

## CONDITIONED REINFORCEMENT AS A FUNCTION OF DURATION OF STIMULUS

JAMES A. DINSMOOR, DALLAS E. MULVANEY, AND  
ALICE R. JWAIDEH

INDIANA UNIVERSITY AND NEWCASTLE STATE HOSPITAL

Pigeons were provided with three keys. Pecking the center key produced grain on a schedule that alternated at unpredictable times between a variable-interval component and extinction. On concurrent variable-interval schedules, pecking either side key produced a stimulus associated with the variable-interval component on the center key provided that said schedule was currently in effect. The independent variable was the length of time this stimulus remained on the keys. Pecking one side key produced the stimulus for 27 seconds, whereas the duration produced by pecking the other key varied for successive blocks of sessions. For the first four birds, the values tested were 3, 9, 27, and 81 seconds. For the second group, numbering three birds, the values tested were 1, 3, 9, and 27 seconds. The dependent variable was the proportion of total side key pecks that occurred on the variable key. For all birds, the function was positive in slope and negative in acceleration. This finding supports a formulation that ascribes the maintenance of observing responses in a normal setting to the fact that the subject exposes itself to the positive discriminative stimulus for a longer mean duration than it does to the negative stimulus.

*Key words:* observing, duration of stimulus, conditioned reinforcer, concurrent schedule, key peck, pigeons

The question of why an experimental subject learns to observe the stimuli for a successive discrimination has plagued behavior theorists for a number of years. (For a detailed review of efforts to solve the problem, see Dinsmoor, Note 1.) With this type of discrimination, the observing response does not affect the frequency with which primary reinforcement is delivered. Nor does it normally lead to any economy in the number of responses required. Explanations in terms of secondary or conditioned reinforcement run into difficulty: the observing response brings the subject into sensory contact not only with the positive discriminative stimulus, which is associated with a higher frequency of reinforcement than other stimuli in the situation, but also with the negative stimulus, which is associated with the absence of reinforcement. In fact, if the rate of reinforcement while observing the positive stimulus is averaged with the zero rate obtained while observing the negative

stimulus, the resulting mean is no higher than the rate of the reinforcement associated with other stimuli in the situation. There seems to be no reason for the subject to prefer exposure to the discriminative stimuli.

Theorists have attempted to cope with this problem in a variety of ways. Wyckoff (1959), for example, showed that the difficulty could be circumvented by postulating, ad hoc, that the value of a stimulus as a conditioned reinforcer is a positively accelerated function of the density of primary reinforcement. Doubling the frequency of primary reinforcement in the presence of a stimulus, then, would more than double the value of the stimulus as a conditioned reinforcer, and the mean reinforcing value of the discriminative stimuli would be greater than that of other stimuli in the situation. Unfortunately for this analysis, the idea of positive acceleration without limit—and observing does occur across a wide variety of parametric values—seems prima facie implausible, and what data we have available (Autor, 1969, p. 144; Herrnstein, 1964, p. 34) indicate that in reality the function is negatively accelerated.

It is possible, of course, that Wyckoff and other writers have incorrectly characterized

---

Reprints may be obtained from James Dinsmoor, Department of Psychology, Indiana University, Bloomington, Indiana 47405 or from Dallas Mulvaney, Newcastle State Hospital, New Castle, Indiana 47362. The authors thank Stuart Reynolds for his technical assistance.

the situation. It may not be appropriate to treat the positive and the negative stimulus simply as two points on a single preference function. Perhaps the reinforcing effect of the positive stimulus and the punishing effect of the negative stimulus should be viewed as quite independent and not necessarily symmetrical functions of their respective densities of primary reinforcement. No data appear to be available on this issue.

Perkins (1955, 1971) has suggested that the reason that observing behavior is acquired, despite the absence of any increase in the mean density of primary reinforcement associated with the stimuli, is that the differential stimulation enables the animal to make preparatory responses suitable to the receipt and to the nonreceipt of the primary reinforcer. Some data collected by McLaughlin and cited in Perkins' 1971 paper appear to be compatible with this point of view and incompatible with other explanations of observing. However, one of the implications of the preparatory response hypothesis is that production of the negative discriminative stimulus, as well as the positive, should be reinforcing. "Absence of PR for US on nonreinforced presentations of the negative stimulus increases the value of conditions following CS presentation on nonreinforced trials" (Perkins, 1971, p. 120). Indeed, if only the preparation for positive outcomes were relevant, the subject could make this response on all trials and would have no need for stimuli indicating which type of outcome was forthcoming. A number of empirical studies have now been published, however, which in their cumulative impact are quite hostile to the supposition that S- is reinforcing (Blanchard, 1975; Dinsmoor, Browne, & Lawrence, 1972; Dinsmoor, Flint, Smith, & Viemeister, 1969; Dinsmoor, Sears, & Dout, 1976; Jenkins & Boakes, 1973; Katz, 1976; Kendall, 1972; Mulvaney, Dinsmoor, Jwaideh, & Hughes, 1974; Wald & Dukich, 1978).

