drinking was characterized by a high rate at the beginning of the session followed by prolonged pauses. This temporal pattern of ethanol drinking should produce maximum behavioral effects (Lester and Freed, 1973; Meisch and Thompson, 1974a) and is similar to the pattern observed with food-deprived rats (Meisch and Beardsley, 1975) and rhesus monkeys (Henningfield & Meisch, 1978).

In addition, during Experiment 3, at identical concentrations, ethanol presentations were generally greater during Determination II than during Determination I. Meisch and Thompson (1974a) similarly found that with an increase in ethanol drinking experience, food-satiated rats drank more ethanol (between 4 and 32% w/v) during the re-determination of intakes compared to the initial determination.

The finding that the number of 8% ethanol dipper presentations was similar during food-satiation and food-deprivation is different from results previously reported by Meisch and Thompson (1973, 1974a). They found that, during food-satiation, levels of dipper presentations were considerably lower than during food deprivation. A number of differences between the earlier studies and the present experiment could account for the discrepancy. For example, different procedures were used to establish ethanol as a reinforcer, and rats from different strains served as subjects. Also, a much larger dipper cup size (0.25 ml) was used in the earlier studies as compared to that of the present study (0.11 ml). In earlier studies, rats were food-satiated by receiving unlimited food only in their home cages. And, possibly most importantly, both food and water were concurrently available with ethanol in the present study but not in the previous studies.

The present results extend the generality of conditions under which ethanol serves as a reinforcer to conditions of food-satiation where water and food are concurrently available. They also substantiate Meisch and Thompson's (1974a) finding that ethanol at high concentrations will serve as a reinforcer for food-satiated rats. In addition, the data from the food-satiated rats closely parallels data of food-deprived rats under similar conditions (Meisch and Beardsley, 1975) in that: (1) above 8% ethanol, dipper presentations of ethanol decreased with increases in concentrations; (2) quantity (mg) consumed increased with increases in concentration; (3) the highest rate of ethanol intake occurred at the beginning of the session.

GENERAL DISCUSSION

The results of the present experiments do not support two testable forms of the caloric hypothesis. When food-deprived rats were given their normally consumed, daily maintenance chow during sessions of Experiment 1, an increase in ethanol drinking was observed. This finding is incompatible with a testable form of the caloric hypothesis which would have predicted that food-deprived rats will not consume ethanol if alternative, normally consumed foods are concurrently present. When rats at ad libitum body weight were given concurrent access to chow, water, and ethanol solutions during Experiment 3, substantial quantities of ethanol in concentrations as high as 32% were drunk in preference to water. This finding is incompatible with another, testable form of the caloric hypothesis which would predict that rats only prefer ethanol to water when *below* ad libitum body weight. Experiment 2 is difficult to evaluate with respect to general arguments of the caloric hypothesis, since it was a *transition* state lasting a predetermined number of sessions during which the rats were continually gaining weight. On one hand, since ad libitum access to chow during sessions of Experiment 2 increased water intake and moderately decreased ethanol intake, some support of the caloric hypothesis should accrue. However, any form of the caloric hypothesis would find it difficult to explain the continued drinking of ethanol when alternative, presumably more palatable sources of calories were concurrently present as was in Experiment 2.

It is important to note that there are data consistent with the caloric hypothesis; these data show that ethanol intake is generally greater when rats are food-deprived (for a review, see Meisch, 1977). However, these data do not prove the hypothesis, for the data are also consistent with alternative formulations such as the notion that food-deprivation increases or strengthens drug-reinforced behavior. For example, higher rates of responding under fixed-ratio schedules were maintained by 8% (w/v) ethanol when rats were food-deprived than when they were food-satiated (Meisch & Thompson, 1973). Also, oral intake of the potent opioid, etonitazene, is markedly increased when rats are food-deprived (Carroll & Meisch, 1979; Meisch, Kliner, & Stark, 1978; Meisch & Stark, 1977). Furthermore, intravenous self-administration of etonitazene and cocaine are substantially increased when rats are food-deprived (Carroll, France, & Meisch, unpublished data). Thus food-deprivation increases intake of noncaloric chemical reinforcers, and this suggests that food-deprivation may increase intake of ethanol via mechanisms that have nothing to do with calories.

