Discriminative performance by three species of monkeys as a function of trial 1 reward contingency, intertrial interval, and prior test experience¹

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Four naive rhesus, 4 naive stump-tailed, and 6 sophisticated squirrel monkeys received 7-trial object discrimination problems in which a single object was presented as rewarded or nonrewarded on Trial 1. The second trial with 2 objects followed after an intertrial interval (ITI) of either 10, 30, 60, 90, 120, or 150 sec., and the remaining 2-object trials were presented with a constant 10-sec. ITI. In all 3 species and with all ITI's the nonrewarded Trial 1 condition resulted in markedly better Trial 2 performance than did the rewarded Trial 1 condition; the effect was attenuated on subsequent trials. All species showed a monotonic decline in performance as a function of ITI's.

Harlow (1959) reported an experiment in which test sophisticated rhesus monkeys were given a single rewarded or a single nonrewarded object on Trial 1, an intertrial interval (ITI) of either 5, 10 or 20 sec., and a standard 2-object Trial 2 condition. Although Harlow observed no systematic differences in performance following the various delay intervals, the relative superiority of Trial 2 performance after a nonrewarded trial remained constant at all delay intervals. The tendency for monkeys to make fewer errors if the Trial 1 object is nonrewarded than if it is rewarded, usually identified as the Moss-Harlow effect (1947), has been repeatedly demonstrated (e.g., Harlow & Hicks, 1957; Leary, 1956; Fletcher & Cross, 1964).

Fletcher & Cross (1964) tested both relatively naive and test-sophisticated rhesus monkeys on discrimination problems involving a single stimulus, rewarded or nonrewarded, on Trial 1 followed by delays of 5 or 30 sec. and 6 subsequent trials with a constant 5-sec. ITI. Superior Trial 2 performance was observed following the nonrewarded Trial 1 responses by sophisticated Ss. Trial 2 performance of relatively naive Ss following a nonrewarded Trial 1 response was also superior to performance following rewarded Trial 1 response but only so long as a short ITI (5 sec.) intervened between the 2 trials. Fletcher & Cross (1964) argued that during a 30-sec. ITI the inhibition associated with an incorrect Trial 1 dissipates to the extent that the probability of a correct response on Trial 2 is not different from chance, but that a 5-sec. ITI is too short for effective dissipation of the tendency.

The present research investigated more completely the described effects of reward contingency and ITI in experimentally naive rhesus, naive stump-tailed, and sophisticated squirrel monkeys.

Method

Four experimentally naive, female rhesus (*Macaca mulatta*) and 4 naive, male stump-tailed monkeys (*Macaca speciosa*) from the University of Wisconsin Primate Laboratory and 6 test-sophisticated, male squirrel monkeys (*Saimiri sciurea*) from the Oklahoma State University Laboratory were employed as Ss. The latter Ss had been used in 2 previous studies of discrimination reversal learning (Cross & Brown, 1965; Cross, Flickling, Carpenter & Brown, 1964).

A standard WGTA with a 3-foodwell formboard was employed for the rhesus and stump-tailed monkeys. The squirrel monkeys were tested in a smaller version of the WGTA (for details, see Cross & Brown, 1965). Multidimensional junk objects served as stimuli.

Naive Ss were first trained to displace a gray block covering a center foodwell to obtain a raisin reward. After pretraining, all Ss received the same experimental procedure. Each day's testing consisted of six 7-trial problems. The set of 12 noncorrection problems presented in each 2-day period (a replication) consisted of a factorial combination of the 2-Trial 1 reward conditions and 6 ITI's. Problem order within each replication was randomized for each S independently, and all Ss received 12 replications of each problem (24 test days).

On Trial 1 a single object was presented in the center position, and the foodwell was baited on rewarded trials and empty on nonrewarded. This single-object Trial 1 was followed by either a 10-, 30-, 60-, 90-, 120-, or a 150-sec. delay before presentation of Trial 2. A 10-sec. ITI intervened between all subsequent trials. On trials 2 through 7 the Trial 1 object and a new object were placed over the peripheral foodwells according to a balanced random series, and the reward value of the Trial 1 object was maintained. Interproblem interval was 60 sec. Currants were used as rewards for squirrel monkeys and raisins for rhesus and stump-tailed Ss.