Perhaps the most popular explanation, over the years, has been that observing produces information concerning future events of biological significance to the organism and that such information is, per se, reinforcing (e.g., Berlyne, 1960; Bloomfield, 1972; D'Amato, 1974; Green & Rachlin, 1977; Hendry, 1969; Lanzetta & Driscoll, 1966; Lieberman, 1972; Schaub, 1969; Schrier, Thompson, & Spector, 1980; Steiner, 1967). The information hypothe-

sis, however, has also been subject to extensive criticism. If it merely directs our attention to certain parameters of the temporal relationship between the conditioned reinforcer and the primary reinforcer, as in theoretical remarks by Egger and Miller (1962, 1963) and by Wilton and Clements (1971), it offers no help in explaining observing. If it is intended as a substitute for the traditional account based on the association in time between the two stimuli and especially if it is to serve as an explanation for observing, it must add the stipulation that negative, as well as positive, information is reinforcing. But as we have just seen in connection with the preparatory response hypothesis, the preponderance of the evidence is opposed to this conclusion.

An alternative solution to the problem of accounting for observing behavior has been offered by Dinsmoor, Browne, Lawrence, and Wasserman (1971). These authors attempted to deal with the phenomenon within the framework of traditional conditioned reinforcement theory. They began by replicating the main features of Wyckoff's (1969) original study of observing, allowing their pigeons to maintain discriminative stimuli on a response key as long as the birds stood on a pedal resting on the floor of the experimental chamber. Unlike Wyckoff, however, Dinsmoor et al. kept separate records of the time that their subjects spent in the presence of the positive discriminative stimulus (variable-interval schedule of reinforcement) and the time that they spent in the presence of the negative stimulus (no reinforcement). As training progressed, the birds kept the positive stimulus on for longer and longer periods each time they produced it; but whenever they produced the negative stimulus they promptly stepped off the pedal again, terminating the stimulus. Evidently the positive or negative character of the stimulus served as the basis for a subsequent discrimination by the subject: if positive, continue to observe it; if negative, turn it off. This hitherto unrecognized characteristic of the situation suggested a mechanism by which the observing might be maintained, even though stepping on the pedal more frequently produced an exposure to the negative than an exposure to the positive stimulus. Perhaps the duration of each exposure was an important parameter governing its effectiveness as a reinforcer or a punisher. If so, the reinforcing

effects of the relatively long exposures to the positive stimulus might override the punishing effects of relatively short exposures to the negative stimulus. Since natural observing responses presumably function in the same way as did the pedal depression, the same mechanism may also account for their acquisition during conventional discrimination training.

In previous attempts to examine the effect of duration, the first author had obtained data that were supportive but not compelling. For the present attempt, we therefore adapted to assess our conditioned reinforcer a design that had proved especially sensitive when used to assess the effects of duration of access to a primary reinforcer—relative rate of responding on two manipulanda under concurrent schedules of reinforcement (e.g., Catania, 1963; Fantino, Squires, Delbruck, & Peterson, 1972; Neuringer, 1967; Todorov, 1973; Walker & Hurwitz, 1971). Pecking the center key produced access to grain on a mixed variable-interval, extinction schedule. On concurrent variable-interval schedules, pecking the side (observing) keys produced displays of the positive discriminative stimulus when the variable-interval schedule was in effect on the center key. The duration produced by pecking one of the keys was held constant until a stable performance was obtained, then changed for the next block of sessions. The duration of the displays produced by pecking the other side key did not vary.

## METHOD

### *Subjects*

Seven White Carneaux hens, five to seven years of age, served. Prior to the present study they were experimentally naive. All birds were maintained at 80% of their free-feeding weights throughout the experiment.