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APPENDIX

List of Tables

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Table 1

Mean dipper presentations of 8% ethanol per 3-hr session during the No Food, Food, and No Food (retest) phases of Experiment 1 (means ± S.E.M.)

	NO FOOD			FOOD			NO FOOD (retest)		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	55.4 (2.66)	60.4 (2.60)	57.9 (1.94)	61.8 (3.01)	61.4 (4.52)	61.6 (2.56)	59.0 (3.18)	60.6 (1.94)	59.8 (1.78)
SB-4	80.6 (7.98)	87.4 (9.09)	84.0 (5.81)	102.4 (8.02)	106.0 (5.18)	104.2 (4.54)	90.0 (2.70)	99.6 (6.83)	94.8 (3.81)
SB-5	50.2 (2.01)	50.8 (3.50)	50.5 (1.90)	88.0 (4.09)	93.6 (3.83)	90.8 (2.80)	54.0 (4.68)	52.6 (5.08)	53.3 (3.26)
SB-6	81.6 (5.85)	84.8 (6.26)	83.2 (4.08)	105.2 (9.84)	109.8 (7.20)	107.5 (5.80)	74.8 (4.35)	85.4 (3.83)	80.1 (3.25)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	67.0 (4.63)[a]	70.9 (5.36)[a]	68.9 (3.43)[a]	89.4 (6.24)[a]	92.7 (5.18)[a]	91.0 (3.93)[a]	69.5 (3.73)[a]	74.6 (4.42)[a]	72.0 (3.03)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 2

Mean dipper presentations of water per 3-hr session during the No Food, Food, and No Food (retest) phases of Experiment 1 (means ± S.E.M.)

RAT	NO FOOD			FOOD			NO FOOD (retest)		
	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	0.8 (0.20)	2.2 (0.49)	1.5 (0.34)	15.2 (2.48)	16.2 (4.78)	15.7 (2.54)	0.6 (0.24)	3.6 (1.78)	2.1 (0.98)
SB-4	3.2 (0.66)	10.4 (2.44)	6.8 (1.69)	48.8 (2.48)	48.8 (10.68)	48.8 (5.17)	3.6 (1.17)	9.6 (3.60)	6.6 (2.05)
SB-5	1.0 (0.45)	1.8 (0.97)	1.4 (0.52)	9.8 (6.58)	13.0 (6.68)	11.4 (4.45)	0.6 (0.24)	1.4 (0.60)	1.0 (0.33)
SB-6	0.4 (0.24)	3.6 (1.12)	2.0 (0.76)	78.6 (20.78)	119.4 (5.48)	99.0 (12.20)	8.0 (3.75)	3.0 (0.55)	5.5 (1.97)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	1.4 (0.39)[a]	4.5 (1.26)[a]	2.9 (0.83)[a]	38.1 (8.08)[a]	49.4 (6.91)[a]	43.7 (6.09)[a]	3.2 (1.35)[a]	4.4 (1.63)[a]	3.8 (1.34)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 3

Mean quantity (mg/kg of body wt.) consumed of 8% ethanol per 3-hr session during the No Food, Food, and No Food (retest) phases of Experiment 1 (± S.E.M.)

	NO FOOD			FOOD			NO FOOD (retest)		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10
SB-1	1420.5 (68.06)	1554.8 (65.45)	1487.7 (49.82)	1594.9 (72.59)	1586.5 (117.40)	1590.7 (65.08)	1527.4 (101.98)	1551.1 (55.05)	1539.3 (54.77)
SB-4	2007.6 (206.65)	2152.1 (235.25)	2079.8 (149.56)	2507.7 (194.11)	2601.5 (132.24)	2554.6 (111.82)	2271.2 (81.16)	2518.5 (169.09)	2394.8 (97.55)
SB-5	1336.0 (52.17)	1321.0 (93.68)	1328.5 (50.61)	2284.7 (107.68)	2440.2 (101.24)	2362.4 (74.34)	1414.2 (122.58)	1387.9 (137.12)	1401.1 (86.81)
SB-6	1984.3 (139.62)	2071.1 (150.98)	2027.7 (98.02)	2548.3 (233.53)	2674.7 (173.63)	2611.5 (138.79)	1844.6 (106.50)	2099.1 (92.37)	1971.9 (78.83)
	n = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40
GROUP	1687.1 (116.63)[a]	1774.8 (136.34)[a]	1730.9 (87.00)[a]	2233.9 (151.98)[a]	2325.7 (131.13)[a]	2279.8 (97.51)[a]	1764.4 (103.06)[a]	1889.2 (113.41)[a]	1826.8 (79.49)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 4

