MOTIVATION IN CONCURRENT VARIABLE-INTERVAL SCHEDULES WITH FOOD AND WATER REINFORCERS¹

RICHARD D. WILLIS, CAROL VAN HARTESVELDT,
KRISTEN K. LOKEN, AND DEBORAH C. HALL

UNIVERSITY OF FLORIDA

The lever pressing of four food- and water-deprived rats was reinforced on concurrent variable-interval schedules. Food reinforced one response, and water reinforced the other. Response rates in baseline were higher in the food component than in the water component. After response patterns and body weights had stabilized, the animals were given access to either food only, water only, both food and water, or neither food nor water (baseline) before daily sessions. Giving food before a session decreased per cent time in the food component, decreased overall response rates for food, and increased overall response rates for water. Giving water before a session increased per cent time in the food component, increased overall response rates for food, and decreased overall response rates for water. Giving both food and water before a session resulted in a combination of prefeeding and prewatering effects. More food and more water were consumed when both were available than when only one was available before a session.

Miller (1967), Teitelbaum (1967), and others have stressed the necessity of using a variety of procedures to study relations between food- and water-related behaviors. Different dependent variables may enter into different functional relations with an independent variable, and *vice versa*.

A two-component concurrent (*conc*) schedule of reinforcement (Ferster and Skinner, 1957) provides one way of studying relations between a food-reinforced operant and a water-reinforced operant. In such a schedule, one response is reinforced with food according to one set of contingencies; simultaneously and independently, a second response is reinforced with water according to a second set of contingencies. The subject may emit either or neither response at any instant; simultaneous emission of both responses is not permitted.

Responses in one component do not change the contingencies in the other component (Catania, 1966).

In the present experiment, the lever pressing of food- and water-deprived rats was reinforced on concurrent variable-interval 15-sec_{food} variable-interval 15-sec_{water} schedules. In a variable-interval (VI) schedule, reinforcement is provided for the first response to occur after n sec from the preceding reinforcement have elapsed, there are several values of n , and the average value of n is the schedule parameter.

The rats received neither food nor water before most daily sessions (baseline). Experimental manipulations consisted of providing access to either food only, water only, or both food and water before sessions.

METHOD

Subjects

Four experimentally naive male Long-Evans descent hooded rats were each approximately 63 days old and weighed approximately 275 g before deprivation procedures started. Throughout this work, each rat was deprived of both food and water. Each rat was housed individually in a light-dark cycle controlled colony room and was run daily in the afternoon. Temperature was maintained at $70 \pm 2^\circ \text{F}$ ($21.1 \pm 1.1^\circ \text{C}$).

¹This research and the writing of this report were supported in part by Research Grant GB-28716X1 from the National Science Foundation to R. D. Willis and C. K. Adams and in part by the Department of Psychology, the College of Arts and Sciences, and the Graduate School at the University of Florida. Appreciation is expressed to Albert E. Powell for assistance in developing this project and to Marc N. Branch and E. F. Malagodi for comments on an earlier version of this manuscript. A portion of these data was presented at the meeting of the Southeastern Psychological Association, Atlanta, 1972. Reprints may be obtained from Dr. Carol Van Hartesveldt, Department of Psychology, University of Florida, Gainesville, Florida 32611.

Apparatus

Two operant chambers each contained two retractable levers, 3 cm above the grid floor and 14 cm apart. The required response force was approximately 0.20 N. A water dipper was 8 cm to the right of the left lever. The water reinforcer was 0.01 cc tap water, available for 2.5 sec and accompanied by a 2.5-sec clicker. A food magazine was 4 cm to the left of the right lever. The food reinforcer was one 0.045-g Noyes standard formula pellet, accompanied by a 2.5-sec tone. There were three white cue lights above each lever. Masking noise was continuously present except for 30 msec following a response; the resulting "pop" served as response feedback. Dim general illumination was provided by a 7.5-W lamp. Each chamber was located in a sound- and light-attenuating box. Standard electromechanical scheduling and recording equipment was located in an adjacent room.

Procedure

The rats were adapted to the food- and water-deprivation regimen and magazine trained. Then, responding was reinforced on *conc VI*_{food} *VI*_{water} schedules. The independent variable was access to food and/or water before sessions.

