Acquisition and extinction of the observing response as a function of stimulus predictive validity*

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In a Prokasy-type E-maze with rat Ss, the predictive validity of discriminative stimuli was varied between .50 and 1.00. Both the observing response and the discrimination were acquired as a positive function of the predictive validity of the stimuli. Although breakdown of the discrimination was seen in the extinction phase, no reduction in the tendency to make the observing response occurred.

The observing response (Ro) has been defined as a response which results in S's exposure to discriminative stimuli, but does not change reinforcement probabilities (Wyckoff, 1952; Prokasy, 1956). Since Wyckoff's demonstration that Ro could be measured independently of reinforcement-producing responses, it has been recognized that Ro must play an important part in discussion of discrimination learning (Bower, McLean, & Meacham, 1966). Recent theoretical discussions have either postulated Ro as an important attentional variable in the overlearning reversal effect (Uhl, Parker, & Wooton, 1967), a possible variable in the attention process (Lovejoy, 1968), or have dismissed Ro as playing no important part in the attention process (Mackintosh, 1965). In order to fit Ro into a discussion such as Lovejoy's, it is necessary to predict the rates of acquisition and extinction of Ro tendencies. The present study is an attempt to identify one of the parameters affecting such rates.

SUBJECTS AND APPARATUS

Forty male albino rats between 90 and 120 days of age were maintained on a 23-h food-deprivation schedule with 12 g of food per day. The apparatus consisted of an E-maze whose end arms terminated in removable delay chamber-goalbox units and has been described elsewhere (Prokasy, 1956). It differed from that described by Prokasy in two respects: the noninformative side ended in a gray delay chamber-goalbox unit, while the informative side ended in either a black or white unit on a given trial, and all floors in the present maze were smooth.

PROCEDURE

Each S was handled 10 min a day for 5 days, and then allowed 10 min of

free exploration in the maze with the discriminative stimuli absent on each of the next 2 days.

On each day of acquisition and extinction training, each S was given eight free-choice trials followed by eight forced trials to equate experience with the two arms. The Ss were run in squads of four, with an intertrial interval of approximately 5 min. Number of free choices to each side and time from the closing of the choice point door to the closing of the door at the entrance of the delay chamber were recorded. All Ss were delayed 10 sec in a delay chamber on each trial. For a given S, one side, right or left, was designated as the Ro side. On this side, a reward of four 45-mg Noyes pellets occurred on half the trials, and the delay chamber-goalbox unit was either black or white, with

the brightness of the unit correlated with the presence (S+) or absence (S-) of a reward. A gray delay chamber-goalbox unit was on the non-Ro side, and reward occurred there randomly on half the trials. The Ss were assigned randomly to five groups of eight, with Ro side and brightness of S+ counterbalanced within groups. The predictive validity of S+ was defined as the relative frequency of pairings of reward with that stimulus. Five values of predictive validity were chosen: 1.00, .875, .75, .625, and .50. Each value of predictive validity identified one group of Ss. For each group, the predictive validity of S- (relative frequency of pairings of nonreward with that stimulus) was equal to the predictive validity of S+. The sequence of black and white presentations for a given day was determined by the toss of a coin, with the restriction that no more than two consecutive presentations of a stimulus were given. For groups with predictive validity of less than 1.00, trials on which S+ was not rewarded or S- was rewarded were determined by a random-number table. During the extinction phase, reward still occurred on half the trials to each side, but the predictive validity of the discriminative stimuli was .50 for all groups; i.e., the discriminative stimuli lost their discriminative function in extinction. All groups had 14 days of acquisition followed by 7 days of extinction.

RESULTS

The percentage of S's choices of the

Fig. 1. Mean transformed choices to the informative side for all groups during acquisition and extinction.