Rat SB-1's water and 8% ethanol reinforced performance, body weight (g), and quantity consumed (mg/kg body wt./3-hr session) over the 28-day period of unlimited food access during Experiment 2.

DAY	DIPPER PRESENTATIONS		BODY WT.	QUANTITY CONSUMED
	8% ETHANOL	WATER		
1	67 (R)[a]	1 (L)	350	1685
2	36 (L)	105 (R)	346	916
3	91 (R)	3 (L)	351	2282
4	31 (L)	127 (R)	353	773
5	74 (R)	52 (L)	365	1784
6	22 (L)	113 (R)	363	533
7	67 (R)	99 (L)	369	1598
8	39 (L)	133 (R)	369	930
9	42 (R)	50 (L)	384	963
10	17 (L)	136 (R)	370	404
11	61 (R)	96 (L)	382	1405
12	22 (L)	144 (R)	385	503
13	68 (R)	44 (L)	390	1534
14	8 (L)	132 (R)	387	182
15	43 (R)	79 (L)	389	973
16	85 (L)	12 (R)	386	1938
17	7 (R)	159 (L)	386	160
18	35 (L)	102 (R)	389	792
19	29 (R)	111 (L)	399	640
20	22 (L)	125 (R)	392	494
21	51 (R)	92 (L)	400	1122
22	33 (L)	111 (R)	399	728
23	20 (R)	155 (L)	395	446
24	28 (L)	145 (R)	396	622
25	17 (R)	172 (L)	398	376
26	57 (L)	108 (R)	398	1260
27	7 (R)	191 (L)	404	153
28	29 (L)	97 (R)	405	630

[a] R: right side; L: left side

Table 5

Rat SB-4's water and 8% ethanol reinforced performance, body weight (g), and quantity consumed (mg/kg body wt./3-hr session) over the 28-day period of unlimited food access during Experiment 2

DAY	DIPPER PRESENTATIONS		BODY WT.	QUANTITY CONSUMED
	8% ETHANOL	WATER		
1	60 (R)[a]	103 (L)	352	1500
2	101 (L)	48 (R)	349	2547
3	10 (R)	206 (L)	350	251
4	134 (L)	14 (R)	361	3267
5	34 (R)	197 (L)	358	836
6	3 (R)	201 (L)	361	73
7	21 (R)	177 (L)	372	497
8	102 (L)	29 (R)	374	2400
9	128 (L)	44 (R)	372	3028
10	165 (L)	51 (R)	370	3924
11	23 (R)	186 (L)	378	536
12	104 (L)	104 (R)	374	2447
13	16 (R)	250 (L)	382	369
14	92 (L)	98 (R)	385	2103
15	23 (R)	159 (L)	394	514
16	114 (L)	105 (R)	391	2566
17	7 (R)	234 (L)	393	157
18	83 (L)	116 (R)	391	1868
19	24 (R)	205 (L)	396	533
20	78 (L)	96 (R)	399	1720
21	25 (R)	215 (L)	396	556
22	82 (L)	100 (R)	401	1800
23	10 (R)	264 (L)	393	224
24	114 (L)	35 (R)	413	2429
25	6 (R)	237 (L)	398	133
26	112 (L)	51 (R)	409	2410
27	72 (R)	180 (L)	397	1596
28	166 (L)	75 (R)	401	3643

[a] R: right side; L: left side

Table 6

Rat SB-5's water and 8% ethanol reinforced performance, body weight (g), and quantity consumed (mg/kg body wt./3-hr session) over the 28-day period of unlimited food access during Experiment 2.