Each subject was provided food and water in its home cage only at the time it was to run for at least three weeks before magazine training. Magazine training was conducted with the levers retracted. After a subject rapidly approached the water dipper following clicker onset and rapidly approached the food magazine following tone onset, both levers were introduced. Responding was then developed on a *conc VI* 15-sec_{food} *VI* 15-sec_{water} schedule. A bidirectional 3-sec changeover delay (COD) was used. Specifically, separate VI tapes, each containing 50 intervals derived from the Fleshler and Hoffman (1962) formulae, scheduled food delivery for one response and water for the other. The two VI schedules were independent. A tape stopped when a hole was detected and did not restart until that reinforcer was delivered. For two subjects (Rats 9 and 12), responses on the left lever produced water and responses on the right lever produced food; every response started a 3-sec COD, during which responses on the other lever could not produce a reinforcer (Findley,

1958). For the other two subjects (Rats 5 and 11), responses on the right lever produced food if the six cue lights were on or water if the cue lights were off; each response on the left lever changed the state of the cue lights and started a 3-sec COD, during which responses on the right lever could not produce a reinforcer (Findley, 1958). Sessions were started by inserting both levers and ended by retracting both levers. Session duration was 90 min ($\pm 4\%$). Five-minute access to water was provided 30 min after each session. Supplemental food was provided at that time if the daily food ration (12.2 g for Rats 5 and 12; 12.6 g for Rats 9 and 11) was not earned in the session. At least 170 training sessions preceded the collection of the data presented and discussed here.

Data collection. Rats received neither food nor water before (typical) baseline sessions. On other occasions, if body weights were within ± 2.5 g of stable baseline weights (299 g for Rat 5, 303.5 for Rat 9, 335.5 for Rat 11, 297 for Rat 12), the rats received access for 30 min to either food only, water only, or both food and water in their home cages immediately before the session. The amount of food and/or water consumed was measured with ± 0.2 -g accuracy. The sequence of tests for Rats 5 and 9 was water, food, both, food, water, both. The sequence for Rats 11 and 12 was food, water, both, water, food, both. Data from the first prewater test for Rat 12 were unusable because of procedural errors; that test was repeated after the second preboth test. No water was provided after sessions that were preceded by water or by both food and water. At least 21 sessions were required to collect the data reported.

Time spent responding in a component was measured by having a recycling timer set at 1-sec ($\pm 4\%$) send time counts to two counters. For Rats 5 and 11, the time counts cumulated in one counter when the six cue lights were on (food component) and cumulated in a second counter when the cue lights were off (water component). For Rats 9 and 12, a response on the right lever caused the time counts to cumulate in one counter (food component) until there was a response on the left lever, which caused the time counts to cumulate in a second counter (water component) until there was a response on the right lever, and so on. The recycling timer sent counts con-

VI 15" FOOD**RAT 11****BASELINE****1.231
resp/sec**

#170

PRE-FOOD: 1.8 gms.**0.712
resp/sec**

#188

PRE-WATER: 12.0 gms.**2.002
resp/sec**

#184

**PRE-FOOD: 6.7 gms.
PRE-WATER: 18.3 gms.****1.432
resp/sec**

#181

Fig. 1. Representative cumulative records of responding by Rat 11 in the food component under each deprivation condition. The cumulating pen reset after 400 responses. Paper ran continuously during the 90-min sessions (Session 184 was 89.1 min). Pips indicate food delivery. Session numbers, amount of food and/or water consumed pre-session, and overall response rates are indicated.

tinuously, including during reinforcer presentation.

Several dependent variables were computed. Relative time in the VI_{food} component

equalled the time spent in the VI_{food} component divided by the sum of the time spent in both components. Overall response rates equalled the number of responses emitted in a

Fig. 2. Representative cumulative records of responding by Rat 11 in the water component under each deprivation condition. Pips indicate water delivery. Format as in Figure 1.

component divided by total session duration. Obtained reinforcement rates were computed by dividing the number of food and water reinforcers by total session duration. For Rats 5 and 11, changeover rates equalled the num-

ber of responses on the left lever divided by total session duration; for Rats 9 and 12, changeover rates equalled the number of response episodes on each lever divided by total session duration, with the first response of an

episode of responses on a lever counted as a changeover.

RESULTS

Data are presented in Table 1 and in Figures 1, 2, and 3. Baseline data are from sessions that immediately preceded (but did not follow) an experimental day, and in which body weights were within the criterion range.

