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OBSERVING RESPONSES IN PIGEONS

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Pigeons were trained on an observing-response procedure in which periods of VR 100 and EXT alternated unpredictably during a white light (mixed stimulus). During VR 100, responses on a food-producing key (the first key) were intermittently reinforced. Responses on the observing key (the second key) produced a green light (positive stimulus) when VR 100 was in effect, and a red light (negative stimulus) for EXT. The birds did not respond on either key during the negative stimulus, but they responded on the food-producing key when the positive stimulus appeared. When observing responses produced the positive or negative stimulus on FR, observing responses were maintained until the FR reached a maximum; beyond this, only food-producing responses occurred. When observing responses did not produce either stimulus, the observing-response rates fell to zero. With prolonged exposure to an FR 20 schedule of observing, observing-response rates during EXT were higher than during VR 100. Chlorpromazine hydrochloride decreased the total response output but markedly increased observing-response rates except when it was administered before sessions of observing response extinction.

In visual-discrimination experiments, different exteroceptive stimuli are correlated with different conditions of reinforcement. For example, pressing a lever (response A) will be reinforced in the presence of a green light (positive stimulus) but not in the presence of a red light (negative stimulus). We will refer to response A as the food-producing response. When the organism develops a visual discrimination, food-producing responses occur in the presence of the positive stimulus but not in the presence of the negative stimulus. However, the development of a visual discrimination implies the concurrent development of observing responses which enable the organism to perceive the positive and negative stimuli. For example, the organism may have to move its eyes or its head to see the stimulus. For the experimental analysis of observing responses, Wyckoff (1952) and Kelleher (1958) required subjects to make a clearly specified response, such as pressing a second lever (response B), in order to produce the appearance of the positive and negative stimuli. We will refer to response B as the observing response. The experiments of Wyckoff (1952) and Kelleher (1958) demonstrated that observing responses ceased when they did not produce the positive and negative stimuli or when the stimuli were not correlated with reinforcement conditions. These results indicate that the appearance of the positive and negative stimuli reinforced observing responses.

The present experiments investigated observing-response rates and observing- response patterns as a function of: 1) varying the number of observing responses required to produce the positive and negative stimuli; 2) giving prolonged exposure to a given observing-response requirement; and 3) administering chlorpromazine.

METHOD

Subjects

The seven subjects were adult male pigeons (White Carneaux) maintained at 75% of their free-feeding weights. Four birds (P2, P4, P7, and P15) had no experimental history and three birds (P1, P9, P10) had had previous experience on various schedules of reinforcement.

Apparatus

Two experimental chambers were used, each containing two Plexiglas response keys mounted 4 in. apart in one wall. A food magazine located below and between the response keys occasionally permitted a 4-sec access to

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grain. Each chamber was in a ventilated picnic icebox; the two iceboxes, which we will identify as A and B, were enclosed in a larger, sound-resistant, ventilated chamber. The programming and recording equipment has been generally described (Ferster & Skinner, 1957).

General Procedure

Birds P2, P4, and P7 were trained in box A. Following magazine training, these birds were conditioned to peck each response key. They received 10 sessions on a 1-min, variable-interval schedule, which alternated unpredictably between the two response keys. This procedure established approximately equal response rates on both keys. Following this variable-interval training, these birds were subjects in a long series of observing-response experiments. We studied P2 and P7 for 3 years and P4 for 2.5 years, before P4 died from an overdose of a drug. Bird P15 replaced P4 for the remainder of the study; it was magazine trained and then conditioned to peck each key. After this brief training, P15 was shifted directly to the observing-response procedure.

Experiments in box B were conducted during the third year of experiments in box A, with Birds P1, P9, and P10. Because of their experimental histories, these birds were started on observing-response experiments without any special training.

The basic experimental procedure was similar to that reported by Kelleher (1958). Pecks on the left key were designated *food-producing responses,* and pecks on the right key, *observing responses.* Periods when food-producing responses were reinforced by food on a 100-response, variable-ratio (VR 100) schedule alternated with periods of extinction (EXT); the duration of each type of period varied from 10 sec to 10 min, averaging 5 min. A white light (mixed stimulus) illuminated the chamber unless observing responses occurred. Observing responses produced 30 sec of either a red light (negative stimulus) correlated with EXT, or a green light (positive stimulus) correlated with VR 100. If the periods alternated during the 30 sec, the stimulus changed accordingly. Each daily session ended when 50 reinforcements had been delivered or 4 hr had elapsed.

Preliminary Training

All birds started on a procedure in which each observing response produced the positive or negative stimulus. Figure 1 shows stable