### *Apparatus*

The experimental chamber measured 30.8 cm long, 30.8 cm high, and 28.2 cm wide. It contained three keys, each 2.6 cm in diameter, centered 5.1 cm apart, 25.6 cm above the floor. Each key could be illuminated from behind with a green or a white bulb rated at five watts. Houselights were mounted on the front corners of the same wall, 29.5 cm above the floor, and contained 10-W bulbs. A circular opening 5.0 cm in diameter, beginning 5.1

cm above the floor, provided access to the food hopper when the latter was in a raised position. Two magazine lights mounted on the rear of the wall just above this opening provided a signal that the hopper was accessible. The opening in the top surface of the hopper itself was 1.5 cm in diameter. The entire assemblage was enclosed in an insulating chamber originally designed for use as an ice chest, and an attached blower provided a masking noise in addition to circulating the air.

Food deliveries and changes in key color were scheduled with Grason-Stadler interval programmers, operating in conjunction with standard electromagnetic control equipment. Data were recorded on electromagnetic counters and running time meters.

### *Procedure*

Experimental sessions commenced at approximately the same time each day and lasted until 50 reinforcements had been delivered. Reinforcement consisted of 4-sec access to mixed grain; during this time the houselights and keylights were darkened and the magazine lights turned on. Initially, during shaping and training sessions, the side keys were covered with electrical tape and the center key was green. Pecking was shaped by the Brown and Jenkins (1968) procedure. In subsequent sessions, it was reinforced on variable-interval schedules averaging, for successive days, 30 sec, 60 sec, and 80 sec. After pecking the center key was reinforced for 3 days on the VI 80-sec schedule, pecking the left key was reinforced for 3 days on the same schedule and pecking the right key was reinforced for 3 days. The key in use was always green, and the other two keys were always covered.

With pecking now established on all three keys, the birds were placed on the observing procedure. All three keys were uncovered. Pecking the center key was reinforced with food on a schedule made up of two components. Under one of the component schedules, pecking was reinforced at intervals ranging from 1 sec to 160 sec and averaging 80 sec (VI 80-sec); under the other component, pecking was never reinforced (extinction). The circuit switched from one schedule to the other at varying intervals ranging from 10 to 180 sec and averaging 90 sec.

In the absence of further action by the bird, all three keys were white, and the overall schedule of reinforcement constituted a mixed schedule. However, pecking the side keys was reinforced on a complex intermittent schedule by transformation of all three keys to green. For the keys to become green, two criteria had to be met. First, it was necessary that the VI schedule be operative on the center (food) key; during the extinction component, no change in color could be produced. Second, production of the green depended on two equal but independent VI 30-sec schedules that were concurrently available on the two side keys whenever green was not already present. Once the color had changed to green, this color was maintained for 27 sec or until the schedule changed on the food key. Green served as the positive discriminative stimulus and was not allowed to remain on the keys when the schedule of food reinforcement reverted to extinction. For the first four birds, a special feature of the circuit postponed any deliveries of grain that would otherwise have been made within 10 sec following a peck occurring on one of the side keys while the keys were white. If the keys changed to green, the restriction was canceled. This feature was retained for the first ten sessions of observing training for the remaining three birds but was phased out before any of the published data were recorded.

The independent variable in this experiment was the length of time for which green was allowed to remain on the keys before reverting to white. For the first four birds, the values employed were 3, 9, 27, and 81 sec, each pitted for a block of sessions against 27 sec on the opposing key; for the remaining three birds, the values were 1, 3, 9, and 27 sec. The sequence of values and the number of sessions required to reach stability at each value are listed in Table 1. For the first block of sessions, the duration of the display produced by pecking either of the side keys was set at 27 sec until a criterion for equality as well as a criterion for stability was met. Both criteria were based on the median rates of pecking while the keys were white for successive blocks of three sessions. To meet the criterion for equality, the medians for the two keys could differ by no more than two responses per minute for two successive blocks. (Bird P1, however, which had a strong bias

Table 1

Sequence of display durations employed for successive blocks of sessions and number of sessions required by each bird to reach stability criterion in each block.

