PUNISHMENT OF AUTOSHAPED KEY-PECK RESPONSES OF PIGEONS

RICHARD K. WESP,¹ KENNON A. LATTAL, AND ALAN D. POLING

WEST VIRGINIA UNIVERSITY

The effects of different voltages of response-dependent and response-independent electric shock on the frequency of key-peck responses engendered by an autoshaping procedure were studied. In Experiments I and II, each response produced a brief electric shock, and response frequency generally decreased more with higher-voltage shock. Preshock frequencies of responding were generally recovered across successive sessions of relatively low-voltage shock delivery but not at higher shock voltages. The effects of response-dependent and response-independent shock were compared in Experiment III by using a yoked-control procedure in which each pigeon received each type of shock delivery at different times. Response-dependent shock generally produced greater decreases in response frequency. In the final experiment, one response-independent shock per autoshaping trial was scheduled. The number of autoshaped responses per trial was related to shock voltages. These results suggest that response-dependent and response-independent electric shock effectively decrease frequency of autoshaped responses.

Key words: punishment, response-dependent electric shock, response-independent electric shock, autoshaping, fixed-trial procedure, key peck, pigeons

Delivery of response-independent food after a response key is illuminated can result in key-peck responding in pigeons (Brown and Jenkins, 1968). This phenomenon has been called autoshaping and these autoshaped responses may persist for many sessions under such conditions (Brown and Jenkins, 1968; Ricci, 1973). A number of studies have described the necessary conditions for the development and maintenance of these responses (see Hearst and Jenkins, 1974, for a review).

Williams and Williams (1969) described a negative automaintenance procedure in which responses during illumination of the response key eliminated food delivery. The imposition of such a negative relationship between a response and the delivery of a reinforcer is an effective technique in eliminating behavior under some conditions (Zeiler, 1971); however,

Williams and Williams reported persistent key pecking under these contingencies. Other techniques of reducing response probability have been studied in relation to autoshaped responding. Schwartz and Williams (1972a) used a two-key procedure to suppress responding during a negative automaintenance procedure. After negative automaintenance was established with pigeons, a second response key, on which pecks had no scheduled consequence, was occasionally illuminated concurrently with the key associated with negative automaintenance. During trials on which both keys were illuminated, response rates on the negative automaintenance key were generally lower than during trials on which only the negative automaintenance key was illuminated. Eliminating food after the trial stimulus (Wasserman, 1972) and eliminating a positive correlation between occurrence of the trial stimulus and food presentation (Gamzu and Williams, 1971) are also effective procedures for reducing frequency of autoshaped responding.

Studies concerned with decreasing the probability of autoshaped responding largely have consisted of manipulations of key illumination, key-peck contingency parameters, or reinforcement parameters and have generally

¹The data in Experiment I were part of a thesis submitted in partial fulfillment of the M. A. degree requirements at West Virginia University by Alan Poling, who is now at the University of Minnesota. We are indebted to Ms. Teresa Poling for her assistance in collecting data in Experiment I. Some of the research was supported by a West Virginia University faculty research grant to the second author. Reprints may be obtained from R. K. Wesp or K. A. Lattal, Department of Psychology, West Virginia University, Morgantown, WV 26506.

not considered the effects of other variables. A technique for decreasing the probability of responding maintained by reinforcement schedules that has not been systematically considered in relation to autoshaping is the delivery of electric shock. The present study examined the effects of both response-dependent and response-independent electric shock on autoshaped responses.

EXPERIMENT I

This experiment examined the short-term effects of different voltages of response-dependent electric shock on autoshaped responding.

METHOD

Subjects

Four naive adult White King pigeons were maintained at 75% of their free-feeding weights.

