HUMAN OBSERVING: MAINTAINED BY STIMULI CORRELATED WITH REINFORCEMENT BUT NOT EXTINCTION

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College students received points exchangeable for money (reinforcement) on a variable-time 60-second schedule that alternated randomly with an extinction component. Subjects were informed that responding would not influence either the rate or distribution of reinforcement. Instead, presses on either of two levers ("observing responses") produced stimuli. In each of four experiments, stimuli positively correlated with reinforcement and/or stimuli uncorrelated with reinforcement were each chosen over stimuli correlated with extinction. These results are consistent with prior results from pigeons in supporting the conditioned-reinforcement hypothesis of observing and in not supporting the uncertainty-reduction hypothesis.

Key words: observing behavior, conditioned reinforcement, information, uncertainty reduction, delay-reduction hypothesis, choice, response-independent reinforcement, lever press, humans

In a typical observing response procedure, reinforcement is provided on either of two (or more) schedules of reinforcement, but in the absence of observing the same stimulus is present throughout (a mixed schedule). Observing responses may produce a stimulus correlated with one of the reinforcement schedules, effectively converting the mixed schedule to a multiple schedule (e.g., Wyckoff, 1952, 1969). The observing responses have no other consequences; that is, they are not required for primary reinforcement. Indeed, they are usually made to a different key or lever than the responses on the reinforcement schedule; in some cases reinforcement is response-independent, and the observing response is the only one available (e.g., Browne & Dinsmoor, 1974).

Experiments on observing have addressed the question of why the contingent stimuli are reinforcing. One hypothesis suggests that they have a positive association with primary reinforcement (the "conditioned reinforcement

hypothesis"); another suggests that they reduce uncertainty (the "uncertainty-reduction hypothesis"). Resolution of this controversy regarding what reinforces observing centers on whether or not stimuli correlated with the absence of reinforcement ("or bad news") maintain responding (Berlyne, 1960; Bloomfield, 1972; cf. reviews by Fantino, 1977, and Fantino & Logan, 1979). Although studies with pigeons have uniformly rejected the proposition that stimuli correlated with the absence of reinforcement maintain observing (e.g., Dinsmoor, Browne, & Lawrence, 1972; Killeen, Wald, & Cheney, 1980; Mulvaney, Dinsmoor, Jwaideh, & Hughes, 1974, and others reviewed by Fantino, 1977), the results of three studies with primates suggest that information about negative events may maintain responding (Lieberman, 1972; Perone & Baron, 1980; Schrier, Thompson, & Spector, 1980). Those results raise the possibility that uncertainty-reduction reinforces observing only for organisms relatively high on the phylogenetic scale. There are, however, interpretational ambiguities associated with each of these studies, suggesting the need for additional research.

Both Lieberman (1972) and Schrier et al. (1980) studied monkeys. Potential problems with the interpretation of Lieberman's results (with rhesus monkeys) have been raised previously by Dinsmoor et al., (1972) and Fantino (1977) and need not be reviewed here. Al-

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though Schrier et al. took care to avoid the same problems, interpretation of their results (with stump-tailed monkeys) is also problematic. These authors used a discrete-trials observing procedure in which responses on the only lever available produced lights, IS+ and IS-, which signaled whether the trial would terminate with response-independent food or with no food, respectively. There were three important conditions. In the baseline condition both stimuli were produced on a variable-interval 15-sec schedule (VI 15-sec) with a range of 7 to 23 sec. In one experimental phase ("Negative DRL") the IS+ continued to be available on the VI 15-sec schedule, but the IS- was produced only when a response met both the VI requirement and was preceded by at least six sec of nonresponding. "DRL" here stands for a differential-reinforcement-of-low-rate schedule in which organisms' responses are reinforced only when they follow one another by more than a specified number of seconds (and, in this experiment, only when the VI requirement had also been met). In the other experimental phase ("Positive DRL") the schedules for producing the two stimuli were the reverse. The authors found that the introduction of either of these experimental conditions produced an immediate decline in the rate of production of the stimulus associated with the requirement for nonresponding. In each case, however, by the final sessions the proportions of IS- (in the Negative DRL condition) and IS+ (in the Positive DRL condition) obtained recovered significantly (their Figures 1 and 2). Largely on the basis of this recovery, the authors concluded that production of the IS- reinforced observing. Other aspects of their data make this conclusion less secure. In the first place, the increase in responses satisfying the 6-sec nonresponding requirement may reflect increased sensitivity, over sessions, to the fact that the minimum interreinforcement interval on the VI schedule is 7 sec. That is, if observing were maintained exclusively by production of IS+ and if responding gradually became sensitive to the fact that responses less than 7 sec into the trial never produced IS+, then more spaced responding would occur over sessions, at least in the first experimental condition. This tendency would be sufficient to account for the obtained increase in production of IS- (which required spaced responding) over sessions in the Nega-

tive DRL condition, which was the first condition for all but one subject (because only group data were presented, it is not clear if data from this subject differed from those of the others).

The results from the authors' Table 1 are more equivocal. Here they presented the mean number of observing-lever responses during the three conditions (as opposed to the proportion of stimuli produced, the data in their Figures 1 and 2). If the nonresponding contingency were effective, one would expect a decrease in responding compared to baseline by the end of the DRL conditions. In fact a 55% decrease in response rate occurs in the Positive DRL condition, supporting the notion that the IS+ is reinforcing (if we ignore the issue raised in the prior paragraph). When we turn to the Negative DRL condition, where a decrease in responding should occur if IS- reinforces observing, we find only a 9% decrease if we average over IS+ and IS- trials as above, and a 12% increase from the final five sessions of baseline to the final five sessions of the Negative DRL condition on IS- trials. Thus, the DRL contingency in the Negative DRL condition does not appear particularly effective by this measure.

In summary, results from the studies with monkeys do not appear conclusive in establishing that stimuli that reduce uncertainty about nonreinforcement are themselves reinforcing. In any event, if we wish to evaluate the proposition that uncertainty reduction reinforces observing only for organisms relatively high on the phylogenetic scale, we might consider exploring the issue with human subjects. Perone and Baron (1980) have recently reported a study in which human observing was apparently reinforced by production of a stimulus correlated with either extinction or with increased effort. In their experiment, young men pulled a plunger on mixed and multiple schedules consisting of a VI schedule alternating with extinction (Experiment 1) or consisting of equal VI schedules in which reinforcement was contingent on different degrees of effort in the two components (Experiment 2). In both experiments, observing responses (key presses) occurred at a higher rate when both the positive and negative stimuli could be produced than when only one could be produced, "demonstrating enhancement of observing behavior by a stimulus correlated with the less favorable of two contingencies" (Perone & Baron, 1980,

p. 239). The authors acknowledged (p. 248) that the results of their first experiment were not entirely conclusive, inasmuch as production of the stimulus correlated with extinction permitted the subject to stop pulling the plunger in its presence without risk of delaying or losing reinforcement. Because the plunger pull required a minimum force of 5 lb, which was approximately 25 times the minimum force required of observing responses, this caution appeared essential.

