SHAPING AVOIDANCE BEHAVIOR IN RESTRAINED MONKEYS¹

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Lever-pulling avoidance behavior of 24 monkeys was actively shaped with a manual shock-control box and a closed-circuit TV system. A negative reinforcement procedure was used wherein a periodically occurring body shock was postponed each time the subject moved toward the lever. All subjects were trainable with this method, two-thirds of them in fewer than five, 1- to 2-hr sessions. Negative reinforcement was more effective than a punishment procedure.

Since expounded by Skinner (1958), the shaping of behavior by reinforcing successive approximations of the desired response has been extensively reported. Using positive reinforcement, several different animals and behaviors have been studied (*e.g.*, Baer, Peterson, and Sherman, 1967; Burnstein and Wolff, 1964; Dews, 1960; Levin and Shapiro, 1962; Levison, Ferster, Niemann, and Findley, 1964; Reynolds, 1963; Skinner, 1962; and Wenzel, Baldwin, and Tschirgi, 1964) and a number of parameters discussed (*e.g.*, Skinner, 1958; and Morrill, 1961). But few explicit extensions of the shaping technique to situations involving negative reinforcement or punishment are found in the literature. The one paper that did deal directly with this problem (Hoffman and Fleshler, 1960) found the results of hand shaping (of avoidance pecking in pigeons) disappointing, and a simpler response and mechanical aids were adopted. Bolles, Stokes, and Younger (1966) briefly mentioned shaping shuttle-box running in rats by terminating shock initially after any bodily movement, and then after door orientation, until the full response was made frequently.

Many other workable, but unemphasized, methods have undoubtedly been devised by investigators in avoidance learning when faced

with difficult animals or when using atypical conditioning hardware. The present method was developed to decrease the amount of research time required for avoidance conditioning of monkeys in restraint chairs and to increase the number of conditionable monkeys in this situation. A negative reinforcement procedure was used wherein a periodically occurring body shock was postponed each time the subject moved *toward* the lever. This method is contrasted with a punishment procedure wherein a body shock was delivered to the subject each time it moved *away* from the lever.

METHOD

Subjects

Twenty-four adolescent (3 to 5 kg) rhesus monkeys (*Macaca mulatta*), five females and 19 males, were on *ad lib* water and a 2-hr daily feeding schedule (8 to 10 A.M.) of one-half orange and a maximum of 30 biscuits of Purina monkey chow. They were housed in primate restraining chairs (Mason, 1958) 18 in. wide, 24 in. deep and 26 to 34 in. high, adjustable to the subject's size. The laboratory was air-conditioned, maintained at approximately 76° F, and was continuously illuminated at approximately 42 ft-c.

Apparatus

Each restraining chair was instrumented with a lever at sitting waist-height immediately in front of the subject and within convenient reach of either forearm. The lever was

¹This research was supported by NIH grants no. MH-02895 and NB-04053 and was conducted in part at the University of Washington Regional Primate Center, funded by NIH grant no. FR00166. Reprints may be obtained from the author, Dept. of Neurological Surgery, University of Washington School of Medicine, Seattle, Washington 98105.

a 5-cm stainless steel, circular rod projecting vertically. When pushed or pulled (with 875 g cm of torque) in any direction, it activated a microswitch that triggered an electronic decade counter (with readout visible to the experimenter) and reset the shock timer. The joystick optimized responding and minimized lever breakage by uni-directional metal fatigue. The electric shock was delivered to the subject's body between the neck and either the buttocks or feet, so that the subject could not avoid the shock by any positioning effort. (The necks of the subjects were shaved. Electrode paste was not used.) The electrodes consisted of nickel-plated steel, twisted-link neck-chain anchored to an aluminum (5052-½ hard) neck-contact plate, and aluminum buttocks and foot bars. A stimulus-light panel was mounted on the chair at sitting eye-level and indicated the training periods by the illumination of a 6-w light with a red frosted jewel.

The shock timer could be operated by means of two rotary switches and a potentiometer, respectively, to deliver electric shock ranging from 0.5 to 20 ma of current for 0.5 to 2 sec in duration with a periodic interval between shocks of from 5 to 100 sec. The shock was 60-Hz constant current sine wave with a 500-v source, and upon delivery triggered an electronic decade counter with readout visible to the experimenter. The current that was delivered was monitored via a meter display of the voltage drop across a resistor in series with the subject.

In addition to the automatic scheduling of shock delivery (Barensten and Lockard, *in press*), a manual delivery or postponement of a shock by closing the shock relay or resetting the shock timer, respectively, was accomplished by means of two push-buttons mounted in a small metal box (2 by 2 by 6 in.) easily held in the experimenter's hands. Moreover, either push button, when pressed, made an audible (approximately 65 dbm rms), 120-msec double-click sound which functioned as a secondary reinforcer or "bridging" stimulus. (This stimulus accompanied both shock postponement and shock delivery but the two procedures were not intermixed for a given subject, see the Discussion section.) The manual control box allowed the shaping of lever-pressing behavior.