Baseline. Responding in baseline is illustrated in the top panels of Figures 1 and 2. High, relatively steady response rates occurred in the VI_{food} component, and decreased gradually during the session (Figure 1). Response rates in the VI_{water} component were moderate and tended to increase during the session (Figure 2). Mean overall response rates were higher in the VI_{food} component than in the VI_{water} component for each subject (Table 1). Mean per cent time in the VI_{food} component ranged from 47% to 65% (Figure 3).

Prefood. The mean amount of food consumed was 2.8 g. The mean per cent time in the VI_{food} component was lower than in baseline for each subject (Figure 3).

Fig. 3. Mean time allocation (triangles) and pre-session food and water consumption (histograms) in baseline (B), when prefed (F), prewatered (W), and both (FW) for each subject.

Rat 11 consumed 1.8 g of food before Session 188, and the overall response rate in the VI_{food} component was lower than the rate during Session 170 (baseline). Rates were lower early in the session than in baseline, and the decrease in rate toward the end of the session

Table 1

Mean time and mean overall responses, reinforcers, and changeovers (CO) per minute. Number of sessions in parentheses.

		<i>Time (sec)</i>		<i>Responses/min</i>		<i>Reinforcers/min</i>		
<i>Condition</i>		<i>Food</i>	<i>Water</i>	<i>Food</i>	<i>Water</i>	<i>Food</i>	<i>Water</i>	<i>CO/min</i>
<i>Rat 5</i>								
Baseline	(5)	3389	1813	54.06	16.58	2.93	2.12	6.64
Prefood	(2)	2728	2512	41.94	22.60	2.62	2.51	7.20
Prewater	(2)	4046	1106	69.80	9.36	3.13	1.54	4.91
Preboth	(2)	3870	1338	57.26	10.42	2.98	1.77	5.17
<i>Rat 9</i>								
Baseline	(3)	2657	3028	46.45	25.98	2.28	2.42	3.60
Prefood	(2)	2262	3414	30.30	25.04	1.99	2.49	3.30
Prewater	(2)	4132	1380	96.81	14.02	2.97	1.89	2.89
Preboth	(2)	3812	2116	69.54	13.39	2.65	1.94	2.86
<i>Rat 11</i>								
Baseline	(5)	3110	2100	84.88	26.76	2.73	2.12	4.61
Prefood	(2)	2429	2784	46.49	29.05	2.33	2.48	5.08
Prewater	(2)	4472	712	133.40	7.81	3.24	0.94	1.96
Preboth	(2)	3790	1418	95.14	11.71	2.81	1.32	2.25
<i>Rat 12</i>								
Baseline	(4)	3240	2419	49.90	19.26	2.76	2.64	5.88
Prefood	(2)	2310	3369	31.06	28.63	2.10	2.75	4.30
Prewater	(2)	3917	1746	70.73	13.19	2.83	2.58	5.59
Preboth	(2)	3471	2213	52.68	15.45	2.74	2.55	5.41

was more pronounced (Figure 1). Prefeeding decreased the mean overall response and reinforcement rates in the VI_{food} component for each subject (Table 1).

The overall response rate in the VI_{water} component for Rat 11 in Session 188 was higher than in Session 170. Rates were higher early in the session than in baseline, and the rates increased toward the end of the session as in baseline (Figure 2). Prefeeding increased overall response rates in the VI_{water} component for Rats 5, 11, and 12 and increased mean obtained reinforcement rates for each subject. Prefeeding did not consistently affect changeover rates (Table 1).

Prewater. The mean amount of water consumed was 10.1 g. The mean per cent time in the VI_{food} component was higher than in baseline for each subject (Figure 3).

Rat 11 consumed 12.0 g of water before Session 184, and the overall response rate in the VI_{food} component was almost twice the rate during Session 170 (baseline). Rates were higher early in the session than in baseline, and the decrease in rates toward the end of the session was less pronounced (Figure 1). Prewatering increased the mean overall response and reinforcement rates in the VI_{food} component for each subject (Table 1).

The overall response rate in the VI_{water} component for Rat 11 in Session 184 was lower than in Session 170. Rates were much lower early in the session than in baseline, and the rates increased toward the end of the session (Figure 2). Prewatering decreased overall response and reinforcement rates in the VI_{water} component and mean changeover rates for each subject (Table 1).

Preboth. The mean amount of food consumed was 5.4 g, and the mean amount of water consumed was 13.7 g. Each subject consumed more food on preboth days than on prefood days ($t = 5.521$, $df = 3$, $p < 0.05$; one-tailed) and consumed more water on preboth days than on prewater days ($t = 2.236$, $df = 3$, $p \simeq 0.06$; one-tailed). The mean per cent time in the VI_{food} component was lower than on prewater days and higher than on baseline days for each subject (Figure 3).