DAY	DIPPER PRESENTATIONS		BODY WT.	QUANTITY CONSUMED
	8% ETHANOL	WATER		
1	82 (L)[a]	2 (R)	336	2148
2	7 (R)	114 (L)	358	172
3	38 (L)	0 (R)	368	909
4	16 (R)	110 (L)	380	371
5	59 (L)	0 (R)	385	1349
6	7 (R)	124 (L)	383	161
7	48 (L)	1 (R)	394	1072
8	0 (R)	151 (L)	390	0
9	82 (L)	7 (R)	389	1855
10	23 (R)	108 (L)	391	518
11	75 (L)	29 (R)	385	1714
12	33 (R)	141 (L)	386	752
13	93 (L)	23 (R)	401	2041
14	21 (R)	161 (L)	397	466
15	55 (L)	0 (R)	404	1198
16	8 (R)	84 (L)	416	169
17	33 (L)	82 (R)	397	732
18	7 (R)	132 (L)	402	153
19	84 (L)	58 (R)	408	1812
20	23 (R)	56 (L)	420	482
21	73 (L)	62 (R)	407	1578
22	4 (R)	118 (L)	406	87
23	11 (L)	54 (R)	414	234
24	37 (R)	95 (L)	409	796
25	87 (L)	39 (R)	405	1890
26	15 (R)	134 (L)	407	324
27	27 (L)	69 (R)	420	566
28	38 (R)	35 (L)	415	806

[a] R: right side; L: left side

Table 7

Rat SB-6's water and 8% ethanol reinforced performance, body weight (g), and quantity consumed (mg/kg body wt./3-hr session) over the 28-day period of unlimited food access during Experiment 2.

DAY	DIPPER PRESENTATIONS		BODY WT.	QUANTITY CONSUMED
	8% ETHANOL	WATER		
1	107 (L)[a]	145 (R)	358	2630
2	71 (R)	222 (L)	371	1684
3	164 (L)	71 (R)	370	3901
4	70 (R)	111 (L)	400	1540
5	48 (L)	343 (R)	382	1106
6	18 (R)	280 (L)	386	410
7	68 (L)	275 (R)	384	1558
8	20 (R)	326 (L)	391	450
9	25 (L)	264 (R)	394	558
10	25 (R)	267 (L)	395	557
11	26 (L)	214 (R)	403	568
12	33 (R)	233 (L)	394	737
13	82 (L)	221 (R)	399	1809
14	25 (R)	302 (L)	406	542
15	89 (L)	172 (R)	420	1865
16	11 (R)	278 (L)	421	230
17	10 (R)	279 (L)	425	207
18	65 (L)	57 (R)	444	1288
19	8 (R)	297 (L)	416	169
20	133 (L)	103 (R)	421	2780
21	8 (R)	247 (L)	432	163
22	128 (L)	121 (R)	426	2644
23	106 (L)	115 (R)	427	2185
24	62 (L)	239 (R)	423	1290
25	58 (R)	212 (L)	434	1176
26	24 (L)	254 (R)	437	483
27	33 (R)	230 (L)	430	675
28	59 (L)	146 (R)	436	1191

[a] R: right side; L: left side

Table 8

Mean dipper presentations of 8% ethanol and water and mean quantity of 8% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination I (± S.E.M.)

	8% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	1420.5 (68.06)	1554.8 (65.45)	1487.7 (49.82)	1594.9 (72.59)	1586.5 (117.40)	1590.7 (65.08)	1527.4 (101.98)	1551.1 (55.05)	1539.3 (54.77)
SB-4	2007.6 (206.65)	2152.1 (235.25)	2079.8 (149.56)	2507.7 (194.11)	2601.5 (132.24)	2554.6 (111.82)	2271.2 (81.16)	2518.5 (169.09)	2394.8 (97.55)
SB-5	1336.0 (52.17)	1321.0 (93.68)	1328.5 (50.61)	2284.7 (107.68)	2440.2 (101.24)	2362.4 (74.34)	1414.2 (122.58)	1387.9 (137.12)	1401.1 (86.81)
SB-6	1984.3 (139.62)	2071.1 (150.98)	2027.7 (98.02)	2548.3 (233.53)	2674.7 (173.63)	2611.5 (138.79)	1844.6 (106.50)	2099.1 (92.37)	1971.9 (78.83)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	1687.1 (116.63)[a]	1774.8 (136.34)[a]	1730.9 (87.00)[a]	2233.9 (151.98)[a]	2325.7 (131.13)[a]	2279.8 (97.51)[a]	1764.4 (103.06)[a]	1889.2 (113.41)[a]	1826.8 (79.49)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 9

Mean dipper presentations of 11.3% ethanol and water and mean quantity of 11.3% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination I (± S.E.M.)

