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CONTROLS FOR AND CONSTRAINTS ON AUTO-SHAPING

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Auto-shaping the pigeon's key-peck response was examined as a respondent conditioning procedure with the use of Rescorla's truly-random control procedure. In the first experiment, pigeons received presentations of brief light on the response key and brief presentations of food where the light and the food were independently presented. All birds failed to key peck after many light and food presentations, but explicit pairing of the light and food rapidly conditioned pecking to the light. Experiment 2 showed that even when an independent light/food presentation schedule was reduced to variable-time 30 sec, additional naive birds would not key peck and only one bird pecked when the schedules were variable-time 15 sec. A third experiment examined an explicit-unpairing control procedure, where the light and food were not only presented on independent schedules but were also separated by a minimum time, and found that auto-shaping did not occur. A fourth experiment investigated a number of control procedures and found them ineffective. A fifth experiment investigated the effects of a physical separation of the locus of the response key and the food dispenser, and a sixth experiment investigated using a tone in place of the light. It was concluded that pecking is generated by auto-shaping procedures only when an intermittently presented keylight is regularly paired with food.

Experimental studies of non-contingent reinforcement were first described by Skinner (1948). He reported that a behavior that is adventitiously followed by a clock-delivered reinforcement would thereafter occur at a higher rate. Skinner called such behavior "superstitious behavior". With pigeons, the rate of key pecking in a test chamber is generally zero before food reinforcement is introduced; thus, the adventitious conditioning of key pecking by means of Skinner's non-contingent reinforcement procedure is rarely observed. Recently, however, Brown and Jenkins (1968) described a procedure (auto-shaping) that seems similar to the method for establishing superstitious behavior. In this procedure, the key-pecking behavior of the pigeon is shaped.

Brown and Jenkins' basic procedure consists of briefly projecting a light of 8 sec duration on a response key on a variable-time (VT) schedule, and then presenting the food-tray for 4 sec immediately upon termination of the light. (A variable-time schedule is composed of a random sequence of discrete time intervals with a specified arithmetic mean and uniform frequency distribution.) A key peck in the presence of the light operates the food tray immediately, while a key peck in the absence of the light delays the onset of the light for 60 sec. Brown and Jenkins interpreted their results in terms of a species-specific tendency of the pigeon to peck at the things it looks at, and adventitious conditioning of superstitious behavior (Morse and Skinner, 1957, 1958).

While the auto-shaping procedure and the superstitious behavior paradigms may be congenial, some investigators have argued that auto-shaping is solely due to a respondent conditioning process (Gamzu and Williams, 1971). Brown and Jenkins (1968) did not dismiss this possibility. Rescorla (1967) argued that the most important criterion for an adequate control procedure for respondent conditioning is that such a control retain as many features of the experimental procedure as possible while excluding the conditioned stimulus (CS)—unconditioned stimulus (US) contingency. He also claimed that all conven-

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tional control procedures (such as the ones used by Brown and Jenkins) confound or change the CS-US contingency. Rescorla also argued that a truly-random relation between the CS and US provides the most appropriate control procedure for respondent conditioning. In this procedure, the CS and US are scheduled entirely randomly and independently in such a way that some pairing of the CS and US may occur by chance alone. The occurrence of the CS, therefore, provides no information about subsequent occurrences of the US. Rescorla has argued that for respondently conditioned responses, CS-US contingency is necessary and sufficient for conditioning. He also argued that spatio-temporal contiguity of the CS and US is not crucial in respondent conditioning.

The primary purpose of the present study was to investigate auto-shaping with the use of the truly-random control procedure (Rescorla control). A second purpose was to investigate an explicit-unpairing control procedure advocated by Kremer and Kamin (1971) as an alternative to the truly-random control procedure; a third purpose was to collect additional data on the importance of CS-US contiguity and contingency in auto-shaping.

EXPERIMENT 1

Method

Subjects

Three experimentally naive Auto-Sexer pigeons obtained from Palmetto Pigeon Plant, Sumter, S. C. (numbers 60, 61, and 62) were maintained at 80% of their free-feeding weight.