In their second experiment, in a "low-effort component," pulls on both the low-effort (5-lb) and high-effort (15- or 20-lb) plungers were effective, whereas in the "high-effort component" only the high-effort responses were effective. Subjects came to respond almost exclusively on the low-effort plunger during the low-effort component in the presence of its discriminative stimulus (S^D for either high- or low-effort plunger responses, or S^+) and almost exclusively on the high-effort plunger during the high-effort component in the presence of its discriminative stimulus (S^D for high-effort plunger response only, or S^-). As the authors concluded, these findings are consistent with the likelihood that the more effortful response was aversive. Subjects again preferred to produce both discriminative stimuli rather than just the one correlated with the low-effort component. Yet the argument may again be made that, by producing both stimuli, subjects could respond more efficiently in the presence of S^- by not pulling the ineffective low-effort plunger, and could respond more efficiently in the presence of S^+ by minimizing emission of the more effortful response.

The results of Perone and Baron appear consistent with either the uncertainty-reduction or the conditioned-reinforcement hypothesis, depending upon which aspects of the data are emphasized. There is no question that the S^- maintained observing and that it "reduced uncertainty" about the requirements for plunger pulling. At issue is whether the S^- maintained observing because it permitted subjects to emit a lower proportion of more effortful responses or because it reduced uncertainty independent of any effect on response efficiency. The results of Perone and Baron do not permit resolution of this issue. Indeed any experiment utilizing response-dependent reinforcement is open to interpretations involving increased efficiency of responding. The present

experiment, therefore, attempts to assess human observing behavior with a procedure involving response-independent reinforcement. The only consequence of subjects' responding is production of stimuli. In different conditions the relationships between stimuli and reinforcement are varied and in most conditions subjects are told—correctly—that their responses cannot affect the rate or distribution of reinforcers. Under these circumstances will subjects choose only the S^+ as required by the conditioned-reinforcement hypothesis or will they choose both S^+ and S^- (relative to stimuli uncorrelated with reinforcement outcomes) as required by the uncertainty-reduction hypothesis?

EXPERIMENT 1

Mulvaney et al. (1974) developed a procedure that permits separate assessment of the contributions to observing made by production of the positive and negative stimuli. The present experiments used a variant of this procedure in which subjects could respond in either of two levers (or not respond at all). In the first experiment, each subject was exposed to three conditions, each involving different stimulus-reinforcer correlations. In one condition responses on either lever produced a stimulus uncorrelated with the schedules in effect (baseline). In a second, responses on one lever produced the positive stimulus when a variable-time (VT) schedule was in effect, and responses on the other lever produced the negative stimulus when extinction (EXT) was in effect (standard observing condition, i.e., S^+ vs. S^-). In the third condition, responses on one lever produced the stimulus correlated with EXT; responses on the other lever produced a stimulus uncorrelated with the schedules in effect. The latter was the most critical group: Would the stimulus correlated with EXT be chosen over the uncorrelated stimulus?

METHOD

Subjects

Subjects were 6 men and 2 women selected from a pool of introductory psychology students who were required by their instructor to act as subjects for credit towards their course grade. Students chose to be in these particular experiments by signing a posted sheet that ad-

vertised an experiment on human observing behavior.

Apparatus

Subjects were seated on a common classroom-type chair in front of a custom built-in table in a room that was 2.5 m long, 1.8 m wide, and 3.0 m high. The room was otherwise empty of furniture. Entry to the room was through a sound-attenuating door that contained a 29 cm by 13 cm mirrored observation window (i.e., a "one-way" window.) Environmental conditions were those of a typical classroom except that external sounds were attenuated with insulated walls.

Two levers and a display panel were on the table. The levers, identical switches (Micro-switch Model BZ-2RW) outfitted with a plastic button, were located 30 cm apart, symmetrically in front of the subject. The switches required a force of 1.2 N to operate and lever travel was 1 cm. A lever operation caused an audible click and illuminated a Sylvania miniature lamp (Model 28PSB), which was located on the display panel 20 cm above the lever. The display panel was an 80 cm by 54 cm metal stand that contained six Sylvania miniature lamps, a counter (Sodeco Model TCeBZ4E), and an interface connector (Jones-type). Four lamps and the counter were centered on the panel, 35 cm above the table top. The four lamps were arranged in a vertical line. The bottom three lamps were capped with green, red (or blue), and blue (or red) filters, respectively, from highest to lowest. Standard relay equipment located in an adjacent room was used to arrange the schedules and record responding.

Procedure

We used a schedule that alternated randomly between extinction (EXT), in which reinforcement never occurred, and a variable-time 60-sec schedule (VT 60-sec) in which reinforcement occurred on the average of every 60 sec, independent of any responding. Each EXT and VT component was in effect for 60 sec. Reinforcement consisted of points, worth ten cents each, produced on a visible counter. In each of three conditions, instructions described correctly the relationship of the stimuli to reinforcement. In one condition—a standard observing condition—the instructions read:

In this experiment you have the chance to occasionally receive points which are worth 10 cents each to you at the end of today's session. Points are more likely during certain periods than during others as you will soon see for yourself.

In front of you are two levers and some lights. The white light will normally be on. You can occasionally cause the blue or red lights to turn on by pressing the levers. [When the blue light is on, points are twice as likely as normal. In contrast, no points will be earned when the red light is on.]

Please press the levers with your finger using only one hand (your preferred hand). This will insure that only one lever is pressed at a time. You may otherwise select to press the levers as you wish in any order.

The light directly above each lever will turn on when you press to let you know that you have pressed hard enough. The green light will turn on briefly when you receive a point. Also you can see the total number of points on the counter in front of you. Remember these points are worth 10 cents each to you after the session.

In two other conditions the portion of the instructions in brackets was replaced with other phrases appropriate to the different conditions. For an alternative in which the blue stimulus was uncorrelated with the schedules, for example, the instructions in the brackets read: "When the blue light is on, some of the time points are twice as likely as normal. However, at other times when the blue light is on, no points will be earned."