Apparatus

A 38.5- by 23.5- by 21.5-cm test chamber was constructed of 1.8-cm thick plywood. The work area was painted flat black. Subjects could be viewed through apertures located on the side and back walls of the chamber. A grain hopper was located behind a 5- by 5-cm opening centered horizontally on the work panel 7 cm from the chamber floor. A single translucent plastic response key, 2.0 cm in diameter, was mounted on the work panel to the left of the feeder opening 14 cm from the chamber floor. This key was fitted with a clear plastic extension that protruded 8 mm from the work panel. A red bulb mounted behind illuminated the key. Key operation required a force of approximately 0.06 N. The chamber was illuminated throughout the session by a 110-V ac 7-W bulb mounted behind a glass shield in the top of the chamber. Standard electromechanical scheduling and recording equipment was used. White noise was present in the chamber during each experimental session.

A 100-msec electric shock was delivered to each bird through 22-gauge nichrome wire electrodes implanted around the pubis bones as described by Azrin (1959). The input was 60 Hz, 110 V ac reduced to the desired voltage by a Standard Electric Products variable resistor (Adjust-A-Volt model 500 B). A 10,000-ohm resistor was connected in series with the

bird. Electrodes were periodically cleaned and the resistance of each bird was regularly checked. Resistance was approximately constant at 1500 to 2000 ohms during the experiment.

Procedure

During the first session, each bird was trained to approach and eat from the illuminated grain hopper, which was presented for 20 sec at random intervals ($X = 35$ sec) without reference to the bird's behavior. After 10 such presentations, duration of hopper presentation was reduced to 10 sec and then to 4 sec for 20 and 40 presentations, respectively. Visual observations of all birds during the final five hopper presentations revealed that each was eating from the raised hopper.

During the second and all subsequent sessions, a fixed-trial autoshaping procedure similar to that described by Brown and Jenkins (1968, Exp. 4) was in effect. The response key was darkened during a variable intertrial interval ($X = 35$ sec; range = 10 to 60 sec) and then illuminated by a red stimulus light for an 8-sec trial interval. At the offset of the red light the grain hopper was raised and illuminated by a white light for 4-sec, independently of the bird's behavior during the trial. Key pecks during each trial and intertrial interval were recorded separately. Each bird was exposed to one session per day, five days per week. Each session was terminated after 60 trials.

During each subsequent session, either no shock (0 V), 18-V, 45-V, or 90-V shock followed each key-peck response according to the sequence in Figure 1. Shock delivery followed all key pecks, *i.e.*, those occurring during both the trial stimulus and the intertrial interval. Each condition was in effect for five consecutive sessions.

In each session, all birds were observed during a randomly selected sequence of five trial presentations by one or both of two observers, who recorded the number of key-directed pecks on each trial. Key-directed pecks were defined as any movement of the beak toward the key. Aborted pecks and pecks that struck the work panel, as well as pecks that struck the key, were defined as key-directed. Interobserver agreement was calculated by dividing the total number of trials during which the birds were observed into the number of trials in which

Fig. 1. Mean responses per trial (60 trials per session) emitted by Birds 6994, 7600, 8346, and 2000 from top to bottom respectively, in each session under each experimental condition. Each experimental condition was presented in the sequence indicated above the graphs. Note that the values along the ordinate are different for Bird 6994.

both observers recorded an equal number of pecks. The between-observer agreement, based on 220 trial observations, was 84%.

RESULTS

The mean responses per trial of each bird during each condition is shown in Figure 1. The birds began to peck the lighted key during the first no-shock (0-V) autoshaping session and continued to peck the lighted key throughout each subsequent no-shock session. Eighteen-volt shock delivery initially decreased mean responses per trial in each of the four birds, while 45 and 90 V consistently produced greater decreases than 18 V. At all voltages, the onset of the effect was rapid after response-dependent shock was introduced. Little systematic evidence of response recovery either within sessions or over the five successive sessions at each shock voltage occurred, regardless of voltage level. Figure 2 shows the distribution of responses across trials during the last session under each condition for the four birds. During all conditions, responses were approximately evenly distributed throughout the session, even though the total number of responses was reduced by shock delivery. Baseline levels of responding generally were recovered following all shock conditions; however, contrast effects (*cf.* Azrin and Holz, 1966) were not reliably obtained following any of the shock conditions. Although the number of responses per trial was lowered by 18-V shock, the proportion of trials in which responses occurred did not systematically change from the 0-V condition. During both the 0-V and 18-V conditions, three birds pecked on nearly all (> 90%) trials. The fourth bird, 6994, regularly key pecked on a far lower proportion of trials, often responding during less than half of the trials under the 0-V and 18-V conditions. Thus, the reduction in response frequency during the 18-V condition generally resulted from a decrease in the mean number of responses occurring during each trial on which pecking occurred. The higher voltage levels greatly increased the proportion of trials without responding for all birds. The decrease in response frequency that occurred during the higher voltage levels, therefore, resulted from both an increase in the proportion of trials without responding and a concomitant decrease in mean number of responses per trial during which at least one peck occurred.