Apparatus

A Grason-Stadler three-key pigeon chamber was enclosed in a ventilated, sound-attenuated chest. White noise and the noise of a ventilating fan were present in the chamber at a level of approximately 80 dB. Electromechanical recording and programming equipment was located in an adjacent room. Reinforcement was 5-sec access to Purina Pigeon Chow.

Procedure

Daily experimental sessions lasted 90 min. After one session of adaptation to the apparatus, which had the response keys covered and the food tray inoperative, each bird received six sessions of magazine training during which the keys were still covered but the food tray was operated for 5 sec at irregular intervals, but on the average of once a minute (VT 1-min). All birds were observed eating from the magazine during this training.

The following 14 days consisted of the truly-random control auto-shaping procedure. In this procedure, the center response key was uncovered and transilluminated by a white light for 5 sec on a VT 1-min schedule. On a second VT 1-min schedule, which was independent of the light presentation, the food tray was operated. Thus, any pairing of the food tray and keylight was only coincidental, except that a key peck during the light immediately terminated the light and operated the food tray. A key peck when the light was not on had no effect but was recorded.

Since all three birds failed to key peck during the truly-random control procedure, the Brown and Jenkins auto-shaping procedure was initiated and continued for the next four sessions. In this procedure, on a VT 1-min schedule, the key was transilluminated with white light for 5 sec. When the keylight terminated, the food tray was presented for 5 sec. A key peck during the light immediately terminated the light and operated the food magazine. A key peck when the light was not on had no effect but was recorded.

Results and Discussion

All birds failed to key peck during the truly-random control auto-shaping procedure. During the Brown and Jenkins auto-shaping procedure, Bird #60 made an initial key peck in the presence of the light after 90 light-food pairings, Bird #61 made an initial key peck after 70 pairings, and Bird #62 pecked after 260 pairings. All birds were regularly pecking in the presence of the keylight by the fourth session. These results show that the birds in this experiment would fall in the upper tail of the distribution of the number of explicit light-food pairings required to produce pecking (Brown and Jenkins, 1968, Figure 2).

EXPERIMENT 2

Since all three birds in Experiment 1 failed to key peck when the keylight and food were

non-contingently presented on variable-time schedules of 1 min (truly-random control VT 1-min), the truly-random control procedure was repeated with a reduction in the variable-time schedules of light and food presentations.

Method

Subjects

Three experimentally naive Silver King pigeons obtained from the same supplier (numbers 63, 64, and 65) were maintained at 80% of their free-feeding weight.

Apparatus

The apparatus was the same as that used in Experiment 1.

Procedure

After adaptation and magazine training as in Experiment 1, the truly-random control auto-shaping procedure (as described in Experiment 1) was initiated and in effect for 10 sessions. Each session, during the auto-shaping phases, ended after 80 reinforcer presentations.

The lengths of the variable-time schedules for the light and food were always the same and each schedule was in effect for 10 days. After the first 10-day period of the truly-random control auto-shaping procedure with the light and food presentations on VT 1-min schedules, a VT 30-sec schedule was in effect for 10 days, then a VT 15-sec schedule for 10 days, and finally a VT 7.5-sec schedule for 10 days.

Since only one bird, #63, key pecked in the presence of the light during the interval-reduction phase of the experiment, the Brown and Jenkins auto-shaping procedure was initiated (as described in Experiment 1). This procedure was in effect for three sessions.

Results and Discussion

In the interval-reduction phase, Bird #63 began key pecking in the presence of the light during the second session of the VT 15-sec schedule and was regularly pecking in the presence of the light by the third session of that schedule. Birds #64 and #65 failed to key peck during this phase of the experiment.

During the Brown and Jenkins auto-shaping procedure, Bird #64 made an initial response in the presence of the light after 71 light-food pairings during the first session and was regularly pecking in the presence of the light by the second session. Bird #65 made an initial response in the presence of the light after 81 pairings of the light and food and was regularly pecking in the presence of the light by the third session. These results also place the birds in this experiment in the upper tail of the distribution reported in Brown and Jenkins' Figure 2 (1968).

