GENERAL ACTIVITY AS INSTRUMENTAL: APPLICATION TO AVOIDANCE TRAINING[1]

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Some data on Sidman avoidance in the pigeon are presented to illustrate a technique of instrumental training which places minimal restriction upon the form of the reinforced response. The effect of a warning signal is demonstrated, and the course of discrimination-reversal is described.

The behavior to be reinforced in an instrumental situation may be defined narrowly or broadly. In one experiment, some highly specialized movement or series of movements may be required; in another, it may be necessary only that the animal go to some designated locality. The data to be presented here were obtained under conditions designed to place the least possible restriction on the form of the reinforced response: any behavior at all was reinforced which was of sufficient magnitude to produce a small displacement of the substrate on which the subject (S) stood.

There are, of course, many reasons, both practical and theoretical, for being interested in this technique. We are interested primarily in its possibilities for the analysis of species-differences in learning (Bitterman, 1960). Requiring nothing beyond an ability to move, it seems well suited for comparative work with animals whose motor properties vary widely. An application of the technique to the study of Sidman avoidance in the pigeon is explored here.

METHOD

The animal's chamber was an enclosure of clear Plexiglas contained in a small picnic chest. The floor of the chamber was a 9-in. square of Plexiglas painted with a solution of carbon and Styrofoam in methyl-ethyl-keytone to provide a resistive surface through which shock could be administered (Longo, Holland, and Bitterman, 1961). The floor was plugged into a Plexiglas base of the same size by means of eight banana plugs and jacks (the plugs in the floor and the jacks in the base), which served both to support the floor and to connect its resistive surface to the output of the shocking circuit. The base was fixed with sheet-metal screws to the bottom of the picnic chest, as was a crystal phonograph cartridge in an electrically shielded case. The cartridge was connected to the base by a short length of stainless-steel tubing running from the needle-holder of the cartridge to a collar at one edge of the base. The arrangement was such that any slight movement of the animal produced a voltage across the cartridge which was amplified and used to operate a relay that defined "response". The amplifying circuit was like one already described (Longo and Bitterman, 1959), except that relay RL1 was replaced with a Potter and Brumfield KCP14. Mounted also in the chest (outside the animal's enclosure) were two colored Christmas-tree lamps which served as discriminanda. Control equipment associated with the chest was designed to program various kinds of Sidman training. There were two complete experimental units, which made it possible to work with two pigeons at the same time.

The Ss were White King cocks obtained from a local dealer. Used previously in a runway experiment (Roberts, Bullock, and Bitterman, 1963) which required that they be maintained at 75% of satiated weight, the animals were continued at that level. There was continuous access to water and grit, with daily feeding about ½ hr after the experimental sessions. About a week before the new experiments, the feet of each S were sanded to remove incrustations, and the daily application of electrode jelly (EKG Sol) was begun. Before each experimental session, the feet were

washed and the soles thoroughly massaged with jelly. These procedures ensured good contact with the shocking surface.

RESULTS AND DISCUSSION

The first data to be reported are for conventional Sidman training with and without a warning signal. Four pigeons were given daily 20-min sessions, with brief (0.5-sec) shock scheduled every 20 sec by a clock which was reset by response (R-S interval = S-S interval = 20 sec). The level of shock used, which elicited a marked startle reaction, was produced with an input of 70 v. into the shocking circuit. At the start of each session, a green light was turned on, remaining on throughout the session. Beginning with the ninth session, a warning signal—a red light which came on 5 sec before each scheduled shock—was added. Beginning with the 19th day, the original conditions (no warning signal) were restored.
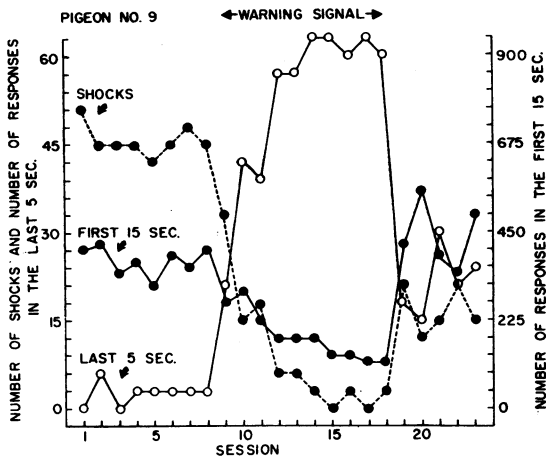

Fig. 1. The effect of a warning signal: Pigeon No. 9.