Less than 5% of all responses of each bird occurred during the intertrial interval. No systematic relation was observed between intertrial interval pecks and experimental conditions when responses during the intertrial interval were considered in relation to total (trial + intertrial) responses, although the absolute number of responses during the intertrial interval was reduced by 45- and 90-V shocks. In general, these latter responses covaried with the number of trial responses. Visual observation indicated that most intertrial pecks were emitted immediately after key illumination terminated. Therefore, many of these responses represented a brief continuation of the behavior engendered by key illumination. This pattern of behavior may account for the observed covariant relationship between intertrial interval responses and total responses. For the visual observation data on key pecking, Pearson product-moment correlations between the number of equipment-recorded key-peck responses and aborted key pecks and pecks that struck the work panel (off-key pecks) showed that these two measurements covaried during both the 0-V condition ($r = 0.64$; $p < 0.01$ for 398 *df*) and all shock conditions combined ($r = 0.71$; $p < 0.01$ for 393 *df*) for all four birds. Visual observation of subjects did not reveal a consistent effect of shock on frequency of off-key pecks.

EXPERIMENT II

One finding in other studies of response-dependent electric shock is that responding often increases progressively over successive sessions in which shock is maintained at a constant intensity. Since each exposure to shock was in effect for only five sessions in the first experiment, the second examined possible recovery of autoshaped responding from shock effects over a larger number of sessions.

METHOD

Subjects

Three White King pigeons with a history of autoshaping were maintained at 75% of free-feeding weights. None had experience with electric shock before this experiment.

Apparatus

The apparatus was the same as that used in the first experiment. Electric shock voltages

Fig. 2. Percentage of total responses occurring in successive blocks of 12 trials during the last day under each condition for Birds 2000, 6994, 7600, and 8346.

greater than 120 V in this and the subsequent experiments were obtained by using a step-up transformer (United Transformer Corp., type S-45), which increased the input voltage to the variable resistor to 750 V.

Procedure

Since the birds had a history of autoshaping, each was placed on the fixed-trial autoshaping procedure described in Experiment I. When the mean responses per trial appeared stable on visual inspection, response-dependent electric shock was introduced following each response; this procedure was different from that in Experiment I, where shock was introduced after only five sessions of autoshaping training. The voltage levels, sequence, and number of sessions of shock are shown in Figure 3.

RESULTS

As in Experiment I, response-rate suppression was a function of the shock voltage level

with each bird. Figure 3 shows large individual differences in the effects of different shock voltages on autoshaped responding. For example, 18 V had little effect on the responding of Birds 6121 and 7411, but it reduced the responding of Bird 6800 by about 50%. Progressive response increases across punishment sessions occurred with Bird 6800 at all but the highest voltage (250 V). The responding of Bird 7411 showed similar recovery from shock effects at 45 V, and the responding of Bird 6121 remained suppressed for 13 sessions at this intensity. When shock was removed, the responding of Birds 6800 and 7411 failed to recover to the levels observed during the initial baseline condition.