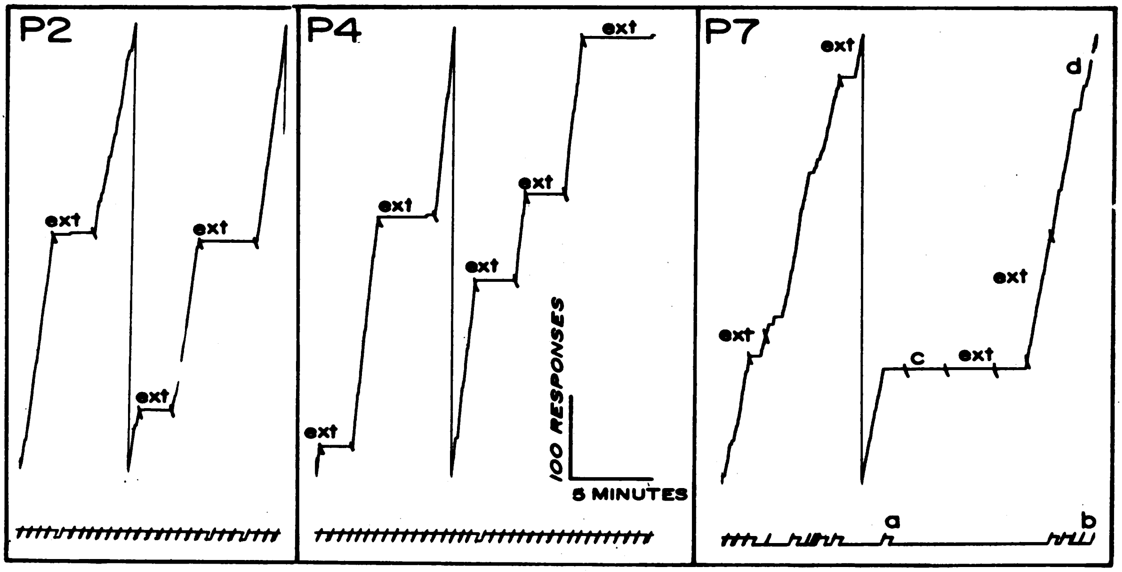

Fig. 1. Final performances on the basic experimental procedure (each observing response producing the discriminative stimulus). Cumulative records of food-producing responses are shown in the upper part of each frame. Food deliveries are not indicated. Pips indicate alternations between EXT and VR 100 periods; EXT periods are labelled. The lower record is displaced upward to show 30-sec intervals when the positive or negative stimulus is on (as at *a*). Brief upward displacements (as at *b*) indicate reinforcements occurring while the white stimulus is on. Both recorders stopped only during reinforcement cycles.

performances of three birds on this procedure. The cumulative-response records in the upper part of each frame show food-producing responses. All birds developed high food-producing response rates in the positive stimulus (indicating VR 100) and extremely low response rates in the negative stimulus (indicating EXT). Birds P2 and P4 developed observing-response rates that were high enough to keep the positive and negative stimuli on for almost the entire session. However, P7 developed relatively low observing-response rates, and the mixed stimulus was on for more than half of each session. In the presence of the mixed stimulus, P7 either paused (as at *c*) or responded at a high rate on the food-producing key (as at *d*). Birds P1, P9, and P15 developed performances comparable with those shown for P2 and P4; the performance of P10 was comparable with that shown for P7.

EXPERIMENT I: INCREASING THE OBSERVING-RESPONSE REQUIREMENT

Procedure

A specified number of observing responses was required to produce the positive or negative stimulus; that is, observing responses produced the positive or negative stimulus according to a fixed-ratio (FR) schedule. The FR value was increased until observing responses ceased. Then, the FR value was decreased to FR 1 and increased again. Four pigeons (P2, P4, P7, and P15) were used.

Results

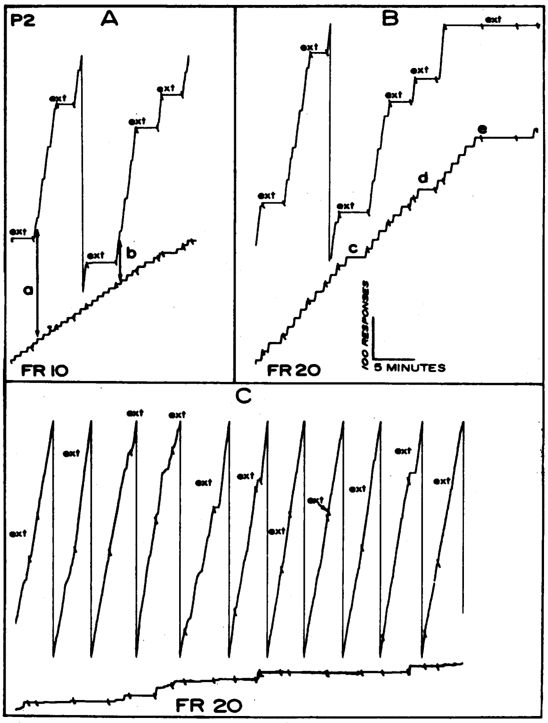

Fig. 2. Effects of increasing the observing-response requirement to FR 10 and FR 20 with P2. Food-producing responses (upper records in each frame) and observing responses (lower records) were simultaneously recorded on two cumulative-response recorders. Both recorders stopped only during reinforcement cycles.

Figure 2A shows the performance of P2 on an FR 10 schedule of observing. Food-producing responses (upper records) and observing responses (lower records) were simultaneously recorded on separate cumulative-response recorders. When the white stimulus was on, observing responses occurred at a high rate until the FR was completed. During the 30-sec intervals in which the red or green stimulus was on, no observing responses occurred. This response pattern on the FR schedule of observing is similar to response patterns on FR schedules of food reinforcement. The vertical lines at *a* and *b* indicate simultaneously recorded segments in which the bird paused briefly on the food-producing key while completing the FR on the observing key. Frames B and C of Fig. 2 show the first two sessions on an FR 20 schedule of observing. Although the observing-response pattern was maintained for most of the first session on FR 20 (frame B), some pauses occurred (as at *c*, *d*, and *e*). In the second session on FR 20 (frame C), observing-response rates decreased markedly and high food-producing response rates were maintained throughout most of the session. Following this session, the response requirement was decreased to FR 1 and then increased again.

Figure 3 shows the performance of P2 at FR 15 and FR 20 as the observing-response requirement was increased for the second time. The distribution of food-producing and observing responses changed. High food-producing response rates were maintained throughout most of each session. The bird occasionally paused on the food-producing key in order to respond on the observing key.