	11.3% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	39.4 (5.86)	31.2 (3.47)	35.3 (3.49)	1.6 (0.68)	2.6 (1.17)	2.1 (0.66)	937.2 (141.96)	753.5 (84.30)	845.3 (83.64)
SB-4	73.2 (2.08)	71.2 (6.53)	72.2 (3.25)	2.8 (0.37)	1.2 (0.37)	2.0 (0.37)	1648.8 (50.41)	1599.6 (150.00)	1624.2 (75.04)
SB-5	53.4 (8.25)	53.8 (4.13)	53.6 (4.35)	0.6 (0.40)	1.4 (0.98)	1.0 (0.52)	1368.9 (214.21)	1389.2 (106.62)	1379.0 (112.85)
SB-6	94.6 (9.56)	81.0 (5.67)	87.8 (5.71)	6.6 (3.59)	2.0 (1.22)	4.7 (2.00)	2276.9 (231.65)	1960.4 (136.62)	2118.7 (137.32)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	65.2 (6.44)[a]	59.3 (4.95)[a]	62.2 (4.20)[a]	2.9 (1.26)[a]	1.8 (0.94)[a]	2.5 (0.89)[a]	1558.0 (159.56)[a]	1425.7 (119.39)[a]	1491.8 (102.21)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 10

Mean dipper presentations of 16% ethanol and water and mean quantity of 16% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination I (± S.E.M.)

	16% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	31.8 (2.42)	34.0 (4.79)	32.9 (2.55)	0 (0.00)	3.8 (1.93)	1.9 (1.11)	1056.9 (79.17)	1124.5 (159.75)	1090.7 (84.80)
SB-4	37.2 (2.91)	36.4 (1.72)	36.8 (1.60)	1.4 (0.98)	0.4 (0.40)	0.9 (0.53)	1153.8 (90.27)	1128.6 (50.89)	1141.2 (49.03)
SB-5	43.0 (3.42)	38.8 (4.16)	40.9 (2.64)	0.6 (0.60)	1.8 (0.20)	1.2 (0.36)	1512.7 (128.57)	1365.3 (147.00)	1439.0 (95.29)
SB-6	43.4 (3.61)	40.2 (3.02)	41.8 (2.28)	8.8 (5.19)	0.4 (0.24)	4.6 (2.82)	1453.5 (121.07)	1340.6 (104.68)	1397.0 (77.76)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	38.9 (3.09)[a]	37.4 (3.42)[a]	38.1 (2.27)[a]	2.7 (1.69)[a]	1.6 (0.69)[a]	2.2 (1.21)[a]	1294.2 (104.77)[a]	1239.8 (115.58)[a]	1267.0 (76.72)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 11

Mean dipper presentations of 22.6% ethanol and water and mean quantity of 22.6% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination I (± S.E.M.)

	22.6% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	33.8 (4.36)	34.8 (1.83)	34.3 (2.24)	6.6 (3.64)	1.8 (1.11)	4.2 (1.97)	1550.0 (200.52)	1599.1 (81.05)	1574.5 (102.28)
SB-4	50.0 (2.57)	51.2 (3.26)	50.6 (1.97)	6.6 (3.26)	0.6 (0.40)	3.6 (1.85)	2147.0 (110.77)	2206.7 (140.26)	2176.8 (84.84)
SB-5	32.0 (3.94)	38.6 (6.37)	35.3 (3.70)	0.4 (0.40)	1.4 (0.51)	0.9 (0.35)	1552.8 (192.63)	1884.4 (313.53)	1718.6 (182.06)
SB-6	44.2 (6.81)	47.4 (2.77)	45.8 (3.50)	4.0 (2.26)	0.2 (0.20)	2.1 (1.24)	1983.9 (300.70)	2127.8 (126.66)	2055.9 (155.67)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	40.0 (4.42)[a]	43.0 (3.56)[a]	41.5 (2.85)[a]	4.4 (2.39)[a]	1.0 (0.56)[a]	2.7 (1.35)[a]	1808.4 (201.16)[a]	1954.5 (165.38)[a]	1881.5 (131.21)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 12

Mean dipper presentations of 32% ethanol and water and mean quantity of 32% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination I (± S.E.M.)