EXPERIMENT III

The first two experiments examined the suppressive effects of response-dependent electric shock on the frequency of autoshaped key-peck

Fig. 3. Mean responses per trial emitted by Birds 6800, 6121, and 7411 in each session under each experimental condition. Each experimental condition was presented in the sequence indicated above the graphs.

responses. Response-independent electric shock delivered during or at the end of a period of time associated with a distinct stimulus suppresses operant responding (*e.g.*, Estes and Skinner, 1941), although such response-independent shocks generally result in less response suppression than equivalent response-dependent electric shock (Azrin, 1956). In the autoshaping procedure, responding is confined almost exclusively to the trial stimulus period. Therefore, the trial stimulus consistently was associated with delivery of electric shock in Experiments I and II. Response suppression could be a conditioned emotional response to the trial stimulus associated with shock delivery and be unrelated to the response-shock dependency. Experiment III examined this possibility by comparing the effects of response-dependent and response-independent shock delivery during the trial stimulus of an autoshaping procedure.

METHOD

Subjects

Four adult White King pigeons were maintained at 75% of their free-feeding weights. Two were experimentally naive and two had

served in a previous autoshaping experiment. None of the subjects had experience with electric shock.

Apparatus

Two test chambers, identical to the one in the first experiment, were used. The work area of one chamber was painted black, the other white. Electric shock sources and the method of shock delivery were the same as in Experiment II. A Montage Audio/Mate model 590 tape recorder was modified to record electrical impulses generated by delivery of each response-dependent shock.

Procedure

The two naive birds were trained to eat from the food magazine as in Experiment I. After these birds ate from the raised hopper, a fixed-trial autoshaping procedure identical to that in Experiment I was in effect for one 60-trial session. In each subsequent session, the birds received two 30-trial sessions per day, one in each experimental chamber. These two daily sessions were separated by 2.5 to 3.5 hr, during which each bird was returned to its home cage.

When, on visual inspection, the mean responses per trial appeared stable in both daily sessions for five consecutive days, electric shock was introduced during the trial stimulus. This occurred after 20, 25, 26, and 32 sessions respectively for Birds 69, 106, 317, and 380. Response-dependent electric shock followed each key peck during the trial stimulus in the first of the two daily sessions and this sequence of response-dependent shocks was recorded on magnetic tape. During the second daily session, the recorded electrical impulses were used to operate the shock-delivery circuit, thereby delivering response-independent shock during the trial stimulus, which was of the same voltage, frequency, duration, and distribution as the response-dependent shock during the first daily session (*cf.* Masterson, 1965). The effects of 18-, 45-, 90-, 120-, and 250-V shocks were examined. The sequence and number of sessions at each voltage level for each bird are shown in Figure 4.

RESULTS

Figure 4 shows the effects of response-dependent and response-independent electric shock on the autoshaped key-peck responses. Before introducing shock, a relatively high rate of responding during the trial stimulus was observed. The number of responses for all birds during the intertrial stimulus was less than 5% of that during the trial stimulus.

As in the previous experiment, shock voltage levels had different effects on each bird. The response-dependent shock had similar suppressive effects to those found in Experiments I and II. The reduction in response frequency was directly related to the voltage level, with greater decreases in response frequency at higher voltages. Response-independent shock with the same parameters as the response-dependent shock generally resulted in a smaller decrease in response frequencies than the response-dependent shock. The responding of Bird 69 was not systematically suppressed during any of the response-independent shock conditions, regardless of the shock voltage. Bird 380 showed little response suppression at 18- or 45-V response-independent shock. Bird 106 showed little suppression in responding at 18 V, but 45-V response-independent shock initially suppressed responding to a level comparable to 45-V response-dependent shock, although this suppressive effect was not main-

tained across sessions. The responding of Bird 317 was initially equally suppressed by 18-V response-dependent and response-independent shock. However, a subsequent removal of shock suggested that the baseline performance had shifted (*cf.* Birds 6800 and 7411 in Experiment II and Bird 69 in this experiment during the last 0-V condition). Subsequent introduction of shock at a higher voltage resulted in some suppression of responding by response-independent shock, but greater suppression by equivalent response-dependent shock was obtained consistently.

The numbers of shocks delivered during response-dependent and response-independent conditions were consistently within 10% of one another for all birds.