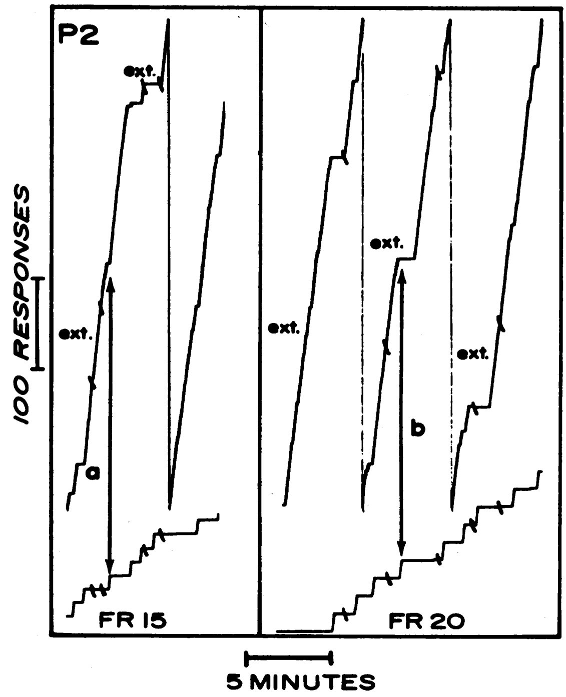

Fig. 3. Effects of increasing the observing-response requirement for the second time with P2.

If observing responses produced the positive stimulus, the bird immediately returned to responding at a high rate on the food-producing key (as at *a*). However, if observing responses produced the negative stimulus, the bird paused until the red stimulus went off and then returned to responding on the food-producing key (as at *b*).

Figure 4 shows the performance of P4 as the observing-response requirement was increased for the first time. Although observing-response performances of P4 could be maintained at relatively high FR values, the results are qualitatively similar to those of P2. Pauses on the observing key increased as the FR was increased, but stable observing-response performances were maintained at FR 30 (frame A) and FR 60 (frame B). High observing-response rates were also maintained during the first session on FR 90 (frame C). During the second session on FR 90 (frame D), however, observing-response rates fell to zero, and the bird responded at a continuous high rate on the food-producing key.

Figure 5 shows the performance of P4 at FR 25 and FR 30 as the observing-response requirement was increased for the second time. The results for P15 were comparable with those for P4.

Bird P7 developed low observing-response rates on FR 1 (Fig. 1). When the observing-response requirement was increased to FR 5, observing-response rates fell to very low values, and the bird responded almost continuously on the food-producing key. When the observing-response requirement was gradually increased to FR 20 over 20 experimental sessions, Bird P7 did maintain low observing-response rates on FR 20. From the start of the experiment, the performance of P7 was similar to that for the other birds when the FR was increased for the second time.

EXPERIMENT II: PROLONGED EXPOSURE TO AN FR 20 SCHEDULE OF OBSERVING

Procedure

Following the study of the effects of increasing the observing-response requirement, Birds P2, P4, and P7 were shifted to an FR 20 schedule of observing. For P1, P9, P10, and P15, the observing-response requirement was gradually increased to FR 20 following preliminary training. The duration of exposure to this procedure ranged from 5 months for P15 to more than 2 years for P2 and P7. All birds were frequently used in drug experiments during this time; base-line performance was always recovered following drug administration.

Results

All birds developed similar response patterns. When observing responses produced the negative stimulus, the bird paused on both keys. When the negative stimulus went off, the bird responded on the observing key until the negative or positive stimulus appeared. If the positive stimulus appeared, the bird responded at a high rate on the food-producing key. When the positive stimulus went off, the bird continued to respond on the food-producing key in the mixed stimulus until several hundred responses occurred without reinforcement. Because of this pattern, observing-response rates were higher in EXT than in VR 100.

To show the difference between observing-response rates VR 100 and EXT, observing