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Fig. 2. Mean difference in running speed to S+ and S- for all groups during acquisition and extinction.

informative side on free trials was taken as the measure of Ro. Because the within-groups variance decreased with an increase in proportion of choices to the informative side, all percentages were subjected to an arcsin transformation. These transformed percentages comprised the data treated in all analyses of Ro acquisition and extinction. The data were subjected to an analysis of variance for the five groups over the 14 days of acquisition. Figure 1 shows the mean transformed proportion of choices to the informative side for the five groups during acquisition and extinction. The analysis yielded a significant main effect of groups ($F = 19.11$, $df = 4/35$, $p < .005$), a significant main effect of days ($F = 19.66$, $df = 13/455$, $p < .005$), and a significant Days by Groups interaction ($F = 1.38$, $df = 52/455$, $p < .025$). These results indicate that groups differed in choices of the informative side as a function of the predictive validity of the stimuli, that Ss made a greater proportion of choices to the informative side as a function of training, and that the groups were affected differently by training, with groups showing a faster increase in proportion of choices to the information side throughout training as a function of the predictive validity of stimuli, with Group .50 exhibiting little or no systematic increase in choices to the informative side. A separate analysis was done over the last 3 days of acquisition and yielded only a significant main effect

of groups ($F = 16.71$, $df = 4/35$, $p < .005$). This shows that groups differed in terminal acquisition of Ro as a positive function of the predictive validity of the stimuli. The lack of significant effect of days, together with the lack of a significant Days by Groups interaction indicates that the groups showed no tendency to change their level of choice during the last 3 days of acquisition.

An analysis of the choice measure for the five groups over the 7 days of extinction had only a significant effect of groups ($F = 18.78$, $df = 4/35$, $p < .005$). A *t* test between the last day of extinction and the last day of acquisition was performed for each group. None of these *t* tests approached significance. Together with the lack of significant effect of days and the lack of a significant Days by Groups interaction, these tests show that the groups showed no evidence of a decreasing proportion of choices to the informative side in extinction.

The difference in the mean running speeds to S+ and S- for the four trials to each was taken as the daily measure of discrimination. The reciprocal of the mean latencies to each stimulus comprised the running speeds. The data for the five groups were subjected to an analysis of variance over the 14 days of acquisition. Figure 2 shows the mean difference in running speed to S+ and S- across the 14 days of acquisition and the 7 days of extinction.

The analysis showed a significant

main effect of groups ($F = 19.56$, $df = 4/35$, $p < .005$), a significant main effect of days ($F = 77.50$, $df = 13/455$, $p < .005$), and a significant Days by Groups interaction ($F = 8.71$, $df = 52/455$, $p < .005$). These results show that groups differed in discrimination as a function of the predictive validity of the stimuli, except for Groups 1.00 and .875, which were not appreciably different from each other; that all groups but Group .50 exhibited increased discrimination with training; and that groups were affected differently by training, with a general tendency toward faster discrimination as a function of stimulus predictive validity. A separate analysis over the last 3 days of acquisition showed only a significant main effect of groups ($F = 1285.0$, $df = 4/35$, $p < .005$), indicating that groups differed in terminal discrimination as a positive function of predictive validity, except for Groups 1.00 and .875, which did not differ. The lack of either a significant effect of days or a significant Days by Groups interaction shows that the groups exhibited no significant change in discrimination over the last 3 days of acquisition.

The data for extinction days were subjected to an analysis of variance for the five groups across the 7 days. The analysis showed a significant main effect of groups ($F = 16.56$, $df = 4/35$, $p < .005$), a significant effect of days ($F = 17.94$, $df = 6/210$, $p < .005$), and a significant Days by Groups interaction ($F = 2.28$, $df = 24/210$, $p < .005$). This indicates that discrimination decreased as a function of extinction, although groups differed in their rate of decrease and in mean discrimination. A *t* test between the last day of extinction and the last day of acquisition was performed for each group. For all groups $df = 7$, and the results were: Group 1.00, $t = 3.61$, $p < .01$; Group .875, $t = 6.19$, $p < .01$; Group .75, $t = 8.96$, $p < .01$; Group .625, $t = 2.72$, $p < .05$; and Group .50, $t = .303$, $p < .50$. The analysis of variance and the *t* test together show that discrimination weakened during extinction, except for Group .50, which showed no tendency to change discrimination level during either acquisition or extinction.

DISCUSSION

The results shown by the choice measure during acquisition are in line with the findings of Atkinson (1961). The greater the predictive validity of the discriminative stimuli available after an occurrence of Ro, the higher is the probability that Ro will occur. It should be noted that in the procedures used by Atkinson, making Ro not only resulted in exposure to discriminative stimuli, but also allowed a greater

probability of reinforcement following the effective response. In the present study, making Ro did not change the reinforcement probabilities, but only exposed S to the stimuli. The results also agreed with Wyckoff's (1952) prediction that Ro formation and the learning of a discrimination must proceed at a common rate so that the greater the discrimination exhibited, the higher the probability of the occurrence of Ro.