The warning signal had much the same effect in this experiment as in lever-pressing experiments with rats and cats (Sidman, 1955; Sidman and Boren, 1957) and in shuttlebox experiments with fish (Behrend and Bitterman, 1962): there was a marked tendency for the rate of response to increase in the presence of the signal and to decrease in its absence (relative to baselines established in prior training without the signal). Plotted in Fig. 1 are the results for a pigeon (No. 9) which received many shocks in the first stage of training,

while Fig. 2 shows the results for a pigeon (No. 12) which received very few shocks in the first stage. Almost all the responses of both birds were made in the first 15 sec of the 20-sec interval; the response of No. 9 may, in fact, be accounted for almost entirely in terms of the bursts of activity evoked by shock. With the introduction of the warning signal, number of responses in the last 5 sec increased dramatically in both birds, number of responses in the first 15 sec fell, and the number of shocks received by No. 9 fell to the same low level as for No. 12. Despite their differing performances in the first phase of the experiment, the two birds began to behave in much the same way with the introduction of the warning signal. In the third phase of the experiment, when the warning signal was withdrawn, the similarity disappeared. Pigeon No. 12 returned to its behavior of the first stage, making very few responses in the last 5 sec and very many responses (even more than before) in the first 15 sec. Pigeon No. 9 made more last-5-sec responses and received fewer shocks than in the first phase. Whether this improvement was due to experience with the warning signal is impossible to say in the absence of data for birds trained without signal for the same number of sessions.

Of the two remaining birds studied with the procedure already described, one behaved in essentially the same way as did No. 9. For reasons unknown, the second gave no evidence at all of learning; its performance throughout the experiment resembled that of No. 9 in the first phase.
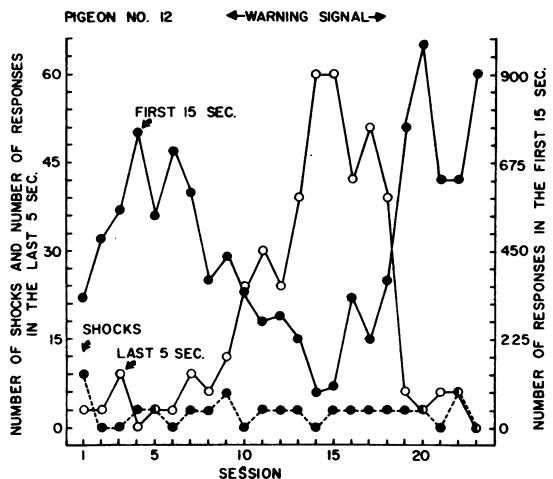

Fig. 2. The effect of a warning signal: Pigeon No. 12.

Other pigeons were trained with a somewhat different procedure. Each 40-min daily session was divided into four 10-min periods. During two of the periods (the first and third on some days, the second and fourth on others), the house-light was one color (*e.g.*, green) and the conventional Sidman schedule (with R-S = S-S = 20 sec) was in effect. During the alternate periods, the house-light was a different color (*e.g.*, yellow) and the shocking circuit was disconnected. After behavior of the five birds trained in this way had stabilized, two were shifted to FR-2 and one to FR-6 by interposing a ratio-device between the response-relay and the relay that reset the timer which scheduled shock. Two additional birds served as controls for sensitization. The responses of these birds did not postpone shock; each of them was shocked at the same time as a yoked experimental bird.

Figure 3 shows some data for a representative experimental bird and its sensitization-control. Number of shocks (the same for both birds) declined to a low level as the number of responses made by the experimental bird in the shock-periods (here marked by a green light) increased. The number of green-responses made by the control bird (much higher to begin with than in the experimental) declined progressively with the number of shocks; the responses recorded for this bird could be traced almost exclusively to bursts of activity immediately following shock. Only the experimental bird showed any tendency to respond in the no-shock periods (marked here by a yellow light), and then only in the earlier sessions. When the conditions for the experimental animal later were changed from CRF to FR-6, its level of response in shock-periods increased from about 200 to 330, while its level of response in no-shock periods and the number of shocks received remained the same. (The two birds shifted from CRF to FR-2 showed smaller increases in level of shock-period response—from about 180 to about 230 responses per 10 min.) Work with rats in a lever-apparatus also has shown that the rate of avoidance responding is increased by FR reinforcement (Verhave, 1959).