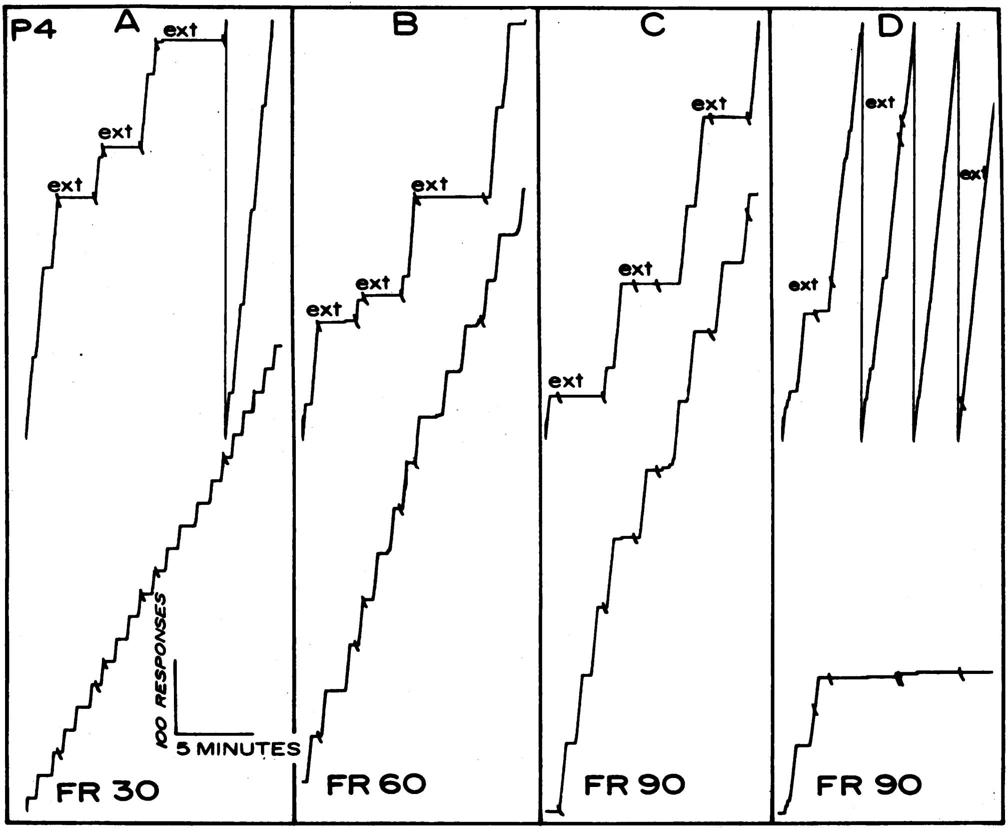

Fig. 4. Effects of increasing the observing-response requirement for the first time with P4.

responses were recorded on two cumulative-response recorders. One recorder ran only during EXT, and the other only during VR 100; both recorders stopped when the positive or negative stimulus was on. Figure 6 shows observing-response records for P2, P4, and P7 after they had been on FR 20 for about 6 months. Although observing-response rates differed among birds, the results show that each bird maintained higher observing-response rates during EXT than during VR 100.

Figure 7 shows representative performances of the other birds after about 5 months on FR 20. Observing responses here were cumulated on one recorder. Again, the cumulative-response records show that these pigeons produced the negative stimulus (correlated with EXT) more frequently than they produced the positive stimulus (correlated with VR 100).

Occasionally, we tested the effects of observing-response extinction, that is, when observing responses did not produce the positive or negative stimulus. Figure 8 shows the effects of observing-response extinction upon the performance of P7. Frame A shows food-producing responses and frame B, observing responses. For the first 10 min, the bird alternated responses between the two keys. For the next 50 min, the bird responded almost continuously on the observing key; then, after the first hour, the bird responded almost continuously on the food-producing key. Observing-response rates remained near zero for the rest of the session.

EXPERIMENT III: EFFECTS OF CHLORPROMAZINE ON OBSERVING RESPONSES

Procedure

In this experiment, we studied the effects of chlorpromazine hydrochloride on performance on the FR 20 schedule of observing. The drug was administered orally 1 hr before the start of the session. The volume of solution administered never exceeded 1 ml, and all doses are in terms of the salt. The effects of

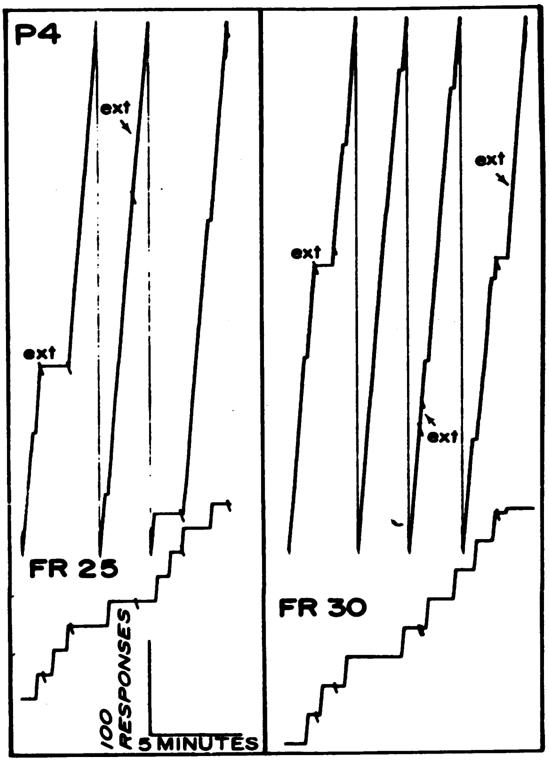

Fig. 5. Effects of increasing the observing-response requirement for the second time with P4.

doses ranging from 2.5 to 30 mg/kg were determined for P2, P4, and P7, and the effects of doses of 5 or 10 mg/kg were determined for P1, P9, P10, and P15.

Results

Figure 9 shows the effects of 10 mg/kg of chlorpromazine on the observing-response performances of P2, P4, and P7. The upper frames show representative control performances for each bird; pauses of variable duration alternate with bursts of responses in which the observing-response requirement is completed. These records do not show the 30-sec periods in which either the red or green stimulus was on. The records show that this dose of chlorpromazine markedly increased observing-response rates by decreasing or eliminating periods of pausing; and these effects were confirmed with P1, P9, P10, and P15.

Figure 10 shows the effects of the full range of doses upon the observing-response performance of P2. Doses of 5, 20, or 30 mg/kg produced extremely high observing-response rates.