Duration (sec)		Squad 1			
Left key	Right key	P1	P2	P3	P4
27	27	102	93	78	75
3	27	51	30	21	18
27	3	45	36	33	27
9	27	114	65	45	36
27	9	92	45	36	30
27	81	108	93	39	27
81	27	78	72	48	21
		Squad 2			
		P1A	P2A	P3A	
27	27	60	66	54	
1	27	15	15	18	
27	1	15	18	18	
3	27	39	30	36	
27	3	30	36	39	
9	27	48	51	54	
27	9	72	60	66	

toward the left key, was finally exempted from this criterion.) To meet the criterion for stability, the medians for two successive blocks could differ by no more than two responses per minute on either key. For subsequent blocks of sessions, the duration of the display produced by one of the side keys was set at 27 sec, and the duration of the display produced by pecking the other side key was set at one of the other values in the series. Each value was tested once with the left key at that value and the right key at 27 sec and once with the right key at that value and the left key at 27 sec. Any sequence effects that might appear for absolute rates of pecking could be corrected by calculating relative rates for the two keys, i.e., proportion of responses on the key in question. A block of sessions was terminated and a new duration employed only when a given bird had met the stability criterion and had shown a consistent preference for one of the keys for 10 successive sessions. Data from occasional sessions in which an apparatus failure or a technician error occurred were omitted from the analysis.

## RESULTS

The mean rate of pecking by each bird on each side key for each block of sessions is presented in Table 2. Only those pecks occur-

Table 2

Mean pecks per minute by each bird on left and right observing keys while they were white for each block of sessions. Means are calculated for the last 10 sessions within each block. The maximum duration of display produced by pecking each key is indicated in the columns to the left.

Duration (sec)		Squad 1									
Left	Right	P1		P2		P3		P4			
		Left	Right	Left	Right	Left	Right	Left	Right		
27	27	44.35	16.43	26.38	21.04	26.45	29.75	15.92	11.28		
3	27	21.71	36.11	12.48	29.02	15.31	38.69	10.03	16.81		
27	3	43.70	18.41	28.91	9.92	36.82	20.14	23.02	6.57		
9	27	23.66	35.39	14.85	18.73	22.71	29.57	15.78	18.13		
27	9	30.95	20.17	21.08	12.71	31.34	27.51	15.39	9.99		
27	81	32.49	33.57	20.79	23.26	21.25	26.63	10.97	18.73		
81	27	37.36	29.18	36.41	12.23	34.54	16.78	18.64	9.95		

		Squad 2							
Left	Right	P1A		P2A		P3A			
		Left	Right	Left	Right	Left	Right		
27	27	19.10	20.33	14.39	16.78	12.74	13.36		
1	27	3.80	14.54	6.99	18.83	2.92	19.18		
27	1	12.91	3.56	18.63	4.81	20.31	4.44		
3	27	8.95	14.36	11.12	17.84	4.51	15.51		
27	3	18.97	9.11	20.19	13.34	15.52	6.20		
9	27	16.21	20.09	14.44	18.61	11.25	16.48		
27	9	22.31	17.28	17.58	12.48	14.69	11.64		

ring while the keys were white were considered. All entries are based on the last 10 sessions within a given block. To correct these values for possible shifts in the level of performance as a function of time, we divided the rate on the key producing the duration of display that varied from block to block by the sum of the rates for the two keys. With one exception, these proportions increased monotonically with increasing durations for all birds on both keys—14 sequences of four entries apiece. The exception was the first determination for Pigeon P1. At a display duration of 27 sec for each key, this bird responded at a higher rate on the left key and a lower rate on the right key than it ever responded during the remainder of the experiment. Evidently this bird had a strong position preference when the consequences of pecking either key were the same, but the preference was reduced during subsequent sessions in which the consequences were different.

The mean proportions, averaged for the two keys, are plotted for the first four birds in Figure 1 and for the remaining three birds in Figure 2. The individual function for each of the birds is positive in slope and negative in acceleration. That is, responding increased with successive increases in duration of dis-

play, but these increases decreased in magnitude. The range of values for different individuals at a given duration is relatively restricted.

## DISCUSSION

We have been able to find only two attempts by other investigators to assess the relationship between the duration of a stimulus and its efficacy as a conditioned reinforcer. In a study by Auge (1973), pigeons pecked an observing key to produce colors that indicated whether the current one-min interval would terminate with a 2-sec or a 10-sec access to mixed grain as the reinforcer for pecking a food key. Ordinarily, the display lasted until the grain was delivered. For a block of test sessions, however, Auge reduced the duration of the stimulus display to 10 sec. As shown in the sections of his Figure 2 labeled *T*, there was a sharp reduction on each such occasion in the probability of pecking the observing key. Unfortunately, Auge's procedure seems to have guaranteed that no food would be delivered in the presence of a 10-sec display. "A changeover delay (COD) prevented a food-producing response from following an observing response by less than 10 sec" (Auge, 1973,