Although it seems clear from these data that the activity of the experimental animals in shock-periods was not due simply to the fact that they were shocked, but to the fact

that response postponed shock, something like a sensitizing or energizing effect appeared. Even after a great deal of experience in the situation, the animals did not begin to respond systematically in any session until they had been shocked at least once. The effect is most evident in the data for sessions immediately following the reversal of the colors marking shock and no-shock periods. In Fig. 4, some representative tracings made in three successive sessions by No. 6, the bird on FR-6, are shown. In Session 80, with green as the shock-period color, the criterion for reversal—fewer than 25 responses in each of four successive no-shock periods—was met; the bird had been reversed several times before. In Session 81, green became the negative (no-shock) color. The level of response to green in Sessions 81 and 82 was high except for the first green-period of Session 82—the first period of the session—in which there was no response at all. Although green previously had been associated with shock, and although it continued to evoke a high level of response when it came after shock in yellow, the animal did not respond to it in the first period of a session.
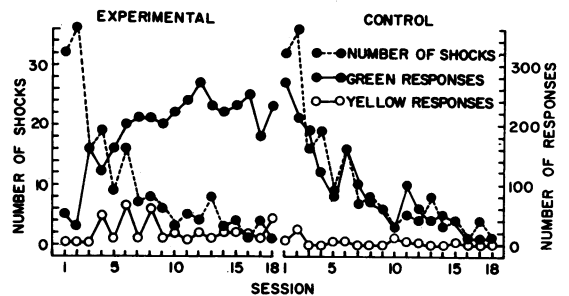

Fig. 3. The performance of an experimental animal and its sensitization-control in the first stage of yellow-green discrimination.