For further analysis of dose-effect relationships, we computed a ratio for each control and drug session. The number of food-pro-

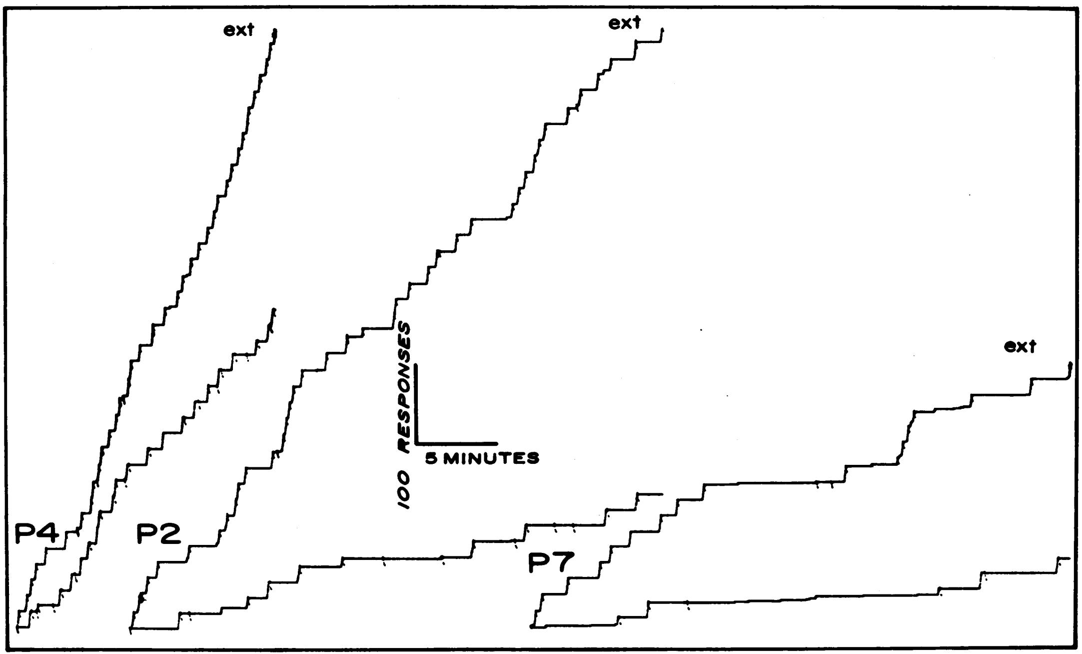

Fig. 6. Observing-response performance after prolonged exposure to an FR 20 schedule of observing. The upper records show observing responses in EXT periods; the lower records show observing responses in VR 100 periods. The recorders did not run during 30-sec intervals in which the positive or negative stimulus was on. When observing responses produced either stimulus, both recorders show a pip.

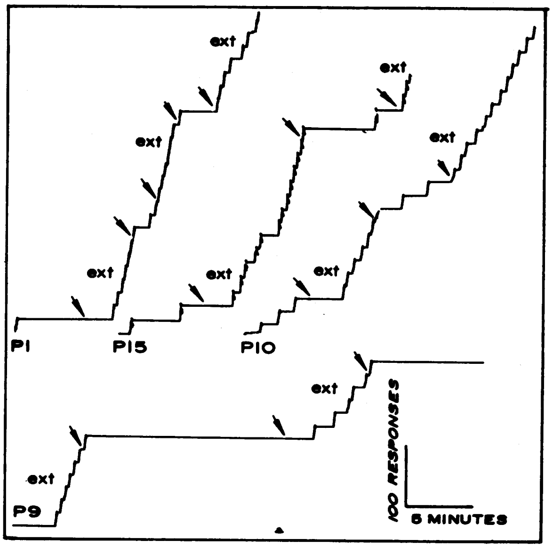

Fig. 7. Observing-response performance after prolonged exposure to an FR 20 schedule of observing. The cumulative records show only observing responses. Small arrows indicate alternations between VR 100 and EXT periods; EXT periods are labelled. The recorder did not run during the 30-sec intervals in which the red or green light was on.

ducing responses in VR 100 in the presence of the green stimulus was divided by the total number of food-producing responses in VR 100. We will refer to this ratio as the *observing* ratio. If no observing responses occurred in a session, the green stimulus would not appear and the observing ratio would be zero. If many observing responses occurred in a session, the green stimulus would appear frequently and the observing ratio would approach 1.00 (assuming that the bird responded on the food-producing key in the presence of the green stimulus). Also, we computed *total response rate* for each control and drug session. The total response rate is the total number of responses, observing and food-producing, occurring in each session divided by time in the session.

Figure 11 shows observing ratios and total response rates for P2, P4, and P7 as a function of doses of chlorpromazine. The medians and ranges from control sessions are shown at the left of each graph. The solid lines and dashed lines indicate the first and second determinations, respectively, of the effects of chlorpro-