In all three conditions, presses on the levers produced lights on a VI 60-sec schedule. A light, once produced, remained lit for 30 sec or until the end of the component, whichever came first. The conditions were: (1) Responses on either lever produced a stimulus that was uncorrelated with the schedules in effect (baseline). (2) Responses on one lever produced a stimulus correlated with the VT schedule when the VT was in effect; responses on the other lever produced a stimulus correlated with EXT when EXT was in effect (standard observing). (3) Responses on one lever produced the stimulus correlated with EXT; responses on the other lever produced a stimulus

uncorrelated with the schedule in effect. Subjects served in each of these conditions for one session. The order of sessions was roughly counterbalanced across subjects (Table 1). The position of the levers and the colors of the lights were also counter-balanced across subjects to control for position or color bias.

The top (unfiltered) lamp on the panel was associated with the mixed VT and EXT schedule. The lamp was illuminated at the start of a session and was darkened when the session ended. It was also darkened for .5 sec every 60 sec, at the end of components. A session consisted of 30 trials. In all sessions, the percentage of trials in which a given lever was potentially effective in producing a stimulus according to the VI schedule—50%—was equated between alternatives. Thus, the upper limit of the duration of exposure of each produced stimulus was approximately 7.5 min per 30-min session.

After the subject was seated in the experimental room and the instructions were given, the experimenter demonstrated the functioning of the apparatus. The experimenter never pressed either lever while or just before a pre-

arranged point registered on the counter. Also, each lever was used to turn on its corresponding colored light once. Subjects completed a written questionnaire following their participation. Four questions attempted to verify that subjects were aware of the function of their responding and the relationship of the lights to reinforcement: (1) "What does the red light mean?" (2) "What does the blue light mean?" (3) "Describe how the left lever worked." (4) "Describe how the right lever worked." One additional questionnaire item asked about strategies or rationale for responding. The item read, "Why did you press the levers as you did? Did you use a strategy?"

RESULTS AND DISCUSSION

Substantial mean levels of observing were maintained and questionnaire items were generally answered correctly. The absolute rate of total observing overall, when averaged over observing conditions, was 47 responses per minute (standard deviation, *s.d.* = 43). Table 1 shows the number of questionnaire items answered incorrectly in each condition. Individ-

Table 1
Design and Principal Results of Experiments 1 and 2

Rate of Pre-exposure Observing ^a and Number of Questionnaire Items Answered Incorrectly ^b												
Subject	Design			Uncorrelated S1 (vs. uncorrelated S2)			Correlated S+ (vs. correlated S-)			Correlated S- (vs. uncorrelated S1)		
	Order of Conditions ^c	S1 Color	S1 Side ^d									
				S1	S2	Errors	S+	S-	Errors	S-	S1	Errors
Experiment 1												
1	BCA	blue	left	2.1	2.2	2	42	1.8	0	2.0	8.0	0
2	ACB	red	left	25	28	0	21	17	1	14	25	1
3	BAC	red	left	30	31	0	54	45	0	71	76	0
4	CBA	red	right	6.9	7.1	0	3.2	.5	0	1.3	7.0	0
5	ACB	blue	left	6.4	6.6	0	6.6	5.4	2	4.4	3.3	0
6	CAB	blue	right	31	21	0	70	64	0	49	68	2
7	BCA	red	right	11	11	0	71	38	0	2.6	17	0
8	ACB	blue	right	9.7	11	0	44	9.0	2	21	33	0
Experiment 2												
1	BCA	blue	left	69	78	0	147	1.5	0	0	186	0
2	CBA	red	left	65	57	0	86	60	0	41	51	0
3	ABC	blue	left	80	148	0	229	2.3	0	1.8	176	0
4	CAB	blue	right	54	48	0	87	4.6	0	25	96	0
5	BAC	red	right	44	46	1	42	8.5	0	40	47	3
6	ABC	red	right	145	128	0	200	107	2	.2	12	1

^aExpressed in responses per min.

^bQuestionnaires contained four items.

^cA = uncorrelated S1 (vs. uncorrelated S2)

B = correlated S+ (vs. correlated S-)

C = correlated S- (vs. uncorrelated S1)

^dThe side and color were the same for S1 and S+, and for S2 and S-.

ual errors are discussed in detail below in relation to the observing results for each condition, to which we now turn.

The main dependent variable was a measure of choice: the proportion of responses made to each lever (the number of responses on one lever divided by the sum of responses made on both) prior to an effective observing response. Responses occasionally could and did occur following exposure to the discriminative stimulus within a trial, that is, after the 30-sec exposure-duration timer timed-out but before a second exposure in that trial or the end of the trial. However, stimuli produced by observing during this period are redundant. The rate of pre-exposure observing is a measure of responding that avoids potential complications of redundancy, discussed by Case and Fantino (1981). The relative rates of pre-exposure observing are plotted for individual subjects and the mean data in Figure 1 for each condition of Experiment 1. (Absolute rates of pre-exposure observing to each lever are provided in Table 1.)

In the baseline condition (left bars) the choice proportions of 7 of 8 subjects were within 5% of exact indifference. The mean choice proportion equaled .50. The results of the experimental conditions are shown by the center and right bars. When presses on one lever produced the stimulus associated with the VT schedule when that schedule was in effect and presses on the other lever produced the stimulus associated with EXT when it was in effect, all subjects preferred the stimulus correlated with the VT schedule despite the fact that both stimuli were informative (center bars). Although preference was large for only half the subjects, a within-subjects analysis of variance confirmed that mean preference in this condition was significantly different from baseline ($F[1,7] = 7.1, p < .05$). In the most critical comparison, 7 of 8 subjects preferred the stimulus uncorrelated with the schedules in effect to that correlated with EXT, even though only the latter stimulus was informative (right bars). Mean preference in this condition was also significantly different from baseline (within-subject analysis of variance, $F(1,7) = 7.7, p < .05$).

Figure 2 plots the mean and individual subject choice proportions of overall observing, that is, pre-exposure plus post-exposure observing. These results are highly similar to those

Fig. 1. Mean and individual choice proportions for each of three conditions of Experiment 1. Choice proportions are based on observing responses made prior to the production of observing stimuli on a given trial ("pre-exposure observing"). The left bar in each panel gives the choice proportion maintained by one stimulus uncorrelated with points compared to the other stimulus, also uncorrelated with points (baseline). The center bar gives the choice proportion maintained by the S+ compared to the S-. The right bar gives the choice proportion maintained by the S- compared to the stimulus uncorrelated with points. Error bar length is one standard deviation.

in Figure 1. In either case results support the conditioned-reinforcement hypothesis unequivocally: The S+ was preferred to the S- in the

Fig. 2. Mean and individual choice proportions for each of three conditions of Experiment 1. Whereas the choice proportions in Figure 1 were based on "pre-exposure observing" only, these choice proportions are based on all observing responses, including those made after production of observing stimuli on a given trial. In all other respects presentation is identical to that of Figure 1.

standard observing condition despite the fact that both stimuli reduced uncertainty to an equal extent; the uncorrelated stimulus was preferred to the S- even though only the latter stimulus reduced uncertainty.