The results of the extinction phase of the present experiment disagree with Wyckoff's original analysis. When the discriminative stimuli lost their discriminative function, discrimination broke down, as shown by Fig. 2, above, but the probability of occurrence of Ro remained at its previous (acquisition phase) level. This finding agrees with the results of Kelleher (1958), although he had used only predictive validities of 1.00 in acquisition.

Mackintosh & Holgate (1968) have shown that animals trained on an inconsistently rewarded discrimination (75:25, or directly comparable to Group .75 in the present study) reversed more slowly than those trained on a consistently rewarded discrimination (100:0, or directly comparable to Group 1.00). They report terminal choices of the 100:0 animals as 98.6% to 100% and terminal correct choices of the 75:25 animals as 84.8% to 91.2%. In the present study, Group 1.00 reached a terminal level of 98.7% and Group .75 reached a terminal level of 90% choices of the Ro side. Mackintosh and Holgate explained the faster reversal of the 100:0 group as resulting from a higher probability of attending to the relevant cue at the end of acquisition rather than in terms of a partial reinforcement effect, causing

slower extinction of old response tendencies for the 75:25 group. The findings of the present study agree with their analysis.

It would seem, then, that Ro might fruitfully be considered as an alternative for "stimulus analyzer" or "attentional process" in discussions of the overlearning reversal effect. Ro seems to behave in the same way as such intervening variables are thought to behave (Lovejoy, 1968), but is amenable to experimental manipulation and direct measurement and control.

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the subject of some controversy (Freedman, 1968; Held & Gottlieb, 1958; Taub, 1968). The traditional concepts of reinforcement are challenged by human studies in which actively produced head or body motion within an optically displaced random patterned environment appeared to be the sole necessary antecedent to the development of postprism aftereffects (Held & Rekosh, 1963).

In lower animals such as domestic fowl, this question has not been raised, possibly because of the widespread belief that prism adaptation does not occur in submammalian organisms. However, adaptation to displacing prisms has been clearly demonstrated in domestic fowl (Rossi, 1967, 1968, 1969). It is tempting to assume that such adaptation represents a kind of behavioral shaping contingent on the food reinforcement received. On the other hand, it is equally possible that the chick is demonstrating a general adaptation to its visually displaced environment, which depends primarily on the informative feedback resulting from his entire behavioral pattern. The necessity for food reinforcement would thus be irrelevant to prism compensation in such a lower animal.

The purpose of the present experiment was to determine if adaptation to lateral optical displacement in domestic fowl could be demonstrated in the absence of food reinforcement for pecking responses.

METHOD

Seventy-four newly hatched White Leghorn cockrels (H-56 Stone) were fitted with latex hoods containing binocularly mounted 8.5-deg (15-diopter) prisms. Half were given base-left oriented prisms; half were given base-right oriented prisms. A nonhooded "starter" chick was added to initiate normal interchick social pecking responses, etc. All chicks, including starters, were force-fed by eye dropper a mixture of liquified parakeet seed and water. All chicks had ad lib access to additional water in the rearing cages.

All hooded chicks were tested for pecking accuracy on Days 4 and 7 using Plast-i-clay panels containing single center-mounted parakeet seeds. At the conclusion of the Day 7 tests, the prism hoods were exchanged for matched control hoods containing 0-deg clear blank plates. The Ss again were tested for pecking accuracy.

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Prism-induced negative aftereffects without food-reinforced feedback in newly hatched chicks*

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Newly hatched chicks wearing hoods containing 8.5-deg prisms were force-fed a diet of liquified seeds. On the seventh day, the prism hoods were changed to 0-deg control hoods, and those chicks that pecked demonstrated significant negative aftereffects. Since the majority of the group did not peck at seed targets, a subgroup was given 3 additional days of exposure to solid seeds while wearing 8.5-deg prisms. This sample also demonstrated significant negative aftereffects. It was argued that, while passive feeding leads to later failure to recognize or prefer solid-food targets, it did not interfere with negative aftereffect development.

The relative contributions of perceptual information processing and

primary reinforcement to prism adaptation in human vision has been