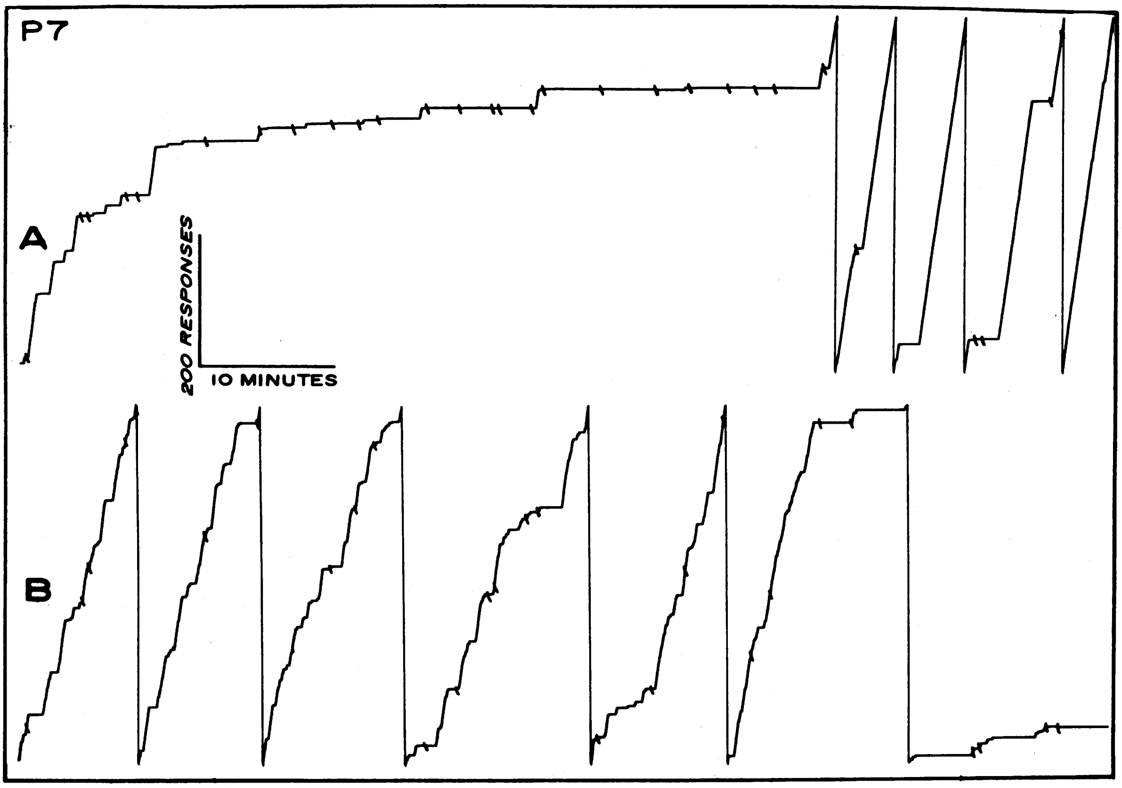

Fig. 8. The effects of extinction of the observing response. The mixed stimulus appeared throughout the entire session.

mazine; and a single point indicates the effects of a third dose of 10 mg/kg for P7. The experiments in the first and second determinations were separated by about 1 year. The results show that the observing ratio is increased by doses ranging from 5 to 30 mg/kg. Except possibly for P7, the dose-effect relationship is almost flat between these doses. The total response rate was inversely related to the dose of chlorpromazine. At all doses tested, the discrimination between the positive and negative stimuli was intact. In summary, as the dose of chlorpromazine was increased, the total response rate decreased accordingly; however, over this same range of doses, observing-response rates increased markedly and remained high.

In another experiment, we studied the effects of chlorpromazine on performance during the extinction of observing responses. Figure 12 shows representative effects with

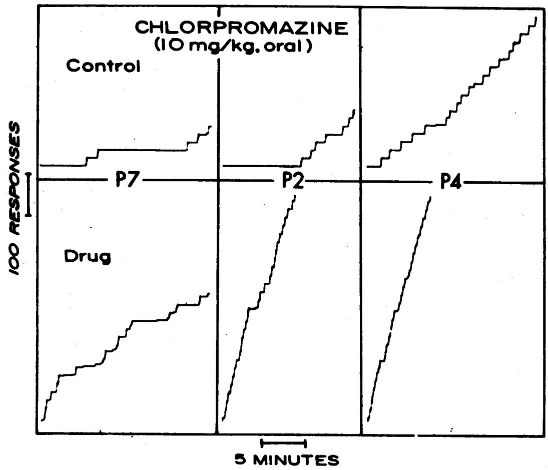

Fig. 9. The effects of chlorpromazine on observing-response performance. The cumulative records show only observing responses. The recorder did not run during the 30-sec intervals in which the red or green light was on.