EXPERIMENT IV

In the third experiment, frequency of response-independent electric shock was determined by the number of response-dependent electric shocks delivered in the preceding session. As a result, shock frequency varied from trial to trial and from session to session. These variations precluded any unconfounded determination of the relation between voltage level of response-independent shock and response rate. The final experiment compared the suppressive effects of several voltages of response-independent shock on autoshaped responding while maintaining a constant shock frequency.

METHOD

Subjects

Three adult White King pigeons were maintained at 75% of their free-feeding weights. Two birds were experimentally naive; Bird 933 had experience on an autoshaping procedure, but no experience with electric shock.

Apparatus

The test chamber, electric-shock source, and method of shock delivery were the same as in Experiment I. A Montage Audio/Mate model 590 tape recorder was used to arrange response-independent shock delivery.

Procedure

After the two naive birds were trained to eat from the raised food hopper, the fixed-trial autoshaping procedure described in Ex-

Fig. 4. Mean responses per trial (30 trials per session) emitted by Birds 69, 380, 317, and 106, from top to bottom respectively, during each experimental condition of Experiment III. During the shock delivery conditions indicated above the graphs, response-dependent shock occurred in the condition indicated by the circles and response-independent shock occurred in the condition indicated by the triangles. Each voltage level was presented in the sequence indicated above the graphs. (Note: The penultimate condition for Bird 317 was 250 V, not 200 as indicated in the Figure.)

periment I was effected for all birds. All parameters of the autoshaping procedure were as described in the first experiment.

When the mean responses per trial showed no systematic trends on visual inspection, the effects of response-independent electric shock during the trial stimulus were studied. The

sequence of shock voltages and number of sessions at each intensity are shown in Figure 5. One response-independent shock was delivered during each of the 60 daily trial stimulus presentations. The location of the shock within each 8-sec trial stimulus was randomly assigned.

Fig. 5. Mean responses per trial emitted by three subjects under each experimental condition. Each condition was presented in the sequence indicated above the coordinates (note the different ordinate values for the subjects). The dashed line is the mean responses per trial obtained during the initial 0-V condition.

RESULTS

Figure 5 shows the mean number of responses per trial for each subject during each session of Experiment IV. Note that Bird 351 responded less frequently during each trial and the values on the ordinate for this bird differ from the other two birds. Bird 351 initially responded relatively frequently (approximately 30 responses per minute) during the intertrial interval when the key was not illuminated, but this responding was eliminated during the first exposure to response-independent shock and these initial rates were not observed subsequently. The two other subjects emitted less than 5% of their total responses during the intertrial interval. As in the previous experiments, there were large individual differences in responding during the different voltages, but the qualitative relation between responses during the trial stimulus and shock voltages was similar for all three birds. Responding during the trial stimulus was an inverse function of shock voltage. The effects of response-independent shock delivery generally were reversible when shock was removed, but there was little evidence of response recovery across successive sessions in which shock was delivered.

GENERAL DISCUSSION

These experiments show that response suppression results from the response-dependent presentation of electric shock following key-peck responses during an autoshaping procedure. The data parallel in several ways the findings of studies of punishment of responses maintained by positive reinforcement schedules (e.g., Azrin and Holz, 1966). Electric shock generally suppressed responding as a function of voltage level and, for the birds exposed to shock for a greater number of sessions, recovery was a function of voltage level. As with punishment of positively reinforced responses, there were large individual differences in the effects of the different shock intensities.

Autoshaped key pecks were systematically suppressed by response-dependent shock, but such pecks were not entirely eliminated at even the highest voltages. That the suppressive effects of electric shock were reversible when shock was removed was surprising, for there was no dependency between the autoshaped response and reinforcer presentation. Azrin

and Holz (1966) contended that "an enduring punishment situation must include reinforcement as well as punishment for the responses" (p. 399). Yet, the present study suggests that autoshaped key pecks are sensitive to a punishment procedure despite the fundamental failure of a reinforcement analysis to account for the autoshaping phenomenon (e.g., Gamzu and Williams, 1971; 1973; Williams and Williams, 1969). Regardless of the mechanisms assumed to account for autoshaping, it is evident that the autoshaping procedure is sufficient to maintain some responding despite either a negative relationship between responding and reinforcement delivery (Schwartz and Williams, 1972b; Williams and Williams, 1969) or a schedule in which responding produces electric shock.