The questionnaire administered immediately following each session contained four

questions that attempted to assess whether instructions were understood and whether subjects were attentive to the correspondence between lever pushed and stimulus produced. Erroneous answers to these questions may indicate that observing results on those occasions should be interpreted with caution. On the other hand, erroneous answers may also occur simply because a question was misunderstood or because of carelessness in answering. In any event, a closer analysis of the few errors that did occur, in relation to the preference results, is warranted. Subject 1 answered that one of the levers in the baseline condition produced both stimuli, while the other lever produced neither. Despite this, approximately equal pressing occurred to both (Figures 1 and 2). Subject 2 claimed that in the two experimental conditions the lever that produced the stimulus correlated with EXT also produced points. This report is consistent with the fact that preference for the stimulus correlated with the VT schedule or uncorrelated with the schedules was less pronounced than the mean preference for all subjects. Subject 5, who did not distinctively restate the meaning attached to the stimuli (as specified by the instructions) in the first experimental condition, produced a small preference. Subjects 6 and 8 each claimed, one time, the reverse of the actual correspondence between levers pressed and stimuli produced. Nonetheless their responding remained consistent with mean responding on these occasions and in the other conditions.

In order to take advantage of the ability of human subjects to report why they responded as they did, a question to this effect was included on the questionnaire. The answers varied considerably and are difficult to categorize. One type of response was a simple description of the distribution of responses between the alternatives that the subject just produced. For example, one subject wrote, "[I] tried to keep the red [S+] on as much as possible and the blue [S-] off." Another type of answer claimed that some pattern was sought as levers were pressed. A third did not specify any clear answer or explicitly specified no reason. These responses were especially common in the baseline condition. Occasionally subjects answered that they thought pressing might produce points directly. For example, one subject wrote, "I think if you push the levers about every 30 seconds it should give you points." Of particu-

lar interest with respect to the uncertainty-reduction hypothesis, no subject claimed to produce the stimulus correlated with EXT because this would then tell them that points were not likely. Indeed, sometimes the response suggested the opposite: "I just pressed the [S+] one since it turned the point light on. I figured why should I press the red [S-] if no points will be given."

EXPERIMENT 2

The results of Experiment 1 were consistent with the conditioned-reinforcement hypothesis of observing but not with the uncertainty-reduction hypothesis. Given that subjects were exposed to each condition for only one session, it appeared essential that they understand the procedure. Thus, Experiment 2 replicated Experiment 1 with the principal exceptions that the instructions made explicit that responding on the levers had no effect upon reinforcement and the postsession questionnaire was rephrased in hope of reducing ambiguous answers.

METHOD

Subjects

Two men and four women served in the experiment. Subjects were obtained in the same way as those in Experiment 1.

Apparatus

The apparatus was the same as that used in Experiment 1.

Procedure

The method of the first experiment was replicated with two major exceptions. First, the instructions were modified by the insertion of a phrase that made more explicit that points were response independent. The first paragraph of the instructions in Experiment 2 read:

In this experiment you have the chance to occasionally receive points which are worth 10 cents each to you at the end of today's session. However nothing you can do will affect the total number of points you receive—it cannot be either increased or decreased by your responding. Points are more likely during certain periods than during others as you will soon see for yourself.

Second, two items on the postsession questionnaire that attempted to assess the subject's awareness of the function of responding were rephrased in an effort to reduce ambiguous answers. The question asked, "What light(s) turned on when the left [right] lever was pressed?" Subjects were given a multiple choice to indicate their answer. The alternatives were (1) red light, (2) blue light, (3) sometimes red, sometimes blue, (4) neither light, and (5) unsure. In addition, if subjects were unsure, they were asked to guess the correct answer.

Table 1 shows the order of conditions and arrangement of stimuli and alternatives for each subject.

RESULTS AND DISCUSSION

More explicit instructions that reinforcement was independent of responding did not deter subjects from emitting a high rate of responding. Absolute rate of total pre-exposure observing averaged over conditions was 145 responses per minute (s.d. = 77). Questionnaire items were answered with high accuracy (Table 1). Figure 3 shows the results of the principal dependent variable, the relative rate of pre-exposure observing. (Absolute observing rates to each lever are provided in Table 1.) The mean and individual-subject results are plotted for each condition. In general, the results replicated closely those of Experiment 1 in all three conditions. Responding was somewhat more variable in Experiment 2, but preferences in the experimental conditions were also more extreme. Mean preference for the stimulus correlated with the VT schedule over the stimulus correlated with EXT (mean = .83) was significantly greater than baseline (mean = .48, $F[1,5] = 14$, $p < .05$). Mean preference for the stimulus correlated with EXT over the stimulus uncorrelated with the schedules was only .19 and was significantly less than baseline ($F[1,5] = 9.6$, $p < .05$). Comparable results were obtained using overall rate of observing as the dependent variable (not shown).

Considering the similarity in procedure between Experiments 1 and 2, it is interesting that absolute response rates were frequently higher in Experiment 2 than in Experiment 1. Responding maintained by S+ and the uncorrelated stimuli was reliably greater (all results are in responses per min): S+, mean = 39 vs. mean = 132 ($t[12] = 3.1$, $p < .01$); uncorrelated S1 in baseline, mean = 15 vs. mean = 76

Fig. 3. Mean and individual choice proportions for each of three conditions of Experiment 2, based on observing responses made prior to the production of observing stimuli on a given trial. Presentation is identical to that of Figure 1.

($t[12] = 4.1$, $p < .01$); uncorrelated S1 in the uncorrelated vs. S- condition, mean = 30 vs. mean = 95 ($t[12] = 2.2$, $p < .05$); and uncorrelated S2 in baseline, mean = 15 vs. mean = 84 ($t[12]$, $p < .01$). It is unclear why the more explicit instructions employed in Experiment 2 would increase response rates as they seemed to here.