EXPERIMENT 3

As reported in Experiments 1 and 2, the truly-random control auto-shaping technique was generally ineffective in causing pigeons to key peck. Even when the light and food presentation schedules were as brief as 7.5 sec, the technique was not sufficient for conditioning. Kremer and Kamin (1971) argued that the truly-random control procedure produces special results not found with other control procedures. They have recommended the use of a procedure that assures that random pairings of a CS and US do not occur. Consequently, an additional control procedure (explicit-unpairing) was investigated.

Method

Subjects

Three experimentally naive Auto-Sexer pigeons obtained from the same supplier (numbers 73, 74, and 76) were maintained at 80% of their free-feeding weight.

Apparatus

The apparatus was the same as that used in Experiments 1 and 2.

Procedure

Following one 90-min session of adaptation to the apparatus, the birds received nine sessions of magazine training during which the response keys were covered but the food tray was presented on a VT 1-min schedule. Each session lasted for 70 reinforcer presentations. All birds were observed eating when the food tray was presented. The center key was uncovered and then the explicit-unpairing control auto-shaping procedure was initiated. This procedure consisted of transilluminating the key with a white light for 5 sec on a VT 1-min schedule and presenting the food on a separate and independent VT 1-min schedule. A minimum of 10 sec must have elapsed after

the termination of a light presentation before the food could be presented, and a minimum of 10 sec must have elapsed after the termination of a food presentation before the light could be presented. Therefore, the light and food presentations were not only unpredictable on the basis of one another, but they were also always separated by a minimum time of 10 sec. A key peck in the presence of the light terminated the light and immediately operated the food magazine. A key peck in the absence of the light had no effect but was recorded. Each session ended after 70 food presentations.

Because all three birds failed to key peck after 19 sessions of the explicit-unpairing control technique (1330 food presentations), the schedules of light and food presentations were reduced from VT 1-min to VT 30-sec. After 10 sessions of the VT 30-sec schedules (700 food presentations), the schedules were reduced to VT 15-sec for 10 sessions (700 food presentations) and then to VT 7.5-sec for 10 sessions (700 food presentations). Finally, the Brown and Jenkins auto-shaping procedure was initiated and in effect for three days.

After all birds were regularly key pecking in the presence of the light, the food magazine was made inoperative but the keylight was still on during an entire 90-min session. Following six sessions of extinction, the light was presented on a VT 1-min schedule but food presentations were contingent on a key peck in the presence of the light.

Results

No birds key pecked when the explicit-unpairing schedule was VT 1-min or VT 30-sec. Bird #73 made an initial key peck after 384 food presentations when the schedule was VT 15-sec, but Birds #74 and #76 failed to key peck even when the schedule was VT 7.5-sec. Birds #74 and #76 key pecked after 78 and 198 food presentations respectively with the Brown and Jenkins auto-shaping technique. All birds continued to peck regularly in the presence of the light after their initial key peck in the presence of the light.

Birds #74 and #76 extinguished (response rates were zero during the 90-min session) by the sixth extinction session, and the response rate of Bird #73 was 0.08 responses per minute during the sixth extinction session. In the final phase of the experiment, the VT 1-min light presentation/food response-contingent phase, the light had to be presented 1, 119, and 9 times for Birds #73, #74, and #76 respectively before the birds began to key peck. Following the first response-contingent food presentation, all birds key pecked regularly in the presence of the light.

Discussion

In both Experiments 2 and 3, one bird began to peck during the VT 15-sec schedule procedure. Four birds did not peck during this procedure, and none of the six birds pecked after having received reinforcement on the VT 1-min and VT 30-sec schedules. Of the two birds that did peck, one required over 1600 food and light presentations, and the other required over 2400 food and light presentations. It should be recalled that in both of these experiments, a peck on the lighted key terminated the keylight and immediately presented food.