Response-dependent and response-independent shock have different effects on rate and pattern of positively reinforced responding (e.g., Azrin, 1956; Hoffman and Flesher, 1965). Experiment IV showed that response-independent shock was sufficient to suppress autoshaped responding of pigeons, especially at relatively high voltages (cf. Schwartz, 1973). However, a direct comparison of response-dependent and response-independent shock in Experiment III showed that autoshaped key-peck response suppression was greater when the shock was dependent on key pecking than when identical shocks were delivered independently of responding. Thus, while shock delivery *per se* may suppress responding, inclusion of a response-shock dependency is more likely to ensure suppression of autoshaped responding.

The absence of consistent contrast effects in most birds in the present study differs from the results of studies of punishment of positively reinforced responding (Azrin, 1960; Holz and Azrin, 1963), indicating that after removal of shock response rates increased above the rate obtained before shock was introduced. However, contrast effects are apparently not as ubiquitous as indicated by early studies, and a shock procedure may be effective in reducing probability of responding without producing contrast effects. Indeed, in the present experiment on several occasions the removal of response-dependent and response-independent shock was followed by decreases in response rates. For example, Bird 7411 (Experiment II) showed an immediate decrease in responding,

which persisted for 13 sessions. Also on removal of shock, Bird 6800 (Experiment II) and Bird 69 (Experiment III, last condition) showed initial increases in responding relative to the original unshocked baseline response frequencies, followed by marked decreases in responding. Other birds, e.g., Bird 317 in Experiment III during the second 0-V condition, failed to return to the original unshocked baseline response frequencies when shock delivery was terminated. The reasons for each of these types of response-rate changes following removal of shock are unclear. Perhaps shock or its removal engenders subtle changes in response topography; however, visual observations of these birds did not reveal any consistent or reliable differences in gross topography of the autoshaped response during these conditions.

The results of Experiment I differ from those of a study by Dunham, Mariner, and Adams (1969), which indicated that off-key pecks increased in relative frequency when on-key pecks maintained by a variable-interval food reinforcement schedule produced shocks, and decreased in relative frequency with shock removal. In Experiment I, the relative proportion of off-key pecking (off-key pecks/off-key pecks + on-key pecks) was not systematically affected by the presence or absence of electric shock. However, a meaningful comparison of these two studies is made difficult by differences in the way in which off-key responses were recorded in each study. The present study utilized human observers and recorded all key-directed pecks. Dunham *et al.* used a "key-within-a-key" method of automatic recording, which recorded only off-key pecks striking a limited area of the work panel. The present study also used a key extension, which was found in a pilot study to reduce the number of off-key responses.

Seligman (1970) suggested that the laws of learning that summarize the behavioral effects of experimental manipulations are based primarily on "arbitrary" behaviors and manipulations and, consequently, may not generalize to other classes of behavior and manipulations. Thus, he suggested that the effects of delivering shock after an autoshaped response might differ considerably from the effects of shock on behaviors maintained by conventional reinforcement schedules. The present study does not indicate this to be the case; the punish-

ment effects that were found utilizing these schedules provide a qualitatively and quantitatively accurate description of the effects produced by delivering shock after the autoshaped key peck. Since a number of studies have indicated that innate or reflexive behavioral patterns can be suppressed by shock and recovered by its removal (Adler and Hogan, 1963; Baenninger and Grossman, 1969; Baenninger and Ulm, 1969; Myer, 1967; Walters and Glazer, 1971), the generality of the effects of electric shock to the autoshaped key-peck response is not particularly surprising.