During training periods each subject was viewed, undisturbed by the experimenter's

presence, by means of a fine-line closed-circuit TV system.

Procedure

Training periods for each subject were less than 2 hr per day and occurred at least 2 hr after the daily intake of food. With each new subject the shock intensity started at 1 ma and then was increased (at the lower intensities) by 0.33 to 0.50 whenever the subject received more than 25 successive shocks without a discernible change in its response. However, no subject was ever given more than 20 ma of current and most were trained using 10 ma or less. (If the current used in training was above 10 ma, once the subjects were trained they would usually perform with less current, *e.g.*, 5 ma.)

The negative reinforcement of shock postponement was always for a fairly gross movement that was obvious to the experimenter via the closed-circuit TV monitor. The shaping of lever-pressing to avoid shock was done in the following sequence of successive approximations: training the subject to (a) make any kind of movement, (b) face forward, (c) make any kind of forearm movement, (d) move forearms toward the lever, (e) grasp the lever with either or both hands, and (f) grasp and release the lever repeatedly. However, only the response being trained at any given moment was negatively reinforced until it was occurring very frequently; all previously reinforced approximations were extinguished.

Each of the 24 subjects were trained by postponing, for an additional 5 sec (via the manual control box), a body shock of 0.5-sec duration that had been automatically scheduled to occur 5 sec after the last shock. The postponement consisted of resetting the shock timer so that the interval between successive shocks for a single reinforcement was between 5 and 10 sec. Frequent successive resets could postpone the shock for a much greater interval.

The scheduled shock interval of 5 sec was selected because continuous shock of even a very low intensity (*e.g.*, 2 ma) was disruptive to the animals. Moreover, several investigators have found that an initial 4- to 5-sec shock-shock interval increases acquisition in Sidman avoidance conditioning (Brady, Porter, Conrade, and Mason, 1958; Black and Morse, 1961; Sidman, 1962).

RESULTS AND DISCUSSION

All subjects were trainable with the negative reinforcement procedure; two-thirds required fewer than five, 1- to 2-hr sessions. The most difficult subject required 13 sessions, and five subjects trained in one session.

Since the subjects were trained sequentially, the experimenter had had more experience in the shaping technique (*e.g.*, was more skilled in timing shock postponement) when training the later subjects. When the 24 subjects are serially grouped into eight subjects each, the data indicate that the last 16 subjects were trained in fewer sessions and at a lower shock intensity than the first eight. (Series I and II: $t = 2.46$, $df = 14$, $p < 0.03$ one-tail test; Series I and III: $t = 1.77$, $df = 14$, $p < 0.05$ one-tail test; there were no significant differences between Series II and III: $t < 1$.) Although not statistically significant, the differences among mean shock intensity of each series parallels exactly those for training periods. (Series I and II: $t = 1.32$, $df = 14$, $p = 0.10$ one-tail test; Series I and III: $t = 1.03$, $df = 14$, $p = 0.16$ one-tail test; and Series II and III: $t < 1$.)

Series I was composed of three males and five females (all other subjects were males). There were no significant differences in the mean weight, mean number of training periods, or mean shock intensity between the sexes ($t < 1$; $t < 1$; and $t = 1.126$, $df = 6$, $p = 0.30$ two-tail test; respectively).

In the adolescent weight range used here, there were no significant correlations between weight and shock intensity or weight and number of training periods for each subject ($r = 0.11$, $t < 1$; and $r = -0.07$, $t < 1$, respectively).

In addition to the negative reinforcement technique reported, a punishment technique was attempted with six monkeys (two females and four males). (In terms of procedure, punishment is defined as the presentation or accentuation of a noxious stimulus and negative reinforcement is defined as the attenuation, cessation, delaying or deletion of a noxious stimulus immediately after a specific response.) In the punishment procedure employed, a body shock (accompanied by the clicking stimulus) was delivered to the subject each time it moved away from the lever. The method of successive approximations of the correct response was also used with this procedure, in

that initially, movements of considerable distance away from the lever were punished, and then sequentially smaller and smaller distances until the subjects were lever-pulling. Inconsistent results were obtained with the punishment procedure because the subjects had two possible classes of responses they could make to avoid shock: (a) overt movements toward the lever, or (b) no overt movements at all. It was observed that those subjects not easily trained with punishment became very inactive.

To eliminate inactivity, a modified punishment procedure was tried wherein the subject was shocked, not only for movements away from the lever, but for every 5 sec of no overt movements. However, this procedure was difficult to administer manually and did not seem to improve ease of training.

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Received 3 June 1968.