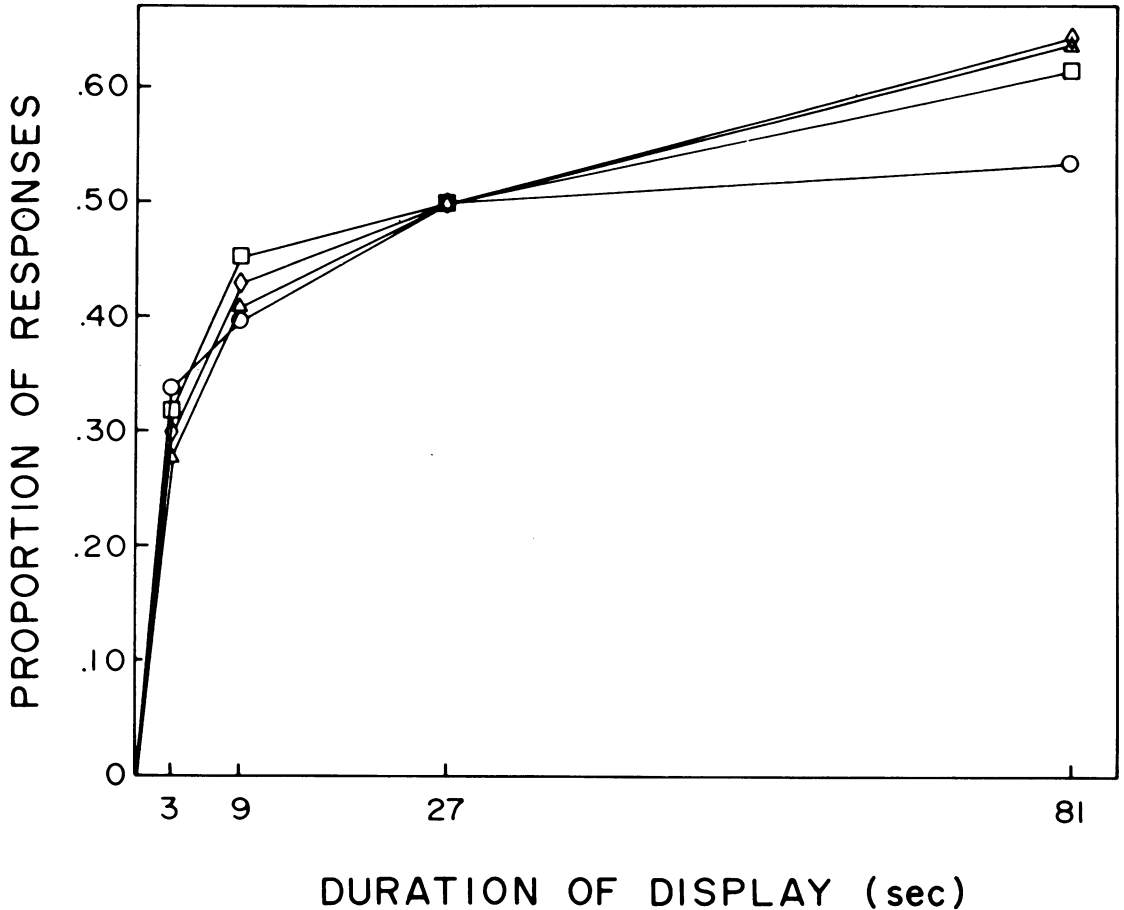


Fig. 1. Proportion of observing responses occurring on the key that produced the stimulus that varied in duration for successive blocks of sessions. The duration for the other key was always 27 sec. Squad 1: P1, circles; P2, triangles; P3, squares; P4, diamonds.

p. 430). Therefore, at this duration the stimulus served as an  $S^+$  or  $S^-$ , and it is not surprising that it did not maintain the observing response.