Two subjects accounted for all of the erroneous answers to questionnaire items. Subject 5 showed the highest preference for the S- in the S- vs. uncorrelated condition, although the choice proportion was still below .50 (.46). Subject 5 also missed three of four questions asked in that condition. This subject answered

that the lever that produced the stimulus uncorrelated with the schedules produced both stimuli. The subject was also unsure which stimulus the other lever produced. The relationship of points to the stimulus uncorrelated with the schedules, as specified in the instructions, was incorrectly restated. Finally, Subject 5 was unsure in the baseline condition which stimulus was produced by one of the levers, yet preference approximated mean preference closely. Subject 6 answered in the first experimental condition that both levers produced both stimuli. Also, the stimulus that was uncorrelated with the schedules in the second experimental condition was incorrectly related to the likelihood of getting points as specified in the instructions.

Subjects gave a variety of answers, when asked why they responded as they did, as in Experiment 1. The answers tended to differ from those of the first experiment somewhat in that on several more occasions in Experiment 2 subjects pointed out that points were delivered independent of responding. Subject 5 came the closest of anyone in either experiment to stating a reason for responding that is at least partially consistent with the uncertainty-reduction hypothesis. The subject claimed to press the lever that produced the stimulus correlated with EXT occasionally in order "to see what would happen." The subject also pointed out that doing this would not affect the total number of points received. Subject 5 nonetheless strongly preferred the stimulus correlated with the VT schedule in this condition.

EXPERIMENT 3

This experiment differed from the prior ones in two principal ways. First, subjects' comprehension of the instructions was assessed after they responded on the procedure for ten minutes. Subjects who failed this test were dismissed. Second, we included a condition in which we assessed preference for the stimulus correlated with the VT schedule as compared to a stimulus uncorrelated with the schedules. This condition had been omitted in the prior experiments because both the conditioned-reinforcement and uncertainty-reduction hypotheses require preference for the stimulus correlated with the VT schedule.

METHOD

Subjects

Twelve men and four women participated. Subjects were chosen either from the student pool of subjects used in the first two experiments or from people who signed a recruitment sheet posted in a hallway of the Psychology Department. The advertisement asked for subjects to participate in exchange for money, approximately \$3.50 per hour session. Of this amount, \$2.00 was paid for attendance, the substitute for credit towards the course grade in the case of the student pool of subjects. All subjects were paid approximately \$1.50 per session, on the average, from points earned in the task.

Three subjects were dismissed from the experiment because of nearly zero rates of responding. The data from these subjects are not directly relevant to testing between the uncertainty-reduction and conditioned-reinforcement hypotheses. Five subjects were dismissed after a trial run of the task (see Procedure).

Apparatus

The apparatus was essentially the same as that used in the first two experiments. The lever feedback lamps were moved from the display to the end of the levers. The lamps and counter in the center of the display were moved down, to 10 cm from the table top. Minor changes were made in the cosmetic appearance of the display stand and the levers.

Procedure

Experiment 3 replicated the first two experiments with the following exceptions. Pretask protocol differed. Following instruction like that used in Experiment 2, additional instruction was given to prepare the subject for a 10-min trial run in the observing procedure. Subjects were told that they needed to correctly answer questions about the task following the trial run in order to continue the experiment. The same questions as in Experiment 2 assessed whether subjects were aware of the function of responding and the relation of the lights to reinforcement. Three additional questions were asked about what the subject should have noticed in the experiment. Two were identical except in making reference to the different stimuli. They read, "Did you ever get a

point when the red [blue] light was on?" The other additional question read,

You received points no matter how you pressed the levers, exactly as stated in the instructions. However, this may not have appeared to be the case. For example, sometimes by chance you may have pressed a lever just as a point was delivered. Based upon what you saw happening overall, did it seem that pressing the levers could either increase or decrease the number of points that you got? If your answer is yes, please explain.

Answers to this question were not used in judging whether to exclude potential subjects on the grounds that they did not understand the procedure. The contingency for dismissal was actually applied only in the first session, although the trial run was conducted in all sessions. If a question was answered incorrectly following the trial run of the second and third sessions, the error was corrected by providing the correct answer and the subject was allowed to continue.

Another difference in procedure in Experiment 3 was the duration of exposure of the discriminative stimuli. This time the stimuli remained present until the end of the trial, thus preventing observing responses from occurring following exposure to a discriminative stimulus within the same trial. In addition, the mixed stimulus remained lit continuously throughout the session rather than darkening at the end of components as in the first two experiments. Also, a different laboratory assistant acted as experimenter in conducting the sessions. Finally, observing was effective in producing a stimulus in 50% of the 32 trials in a session, after a VI 15-sec schedule requirement was met.

The design of Experiment 3 was essentially the same as that of the other experiments except that the baseline condition of Experiments 1 and 2, where both levers produced stimuli uncorrelated with the schedules, was not conducted. In its place a new condition tested preference for producing a stimulus correlated with the VT schedule when VT was in effect compared to a stimulus uncorrelated with the schedules. The symmetrical arrangement of the design allowed assessment of the degree of transitivity in choice. Table 2 shows the order

Table 2
Design and Principal Results of Experiment 3

Subject	Design		Rate of Pre-exposure Observing ^a and Number of Questionnaire Items Answered Incorrectly ^b								
			Correlated S+ (vs. uncorrelated S2)			Correlated S+ (vs. correlated S-)			Correlated S- (vs. uncorrelated S1)		
	Order of Conditions ^c	S1 Color	S1 Side ^d	S+	S2	Errors	S+	S-	Errors	S-	Errors
1	BAC	blue	left								
Trial run				77	149	0	40	88	0	174	61
Full Session				127	112	0	25	168	2	184	30
2	ABC	red	left								
Trial run				36	29	0	29	24	2	11	35
Full session				57	30	1	59	6.6	0	6.4	26
3	CBA	blue	left								
Trial run				140	57	0	28	31	2	61	81
Full session				71	58	0	61	.6	0	78	87
4	BCA	red	right								
Trial run				21	20	1	22	3	0	.7	54
Full session				8.5	8.5	0	12	1.8	0	.7	10
5	ACB	blue	right								
Trial run				81	63	0	134	47	0	54	54
Full session				97	76	0	116	26	0	16	158
6	CAB	red	right								
Trial run				6.9	7.1	0	2.5	2.1	0	57	50
Full session				12	9.9	0	6.4	4.6	0	17	12
7	BAC	blue	left								
Trial run				1.6	1.1	0	3.5	4.7	0	.1	1.4
Full session				1.2	.8	0	.9	.1	0	0	1.0
8	CBA	blue	left								
Trial run				5.9	5.3	0	5.6	5.4	0	2.0	7.3
Full session				6.0	5.4	0	8.1	6.9	0	1.6	2.4

^aExpressed in responses per min.

^bQuestionnaires contained six items.