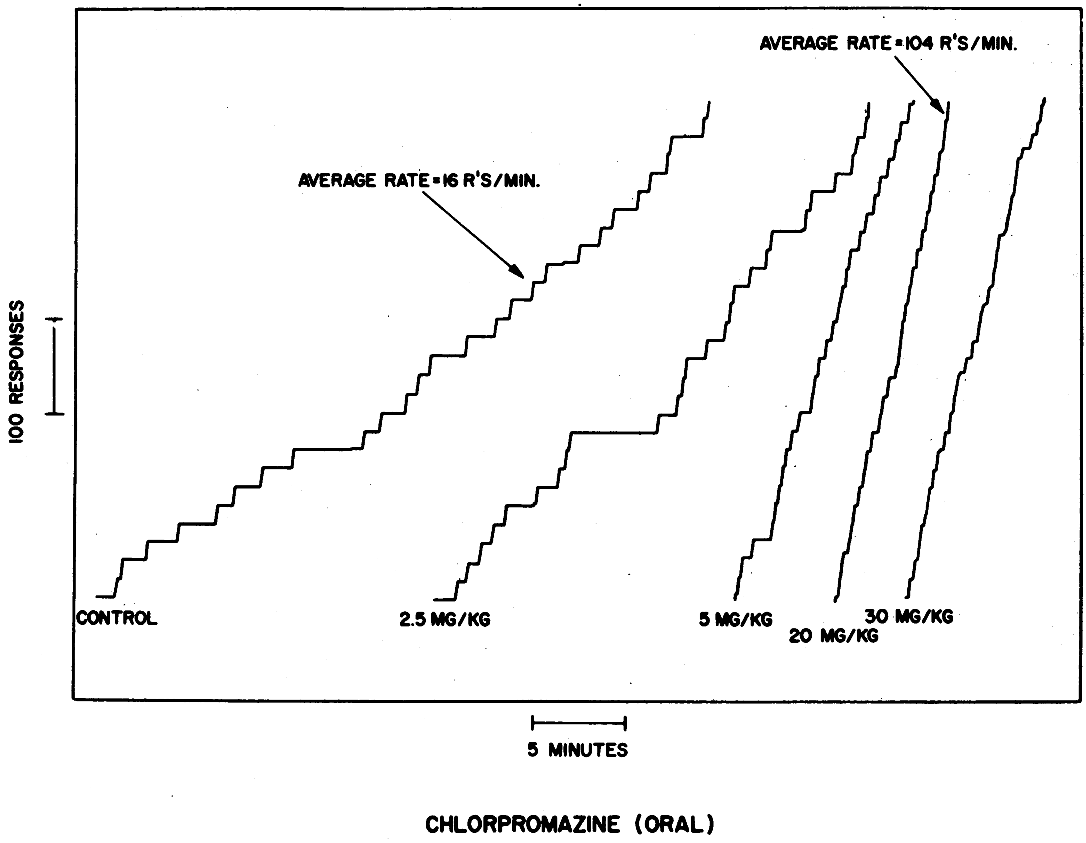

Fig. 10. The effects of several doses of chlorpromazine on observing-response performance. The cumulative records show only observing responses. The recorder did not run during the 30-sec intervals in which the red or green light was on.

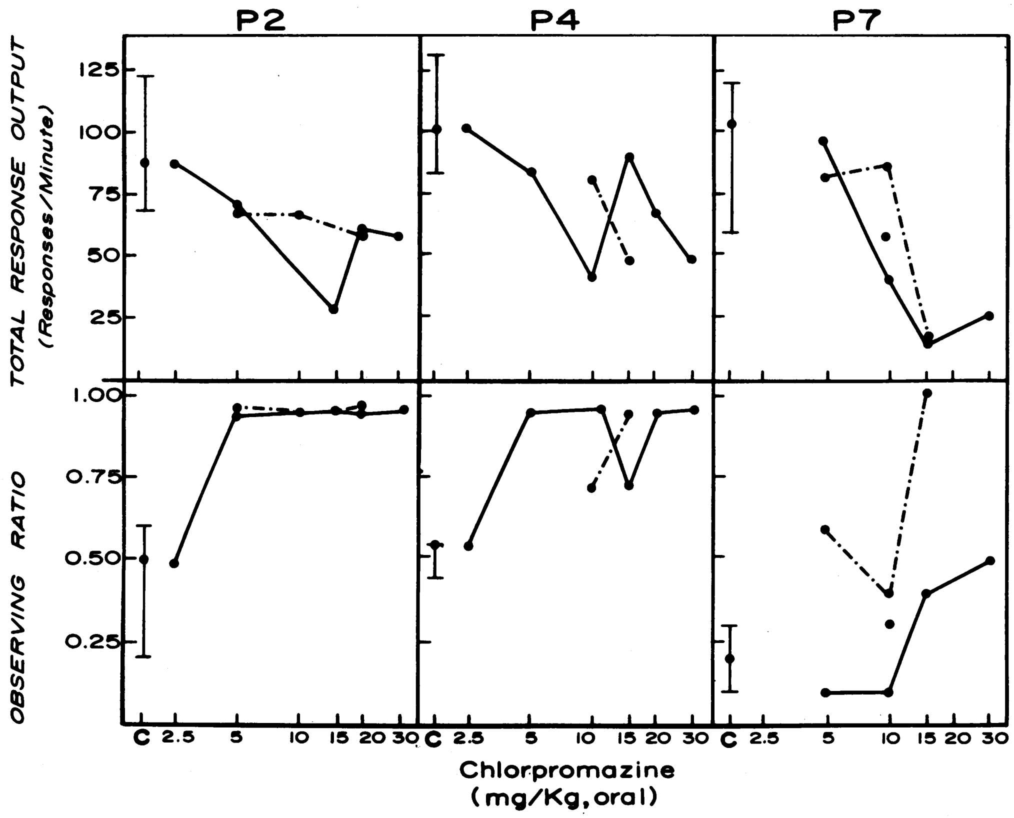

Fig. 11. The effects of chlorpromazine on total response output (upper frames) and observing ratios (lower frames). The medians and ranges from control sessions (C) are shown at the left of each frame. The abscissa is a logarithmic scale.

two pigeons. Birds P2 and P4 had three successive sessions of observing-response extinction. Chlorpromazine (10 mg/kg) was administered to P2 before the second session of observing-response extinction, and to P4 before the third session of observing-response extinction. Chlorpromazine did not retard or reverse the effects of extinction on observing-response rates.

In a subsequent experiment in which the positive and negative stimuli appeared throughout each session independently of observing responses, observing-response rates were near zero. Chlorpromazine (10 mg/kg) did not increase observing-response rates under these conditions.

DISCUSSION

These observing-response experiments are similar to schedule-preference experiments (Ferster & Skinner, 1957). If observing responses do not occur, a mixed VR 100 EXT schedule is in effect on the food-producing key; that is, the same exteroceptive stimulus is correlated with both VR 100 and EXT. If observing responses do occur, a multiple VR 100 EXT schedule is in effect for 30 sec; that is, different exteroceptive stimuli are correlated with VR 100 and EXT. The results for the preliminary training procedure (see Fig. 1), in which the observing-response schedule was FR 1, indicate that the birds kept the multiple schedule in effect for most of each session. The results also suggest that the net conditioned reinforcing effect of the positive and negative stimuli correlated with 0.01 and zero probabilities of food reinforcement, respectively, is greater than the conditioned reinforcing effect of the mixed stimulus correlated with an intermediate probability of reinforcement. Using a delay of reinforcement