	32% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	20.4 (1.94)	16.6 (2.09)	18.5 (1.49)	6.0 (2.21)	1.6 (0.93)	3.8 (1.35)	1334.1 (131.64)	1207.7 (124.90)	1270.9 (88.10)
SB-4	39.2 (3.29)	42.0 (1.76)	40.6 (1.82)	2.6 (1.40)	0.4 (0.40)	1.5 (0.78)	2545.6 (194.92)	2552.9 (104.04)	2549.2 (104.16)
SB-5	19.0 (0.77)	22.4 (2.58)	20.7 (1.39)	0 (0.00)	1.6 (0.68)	1.0 (0.42)	1291.8 (49.62)	1524.7 (176.95)	1408.3 (94.93)
SB-6	39.0 (2.10)	38.8 (3.54)	38.9 (1.94)	18.4 (9.58)	4.4 (2.29)	11.4 (5.20)	2442.4 (137.79)	2426.9 (210.06)	2434.6 (118.45)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	29.4 (2.03)[a]	30.0 (2.49)[a]	29.7 (1.66)[a]	6.8 (3.30)[a]	2.0 (1.08)[a]	4.4 (1.94)[a]	1903.5 (128.49)[a]	1928.1 (153.99)[a]	1915.8 (101.41)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 13

Mean dipper presentations of 8% ethanol (retest) and water and mean quantity of 8% ethanol (retest) consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination I (± S.E.M.)

	8% ETHANOL (retest)			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10
SB-1	97.2 (7.75)	84.6 (5.71)	90.9 (5.00)	2.2 (1.11)	1.0 (0.45)	1.6 (0.60)	1551.9 (122.08)	1347.9 (91.48)	1449.9 (79.54)
SB-4	47.6 (3.74)	45.2 (2.76)	46.4 (2.23)	5.2 (2.58)	0.8 (0.37)	3.0 (1.43)	718.5 (56.32)	686.2 (42.65)	702.3 (33.74)
SB-5	63.6 (5.91)	67.2 (7.47)	65.4 (4.53)	0.2 (0.20)	4.0 (1.30)	2.1 (0.89)	1047.7 (98.21)	1100.4 (125.42)	1074.1 (75.61)
SB-6	119.4 (7.93)	126.2 (12.88)	122.8 (7.22)	1.4 (0.75)	4.6 (3.87)	3.0 (1.93)	1853.3 (125.93)	1979.6 (196.31)	1916.4 (111.94)
	n = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40
GROUP	82.0 (6.33)[a]	80.8 (7.21)[a]	81.4 (4.75)[a]	2.3 (1.16)[a]	2.6 (1.50)[a]	2.4 (1.21)[a]	1292.9 (100.64)[a]	1278.5 (113.97)[a]	1285.7 (75.21)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 14

Mean dipper presentations of 8% ethanol and water and mean quantity of 8% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination II (± S.E.M.)

RAT	8% ETHANOL LEFT	8% ETHANOL RIGHT	8% ETHANOL TOTAL	WATER LEFT	WATER RIGHT	WATER TOTAL	QUANTITY CONSUMED LEFT	QUANTITY CONSUMED RIGHT	QUANTITY CONSUMED TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	56.0 (2.83)	59.2 (8.14)	57.6 (4.10)	0.2 (0.20)	0 (0.00)	0.1 (0.10)	884.8 (41.50)	937.2 (129.47)	911.0 (64.68)
SB-4	101.2 (7.50)	94.2 (2.62)	97.7 (3.92)	8.0 (2.35)	1.0 (0.00)	4.5 (1.61)	1504.9 (109.60)	1404.3 (40.33)	1454.6 (57.55)
SB-5	88.6 (7.55)	80.4 (5.40)	84.5 (4.52)	0.6 (0.24)	1.4 (0.40)	1.0 (0.26)	1418.8 (157.98)	1296.4 (83.45)	1364.8 (73.77)
SB-6	119.4 (7.93)	126.2 (12.88)	122.8 (7.22)	1.4 (0.75)	4.6 (3.87)	3.0 (1.93)	1853.3 (125.93)	1979.6 (196.31)	1916.4 (111.94)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	91.3 (6.45)[a]	90.0 (7.26)[a]	90.7 (4.94)[a]	2.6 (0.89)[a]	1.8 (1.07)[a]	2.2 (0.98)[a]	1415.5 (108.80)[a]	1404.4 (112.39)[a]	1411.7 (76.99)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 15