^cA = correlated S+ (vs. uncorrelated S2); B = correlated S+ (vs. correlated S-);

C = correlated S- (vs. uncorrelated S1)

^dThe side and color were the same for S1 and S+, and for S2 and S-.

of conditions and the arrangement of stimuli and alternatives for each subject.

RESULTS AND DISCUSSION

Absolute rate of total observing averaged over all conditions was 76 responses per minute (s.d. = 80). Questionnaire items were answered with even somewhat higher accuracy than in the first two experiments. Table 2 shows the number of questions answered incorrectly by each subject in each condition. Errors are tabulated separately for the questionnaire that followed the 10-min trial run and for the one that followed the full 32-min session. The errors in the trial-run questionnaire were those made in the second or third session, because subjects were excused from the experiment if they missed an item on the trial-run question-

naire for the first session. Subjects' choice proportions during the 10-min trial run were calculated and assessed (Table 2). At this point none of the preferences was significantly different from .50 (preference for the stimulus correlated with the VT over the uncorrelated stimulus was .54, $t(7) = 1.1$, $p > .1$; preference for the stimulus correlated with VT over the stimulus correlated with EXT was .55, $t(7) = .73$, $p > .1$; and preference for the stimulus correlated with EXT over the uncorrelated stimulus was .34, $t(7) = 1.7$, $p < .1$).

Figure 4 plots the mean and subject choice proportions for each condition in the full 32-min session (see Table 2 for the absolute rates of observing). The results of the new condition examined in this experiment are shown by the left bars. Mean preference for the stimulus cor-

Fig. 4. Mean and individual choice proportions for each of three conditions in Experiment 3, based on observing responses made prior to the production of observing stimuli on a given trial. The left bar in each panel gives the choice proportion maintained by the S+ compared to the stimulus uncorrelated with points. In all other respects data presentation is identical to that of Figure 1.

related with the VT schedule compared to the stimulus uncorrelated with the schedules (.56) was significantly greater than .50, that is, indifference ($t[7] = 3.17, p < .01$). Mean preference for the stimulus correlated with the VT schedule compared to the stimulus correlated with EXT (center bars, .71) was also signifi-

cantly greater than .50 ($t[7] = 2.0, p < .05$). Relative rate of responding for the stimulus correlated with EXT compared to the stimulus uncorrelated with the schedules (right bars, .33) was not significantly less than .50 ($t[7] = 1.5, p < .1$).

The pattern of results across conditions can be tested for consistency with the principle of transitivity in choice behavior (cf. Navarick & Fantino, 1974). Two subjects (2 and 3) exhibited strong transitivity in their choices, five (1, 4, 5, 7, and 8) exhibited moderate transitivity in theirs, and the remaining subject (6) exhibited weak transitivity in his.

A questionnaire item that was missed following a trial run was always answered correctly following the full session. Therefore, the correction of erroneous answers following the trial run seems to have been effective. Nonetheless, some errors occurred after the full session even though these items had been answered correctly following the trial run. These errors may help account for the anomalous data from Subject 1. This subject was the only one in this experiment (and the only one of 22 in all three experiments) showing a preference for S- over S+ (.87). In this condition Subject 1 claimed that the lever that produced the stimulus correlated with EXT actually produced the stimulus correlated with the VT schedule.

When asked why they responded as they did, subjects again gave a variety of answers that are difficult to categorize. Again no answer indicated that the stimulus correlated with EXT was produced in order to tell when points would not be delivered. However, subjects did occasionally explain their responding by saying they tried to turn on the stimuli to discover when they would get points.

EXPERIMENT 4

The 22 subjects of the present experiments were each exposed to one session of each of three conditions. It is possible, of course, that different results would occur if subjects were studied for several sessions in each condition. Given the consistency of the results in each condition and especially given subjects' generally accurate understanding of the procedure, however, there is no reason to expect a change in the direction of preference over repeated sessions. Nonetheless, in the present experiment, four subjects were studied for nine

sessions in choice for the stimulus correlated with EXT vs. the uncorrelated stimulus.

METHOD

Subjects

Two men and three women were selected through a recruitment sheet posted in a hallway of the Psychology Department. This time, however, subjects were solicited for nine sessions. One subject was dismissed from the experiment after the second session for tampering with the apparatus. Subjects were paid \$2.00 per session for participation plus approximately \$2.00 per session for points.

Apparatus

The apparatus was essentially the same as that used in Experiment 3 except that three levers were on the table. The third lever had a green button and was centered between the other levers, which had yellow buttons.

Procedure

Subjects were exposed to one condition in which they could observe a stimulus correlated with EXT and a stimulus uncorrelated with the schedules. This condition was selected since it is the one for which the predictions of the conditioned-reinforcement and the information hypotheses are most discrepant. As in the comparable condition of the prior experiments, the VT 60-sec and EXT schedules alternated randomly every 60 sec, and one observing lever produced a stimulus correlated with EXT while the other observing lever produced a stimulus that was uncorrelated with the schedules. Each subject was studied for nine sessions. Half the subjects were studied in one, and the other half in three, sessions per day. Trial runs in the observing procedure preceded the first two or three full sessions of observing for subjects who were studied in one session per day. Trial runs preceded the first full session of observing of the first and second days for subjects who were studied in three sessions per day. Side and color of the alternatives differed for different subjects. The procedure differed from that of Experiment 3 in three additional ways. In the first place, trial-run data were not used to potentially dismiss subjects. Second, a consummatory response, described in the instructions below, was employed since it sometimes increases subjects' sensitivity to experimental contingencies (e.g., Matthews,

Shimoff, Catania, & Sagvolden, 1977). Finally, the instructions differed to reflect the presence and function of the third lever. In particular, "two levers" was replaced with "three levers," the original levers were referred to as "side levers," and the instructions regarding the green light and center lever were as follows:

The green light will turn on when you obtain a point. Press the center lever once when the green light comes on in order to acknowledge that you got it. This press on the center lever will also cause the green light to turn off and the counter in front of you to increment. The counter shows the number of points that have accumulated so far. Remember, these points are worth 10 cents each.

RESULTS AND DISCUSSION

Accuracy in answering questionnaires and absolute and relative rates of observing were generally comparable to results of prior studies that employed one session per condition. These data are shown in Figure 5 for each subject and session of Experiment 4. The questionnaire results summarized in the bottom panels illustrate the decrease in frequency of incorrect answers that occurred over sessions. All subjects answered at least one item incorrectly and all were perfectly accurate over several sessions before testing ended.

The pattern of absolute rate of observing over sessions was distinctly different for each subject (middle panels of Figure 5). However, within-subject variability in this measure was small by the end of testing in three out of four cases (i.e., Subjects 2, 3, and 4). The absolute rate of observing of one subject (Subject 4) decreased systematically over the first few sessions. The other variability in absolute rates of observing did not appear systematic.