As Fig. 4 suggests, the course of reversal was characterized by a decline in the level of response to the previously positive color. The fact that the colors had been reversed in a given session was difficult to tell from response to the previously negative color alone; after being shocked once for failure to respond to it in a given period, the bird would begin to show its customary shock-period rate. Reversal was evident mainly in the level of response to the previously positive color, which was high (except during the first period of a session) in the early post-reversal sessions, and fell off as
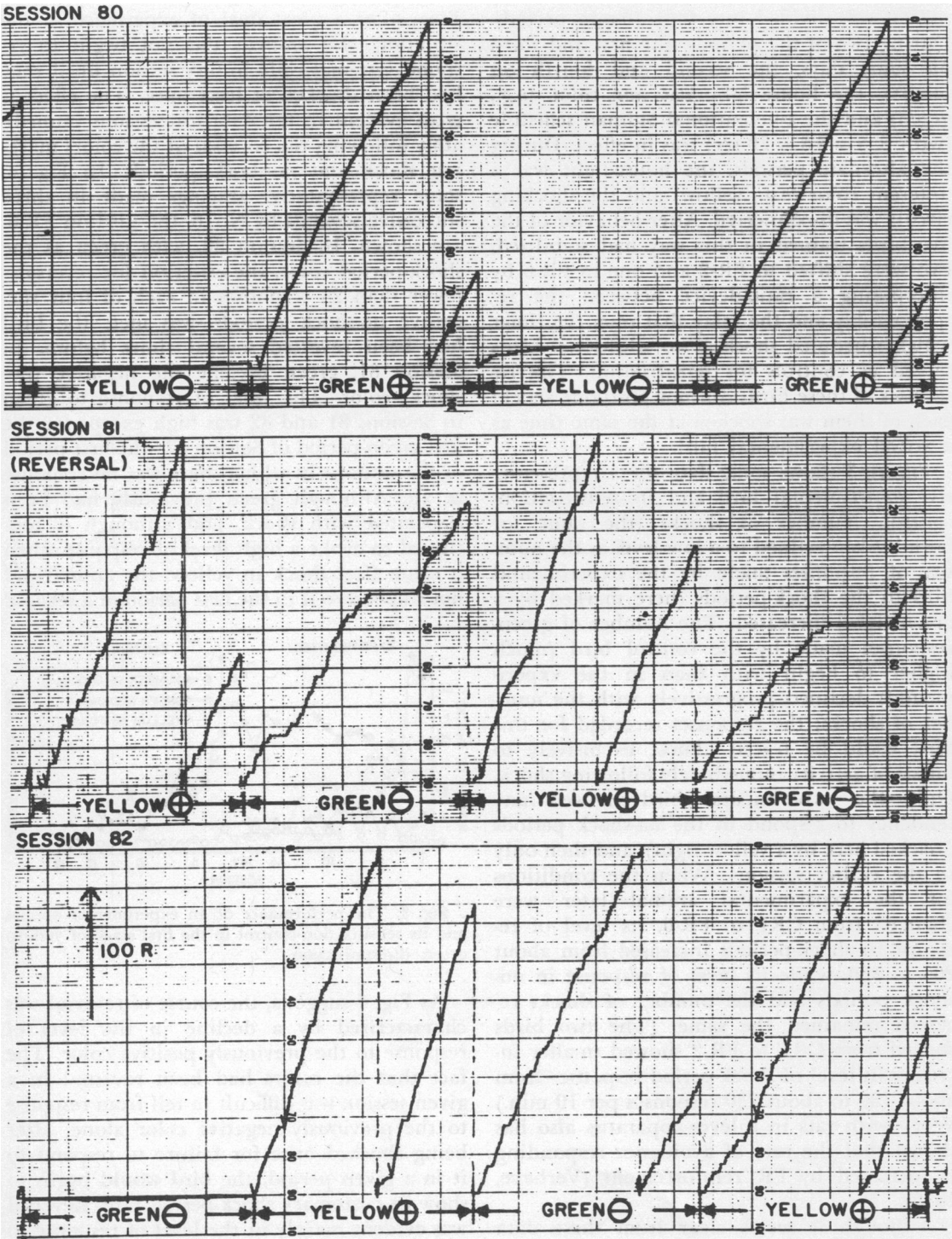
Fig. 4. Tracings of Pigeon No. 6 for three successive sessions in the yellow-green discrimination.

training continued. It is clear, then, that the animals were making a color-discrimination. Had they been reacting in terms of shock alone, as they might conceivably have learned to, reversal should have had no effect at all; *i.e.*, response in shock-periods should have been high and response in no-shock periods should have been low quite irrespective of their colors in any given session.

Of the five birds tested, four showed no evidence of progressive improvement in reversal analogous to that which has been found in the pigeon under other circumstances (Bullock and Bitterman, 1962), although it is possible that all might have shown improvement had the experiment been carried further; in the time available, the birds managed to complete no more than five to seven reversals. The only bird which gave clear evidence of improvement was No. 6, the only one trained on FR-6. (In Reversal 1, it made 1272 responses to the negative stimulus and required 16 sessions to reach the criterion; Reversal 2, 1514 responses and 19 sessions; Reversal 3, 975 responses and nine sessions; Reversal 4, 981 responses and nine sessions; Reversal 5, 448 responses and seven sessions.) The initial difficulty of reversal was considerably greater for this bird than for the others; in the later reversals, its performance began to approximate that of the two birds trained on FR-2, which in turn was somewhat poorer, both in terms of negative responses and sessions to criterion, than that of the CRF birds.

Under both sets of training conditions, the birds tended to adopt a characteristic crouching posture which involved a marked lowering of the anterior portion of the body. The response, which was superimposed on this posture, took the form of hopping or of stamping the feet, often accompanied by fluttering of the wings. This behavior probably was determined, not only by the structure of the animals, but also by the type of enclosure and by the drive-reinforcement conditions employed. It is conceivable, for example, that a larger enclosure would have promoted avoidance of shock by running, while the substitution of food-reward for the avoidance procedure would have produced an array of other patterns. These problems are worth study in their own right, as is the relation between the kinds of behavior generated in general-activity situations and those which appear in situations which provide reinforcement independently of behavior (Skinner, 1948).

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