Although the original authors chose to discuss it in terms of number of primary reinforcers, an earlier study by Fantino and Herrnstein (1968; also reported in Fantino, 1969) could also be construed as an examination of the effects of the duration of a conditioned reinforcer. The basic design was a two-component concurrent chained schedule. Pigeons pecked on two concurrently available keys to produce changes in color on variable-interval 60-sec schedules. Once the color had changed on a given key, pecking that key was reinforced with access to grain on a variable-interval 15-sec schedule. The difference in the consequences of pecking either key in the ini-

tial link, aside from the difference in colors produced, resided in the number of primary reinforcers delivered before the final link was terminated. The values employed ranged from one delivery to 10 deliveries of grain. Since the length of time the stimulus remained present covaried with the number of times grain was delivered, the variable in question could also be characterized in terms of the duration of the stimulus produced by pecking either key. As in the present study, the rate of primary reinforcement in the presence of the stimulus would be constant. The functions obtained by Fantino and Herrnstein (e.g., Figures 2 and 3 in the 1968 report or 7.5 and 7.6 in the 1969 report) appear to be similar in form to those we have obtained (Figures 1 and 2). The difficulty with the Fantino and Herrnstein study, for our purposes, was that

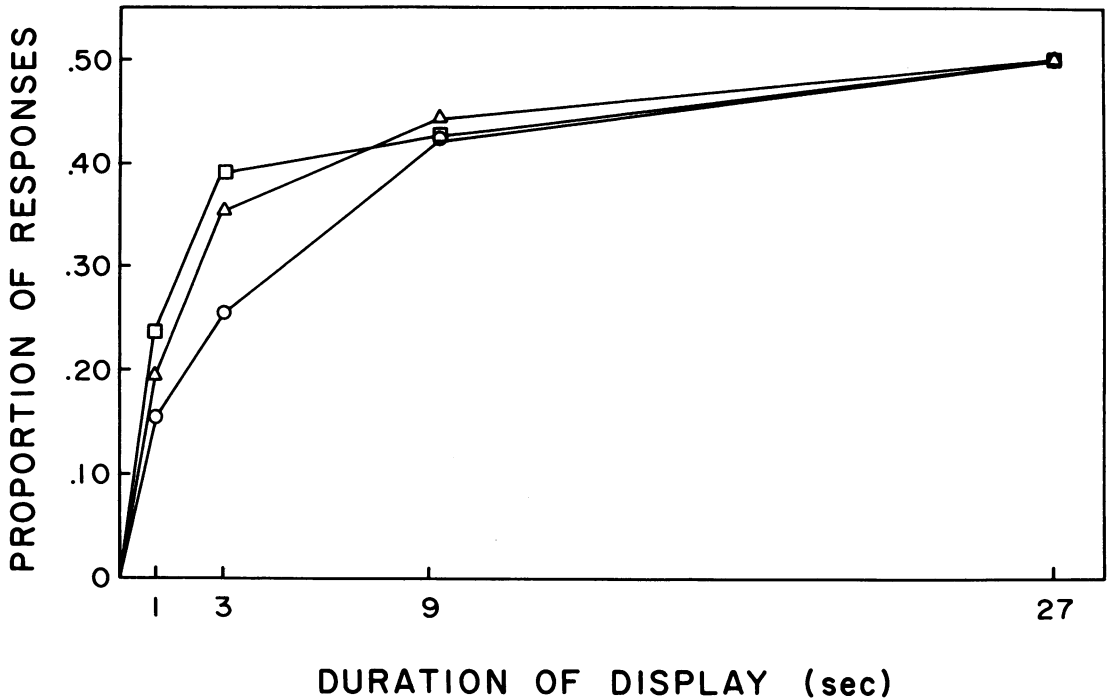


Fig. 2. Proportion of observing responses occurring on the key that produced the stimulus that varied in duration for successive blocks of sessions. The duration for the other key was always 27 sec. Squad 2; P1A, triangles; P2A, squares; P3A, circles.

it was conducted with a concurrent chain rather than with an observing procedure. Although the rate of primary reinforcement in the presence of either terminal stimulus was the same, the difference in durations meant that the overall rate of primary reinforcement, averaging the time spent in the two links, varied with the key that was pecked. The relative rate of responding might represent a preference for a high density of primary reinforcement rather than a preference for a long duration of stimulus.