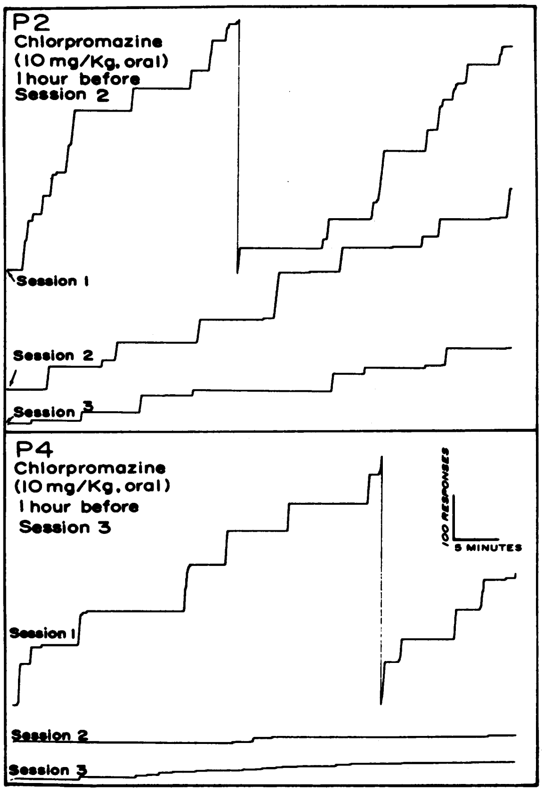

Fig. 12. The effects of chlorpromazine on extinction of observing responses. The mixed stimulus appeared throughout all three sessions.

procedure with rats in a T-maze, Prokasy (1956) obtained similar results. These findings support the notion that as the probability or frequency of reinforcement correlated with a stimulus increases, the conditioned reinforcing effect of the stimulus increases in a positively accelerated fashion (*cf.* Wyckoff, 1959). On FR schedules of observing, observing responses occurred in a regular biphasic pattern. In the mixed stimulus, the birds either paused on the observing key (initial pause) or responded at a high rate (the terminal rate) that was maintained until the positive or negative stimulus appeared. This pattern of responding is similar to that which would occur on an FR schedule of food reinforcement. As the FR schedule of observing was increased, the durations of the initial pauses increased, but terminal response rates were maintained until a maximum FR value was reached. Beyond this maximum FR, which differed for individual birds, the birds responded only on the food-producing key. In general, the present results confirm the results of previous observing-response experiments with chimpanzees (Kelleher, 1958).

For some of the birds, relatively high observing-response rates were maintained when the FR schedule of observing was increased for the first time. These high response rates probably were maintained because the birds had not had sufficient exposure to the mixed schedule. Pauses on the observing key in the mixed stimulus were accompanied by pauses on the food-producing key; that is, these birds did not respond on the mixed schedule. When the FR schedule was increased for the second time, or when the birds had prolonged exposure to an FR schedule, all birds developed high food-producing response rates in the mixed stimulus; and the observing-response patterns of the different birds became more comparable. If the birds' had been exposed to both multiple and mixed schedules before the preliminary training procedure, the individual differences in observing-response patterns that occurred when the FR was increased for the first time could probably have been minimized.

Kelleher (1958) reported that average observing-response rates of chimpanzees were higher in VR periods than in EXT. Two reasons may explain our opposite results in this study with pigeons. First, the chimpanzees did not have the prolonged training on a single FR schedule of observing that the pigeons did. Second, the chimpanzees made observing responses and food-producing responses at the same time by using both hands; for the pigeons, observing responses and food-producing responses were mutually exclusive.

Perhaps because the two responses were mutually exclusive, the pigeons made a complex adjustment to schedule contingencies on the FR 20 schedule of observing. In the presence of the positive stimulus, the birds responded at a high rate on the food-producing key. In the presence of the negative stimulus, the birds did not respond on either key. In the presence of the mixed stimulus, the disposition to respond on the observing key was in competition with the disposition to respond on the food-producing key. The actual response dispositions at any moment appeared to be a function of preceding stimulus conditions. When the mixed stimulus followed the positive stimulus, the VR 100 period was probably still in effect; thus, the disposition to respond on the food-producing key was prepotent over the disposition to respond on the observing key. As time passed in the presence of the mixed stimulus, it became less probable that the VR 100 period was still in effect; and the disposition to respond on the observing key increased until it became prepotent. When the mixed stimulus followed the negative stimulus, the EXT period was probably still in effect; thus, the disposition to respond on the observing key was prepotent over the disposition to respond on the food-producing key. This interpretation is consistent with the finding that observing-response rates were higher during EXT than during VR 100.

The striking effects of chlorpromazine on behavior on the observing-response schedule deserve careful consideration. The increase in observing-response rates after chlorpromazine is not part of a generalized increase in responding. Indeed, the total response output decreases as the dose of chlorpromazine increases; this finding is consistent with almost all reports of the effects of chlorpromazine on response output in animals. Chlorpromazine did not increase observing-response rates when observing responses were undergoing extinction or when the discriminative stimuli were on throughout the session. The effect of chlorpromazine on observing responses is apparently specific to the particular contingencies in effect on the FR schedule of observing.

After receiving chlorpromazine, the birds remained on the multiple schedule for most of the session. Dews has suggested that . . . . "discriminatory behavior not based on exteroceptive stimuli is more readily disrupted by drugs than discriminatory behavior based on explicit environmental stimuli." (Dews, 1958, p. 80). As we noted above, the patterns of responding on the FR 20 schedule of observing appear to be based upon a complex adjustment to the schedule contingencies, including a discrimination between mixed-following-negative and mixed-following-positive. If chlorpromazine disrupted this complex discrimination, it would increase the disposition to respond on the observing key. This interpretation of the effects of chlorpromazine must remain speculative until further experiments are conducted with modifications of the observing-response procedure.

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