Of greatest interest is how the relative rate of observing the stimulus correlated with EXT varied with time in the procedure (top panels of Figure 5). As can be seen, there was no tendency for subjects to prefer S— more over time. Mean preference for S— averaged over the last two, three, or four sessions was always less than mean preference over the first two, three, or four sessions. The mean choice proportion for the stimulus correlated with EXT was .21 in the first session and .22 in the last session. The mean choice proportion was .23 averaged over

Fig. 5. Individual choice proportions, rate of total observing, and number of questionnaire items answered incorrectly in Experiment 4. Preference was calculated with respect to the stimulus correlated with EXT (relative to the stimulus uncorrelated with reinforcement). The unfilled circles in the bottom panels are the results of the questionnaire administered following a 10-min trial run in the procedure; all other results are from full sessions of observing. Subjects 1 and 2 were studied in single sessions per day, and Subjects 3 and 4 were studied in three sessions per day.

all nine sessions and .17 averaged over the last three sessions. Only the preference of Subject 1 did not appear stable by the end of training. Meaningful differences in preference depending upon whether subjects were studied in 1 (i.e., Subjects 1 and 2) or 3 (i.e., Subjects 3 and 4) sessions per day were not apparent.

As in Experiment 3, subjects' choice proportions were assessed during the first 10-min trial run. Preference for the uncorrelated stimulus was evident for only one of four subjects in this first exposure to the procedure. In particular, choice proportions for Subjects 1 to 4, expressed in terms of the stimulus correlated with EXT, were .56, .05, .54, and .48, respectively. Comparable choice proportions in the immediately following full sessions were .20, .00, .44, .20. Thus, for each subject preference for the stimulus correlated with EXT declined

from the trial run to the first session (the mean choice proportion changed from .41 to .21).

GENERAL DISCUSSION

The present experiments assess the conditioned-reinforcement hypothesis of observing in humans. One version of this hypothesis, the delay-reduction hypothesis, requires that observing be maintained only by stimuli correlated with a reduction in time to reinforcement (e.g., Case & Fantino, 1981; Fantino, 1969, 1977). In the present experiments the mean waiting time to reinforcement correlated with the mixed stimulus was 120 sec, whereas the mean waiting time correlated with the S+ was only 60 sec. Thus, the S+ was correlated with a reduction in waiting time to reinforcement and should have reinforced observing. On the

other hand, the S— was correlated with an increase in waiting time and should not have maintained observing (when compared with either the S+ or a stimulus uncorrelated with waiting time). Comparable predictions are made by the other version of the conditioned-reinforcement hypothesis, the reinforcement-density hypothesis. See Fantino (1977), Case (1981), or Case and Fantino (1981) for a discussion of the two versions. The present experiments assessed these predictions in a choice procedure.

The critical comparison in all four experiments involved choice for the S— vs. the stimulus uncorrelated with the schedules in effect. According to the conditioned-reinforcement hypothesis, the S— is paired with EXT and should not be preferred. According to the uncertainty-reduction hypothesis, however, the informative S— should be preferred to the uninformative uncorrelated stimulus. 19 of 22 subjects in Experiments 1 to 3 preferred the uncorrelated stimulus (mean choice proportion .70), a result clearly inconsistent with the uncertainty-reduction hypothesis. This result and those of two other comparisons are consistent with the conditioned-reinforcement hypothesis: 21 of 22 subjects preferred S+ to S— (mean choice proportion, .73); 7 of 8 subjects preferred S+ to the uncorrelated stimulus (the eighth subject's choice proportion was .50; the mean of the 8 was .56). Finally, in the baseline conditions, subjects' choice proportions tended to be close to .50 (mean choice proportion of .49 for one lever).

A strong case for conditioned reinforcement, as opposed to uncertainty reduction, would require that the absolute rate of observing maintained by a stimulus be an increasing function of the rate of reinforcement associated with it. In order to test this requirement, the mean rates maintained by the S+, uncorrelated, and S— stimuli were calculated for each subject of Experiments 1 to 3. The mean rates of observing maintained by the S+, uncorrelated, and S— stimuli were 65, 45, and 26 responses per minute, respectively, averaged over all 22 subjects. Pairwise within-subjects analyses of variance were conducted and they revealed that significantly greater absolute rates were maintained by S+ than by S— ($F[1,21] = 7.5, p < .05$) and by S+ than by an uncorrelated stimulus ($F[1,21] = 9.5, p < .01$). However, significantly greater rates of observ-

ing were not maintained by an uncorrelated stimulus than by S— ($F[1,21] = 3.2, p < 0.1$), in contrast to the choice data. Although it remains the case that the uncertainty-reduction hypothesis finds no support in the present data, whether one considers choice or absolute rate of observing, the latter result does not support one strong prediction of the conditioned-reinforcement hypothesis. This anomalous result depends upon the data of the first subject of Experiment 3, who claimed that the lever that produced the stimulus correlated with EXT actually produced the stimulus correlated with the VT schedule. When his data are excluded the difference in mean rate becomes significant: means of 44 vs. 19 responses per min, $F(1,20) = 7.3, p < .05$. It should be noted also that behavioral analysts have long recognized that choice is a more sensitive measure than absolute rate (Nevin, 1973), and that most choice experiments using animal subjects omit analysis of absolute rates.

The 22 subjects in the first three experiments were each exposed to one session of each of three conditions. All four subjects in Experiment 4, exposed to nine sessions of the choice between S— and the stimulus uncorrelated with the schedules in effect, preferred the uncorrelated stimulus (choice proportions averaged over all nine sessions were .62, 1.00, .56, and .91 for Subjects 1 to 4, respectively, expressed in terms of the uncorrelated stimulus). Thus, the preferences obtained in Experiments 1 to 3 do not appear dependent on the use of a single session per condition.

Is there any evidence that preference changed within the first session? If not, one might argue that the obtained preference somehow reflected the subjects' response to the instructions rather than to the experimental contingencies encountered. The results from Experiments 3 and 4, however, show that preferences were generally not manifest in the 10-min "trial-run" period. Thus, it was the subjects' additional experience with the procedure that led to the consistent preferences obtained.