Although the concurrent observing design holds the overall density of reinforcement constant, it must be recognized that it imposes certain constraints on the experimenter's freedom of action. In the present instance, for example, it was not always possible to maintain the food-associated stimulus for the full length of time assigned to it. If the schedule of primary reinforcement shifted from variable-interval to extinction before the specified time had elapsed, it was necessary either to terminate the stimulus or to permit a reduction in the rate of primary reinforcement in its presence. We chose the first alternative,

termination of the stimulus. Therefore, the durations specified in the results section are maximal or limiting durations. Although it is possible that this aspect of the procedure exercises some influence on the precise shape of the functions we have obtained, in no way does it call into question our basic finding that the effectiveness of a stimulus as a conditioned reinforcer increases quite reliably as a function of its duration. Premature terminations would increase in frequency at the longer durations and would therefore tend to reduce the magnitude of this effect; that is, they would act in a direction contrary to our finding. The emergence of a positive relationship despite this limitation indicates either the robustness of the original phenomenon or the weakness of the limitation.

The conclusion that longer lasting stimuli have a greater effect on the response that produces them is consistent with and increases the plausibility of earlier accounts of the reinforcement of observing advanced by Dinsmoor, Browne, Lawrence, and Wasserman (1971) and by Browne and Dinsmoor (1974). As mentioned earlier, when the subject estab-

lishes sensory contact with (i.e., observes) a positive discriminative stimulus, it maintains that contact for a longer period than when it inadvertently makes contact with the negative stimulus. This presumably holds true for natural observing responses as well as for the artificial variety. The greater efficacy of a longer lasting stimulus, as demonstrated in the present study, offers a plausible mechanism to account for the net reinforcing effect when the positive and negative stimuli are available to the subject for equal proportions of the time and are associated with equal but opposite changes in the density of reinforcement.

### REFERENCE NOTE

1. Dinsmoor, J. A. *The reinforcement of observing*. Manuscript submitted for publication, 1980.

### REFERENCES

- Auge, R. J. Effects of stimulus duration on observing behavior maintained by differential reinforcement magnitude. *Journal of the Experimental Analysis of Behavior*, 1973, 20, 429-438.
- Autor, S. M. The strength of conditioned reinforcers as a function of frequency and probability of reinforcement. In D. P. Hendry (Ed.), *Conditioned reinforcement*. Homewood, Ill.: Dorsey, 1969.
- Berlyne, D. E. *Conflict, arousal, and curiosity*. New York: McGraw-Hill, 1960.
- Blanchard, R. The effect of S- on observing behavior. *Learning and Motivation*, 1975, 6, 1-10.
- Bloomfield, T. M. Reinforcement schedules: Contingency or contiguity. In R. M. Gilbert & J. R. Milenson (Eds.), *Reinforcement: Behavioral analyses*. New York: Academic Press, 1972.
- Brown, P. L., & Jenkins, H. M. Auto-shaping of the pigeon's key-peck. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 1-8.
- Browne, M. P., & Dinsmoor, J. A. Wyckoff's observing response: Pigeons learn to observe stimuli for free food but not stimuli for extinction. *Learning and Motivation*, 1974, 5, 165-173.
- Catania, A. C. Concurrent performances: A baseline for the study of reinforcement magnitude. *Journal of the Experimental Analysis of Behavior*, 1963, 6, 299-300.
- D'Amato, M. R. Derived motives. In *Annual Review of Psychology*, 1974, 25, 83-106.
- Dinsmoor, J. A., Browne, M. P., & Lawrence, C. E. A test of the negative discriminative stimulus as a reinforcer of observing. *Journal of the Experimental Analysis of Behavior*, 1972, 18, 79-85.
- Dinsmoor, J. A., Browne, M. P., Lawrence, C. E., & Wasserman, E. A. A new analysis of Wyckoff's observing response. *Proceedings of the 79th Annual Convention of the American Psychological Association*, 1971, 6, 679-680. (Summary)
- Dinsmoor, J. A., Flint, G. A., Smith, R. F., & Viemeister, N. F. Differential reinforcing effects of stimuli associated with the presence or absence of a schedule of punishment. In D. P. Hendry (Ed.), *Conditioned reinforcement*. Homewood, Ill.: Dorsey, 1969.
- Dinsmoor, J. A., Sears, G. W., & Dout, D. L. Observing as a function of stimulus difference. *Journal of Experimental Psychology: Animal Behavior Processes*, 1976, 2, 154-162.
- Egger, M. D., & Miller, N. E. Secondary reinforcement in rats as a function of information value and reliability of stimulus. *Journal of Experimental Psychology*, 1962, 64, 97-104.
- Egger, M. D., & Miller, N. E. When is a reward reinforcing? An experimental study of the information hypothesis. *Journal of Comparative and Physiological Psychology*, 1963, 56, 132-137.
- Fantino, E. Conditioned reinforcement, choice, and the psychological distance to reward. In D. P. Hendry (Ed.), *Conditioned reinforcement*. Homewood, Ill.: Dorsey, 1969.
- Fantino, E., & Herrnstein, R. J. Secondary reinforcement and number of primary reinforcements. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 9-14.
- Fantino, E., Squires, N., Delbruck, N., & Peterson, C. Choice behavior and the accessibility of reinforcement. *Journal of the Experimental Analysis of Behavior*, 1972, 18, 35-43.
- Green, L., & Rachlin, H. Pigeons' preferences for stimulus information: Effects of amount of information. *Journal of the Experimental Analysis of Behavior*, 1977, 27, 255-263.
- Hendry, D. P. Introduction. In D. P. Hendry (Ed.), *Conditioned reinforcement*. Homewood, Ill.: Dorsey, 1969.
- Herrnstein, R. J. Secondary reinforcement and rate of primary reinforcement. *Journal of the Experimental Analysis of Behavior*, 1964, 7, 27-36.
- Jenkins, H. M., & Boakes, R. A. Observing stimulus sources that signal food or no food. *Journal of the Experimental Analysis of Behavior*, 1973, 20, 197-207.
- Katz, H. N. A test of the reinforcing properties of stimuli correlated with nonreinforcement. *Journal of the Experimental Analysis of Behavior*, 1976, 26, 45-56.
- Kendall, S. B. Some effects of response-dependent clock stimuli in a fixed-interval schedule. *Journal of the Experimental Analysis of Behavior*, 1972, 17, 161-168.
- Lanzetta, J. T., & Driscoll, J. M. Preference for information about an uncertain but unavoidable outcome. *Journal of Personality and Social Psychology*, 1966, 3, 96-102.
- Lieberman, D. A. Secondary reinforcement and information as determinants of observing behavior in monkeys (*Macaca mulatta*). *Learning and Motivation*, 1972, 3, 341-358.
- Mulvaney, D. E., Dinsmoor, J. A., Jwaideh, A. R., & Hughes, L. H. Punishment of observing by the negative discriminative stimulus. *Journal of the Experimental Analysis of Behavior*, 1974, 21, 37-44.
- Neuringer, A. J. Effects of reinforcement magnitude on choice and rate of responding. *Journal of the Experimental Analysis of Behavior*, 1967, 10, 417-424.
- Perkins, C. C., Jr. The stimulus conditions which follow learned responses. *Psychological Review*, 1955, 62, 341-348.