Results and Discussion

For all species and at all ITI's, Trial 2 performance (Fig. 1) following a nonrewarded Trial 1 response was consistently superior to performance following a Trial 1 rewarded response. The data in Fig. 2 show that the effect was largely restricted to Trial 2. Thus the effect obtained previously with sophisticated rhesus monkeys (Moss & Harlow, 1947; Fletcher & Cross, 1964) is obtained also with naive rhesus, naive stump-tailed, and sophisticated squirrel monkeys.

Fig. 1. Mean percentage correct responses for all species following rewarded and nonrewarded single objects on Trial 1 as a function of intertrial interval between Trials 1 and 2.

The number of correct responses on Trial 2 were subjected to a 3-factor repeated measures analysis of variance (Reward Contingency, ITI, Species). The main effect of Reward Contingency was significant ($p < .001$), as was ITI ($p < .01$). In a further 3-factor analysis of variance (Reward Contingency, Trials, Species) performed on Trials 2-7 data, Reward Contin-

Fig. 2. Mean intraproblem performance following a single object, rewarded or nonrewarded, on Trial 1 for all species.

gency ($p < .001$), Trials ($p < .001$) and Reward Contingency by Trials ($p < .001$) were significant effects. Neither the Trial 2 nor Trials 2-7 analysis revealed a significant effect of Species or Species by Reward Contingency interaction. Thus the effects of reward contingency and ITI were highly similar in all species.

Combined Trial 2 performance of all species (i.e., mean of species data in Fig. 1) following a rewarded Trial 1 did not differ significantly from chance even after a 10-sec. ITI. However, Trial 2 performance following a nonrewarded Trial 1 (significantly different from chance even at the lowest point, $p < .001$ for 120-sec. ITI) declined monotonically as a function of ITI's (Page's $L = 1098$, $p < .01$). A cursory examination of Fig. 1, however, suggests that the most pronounced decrement occurred after ITI's of 10 to 60 sec. Contrary to the results of Fletcher & Cross (1964), Trial 2 performance following a nonrewarded Trial 1 did not drop to chance even after a 150-sec ITI.

In spite of differences in species, sex, previous test experience, and apparatus, the findings reported here give strong added support regarding differential effects of Trial 1 reward contingency. Further support for an inhibitory mechanism of learning (Harlow & Hicks, 1957) is provided by the obtained decay, with merely the passage of time, of the inhibitory tendency associated with a nonrewarded response.

References

- Cross, H. A., & Brown, L. T. Discrimination reversal learning in squirrel monkeys as a function of acquisition trials. *J. comp. physiol. Psychol.*, 1965, in press.
- Cross, H. A., Fickling, R. M., Carpenter, J. B., & Brown, L. T. Discrimination reversal performance in squirrel monkeys as a function of prereversal experience and overlearning. *Psychon. Sci.*, 1964, 1, 353-354.
- Fletcher, H. J., & Cross, H. A. Effects of Trial 1 reward contingency, intertrial interval, and experience in intraproblem discrimination performance of monkeys. *J. comp. physiol. Psychol.*, 1964, 57, 318-320.
- Harlow, H. F., & Hicks, L. H. Discrimination learning theory: uniprocess vs. duoprocess. *Psychol. Rev.*, 1957, 64, 104-190.
- Harlow, H. F. Learning set and error factor theory. In S. Koch (Ed.), *Psychology: a study of a science*. Vol. 2. New York: McGraw-Hill, 1959. Pp. 429-537.
- Leary, R. W. The rewarded, the unrewarded, the chosen and the unchosen. *Psychol. Rep.*, 1956, 2, 91-97.
- Moss, E. M., & Harlow, H. F. The role of reward in discrimination learning in monkeys. *J. comp. physiol. Psychol.*, 1947, 40, 333, 342.
- Page, E. B. Ordered hypotheses for multiple treatments: a significance test for linear ranks. *J. Amer. Statist. Assoc.*, 1963, 58, 216-230.

Note

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