The issue of instructional control is an important and complex one in the study of human behavior. In designing the present experiments, we considered two general strategies: the use of minimal instructions and the use of instructions that are as explicit as possible. Because the research of Baron, Kaufman, and Stauber (1969) and Shimoff, Catania, and Mat-

thews (1981) and others suggests that humans come to be insensitive to operant contingencies in lever-pressing tasks under minimal instructions, we chose the latter strategy. The fact that the instructions were quite explicit, especially in Experiments 2 to 4, does not, however, guarantee that subjects understood them nor that subjects' responding was even partially controlled by the contingencies. The results of our questioning, however, suggest that subjects did understand the instructions. The orderly preference results plus the change in preference across the session (Experiments 3 and 4) suggest that the contingencies were effective. Moreover, instructions were varied, albeit not dramatically, across the first three experiments without affecting the basic results. It is likely, therefore, that whatever role was played by instructions, the subjects' experience with the experimental contingencies also affected their responding.

A related important and complex issue in the study of human behavior is that of superstitious responding. In the present experiments the argument could be made that subjects were responding in the erroneous belief that responding was necessary for obtaining points. Although this argument may never be put entirely to rest in any experiment, in the present experiments any such superstitious responding would have occurred despite explicit instructions, demonstrations, contingencies, and subjects' verbalizations to the contrary. In any event results from each of the present experiments support those obtained with pigeons in a number of studies by suggesting that the conditioned-reinforcement hypothesis accounts for observing. As with pigeons, human observing behavior is not maintained by uncertainty reduction, at least as assessed by the present experiments.

There may, of course, be conditions under which uncertainty reduction might reinforce observing, even when such uncertainty reduction does not permit more efficient responding. Schaub (1969) originally raised the possibility that the reinforcing effect of a cue could be a combination of associative and informational factors. There is no evidence that informational factors control responding in the present studies. Indeed, a review of prior studies that have been so construed also fails to specify conditions under which uncertainty reduction acts as a reinforcer. For example, although Green

and Rachlin (1977) concluded that their data argue against the adequacy of quantitative formulations of the uncertainty-reduction hypothesis (Shannon & Weaver, 1949; Wilton & Clements, 1971), they suggested that S- may nonetheless reinforce observing in qualitative agreement with the hypothesis if interim responding during EXT is made sufficiently valuable relative to responding maintained by food. They proposed that manipulations such as increasing chamber size or decreasing food deprivation might increase the ability of S- to reinforce observing but reported no data relevant to these predictions. Moreover, the preference for the informative alternative that Green and Rachlin found in their choice procedure is in qualitative agreement with similar studies (see review by Fantino, 1977) and with the conditioned-reinforcement hypothesis. In each case the contribution of producing S- to the maintenance of observing was not assessed independently, and the same response that produced S- and was maintained relative to control stimuli also always produced S+ occasionally. These same considerations and others apply to an experiment by Catania (1975, Experiment 3), who studied pigeons' preference using an unconventional concurrent-chains schedule in which each of two mutually exclusive terminal links contained two illuminated response keys. In one terminal link (informative alternative), the keys were different colors (e.g., red and green) and were consistently associated with FI and EXT schedules. The two keys in the other terminal link (uninformative alternative) were identical (e.g., both blue). Upon entry into this terminal link the same FI schedule was assigned randomly to one of the keys and EXT was assigned to the other. In the first place this study did not assess independently the contribution of S- to the preference for the informative alternative. In the second place the procedure encouraged the possibility that the informative alternative allowed more efficient distribution of responding that produced reinforcement, that is, subjects were required to distribute their responses between both keys in the uninformative terminal link in order to obtain all the scheduled reinforcement, whereas only one key needed to be pecked in the informative terminal link.

Perone and Baron (1980) found that humans' observing was maintained by production of an S- as well as by an S+. One interpreta-

tion of their results stipulates that uncertainty reduction reinforces observing in humans. As noted in the Introduction, however, a second interpretation of their results stresses the fact that production of the S+ and S- permitted subjects to emit a lower proportion of effortful responses. Perone and Baron attempted to refute this argument with data from their second experiment by noting that for two of their three subjects (GC and BJ, but not RV) total work and work per reinforcer were not lower in the observing condition than in a control condition in which stimuli were uncorrelated with the plunger requirement. Not only is this counter-argument marginal for one of the two subjects (their Table 3 shows that BJ as well as RV emitted less total work and work per reinforcer in the observing condition), but also these measures may be misleading owing to a contrast-like effect in the data for Subjects GC and BJ. Specifically, for both subjects substantially more of the less-effortful (5-lb) pulls were made in the observing condition, thereby contributing to the work measures (182 vs. 94 less-effortful responses for GC and 384 vs. 85 less-effortful responses for BJ in the observing and uncorrelated conditions, respectively). When different, and we believe more appropriate, measures are used, the argument that the observing stimuli affected the distribution of effortful responses is supported. First of all, two of three subjects made fewer 15-lb plunger pulls when observing was effective than in the control condition (509 vs. 1016 for RV, 314 vs. 539 for BJ, comparing "observing" and "uncorrelated" rows in Table 3). More importantly, when the proportion of less-effortful responses made in each condition is derived from the data, results from all three subjects support the argument that the observing stimuli permitted a less-effortful distribution of responding. The proportion of 5-lb pulls (as opposed to 15-lb pulls) increased by an average of .23 in the observing condition compared to the uncorrelated condition (from .44 to .57 for RV; from .34 to .49 for GC; from .14 to .55 for BJ; from .31 to .54 for the mean of the three subjects). So far as we know, all would agree that uncertainty reduction that provides discriminative stimuli for more efficient responding should maintain observing. A less ambiguous test of the proposition that information about negative events (i.e., production of the S-) is reinforcing would involve response-in-

dependent reinforcement. In that case production of the observing stimuli could affect the rate or distribution of neither reinforcement nor responding required for reinforcement. The present experiments provided such a test and provided no support for the uncertainty-reduction hypothesis.

In an ostensible exception to the present analysis, studies using pigeons as subjects in response-dependent reinforcement procedures have found consistently that S- will not maintain observing. In each of these studies, however, unlike that of Perone and Baron, the reinforcement lever was not significantly more difficult to operate than the observing lever(s). Response efficiency therefore could not have been increased much (if at all) by observing S-. Furthermore, whether arranging the contingencies identically will produce similar effects in pigeons is an open question (currently being pursued in our laboratory) for at least two reasons. First, the level of deprivation typically required in order to control pigeons' behavior may make S- more punishing than it was for adults earning money, irrespective of efficiency considerations. Second, there may well be phylogenetic differences in the potential utility of observing S- in pigeons and humans. Based on the data in this and prior research, however, there is little reason to expect support for the uncertainty-reduction hypothesis. Most of the data in pigeons and humans are consistent with the conditioned-reinforcement hypothesis: Stimuli correlated with reinforcement maintain observing, but stimuli correlated with the absence of reinforcement do not.

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