Although the pigeon's operant level (spontaneous rate) of pecking in an apparatus such as employed here is generally said to be zero, in our experience, with 100 to 200 birds from this supplier, we have found that some birds do occasionally peck the key. Such pecks are infrequent (only one or two in 20 to 30 hourly sessions) and some birds do not seem ever to peck spontaneously. The two birds in Experiments 2 and 3 that did peck during the VT 15-sec schedule procedure were exceptionally well magazine trained. It seems plausible, therefore, that these birds first pecked for reasons other than the experimental procedures and their pecking was maintained by subsequent response-contingent reinforcement (Skinner, 1938, p. 69). This interpretation gains additional force when it is recalled that four other birds did not peck after several thousand additional food presentations, and that all birds in the two experiments reported here auto-shaped with the Brown and Jenkins procedure.

EXPERIMENT 4

Experiments 1, 2, and 3 suggest that the occurrence or acquisition of the pigeon's key-peck response is rather specific to the procedures developed by Brown and Jenkins. If a respondent conditioning process is responsible for the auto-shaping phenomenon, then

it would also be reasonable to expect that several procedures that are analogous to control procedures used in respondent conditioning should not produce auto-shaping in otherwise conditionable birds. Experiment 4 was performed to provide data on the efficacy of five additional possible control procedures.

METHOD

Subjects

Three experimentally naive Auto-Sexer pigeons obtained from the same supplier (numbers 51, 52, and 53) were maintained at 80% of their free-feeding weight.

Apparatus

The apparatus was the same as that used in Experiments 1, 2, and 3.

Procedure

Each experimental session was 90 min except when noted.

Procedure 1 (operant level). Each bird received three days of adaptation to the apparatus with the response keys covered and the food magazine inoperative. During the next three days, operant levels were taken with the center key uncovered and illuminated with white light but with the food magazine still inoperative. Key pecks had no effect but were recorded. The following day, each bird received 3 hr of magazine training during which the food magazine was operated for 5 sec on a VT 1-min schedule. The response key was covered during magazine training. All birds were observed eating from the magazine during this session. The following four sessions consisted of operant level recording with the key again uncovered and illuminated with white light and with the food magazine inoperative. Next, on the twelfth day of the experiment, all birds again received a food magazine training session for 90 min during which the magazine was operated for 5 sec on a VT 1-min schedule with the response key covered. Again, all birds were observed eating from the food magazine. For four days following magazine training, operant levels were again taken with the key uncovered and the magazine inoperative.

Procedure 2 (operant level/blinking light). Following Procedure 1, each bird again received one session of magazine training with the response key covered. Then, for four days, operant level was again taken with the magazine inoperative but now the response key was illuminated with white light for 15 sec on a VT 15-sec schedule; *i.e.*, the keylight was on for 15 sec and then off for 15 sec, then on for 15 sec, *etc.*

Procedure 3 (phantom auto-shaping). Once again the birds received one session of magazine training with the response key covered and the food tray operated for 5 sec on a VT 1-min schedule. Following magazine training and on a VT 1-min schedule, the key was illuminated for 5 sec but no food was presented. A key peck during this period immediately terminated the light. This procedure was in effect for eight days.

Procedure 4 (magazine training/phantom auto-shaping). During the first 45 min of each of the next four sessions, the food tray was presented for 5 sec on a VT 1-min schedule. During such 45-min periods, the key was not illuminated. During the second 45 min of each session, the bird was subjected to the phantom auto-shaping procedure in which the key was illuminated for 5 sec on a VT 1-min schedule and a key peck terminated the light but the food magazine was not in operation.

Procedure 5 (free food/free light). Each bird next received four sessions of exposure to a multiple variable-time 1-min free food variable-time 1-min free light schedule. On this schedule, 15-min components occurred in simple alternation. During the first component, the key remained unlighted but the food magazine was operated on a VT 1-min schedule. During the second component, the key was illuminated for 5 sec on a VT 1-min schedule but the food magazine was inoperative. Each component appeared three times each session and each session always started with the free food component.

Procedure 6 (Brown and Jenkins auto-shaping). The final phase of the experiment consisted of four sessions of the standard auto-shaping procedure. On a VT 1-min schedule, the response key was illuminated with white light for 5 sec. When the keylight terminated, the food magazine was operated. A key peck during the light immediately terminated the light and operated the food magazine. A key peck when the light was not on had no effect but was recorded.