Mean dipper presentations of 11.3% ethanol and water and mean quantity of 11.3% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination II (± S.E.M.)

	11.3% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10
SB-1	62.2 (4.87)	61.4 (4.78)	61.8 (3.22)	1.0 (0.45)	0.6 (0.24)	0.8 (0.25)	1349.0 (107.50)	1322.6 (102.31)	1335.8 (70.10)
SB-4	65.8 (6.03)	58.8 (3.56)	62.3 (3.50)	11.4 (3.87)	1.0 (0.45)	6.2 (2.52)	1414.9 (129.83)	1262.9 (76.54)	1338.9 (75.43)
SB-5	62.6 (7.99)	54.6 (5.35)	58.6 (4.73)	1.2 (0.73)	1.4 (0.40)	1.3 (0.40)	1412.1 (185.20)	1227.9 (115.42)	1320.0 (107.36)
SB-6	50.0 (7.01)	59.8 (4.35)	54.9 (4.22)	1.2 (0.73)	0.6 (0.60)	0.9 (0.46)	1089.2 (152.37)	1307.6 (94.44)	1198.4 (92.01)
	n = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40
GROUP	60.2 (6.48)[a]	58.7 (4.51)[a]	59.4 (3.92)[a]	3.7 (1.45)[a]	0.9 (0.42)[a]	2.3 (0.91)[a]	1316.3 (143.73)[a]	1280.3 (97.18)[a]	1298.3 (86.23)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 16

Mean dipper presentations of 16% ethanol and water and mean quantity of 16% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination II (± S.E.M.)

	16% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	31.0 (2.77)	31.2 (2.63)	31.1 (1.80)	0.6 (0.60)	0.6 (0.40)	0.6 (0.34)	935.2 (84.67)	934.4 (82.84)	934.8 (55.84)
SB-4	66.4 (3.75)	64.0 (4.38)	65.2 (2.75)	10.0 (2.81)	0.2 (0.20)	5.1 (2.11)	2000.1 (117.23)	1871.3 (92.67)	1935.7 (73.64)
SB-5	41.0 (3.48)	44.8 (3.76)	42.9 (2.50)	0.4 (0.24)	0.2 (0.20)	0.3 (0.15)	1286.7 (105.01)	1406.7 (112.42)	1346.7 (75.23)
SB-6	73.8 (6.21)	74.6 (3.91)	74.2 (3.46)	1.8 (1.32)	0.2 (0.20)	1.0 (0.68)	2281.2 (194.18)	2333.6 (130.66)	2307.4 (110.68)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	53.1 (4.05)[a]	53.7 (3.67)[a]	53.4 (2.63)[a]	3.2 (1.24)[a]	0.3 (0.25)[a]	1.8 (0.82)[a]	1625.8 (125.27)[a]	1636.5 (104.65)[a]	1631.2 (78.85)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 17

Mean dipper presentations of 22.6% ethanol and water and mean quantity of 22.6% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination II (± S.E.M.)

