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Sequential Effects of Punishment

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The present report is concerned with the effects of punishment on behavior that is simultaneously being maintained by positive reinforcement. Previous studies (Estes, 1944) have indicated that responding is reduced so long as the punishment is in effect. The present findings reveal that the degree of suppression varies markedly during the course of the punishment process. White Carneaux pigeons, maintained at 80 percent of the weight they attained when allowed to feed ad libitum, were reinforced for 1 hour per day for responding (pecking) at an illuminated disc in accordance with a 1-minute variable-interval schedule of food reinforcement. Under this schedule, the response produces food reinforcement at varying time intervals, the average of which is 1 minute. This reinforcement procedure produces a fairly stable and uniform rate of responding which serves as a base line for evaluating the effects of punishment. This punishment was delivered immediately after every response and consisted of a brief electric shock delivered through implanted electrodes (Azrin, 1959).

Figure 1 shows the effect of the addition of punishment for 23 days to the food-reinforced responses of one subject. The punishment used here is a 30-v. 60-cy/sec shock of 30-msec duration delivered through 10,000-ohms resistance in series with the subject. It can be seen that responding is reduced immediately by the initial addition of the punishment. On succeeding days the number of responses gradually increases, and recovery is complete after several days. At that time, the number of responses during punishment is equal to or greater than the number before punishment was introduced. It can be seen that, when the punishment is removed, responding increases for the first 3 days and then returns to a level approximating the prepunishment performance. It may be noted that the variable-interval schedule employed permitted the animal to receive as many food reinforcements during the punishment period as during periods

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without punishment as long as a low trickle of responses was made. The changes noted above of (1) a day-by-day recovery from the initial effects of punishment and (2) a temporary increase in responding upon the elimination of punishment have both been replicated with several other subjects.

Recovery from the effects of punishment occurs not only from day to day but also within each 1-hour session. Figure 2 shows the actual cumulative response record for a different subject under more severe punishment —a shock of 10-ma intensity. Before punishment (Figure 2, top) the rate of responding is fairly uniform throughout the hour, at about 110 responses per minute. Under punishment, however (Figure 2, bottom), the rate of responding shows a gradual recovery throughout the hour. In the first few minutes of the punishment period, the rate of response is essentially zero, but by the end of the hour, the rate of response stabilizes at about 15 responses per minute. The absence of complete recovery from punishment here is attributable to the greater intensity of the shock used. This response record was obtained after 20 days under punishment and represents a fairly stable state. The responses show an orderly increase throughout the hour, with no increase in variability such as is generally assumed to accompany punishment. The absence of such variability is in large part attributable to the corresponding lack of variability in the shock intensity, a nonvariability achieved through the use of implanted electrodes

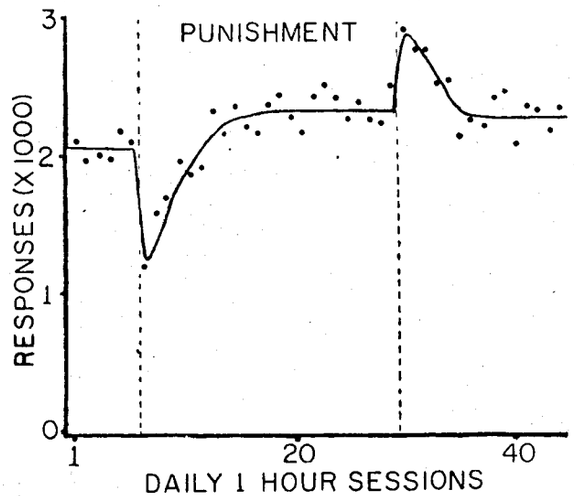

Figure 1. Effect of the addition and removal of punishment upon the food-reinforced responses of one subject. The punishment was a brief electric shock which followed every response on the days between those represented by the vertical dashed lines. Food reinforcement was produced according to a variable-interval schedule with a mean of 1 minute on all days.

rather than the usual electrified grid. This recovery from the initial effects of punishment within each session has characterized the behavior of all of the 14 other subjects studied, although the degree of recovery may be somewhat more or less than that seen in Figure 2. It may be noted that this recovery does not seem to be attributable to any local tissue changes, since recovery continued when the locus of the electrodes was changed during the recovery process. Rather, the phenomenon seems to be very

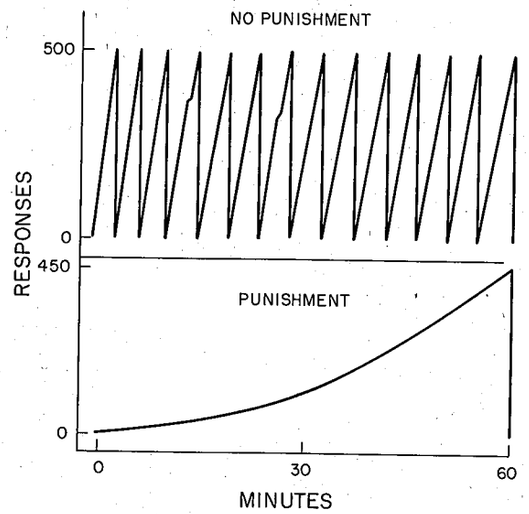

Figure 2. (Top) Cumulative record of the food-reinforced responses of one subject prior to the addition of punishment. The food reinforcement (not indicated on the record) is produced at variable intervals, the average of which is 1 minute. The vertical lines represent the resetting of the recorder pen. (Bottom) A cumulative record of the responses for the same subject during punishment. The same schedule of food reinforcement prevails, but punishment in the form of a brief electric shock is produced by every response.

general. Similar recovery has been noted with several intensities of punishment, levels of food deprivation, and schedules of reinforcement, as well as with electrified grids rather than implanted electrodes.

The temporary increase in responding after the removal of punishment seems to involve some type of contrast effect. Previous studies have revealed that the addition of punishment during extinction (Estes, 1944) produced a reduction in responding and that the later removal of the punishment produced a temporary increase in responding which appeared to be a type of compensation for the behavioral reduction. The present study reveals that this same temporary increase follows the removal of the punishment, even though the punishment has ceased to be effective. It appears, therefore, that this compensatory increase in responding does not

require that the behavior in question be suppressed at the time the punishment is removed.

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