Results and Discussion

During Procedure 1 (operant level), Bird #51 emitted one peck, Bird #52 emitted nine pecks, and Bird #53 emitted no pecks. During Procedure 2 (operant level/blinking light), Birds #51 and #52 did not peck, and Bird #53 pecked once. During Procedure 3 (phantom auto-shaping), none of the birds pecked. During Phases 4 (magazine training/phantom auto-shaping) and 5 (free food/free light), Birds #51 and #52 did not peck at all, and Bird #53 pecked once during each procedure.

Only after the standard auto-shaping procedure was initiated (Procedure 6) did the birds begin to key peck. All birds were key pecking in the presence of the light by the third auto-shaping session. Birds #51, #52, and #53 required 68, 82, and 11 food presentations respectively before they began pecking and emitted 267, 342, and 232 pecks, respectively, during Procedure 6. These results are similar to those reported by Brown and Jenkins.

These data lend support to the suggestion that the phenomenon of auto-shaping is a specific result of the procedures developed by Brown and Jenkins and not the result of sensitization, pseudoconditioning, or the eliciting effects of novel stimuli or non-contingent food presentations. Furthermore, in Procedures 1 through 5 of Experiment 4, the food (US) was in no way contingent upon the light (CS), and, as would be predicted by Rescorla (1967), conditioned pecking did not occur.

EXPERIMENT 5

The results of Experiments 1, 2, 3, and 4 seemed to support the suggestion that auto-shaping is functionally similar to the respondent conditioning process. Experiment 5 attempted to determine whether an arbitrary spatio-temporal discontinuity between the CS-US would interfere with the course of acquisition of the key-peck response. An experiment by Ricci and Perkins (1971) showed that auto-shaping was possible with a procedure functionally similar to Pavlov's long-delay conditioning (Kimble, 1961). Experiment 5 further reduced the probability of adventitious conditioning of the kind described by Skinner (1948) by physically separating the locus of the response and the site of the food.

Method

Subjects

Three experimentally naive White Carneaux pigeons obtained from the same supplier (numbers 48, 49, and 50) were maintained at 80% of their free-feeding weight.

Apparatus

The apparatus was the same as that used in Experiments 1, 2, 3, and 4 except that the pigeon chamber had a fourth response-key mounted on the back wall directly opposite the center key on the front wall.

Procedure

Each experimental session lasted 90 min. After adaptation to the apparatus and magazine training to produce regular eating from the food tray (as in Experiments 1, 2, and 3), the back response key was uncovered and a version of the Brown and Jenkins auto-shaping procedure was initiated. On a VT 1-min schedule, the back key was illuminated with a green light for 5 sec. When the green light terminated, the food magazine was operated for 5 sec. A key peck during the green light immediately terminated the light and operated the food magazine. The key was illuminated with a red light at all other times. A key peck in the presence of the red light had no effect but was recorded. The front keys remained covered at all times.

Results and Discussion

All birds auto-shaped with this procedure. The number of green light-food pairings before the first key peck was 82 for Bird #48, 88 for Bird #49, and six for Bird #50. These results (which are comparable to those of Brown and Jenkins' Experiment 3), combined with those of Experiments 1, 2, and 3, and the results of Gamzu and Williams (1971) indicate that a contingency between the lighted key and the food seems to be necessary and sufficient for effective auto-shaping. Furthermore, these studies suggest that the auto-shaping procedure is functionally similar to respondent conditioning. Kimble (1961) reported that the physical nature of a CS is largely unimportant as long as it is a stimulus for the ani-

mal. Experiment 6 sought to determine whether this was true of what appears to be a CS in auto-shaping.

EXPERIMENT 6

Method

Subjects

Three experimentally naive White King pigeons obtained from the same supplier (numbers 40, 41, and 42) were maintained at 80% of their free-feeding weight.

Apparatus

A BRS-Foringer three-key pigeon chamber (similar to that used in the previous experiments) served as the apparatus. White noise and the noise of a ventilating fan were present in the chamber at a level of approximately 80 dB. All recording and scheduling equipment was located in an adjacent room. Five seconds' access to Purina Pigeon Chow was the reinforcer. All sound-level measurements were made with a General Radio sound-level meter with the tip of the microphone occupying approximately the same place as occupied by a bird's head prior to striking the center key. The 1000-Hz tone was produced by a General Radio oscillator.

