ESCAPE BEHAVIOR UNDER CONTINUOUS REINFORCEMENT AS A FUNCTION OF AVERSIVE LIGHT INTENSITY¹

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In 11 male albino rats, lever-pressing responses, maintained under a CRF escape schedule with light as the aversive stimulus, were examined at each of five intensities, *viz.*, 2.5, 18, 105, 190, and 386 ft-C. The function relating reciprocal of latency of the escape response to aversive light intensity passed through a maximum.

Continuous reinforcement, CRF, of an escape response may be said to occur when the first such response occurring after onset of an aversive stimulus is immediately followed by termination of the stimulus. Under an interval reinforcement schedule, an escape response terminates the stimulus only when it occurs after an interval of time—either fixed or varying—after onset of the stimulus.

With cats and aversive noise, the function relating strength of the escape response to aversive stimulus intensity (a) passes through a maximum in the interval reinforcement case, but (b) is a negatively accelerated monotonic function in the continuous reinforcement situation (Barry and Harrison, 1957). With rats and aversive light, the intensity-escape function (a) passes through a maximum in the fixed-interval case (Keller, 1941; Kaplan, 1952), but (b) has not been investigated under continuous reinforcement (Kaplan, 1957a). The present report describes such an investigation.

METHOD

Subjects

Eleven random-bred male albino rats of the Charles River CD strain, 100 days old at the start of the experiment, were maintained under *ad libitum* feeding and housed in individual storage cages in semi-darkness. Water was available at all times, but food was withheld during experimental sessions.

Apparatus

The test chamber, shown in Fig. 1, was a Plexiglas cage, *PC*, with inside dimensions of 10½ by 10½ by 6 in. high. It rested on a cage base, *CB*, containing parallel stainless steel rods, ¼ in. in diameter and spaced ⅞ in. on

Fig. 1. Diagram of the test apparatus.

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centers. A Gerbrands lever (not shown), requiring about 12 to 13 g to trip its micro-switch, projected $\frac{1}{2}$ in. into the cage and was mounted 2 in. above the rod floor. The ceiling of the cage was a sheet of clear plate glass, *GP*, above which a lamp housing, *L*, was suspended on a lamp-housing column, *LC*, rising from a base-board, *B*. The housing was $12\frac{1}{2}$ in. high by $10\frac{3}{4}$ in. wide by 12 in. deep. Its floor was the lower of two ground glass diffusing plates, *GG*, separated by 3 in. The upper plate was $8\frac{3}{4}$ in. below the lid of the housing, which contained separate receptacles for five incandescent light bulbs, combinations of which were utilized to generate the various light intensities employed.

This entire complex was housed in a sound-absorbing cubicle, *C*, 34 in. high by $33\frac{1}{2}$ in. deep by 26 in. wide, inside dimensions. For ventilation, air was drawn into the cubicle through light-baffled vents, *V*, and exhausted by a darkroom fan, *F*. Additional ventilation was provided by external fans coupled to the lamp housing by flexible hose. A cubicle panel, *CP*, served as a junction for electrical connections between the test apparatus and masking noise loudspeaker (not shown), and the programming and recording equipment—timers, electromagnetic relays and counters, operations recorders, and noise generator—located in a separate, sound-absorbing control room. A $7\frac{1}{2}$ -w red light, *CL*, mounted on the panel, was 21 in. above the cage floor. During those intervals when aversive light was terminated (see Procedure), this red light was illuminated, except for S-7, S-8, S-9, and S-11, whose data (not shown) revealed no apparent effect of the different treatment.

Intensities

Intensity was treated in terms of light falling on the subjects. Illuminance measures were obtained with a Macbeth illuminometer in a manner similar to Hanson's (1951). The reflecting plate was placed on the cage floor at an angle of 45° directly below the center of the lamp housing. Five different intensities were employed: 2.5, 18, 105, 190, and 386 foot-candles.

Temperature

In the case of 30 min of uninterrupted light of 386 foot-candles, a temperature rise of 5° Fahrenheit was observed.

Procedure

a. *Experimental Sessions.* Each session was approximately 30 min long, and each rat received one session per day. Light was on when the rat was placed in the test chamber and when it was removed. Each depression of the lever in light terminated the stimulus for 1 min.

b. *Conditioning.* For most of the rats, it was necessary to reinforce (by terminating the light) approximations of the lever-pressing response for varying numbers of sessions before this response occurred with any regularity. For all rats, this shaping procedure was begun under 18 foot-candles, but for some of them the response was finally established under one of the other intensities. The escape response was considered to be established when the average response latency for each in a series of five sessions no longer tended to decrease with successive sessions.

c. *Test Phase.* In this phase, each rat had five consecutive sessions under each of the five intensities. The order of presentation of the five intensities differed for each rat.

RESULTS

The data are presented in terms of the reciprocal of the latency of the escape response in minutes. For each rat, this value was derived from the average latency for each session, and for each intensity, a five-session or four-session median was computed.³

When this median of reciprocal latency is plotted as a function of aversive light intensity in log foot-candles for each of the 11 rats, each of the 11 curves so obtained passes through a maximum. Seven rats show a peak at 18 foot-candles, three at 105 foot-candles, and one at 190 foot-candles. Samples of the curves, representing various intensity peaks, are shown in Fig. 2.

DISCUSSION

The form of these intensity-escape curves supports findings of Keller (1941) and Kaplan (1952), with most of the peaks appearing at 18

³In some instances, records were considered suspect because of apparatus malfunctions, and the session data were not included in the computations.

Fig. 2. Median reciprocal of latency in minutes as a function of log foot-candles.

foot-candles. This intensity, produced by a 25-w bulb, also generated the maxima in previous studies of (a) 0.5-min fixed-interval escape responding (Kaplan, 1952) and (b) changes elicited in breathing amplitude by 0.5-min presentations of light (Kaplan, 1957b), although a different strain of rats was used.

While peaked curves were not obtained in the CRF case for cats exposed to aversive noise (Barry and Harrison, 1957), it has been suggested that, under this schedule, maxima could be generated—but most likely at higher intensities than under interval schedules (Kaplan, 1957a). In the former instance, exposure to aversive stimulation would ordinarily tend to be shorter, and, beyond a critical amount of the stimulation—determined jointly by intensity and duration—the depressant effect of

stimulus exposure may predominate the reinforcing effect arising from its termination.

To the extent that maxima were obtained, the present findings support this view. The concentration of peaks at lower rather than higher intensities could be a function of CRF escape latencies (aversive stimulus exposures) that appear characteristically longer in the present subjects when compared with those of Wistar rats, used in previous studies.

Individual differences in peak-generating intensities have already been noted for the present subjects. They could be widespread in cats as well and thus account in part for the discrepancy between our data and those of Barry and Harrison (1957), whose report was based upon a smaller number of subjects.

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