Drug effects upon visual signal-from-noise detection by monkeys¹

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Abstract

Monkeys' performance on a previously learned task involving visual signal-from-noise detection was shown to be a moderately sensitive behavioral drug assay which is more specific to the effects of chlorpromazine (CPZ) than pentobarbital (PB). Magnitude of the effect of CPZ was inversely related to the detectability of the visual signal.

Introduction

The general problem is to develop methods for studying a continuum of complex behavior in animals and to employ these methods as behavioral drug assays to determine the interaction between drug effects and behavioral complexity. One such method (Polidora, 1963) revealed that with certain drugs there was a direct relation between the magnitude of a drug's effect and the complexity of the spatial response sequence S was required to perform—the more complex the sequential behavior, the greater was the effect of a given drug dose.

This preliminary report describes a second method, one which is designated to assess the ability of drugged monkeys to detect visual signals imbedded within visual "noise." In this method complexity of behavior is defined in terms of the objective detectability of the signal S is required to discriminate.

Method

Three adult male rhesus monkeys were used. The apparatus consisted of a test box and stimulus display in one room and a control console in a remote room. The test box was a 2-ft cube wired to introduce scrambled electric shock independently to the aluminum walls, ceiling, and the grid floor. The S monitored the display through the bottom-hinged, transparent front wall of the box and made instrumental responses by pushing this window to close a top-mounted micro-switch. The stimulus display, positioned 6 ft from S's box, consisted of 121 1-in diameter lights spaced 2 in apart in an 11 x 11 array. Visual "noise" which persisted throughout a session was produced by lighting and extinguishing each of these lights independently for random durations. Visual "signals" (patterns) were produced by lighting a particular configuration of these lights continuously for a specified duration; nonsignal lights continued as noise during signal presentation.

The task was in essence one of discrete-trial avoidance conditioning with a 10-sec. visual signal CS, 0.5-sec. shock UCS, 1-min. average intertrial intervals, and 50-trial sessions. Intertrial responses

were recorded but not punished. Each S was initially trained to avoid shock by responding to large signals (many lights) which occurred at maximal brightness against visual noise of very low light intensity. Successive stages of increases in the brightness of the noise (to maximum) and decreases in the number of signal lights were continued until each S detected in five consecutive sessions more than 90% of the signals to be used in the drug experiments. (Intertrial responses per criterion session averaged 46, 93, and 85 for the 3 Ss.) Training and test phases consisted of two daily sessions 4 hr. apart with an added evening session on drug days.

Drugs were administered 15 min. before the Wednesday morning session, saline immediately before the preceding Tuesday morning session. Isotonic solutions of powdered chlorpromazine hydrochloride (CPZ) and pentobarbital sodium (PB) were injected intramuscularly (see Polidora & Bowman, in press, for detailed procedure).

Drug experiments were conducted in two phases. In Phase I S1 was tested with 6 x 6 solid-square signals (36 lights which invariably appeared in the center of the display), and S2 and S3 were tested with similar 9 x 9 signals. Each of the 3 Ss received each drug and dose (see Fig. 1) twice in different random orders. In Phase II S1 and S2 were retrained to detect 9 x 9 and 6 x 6 signals, respectively, and each S was tested under the large and small CPZ doses once. S3 was not tested.

Results and Discussion

The curves in Fig. 1 describe the dose-response and time-response effects of CPZ and PB upon signal detection behavior (Phase I). Considering the relatively small and transient effects of PB (even at the nearly anesthetic 32 mg/kg dose), it seems unlikely that the systematic effects of CPZ are attributable solely to the motor side-effects of large doses of CPZ.

Intertrial responses decreased under large doses of CPZ and increased (occasionally to as high as 4 responses per min.) under small CPZ and all PB doses. This latter result establishes that failures to avoid were not due simply to an inability to perform the window-pressing response, and it even suggests a dissociation between the mechanisms associated with responding to signals and those associated with responding to noise. Furthermore, decreased signal detection coupled with increased intertrial responding indicates that "detections" under either control or

Fig. 1. Percentage of signals detected by 3 Ss as a function of time since injection. Solid-line curves present mean detections (two determinations per S) under 0.25, 0.50 and 1.00 mg/kg CPZ (top) and under 4, 8, 16, and 32 mg/kg PB (bottom). Dashed-line curves depict control (saline) performance on the preceding day.

drug conditions were not achieved by random responding alone.

Figure 2 depicts the influence of signal detectability upon performance under CPZ. Again (cf. Polidora, 1963), a direct relation between drug effect and behavioral complexity was obtained—the more complex the behavior (detection of smaller signals), the greater was the effect of a given dose of CPZ. Future experiments will attempt to ascertain whether this differential effect was due simply to luminosity, or whether signals of an equal number of lights but different pattern (e. g., solid-square, geometric patterns,

Fig. 2. Percentage of signals detected by Ss as a function of time since injection of saline, and 0.25 and 1.00 mg/kg CPZ. Solid-line curves represent drug effects with signals of high detectability (9 x 9 solid-square, 67% of the lights) and the dashed-line curves, signals of lower detectability (6 x 6 solid-square, 30% of the lights). The following session data were pooled: 6 x 6 signals, second determination in Phase I for S1 and S2 in Phase II; 9 x 9 signals, S1 in Phase II and second determination in Phase I for S2.

random arrays) also give rise to larger drug effects as a function of lower pattern detectability. In addition, “search” performance (one signal which appears at a different display location on every trial) will also be studied.

References

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Note

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