Rat 11 consumed 6.7 g of food and 18.3 g of water before Session 181. Response rates in the VI_{food} component were slightly lower than in Session 184 (prewater) early in the session and slightly higher than in Session 188 (pre-

food) at the end of the session. The change in rates was abrupt and occurred about 1 hr into the session (Figure 1). Mean response and reinforcement rates in the VI_{food} component were higher than in baseline for each subject (Table 1).

An abrupt change in response rates in the VI_{water} component (Figure 2) coincided with the change in rates in the VI_{food} component for Rat 11. Early in the session, response rates in the VI_{water} component were low as in Session 184 (prewater). Rates at the end of Session 181 were higher than in Session 184 but lower than at the end of Sessions 170 (baseline) and 188 (prefood). Mean response and reinforcement rates in the VI_{water} component and mean changeover rates were lower than in baseline for each subject (Table 1).

DISCUSSION

In most research on motivational interactions between food- and water-related behaviors (see Bolles, 1967, for a review), independent groups of subjects are used. The independent variable is chronic deprivation of food, water, or both. The primary dependent variables are the latency to eat and/or drink and the amount of food and/or water consumed. In the present experiment, rats chronically deprived of both food and water were trained on concurrent VI_{food} VI_{water} schedules. A within-subjects design was used in which the independent variable was brief availability of food and/or water before experimental sessions. Measuring food and/or water consumption before experimental sessions validated the symmetry between our procedures and results and those using different methods. For example, Hamilton and Flaherty (1973) found that food-deprived rats tended to eat before drinking and to consume less water than nondeprived rats. Water-deprived rats tended to drink before eating and to consume less food than nondeprived rats. Rats deprived of both food and water tended to behave like rats deprived of food but not water. The present data on pre-session eating and drinking are consistent with those of Hamilton and Flaherty. We found that availability of food enhanced drinking, and availability of water enhanced eating in rats deprived of both.

Our primary interest was the effects of acute changes in deprivation levels on time alloca-

tion and rates of concurrent operants reinforced with food and water. Time allocation in concurrent VI VI schedules is considered an index of choice (Baum and Rachlin, 1969). Per cent time in the VI_{food} component was greatest on prewater days, second on preboth days, third on baseline days, and lowest on prefood days. The value of the food reinforcer relative to the water reinforcer presumably had the same rank-order. Eating on preboth days apparently attenuated slightly the effects of drinking. Hamilton and Flaherty (1973) found that depriving a rat of food is functionally similar to depriving a rat of both food and water. The present data indicate that reducing water deprivation is functionally similar to reducing deprivation of both food and water.

Prefeeding reduced overall response rates in the VI_{food} component, and prewatering reduced overall response rates in the VI_{water} component. These are probably instances of satiation. These findings complement data from Clark (1958), who demonstrated a direct relation between hours of food deprivation and response rates on VI_{food} schedules.

Prefeeding increased overall response rates in the VI_{water} component, and prewatering increased overall response rates in the VI_{food} component. Perhaps the availability of one reinforcer before a session functionally increased the deprivation level associated with the other reinforcer. Furthermore, within sessions under all four deprivation conditions, responding and time in the VI_{food} component decreased, and responding and time in the VI_{water} component increased. Our rats typically consumed over 90% of their daily food ration within sessions. When food enters the stomach, intracellular water goes to the stomach and assists digestion; temporary cellular dehydration results (Bolles, 1967). Thus, the increases in water-reinforced responding within sessions could have reflected functional increases in the level of water deprivation.

Alternatively, increases in rates in one component may have depended upon decreases in rates of competing responses and/or reinforcers in the other component. Motivational effects and the effects of competing responses and reinforcers could be quantified by measuring behavior in both single-response and concurrent operant paradigms. We predict that the present findings would replicate in a single-

response paradigm. For example, prewatering a rat deprived of both food and water would probably increase the rate of a food-reinforced operant in the absence of a concurrent water-reinforced response.

Concurrent schedules can be conceptualized as multiple schedules in which the experimental subject changes the components (Catania, 1966; Killeen, 1972a). Such a conceptualization raises questions about stimulus control. The reciprocal changes in rates of responding following changes in deprivation levels document that stimulus control was achieved for each subject. For Rats 9 and 12, the right lever (plus stimuli near it) controlled food-reinforced responding; the left lever (plus stimuli near it) controlled water-reinforced responding. For Rats 5 and 11, the presence of six nonilluminated cue lights controlled water-reinforced responding; the presence of six illuminated cue lights controlled food-reinforced responding. Qualitatively different stimuli that differentially reinforce concurrent operants can establish stimulus control.

