Brightness difference thresholds in the pigeon using the conditioned suppression technique¹

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By illuminating a translucent key in a pigeon Skinner box with a constant light source (I) and superimposing a second light (ΔI) as a warning stimulus terminated with electric shock, a modified conditioned suppression technique was used successfully to determine brightness difference thresholds in three White Carneaux pigeons. The generated ΔI thresholds were found to be consistent with Weber's Law across I values of 1.15 to 1.35 log ft.-L. Variability of the ΔI thresholds for each of the I values was minimal and did not exceed 0.3 log ft.-L for any S.

Brightness difference thresholds have been determined for a single I value of 0.50 ft.-L in pigeons by Mentzer (1966) using either discrete trial, forced choice, or yes-no variations of the method of constant stimuli. Mentzer indicated that his results could have been confounded at low ΔI values due to habits of preference for the brighter of two stimulus lights giving increased perseveration errors. This seems to be a problem inherent in a two-choice discrimination threshold paradigm. Using only one key, a modified version of the conditioned suppression technique has been shown to be an effective and reliable means for establishing sensory thresholds in pigeons. CFF thresholds have been determined as a function of intensity (Hendricks, 1965) and as a function of pulse to cycle fraction (Powell, 1966). Olfactory thresholds to amyl and butyl acetate (Henton et al, 1966) and auditory thresholds across different frequencies (Dalton, 1966) have been studied by this suppression technique.

The purpose of the present study is to evaluate the efficacy of the conditioned suppression technique in determining brightness difference thresholds in pigeons for several values of background illumination (I).

Method

Three White Carneaux pigeons reduced to 80% of their ad lib body weight were housed in a semi-darkened room. A standard pigeon Skinner box was located in a sound-proofed room separate from the control panel, containing switching circuits which controlled the stimulus presentation durations and reinforcement schedules. All responses were recorded on impulse counters and on a cumulative recorder. A rheostat allowed for attenuation of the grain hopper light and a white noise generator provided a continuous masking sound to the pigeon.

The light sources for I and ΔI were two 6-v tungsten filament lamps. The light for I was collimated, passed through a filter box, a beam splitter and was imaged through the end of a length of flexible fiber optics. The opposite end of the fiber optic light tube was located

5 mm from the back of the translucent pigeon key giving a spot of approximately 1/2 in. diameter on the key. The light for ΔI was passed through a collimating lens, a Kodak neutral density wedge, and was superimposed on the light from I by the beam splitter. The intensity of I was discretely decreased by means of Kodak neutral density filters and that of ΔI was attenuated by the circular wedge. Unfiltered, the respective intensities of I and ΔI were 2.15 and 1.20 log ft.-L.

Each S was shaped to peck the key for grain reinforcement and gradually trained to respond on VI-30 sec., VI-1 min., and finally VI-2 min. reinforcement schedules. During the daily training sessions, the intensity of the grain hopper light was gradually reduced. After approximately 25 sessions, when stable response rates had been achieved on the VI-2 min. schedule, electrodes were implanted around the birds' pubis bones using Azrin's (1959) technique.

Between reinforcements, and as the S was responding at a stable rate, the conditioned stimulus (ΔI), was superimposed on the background (I) at the pigeon key for 15 sec. Contiguous with ΔI offset, a 40 msec. electric shock was delivered to the S. After several ΔI -shock pairings, suppression of responding developed during ΔI presentations. If a sample of the number of responses that occur in the 15 sec. period prior to the ΔI onset is compared with those responses that occur during the ΔI period an index of the bird's sensory capability may be inferred. This comparison is best expressed as a suppression ratio (Hoffman et al, 1963) and was computed for each trial by the formula $\frac{x-y}{x}$.

X is the number of responses emitted 15 sec. prior to ΔI onset and y is the number of responses occurring during ΔI . A value of 1.0 would indicate complete suppression and a value of 0.0 would indicate no suppression. For the initial training, ΔI was set at 1.20 log ft.-L and I at 0.15 log ft.-L.

Reliably high suppression ratios (SRs) were obtained within a few sessions of ΔI -shock presentations. In order to determine the ΔI threshold value for a given I, trials were run where the intensity of ΔI was lowered in 0.2 log ft.-L steps. At each decreasing ΔI step, the S was run to a suppression criterion of three out of four successive trials with SRs of 0.5 or higher. As soon as this criterion had been achieved, the intensity of ΔI was decreased an additional 0.2 log ft.-L. The intertrial interval was varied randomly with an average interval of approximately 1.5 min. This latter procedure was to prevent temporal or pattern-of-pre-

sensation discrimination of the trial sequences. The difference threshold was defined as that intensity of ΔI on which the suppression criterion failed to be achieved after 10 or more trials. Difference thresholds for I values of 1.15, 0.65, -0.35, and -0.85 log ft.-L were obtained for all three Ss and also for -1.35 log ft.-L for two of the Ss. Baseline control trials were periodically run to determine the stability of the baseline response rate. These trials consisted of recording the number of responses made in two successive 15 sec. periods, neither ΔI nor shock being presented, and computing a baseline SR.

Results

The mean SRs for each intensity of I as a function of the brightness of ΔI for one of the Ss are presented in Fig. 1. Also indicated is the amount of suppression during the baseline control trials for each I value used. The ΔI thresholds are indicated by the last points on each of the six functions where the SRs fall well below the 0.5 SR criterion. It can be seen that the baseline data fluctuate about zero. Data for the other two birds were similar.

In Fig. 2, the ΔI values for this same S are plotted as a function of the six I values. Where vertical lines were drawn between the points, this indicated the amount of variability for the ΔI thresholds upon replication. It can be seen that the replication for this bird yielded identical thresholds at three of the I values. The diagonal line with a slope of 1.0 indicates that the Weber fractions ($\Delta I/I$) are fairly consistent as the I values decrease.

Variability of the threshold values upon replication was minimal and never exceeded 0.3 log ft.-L for any of the three Ss. The values of the Weber fractions for the I value of -0.35 log ft.-L for the three birds were found to be 0.73, 0.36, and 0.89. These individual differences between Ss were comparable to those found by Mentzer (1966) with an I value of 0.50 ft.-L. Weber

Fig. 1. The mean suppression ratios based on the three criterion trials for each intensity of I as a function of ΔI brightness for Bird #32. The bottom curve represents the means of ten baseline control trials at each I value.

Fig. 2. The relationship between ΔI threshold values and the I values used for Bird #32.

fractions for other I values used in this study gave consistency within Ss, but similar differences were noted between the three Ss.

Discussion

The conditioned suppression technique was found to be a reliable and effective means for obtaining brightness difference thresholds in the pigeon. The technique utilized aversive control superimposed upon a stable baseline of responding which was maintained by positive reinforcement. Since only one response key was necessary, position and preference habits did not pose a problem. Even though the discriminations became increasingly difficult as the intensity of the ΔI light decreased, effective stimulus control was maintained.

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Note

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