	22.6% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	52.4 (4.78)	50.8 (3.10)	51.6 (2.70)	0.4 (0.24)	0.2 (0.20)	0.3 (0.15)	2154.4 (202.53)	2102.2 (125.76)	2128.3 (112.72)
SB-4	72.2 (7.52)	60.2 (3.07)	66.2 (4.32)	12.2 (3.43)	1.4 (0.51)	6.8 (2.43)	3053.6 (334.70)	2565.4 (131.31)	2809.5 (188.01)
SB-5	38.0 (1.92)	43.0 (1.97)	40.5 (1.54)	0.8 (0.37)	1.0 (0.45)	0.9 (0.28)	1642.5 (80.58)	1863.0 (88.16)	1752.7 (67.24)
SB-6	47.8 (3.04)	40.0 (1.18)	43.9 (2.76)	2.6 (1.63)	0.6 (0.40)	1.6 (0.86)	2045.9 (134.56)	1706.6 (183.85)	1876.2 (121.38)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	52.6 (4.32)[a]	48.5 (2.33)[a]	49.2 (2.83)[a]	4.0 (1.42)[a]	0.8 (0.39)[a]	2.4 (0.93)[a]	2224.1 (188.09)[a]	2059.3 (132.27)[a]	2141.7 (122.34)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 18

Mean dipper presentations of 32% ethanol and water and mean quantity of 32% ethanol consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination II (± S.E.M.)

	32% ETHANOL			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*	*n = 5*	*n = 5*	*n = 10*
SB-1	33.6 (2.44)	34.2 (4.00)	33.9 (2.21)	0.8 (0.37)	0.4 (0.24)	0.6 (0.22)	1960.1 (148.87)	1995.1 (230.28)	1977.6 (129.40)
SB-4	38.8 (3.25)	34.8 (2.82)	36.8 (2.13)	8.2 (2.20)	2.4 (0.75)	5.3 (1.46)	2345.3 (197.38)	2108.2 (175.00)	2226.8 (130.48)
SB-5	19.0 (3.66)	21.0 (2.02)	20.0 (2.00)	1.4 (0.68)	0.4 (0.24)	0.9 (0.38)	1161.0 (225.86)	1278.5 (122.59)	1219.7 (122.72)
SB-6	39.2 (7.23)	32.6 (5.09)	35.9 (4.31)	13.2 (9.56)	0 (0.00)	6.6 (5.02)	2313.8 (426.48)	1921.3 (290.88)	2117.5 (252.00)
	n = 20	*n = 20*	*n = 40*	*n = 20*	*n =20*	*n = 40*	*n = 20*	*n = 20*	*n = 40*
GROUP	32.7 (4.15)[a]	30.7 (3.48)[a]	31.7 (2.66)[a]	5.9 (3.20)[a]	0.8 (0.31)[a]	3.4 (1.77)[a]	1945.1 (249.65)[a]	1825.8 (204.69)[a]	1885.4 (158.65)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)

Table 19

Mean dipper presentations of 8% ethanol (retest) and water and mean quantity of 8% ethanol (retest) consumed (mg/kg of body wt.) per 3-hr session during Experiment 3, Determination II (± S.E.M.)

	8% ETHANOL (retest)			WATER			QUANTITY CONSUMED		
RAT	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL	LEFT	RIGHT	TOTAL
	n = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10	*n* = 5	*n* = 5	*n* = 10
SB-1	66.6 (6.63)	57.4 (6.01)	62.0 (4.49)	0.4 (0.40)	0 (0.00)	0.2 (0.20)	981.9 (97.73)	849.2 (87.33)	915.5 (65.62)
SB-4	59.0 (4.14)	56.4 (6.27)	57.7 (3.57)	6.0 (3.33)	14.8 (12.83)	10.5 (6.40)	968.4 (45.21)	1014.3 (86.64)	991.3 (46.70)
SB-5	77.2 (8.56)	74.4 (5.82)	75.8 (4.90)	0.6 (0.60)	1.6 (0.24)	1.1 (0.35)	1178.1 (140.13)	1122.4 (85.51)	1150.3 (77.94)
SB-6	74.2 (10.84)	73.2 (11.11)	73.7 (7.32)	0.4 (0.40)	0 (0.00)	0.2 (0.20)	1077.7 (160.77)	1065.9 (161.55)	1071.8 (107.46)
	n = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40	*n* = 20	*n* = 20	*n* = 40
GROUP	69.3 (7.54)[a]	65.4 (7.30)[a]	67.3 (5.07)[a]	1.9 (1.18)[a]	4.1 (3.27)[a]	3.0 (1.79)[a]	1051.5 (110.96)[a]	1013.0 (105.26)[a]	1032.2 (74.43)[a]

[a] Mean S.E.M. (n = 4; 4 rats X 1 S.E.M. each)