In the present experiment, responding in the food component and responding in the water component were operants that were apparently independent with respect to their scheduled consequences. It is unlikely that responding in the water component was an instance of schedule-induced polydipsia. Schedules of VI_{food} as low as 15 sec do not occasion excessive induced drinking, and prewatering has only minor effects on established schedule-induced water consumption (Falk, 1969). Prewatering had major effects on VI_{water} responding in the present experiment. It is also unlikely that superstitious chaining (Catania, 1966) could account for responding in either component because changes in deprivation levels produced reciprocal changes in VI_{food} and VI_{water} response rates. Response rates would have changed in the same direction if superstitious chaining had occurred.

Two subjects were trained with a two-lever concurrent schedule; two other subjects were trained with a changeover-lever concurrent schedule. The data from the two procedures were highly similar. Functional relations between independent and dependent variables might at times interact with the type of concurrent schedule used, but there was definitely no indication of such an interaction in the present data.

For each subject, VI_{food} response rates exceeded VI_{water} response rates in baseline. Comparable results were obtained by Fallon, Thompson, and Schild (1965) and Hearst (1961) for rats trained on *conc* VI_{food} VI_{water} schedules, by Thompson (1964) for roosters on *conc* FR_{food} FR_{water} schedules, and by Findley (1962) for a monkey on *conc* FR_{food} FR_{water} schedules. The discrepancy between food-reinforced and water-reinforced response rates generalizes across several experimental conditions and species, but different experimental parameters could reverse the relation. One could use a food reinforcer equal in magnitude to that consumed daily on free-feeding food and water plus a water reinforcer equal to a small fraction of free-access water intake.

The present experiments were not designed to test the applicability of the matching law (Baum, 1973; Baum and Rachlin, 1969; Catania, 1966; 1973; Herrnstein, 1961; 1970; Killeen, 1972*b*; Rachlin, 1971; 1973; Revusky, 1963) to concurrent operants with different reinforcers (*e.g.*, Hollard and Davison, 1971). Such an experiment ideally would adjust experimental parameters to produce matching in baseline, then change schedule parameters while keeping deprivation levels constant (Baum and Rachlin, 1969).

The amount of food and water was unrestricted on preboth days to permit measuring the amounts consumed. If the amounts consumed when only one substance was available had been used on preboth days, a quantitative analysis of time allocation in the context of matching could have been undertaken. One could assume that

$$\frac{T_{\text{food}}}{T_{\text{water}}} = k \frac{r_{\text{food}}}{r_{\text{water}}}, \quad (1)$$

in which T equals time, r equals obtained reinforcers, and k equals a constant reflecting bias for one of the concurrent baseline schedules. If prefeeding devalued food reinforcers by a factor, x , and if prewatering devalued water reinforcers by a factor, y , then

$$\frac{T_{\text{food}}}{T_{\text{water}}} = k \frac{x r_{\text{food}}}{y r_{\text{water}}}, \quad (2)$$

on prefood days, and

$$\frac{T_{\text{food}}}{T_{\text{water}}} = k \frac{r_{\text{food}}}{y r_{\text{water}}}, \quad (3)$$

on prewater days. Equation (1) could be solved

for k , then Equation (2) for x , and Equation (3) for y . The predicted values of $T_{\text{food}}/T_{\text{water}}$ ($T'_{\text{food}}/T'_{\text{water}}$) could be computed in the formula

$$\frac{T'_{\text{food}}}{T'_{\text{water}}} = k \frac{x r_{\text{food}}}{y r_{\text{water}}}, \quad (4)$$

for preboth days. Discrepancies between measured values of $T_{\text{food}}/T_{\text{water}}$ on preboth days and $T'_{\text{food}}/T'_{\text{water}}$ would pose questions about assumptions underlying this model. A similar analysis in terms of response matching would be possible. The present data were not analyzed in this manner because the amounts of food and water consumed on preboth days exceeded the amounts consumed when the substances were presented singly.

We used rats because of their popularity in research on food and water regulation. We used VI 15-sec schedules so that frequent reinforcement might assist establishing stimulus control. We used a probe technique (*e.g.*, prefeeding) rather than a steady-state design to vary deprivation levels. The probe technique facilitated recapturing baseline weights. Systematic replications (Sidman, 1960) using different species, schedules, schedule parameters, and methods of varying deprivation levels will determine the generality of the present data.

