Selective resistance of performance on a schedule of reinforcement to disruption by forebrain lesions[1]

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Abstract

Following bilateral ablation of portions of the forebrain, pigeons retained their usual, pre-operative performance on the fixed-ratio component of a multiple schedule, but had strikingly abnormal performances on the fixed-interval component.

Problem

The resistance of a learned performance to change may differ depending on the schedule of reinforcement. For example, a drug may have no effect on the performance on a fixed-ratio schedule while radically changing or even abolishing completely responding on a fixed-interval schedule (Dews, 1955, Herrnstein & Morse, 1956). The present report shows that the resistance of the ratio performance is similarly applied against the disruptive effects of discrete lesions of the central nervous system.[2]

Subjects

Five adult, white Carneaux pigeons were successfully maintained at 80% of their free-feeding weights.

Apparatus

A standard experimental chamber for operant conditioning contained a transilluminated response key, a magazine for presenting the reinforcer (3.5 sec. of access to grain), general illumination, and a white noise for masking extraneous sounds.

Procedure

The birds were reinforced daily on a multiple schedule. A fixed-interval (FI) component of 4 min. with a red key alternated with a fixed-ratio (FR) component of 55 responses with a green key. Each was presented 10 times per session.

When both performances were stable from day to day, portions of the brains of three pigeons were ablated by suction under pentobarbital sodium anaesthesia (9 mg/bird). Two pigeons were exposed to the surgical procedure without damage to brain tissue. Their performances continued to be normal. After surgery, all five pigeons were reinforced on the same multiple schedule for three months, then sacrificed.

Results and Discussion

The ablation removed the entorhinal area, the accessory hyperstriatum, and most of the dorsomedial hyperstriatum, leaving the more lateral hyperstriatum (Huber & Crosby, 1929). The lesions were about 4 mm long, 2 mm deep, and tapered from 3 mm to 1 mm wide caudo-rostrally. The filled areas in Fig. 1 show the location of the largest, most caudally extended lesion (bird 22) on sections from the numbered locations on the side view of the brain.

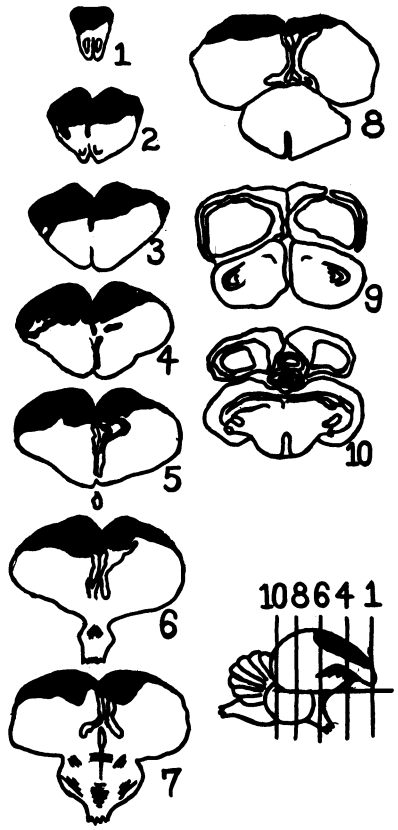

Fig. 1. Tracings of serial sections of pigeon brain taken at the angle and from the locations indicated by number on the drawing of the lateral aspect of the brain. The filled areas indicate the location of the largest lesion. The other two lesions did not extend caudally into section 8.

Figure 2A is a segment of a cumulative record obtained from pigeon 22 shortly before surgery. The recording pen was offset downward about 1 mm (at c) and held down throughout each fixed interval. The pen automatically reset to the baseline from the top of the recording paper. The typical performance on the fixed ratio (e.g., between a and b) is characterized by a high, sustained rate, with no pauses or breaks until reinforcement occurs (at b), and the fixed interval begins. The performance on the interval begins with a pause of about 2 min. (e.g., at b and c) and changes rapidly to a high rate of responding which was sustained until reinforcement.

Figure 2B shows, for each lesioned bird, the initial post-operative performance on the ratio followed by the

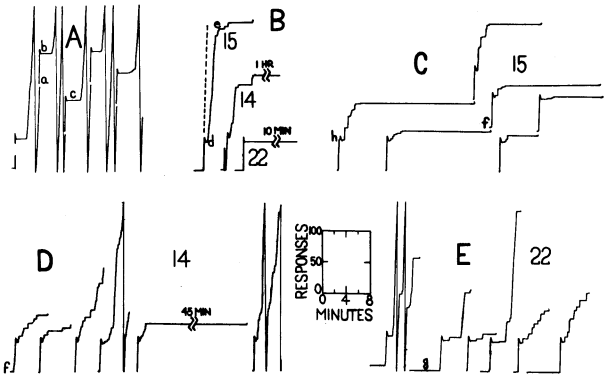

Fig. 2. Cumulative records of performance of three pigeons (15, 14, and 22) on a multiple FI 4 min. FR 55 schedule of reinforcement before (part A), immediately after (part B), and after (parts C, D, and E) ablation of the forebrain tissue indicated in Fig. 1. The recording pen was displaced and held downward about 1 mm throughout the intervals.

performance on the interval. The ratio performance of each bird is normal, with the characteristic high, sustained rate. However, the interval performance is markedly changed. Pigeons 15 and 14 lack the characteristic pause at the start of the interval (d in Fig. 2B, cf. c in Fig. 2A), and both show an abnormal deceleration of responding midway through the interval (e in Fig. 2B), suddenly breaking from a high rate into a pause. All three birds had abnormally long pauses during the interval.

These ratio performances show that the response of pecking has not been disrupted and that the pigeons can respond at high rates. Also, the normal ratio performance and direct observation of eating show that food remained effective as a reinforcer.

Moreover, the sensory discrimination between the stimuli associated with the component schedules of the multiple schedule has not been impaired: there is at least a short pause at the start of the interval and the rates of responding during the initial ratio and interval performance in Fig. 2B are different, as the extended dotted line emphasizes.

The sustained effects of the lesions are shown in the remaining records from later sessions. The ratio performances themselves continue to be characteristic of the normal pigeon. However, the occasional pauses which occur at the beginning of the ratios (f in Figs. 2C and 2D and g in Fig. 2E) were not observed in the pre-operative performance. Very short pauses, as at h, during the ratio occasionally occur during control performances also.

The interval performances continue to be abnormal. The initial pause is consistently absent or shorter than normal, suggesting that the lesion may disinhibit responding. However, the abrupt breaks from a high rate into a pause several times during the typical interval show that the effect is not simply a disinhibition of responding.

It is not known what characteristics of the schedule or of the performance produce the resistance to disruption. It is best to conclude at present only that performances on a fixed-ratio schedule are more resistant to disruption by these lesions, and that the schedule of reinforcement is an effective variable in the determination of the effects of brain damage on learned behavior.

References

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Notes

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2. A previous indication of this finding appears in C. B. Ferster and B. F. Skinner, *Schedules of reinforcement*. New York: Appleton-Century-Crofts, 1957.