REFERENCES

- Adler, N. and Hogan, J. Classical conditioning and punishment of an instinctive response in *Betta Splendens*. *Animal Behavior*, 1963, 11, 351-354.
- Azrin, N. H. Some effects of two schedules of immediate and non-immediate punishment. *Journal of Psychology*, 1956, 42, 3-21.
- Azrin, N. H. A technique for delivering shock to pigeons. *Journal of the Experimental Analysis of Behavior*, 1959, 2, 161-163.
- Azrin, N. H. Effects of punishment intensity during variable-interval reinforcement. *Journal of the Experimental Analysis of Behavior*, 1960, 3, 123-142.
- Azrin, N. H. and Holz, W. Punishment. In W. K. Honig (Ed.), *Operant behavior: areas of research and application*, New York: Appleton-Century-Crofts, 1966. Pp. 380-447.
- Baenninger, R. and Grossman, J. Some effects of punishment of pain-elicited aggression. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 1017-1022.
- Baenninger, R. and Ulm, R. Punishment of the killing of mice by rats. *Journal of Comparative and Physiological Psychology*, 1969, 69, 628-635.
- Brown, P. and Jenkins, H. M. Autoshaping of the pigeon's key peck. *Journal of the Experimental Analysis of Behavior*, 1968, 11, 1-8.
- Dunham, P., Mariner, A., and Adams, H. Effects of punishment on off-key pecking. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 789-797.
- Estes, W. and Skinner, B. F. Some quantitative properties of anxiety. *Journal of Experimental Psychology*, 1941, 29, 390-400.
- Gamzu, E. and Williams, D. Classical conditioning of a complex skeletal response. *Science*, 1971, 171, 923-925.
- Gamzu, E. and Williams, D. Associative control and autoshaping. *Journal of the Experimental Analysis of Behavior*, 1973, 19, 225-232.
- Hearst, E. and Jenkins, H. M. *Sign-tracking: The stimulus-reinforcer relation and directed action*. Austin, Texas: The Psychonomic Society, 1974.
- Hoffman, H. S. and Fleshler, M. Stimulus aspects of aversive controls: the effects of response contingent shock. *Journal of the Experimental Analysis of Behavior*, 1965, 8, 89-96.

- Holz, W. and Azrin, N. A comparison of several procedures for eliminating behavior. *Journal of the Experimental Analysis of Behavior*, 1963, 6, 399-406.
- Masterson, F. A. Yoked control without a duplicate apparatus: a response recorder-playback system. *Journal of the Experimental Analysis of Behavior*, 1965, 8, 395-396.
- Myer, J. Prior killing experience and the suppressive effects of punishment in the killing of mice by rats. *Animal Behavior*, 1967, 15, 59-61.
- Ricci, J. A. Key pecking under response-independent food presentation after long simple and compound stimuli. *Journal of the Experimental Analysis of Behavior*, 1973, 19, 509-516.
- Schwartz, B. Maintenance of keypecking in pigeons by a food avoidance but not by a shock avoidance contingency. *Animal Learning and Behavior*, 1973, 1, 164-166.
- Schwartz, B. and Williams, D. The role of the response-reinforcer contingency in negative automaintenance. *Journal of the Experimental Analysis of Behavior*, 1972, 17, 350-363. (a)
- Schwartz, B. and Williams, D. Two different kinds of key peck in pigeons: some properties of responses maintained by negative and positive response-reinforcer contingencies. *Journal of the Experimental Analysis of Behavior*, 1972, 18, 201-216. (b)
- Seligman, M. On the generality of the laws of learning. *Psychological Review*, 1970, 70, 406-418.
- Walters, G. C. and Glazer, R. D. Punishment of instinctive behavior in the Mongolian Gerbil. *Journal of Comparative and Physiological Psychology*, 1971, 75, 331-340.
- Wasserman, E. A. *Autoshaping: The selection and direction of behavior by predictive stimuli*, Unpublished doctoral dissertation, Indiana University, 1972.
- Williams, D. R. and Williams, H. Automaintenance in the pigeon: sustained pecking despite contingent non-reinforcement. *Journal of the Experimental Analysis of Behavior*, 1969, 12, 511-520.
- Zeiler, M. D. Eliminating behavior with reinforcement. *Journal of the Experimental Analysis of Behavior*, 1971, 16, 401-405.

Received 28 July 1976.

(Final Acceptance 22 November 1976.)