- Perkins, C. C., Jr. Reinforcement in classical conditioning. In H. H. Kendler & J. T. Spence (Eds.), *Essays in neobehaviorism: A memorial volume to Kenneth W. Spence*. New York: Appleton-Century-Crofts, 1971.
- Schaub, R. E. Response-cue contingency and cue effectiveness. In D. P. Hendry (Ed.), *Conditioned reinforcement*. Homewood, Ill.: Dorsey, 1969.
- Schrier, A. M., Thompson, C. R., & Spector, N. R. Observing behavior in monkeys (*Macaca arctoides*): Support for the information hypothesis. *Learning and Motivation*, 1980, **11**, 355-365.
- Steiner, J. Observing responses and uncertainty reduction. *Quarterly Journal of Experimental Psychology*, 1967, **19**, 18-29.
- Todorov, J. C. Interaction of frequency and magnitude of reinforcement on concurrent performances. *Journal of the Experimental Analysis of Behavior*, 1973, **19**, 451-458.
- Wald, B. A., & Dukich, T. D. Observing behavior: Redundant stimuli and time since information. *Animal Learning and Behavior*, 1978, **6**, 380-384.
- Walker, S. F., & Hurwitz, H. M. B. Effects of relative reinforcer duration on concurrent response rates. *Psychonomic Science*, 1971, **22**, 45-47.
- Wilton, R. N., & Clements, R. O. The role of information in the emission of observing responses: A test of two hypotheses. *Journal of the Experimental Analysis of Behavior*, 1971, **16**, 161-166.
- Wyckoff, L. B., Jr. Toward a quantitative theory of secondary reinforcement. *Psychological Review*, 1959, **66**, 68-78.
- Wyckoff, L. B., Jr. The role of observing responses in discrimination learning. In D. P. Hendry (Ed.), *Conditioned reinforcement*. Homewood, Ill.: Dorsey, 1969.

*Received August 25, 1980*

*Final acceptance February 16, 1981*