Procedure

Each experimental session lasted 90 min. After the birds were adapted to the chamber and successfully magazine trained (as in the previous experiments), each bird progressed through the following phases:

Phase 1 (auto-shaping with a tone). The center key was uncovered and constantly illuminated with white light. On a VT 1-min schedule, a 1000-Hz tone was presented for 10 sec and was followed immediately by a 5-sec presentation of food. During tone presentations, the masking white noise was absent and the intensity of the tone was approximately 80 dB. A key peck during the tone immediately terminated the tone and presented the food tray for 5 sec. Key pecks before and after the tone had no effect but were recorded. This procedure was in effect for 11 days.

Phase 2 (auto-shaping with a keylight). Since all birds failed to key peck in Phase 1, they were then trained to key peck with the Brown and Jenkins procedure. The key was illuminated with red light for 5 sec on a VT 1-min schedule. Termination of the light was immediately followed by a 5-sec presentation of the food tray. A key peck during the red light immediately terminated the red light and operated the food magazine. Key pecks before and after the red light had no effect but were recorded. The key was illuminated with white light except when the red light was presented. This procedure was in effect for three days, at which time all birds were pecking constantly in the presence of the red light.

Phase 3 (phantom-light procedure). For the next two days the auto-shaping procedure was continued as in Phase 2, except that the red light was not presented before food presentations. The food magazine was still operated on a VT 1-min schedule and key pecks that occurred 5 sec before the food was presented were counted separately from any other key pecks.

Phase 4 (auto-shaping with a tone). The final stage of this experiment consisted of attempting to auto-shape the birds with a tone as in Phase 1. This phase was continued for three days.

Results and Discussion

All birds failed to auto-shape during Phase 1 (auto-shaping with a tone). As expected from Brown and Jenkins (1968), all birds did auto-shape and were pecking the positive stimulus light consistently during Phase 2 (auto-shaping with a keylight). Birds #40, #41, and #42 required 37, 39, and 45 food presentations respectively before their initial key peck. The birds did not peck during the phantom-light procedure (Phase 3), nor did they peck during Phase 4 (auto-shaping with a tone). Additionally, regular observation of the birds throughout the experiment revealed no pecking at the tone source or any other parts of the chamber.

These results were unexpected, since several previous experiments in our laboratory (Patterson and Winokur, 1973; and Patterson, 1971) employing the same equipment, tone frequencies, tone intensities, and pigeons from the same supplier showed that a tone could become an effective discriminative stimulus or a conditioned reinforcer for pigeons. We

therefore conclude that although a tone is a stimulus for the pigeon, it does not seem to be a sufficient stimulus for the auto-shaping of the key-pecking response. Consequently, if auto-shaping is a respondent conditioning process, it is unlike many other respondent conditioning processes, *e.g.*, salivary conditioning, "fear" conditioning, eyelid conditioning, in that auto-shaping seems to be restricted to stimuli occurring in the visual modality, whereas most other forms of respondent conditioning do not.

GENERAL DISCUSSION

This paper reports several experiments that were designed as control experiments (Sidman, 1960) for those experiments on auto-shaping reported by Brown and Jenkins (1968). The present experiments, and those of other authors cited here, indicate that auto-shaping of the pigeon's key-peck response is a robust effect in that it is easily reproducible with different varieties of birds, different brands of operant conditioning apparatus, different experimenters, and different laboratories. Furthermore, the effect appears to be specific to a set of operations, namely the presentation of food contingently upon the presentation of a visual stimulus. The results of our first five experiments indicate that merely introducing food and light into the pigeon's environment will not produce conditioned key pecking.

Brown and Jenkins found that the pre-food stimulus event could be a light onset, a light offset, or a change in the hue of a light; however, all of the effective stimuli had the subsequent food contingent upon their occurrence. Our experiments showed that if the contingency between the light and food was lacking, no conditioning occurred, but if the contingency was established, conditioned pecking readily occurred. The results were usually within the upper limits of the same range of numbers of light-food contingent pairings observed by Brown and Jenkins.