REFERENCES

- Baum, W. M. The correlation-based law of effect. *Journal of the Experimental Analysis of Behavior*, 1973, 20, 137-153.
- Baum, W. M. and Rachlin, H. C. Choice as time allocation. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 861-874.
- Bolles, R. C. *Theory of motivation*. New York: Harper & Row, 1967.
- Catania, A. C. Concurrent operants. In W. K. Honig (Ed.), *Operant behavior: areas of research and application*. New York: Appleton-Century-Crofts, 1966. Pp. 213-270.
- Catania, A. C. Self-inhibiting effects of reinforcement. *Journal of the Experimental Analysis of Behavior*, 1973, 19, 517-526.
- Clark, F. C. The effect of deprivation and frequency of reinforcement on variable-interval responding. *Journal of the Experimental Analysis of Behavior*, 1958, 1, 221-228.
- Falk, J. L. Conditions producing psychogenic polydipsia in animals. *Annals of the New York Academy of Sciences*, 1969, 157, 569-593.
- Fallon, D., Thompson, D. M., and Schild, M. E. Concurrent food- and water-reinforced responding under food, water, and food-plus-water deprivation. *Psychological Reports*, 1965, 16, 1305-1311.

- Ferster, C. B. and Skinner, B. F. *Schedules of reinforcement*. New York: Appleton-Century-Crofts, 1957. Pp. 703-721.
- Findley, J. D. Preference and switching under concurrent scheduling. *Journal of the Experimental Analysis of Behavior*, 1958, 1, 123-144.
- Findley, J. D. An experimental outline for building and exploring multi-operant behavior repertoires. *Journal of the Experimental Analysis of Behavior*, 1962, 5, 113-166.
- Fleshler, M. and Hoffman, H. S. A progression for generating variable-interval schedules. *Journal of the Experimental Analysis of Behavior*, 1962, 5, 529-530.
- Hamilton, L. W. and Flaherty, C. F. Interactive effects of deprivation in the albino rat. *Learning and Motivation*, 1973, 4, 148-162.
- Hearst, E. Effects of *d*-amphetamine on behavior reinforced by food and water. *Psychological Reports*, 1961, 8, 301-309.
- Herrnstein, R. J. Relative and absolute strength of response as a function of frequency of reinforcement. *Journal of the Experimental Analysis of Behavior*, 1961, 4, 267-272.
- Herrnstein, R. J. On the law of effect. *Journal of the Experimental Analysis of Behavior*, 1970, 13, 243-266.
- Hollard, V. and Davison, M. C. Preference for qualitatively different reinforcers. *Journal of the Experimental Analysis of Behavior*, 1971, 16, 375-380.
- Killeen, P. A yoked-chamber comparison of concurrent and multiple schedules. *Journal of the Experimental Analysis of Behavior*, 1972, 18, 13-22. (a)
- Killeen, P. The matching law. *Journal of the Experimental Analysis of Behavior*, 1972, 17, 489-495. (b)
- Miller, N. E. Behavioral and physiological techniques: rationale and experimental designs for combining their use. In C. F. Code (Ed.), *Handbook of physiology: Section 6: Alimentary canal, volume I: Control of food and water intake*. Baltimore: Waverly Press (American Physiological Society), 1967. Pp. 51-61.
- Rachlin, H. On the tautology of the matching law. *Journal of the Experimental Analysis of Behavior*, 1971, 15, 249-251.
- Rachlin, H. Contrast and matching. *Psychological Review*, 1973, 80, 217-234.
- Revusky, S. H. A relationship between responses per reinforcement and preference during concurrent VI VI. *Journal of the Experimental Analysis of Behavior*, 1963, 6, 518.
- Sidman, M. *Tactics of scientific research*. New York: Basic Books, 1960.
- Teitelbaum, P. Motivation and control of food intake. In C. F. Code (Ed.), *Handbook of physiology: Section 6: Alimentary canal, volume I: Control of food and water intake*. Baltimore: Waverly Press (American Physiological Society), 1967. Pp. 319-335.
- Thompson, T. I. Visual reinforcement in fighting cocks. *Journal of the Experimental Analysis of Behavior*, 1964, 7, 45-49.

Received 5 November 1973.

(Final Acceptance 14 May 1974.)