It seems reasonable to us that the number of light-food pairings required to produce the first key peck in our experiments should be somewhat greater than the median number observed by Brown and Jenkins. Minor procedural differences such as keylight duration, which was longer in their experiments, and the nature of the reinforcer (more familiar and more preferred grain *versus* pelletized chow) may have tended to make their birds train faster. However, the major procedural difference seems to be the most likely source of the discrepancy between the two sets of findings: the birds in our experiments were always exposed to large numbers of non-pairings of food and the keylight before the explicit pairing of the two. According to the theory of conditioning developed by Rescorla (1967), such non-pairings would tend to make the stimulus involved inhibitory with respect to the later conditioning of any responses. Several experiments have produced this phenomenon, usually utilizing respondent conditioning, and have been discussed as adaptation (Kimble, 1961).

These results and conclusions are similar to those found by Hearst and his co-workers (Peterson, Ackill, Frommer, and Hearst, 1972; Wasserman, Markman, and Hearst, 1971). One paper (Peterson *et al.*, 1972), reported an auto-shaping phenomenon in which two groups of rats received food pellets or electrical stimulation of their brains, respectively. Animals of both groups tended to approach and touch a stimulus whose presentation was predictive of (*i.e.*, followed by) the reinforcing event. Another stimulus, which did not predict the reinforcer, was not effective in producing approach, licking, gnawing, and handling behavior.

Wasserman *et al.* (1971) performed several experiments that tended to show that pigeons generally would not peck at a lighted key if the over-all level of illumination in the experimental chamber was a valid predictor of food presentations. Wasserman *et al.* (1971) predicted that a diffuse cue, such as an auditory stimulus, would be ineffective in auto-shaping pigeons' key-pecking behavior. The results of the present Experiment 6 support Wasserman's prediction.

A number of investigators have suggested that auto-shaping is related to respondent conditioning processes (Staddon and Simmelhag, 1971; Williams and Williams, 1969; Bindra, 1972). It should also be noted that many references to respondent or Pavlovian processes are qualified with suggestions as to alternative mechanisms such as cognitive sets of industriousness or laziness (Enberg, Hansen, Welker, and Thomas; 1972), or species-

specific tendencies (Brown and Jenkins, 1968). Wasserman *et al.* (1971) have, however, argued that the auto-shaping and respondent conditioning processes are fundamentally the same. They claim that any dissimilarities between the results of the two procedures may be because the animal in the auto-shaping situation can approach and contact the pre-reinforcement stimulus while those in the respondent conditioning situation can not. We have no reliable information about the probability that an unrestrained animal will approach and contact the conditioned stimulus for an appetitive unconditioned stimulus in a respondent conditioning situation; however, we do know that various investigators have been able to use stimuli such as hissing noises, electric fans, metronomes, bells, buzzers, lights, colored paper, and geometrical forms as conditioned stimuli, and that according to the traditional account of respondent conditioning, most organisms seem indifferent as to which stimuli are used (Kimble, 1961).

If auto-shaping is a respondent conditioning process, the birds in Experiment 6 should have been conditioned to peck in the presence of the tone. Although the results of Experiments 1 through 5 are highly consonant with a traditional interpretation of auto-shaping as a form of respondent conditioning, the outcome of Experiment 6 casts some doubt upon this interpretation. It should be noted that some writers have argued that the traditional account of Pavlovian conditioning must be revised (Rescorla, 1967) and that various genetically controlled constraints on the forms of the laws of learning must be acknowledged (Seligman and Hager, 1972). Specifically, Seligman (1970) argued that pigeons are genetically prepared to associate pecking a lighted key with food. Seligman did not claim that the pigeon is unprepared to associate auditory stimuli with food, but the results of Experiment 6 are consistent with that natural extension of his theory. Nevertheless, we do not consider our work to have provided conclusive evidence as to the correctness of any account of respondent conditioning, and must agree with Jenkins and Moore (1973) that further examination of the functional similarities and dissimilarities between the auto-shaping and traditional respondent conditioning procedures may be helpful in elucidating the relationship between the two phenomena.

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