Effects of magnitude of reinforcement in *Macaca speciosa*¹

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Four adolescent stumptail monkeys were subjected to repeated shifts in magnitude of reinforcement (1, 3, or 9 pellets) while performing on a free-operant variable-interval reinforcement schedule. Rate-magnitude functions were found to be similar to those obtained with other primate and subprimate species.

The present study was undertaken to determine whether the stumptail macaque (*M. speciosa*), an Old World monkey species rapidly becoming well-known for its tameness and adaptability to behavioral test situations, exhibits a relation between instrumental performance and magnitude of reinforcement that is similar to that observed in rhesus monkeys (e.g. Schrier, 1965) and in subprimates (reviewed by Pubols, 1960). A secondary interest was to study the effects of adding external cues correlated with varying reward magnitude levels.

Method

Four adolescent female stumptail monkeys having a history of fixed-ratio, variable-ratio, and fixed-interval training were tested on a VI 1 (variable-interval of 1 min.) schedule in a Lehigh Valley 1469 test chamber. The chamber was equipped with a single (right-hand) lever, a 3-color cue light over the lever, and a dispenser for delivering 45-mg sucrose pellets. The experiment was automatically programmed such that reinforcing events could consist of from 1 to 9 pellets, delivered at the rate of approximately 4/sec.

Following stabilization of baseline lever responding reinforced by a single pellet (Phase 1), each S was exposed to daily shifts in reinforcement magnitude, between 1 and 9 pellets (2 Ss) or 1 and 3 pellets (2 Ss) for 12 sessions (Phase 2) and among 1-, 3-, and 9-pellet levels for an additional 18 sessions (Phase 3). In Phase 4, 18 more sessions like those of Phase 3 were given, except that each of the three magnitude levels was associated with a particular cue-light color (red, green, or white) flashing at a 10/sec. rate throughout the session. Sessions were 35 min. long in these four phases.

Phase 5 consisted of 12 34-min. sessions, in each of which there were three 10-min. "baseline" periods separated by two 2-min. "probes." In the baseline periods the usual VI 1 conditions and cues-magnitude correlation prevailed, with daily shifts as in Phase 4. The probes consisted of nonreinforced presentations of the two cue-light colors not associated with the baseline magnitude of a given session. Thus, for example, a given session could consist of 10 min. of VI baseline

responding under "green" reinforced by 3 pellets, followed by 2 min. of "white" (normally associated with 1 pellet), followed by a return to the baseline for 10 min., followed by 2 min. of "red" (normally associated with 9 pellets), followed by a second return to the baseline for the final 10 min. of the session. On a different day the same S could have "white, 1-pellet" baseline conditions and "red" and "green" nonreinforced probes.

Results and Discussion

Individual plots of lever-pressing rate as a function of reward magnitude in the last 30 min. sessions of Phases 3 and 4 showed, in general, the negatively accelerated function typical of magnitude studies with other species. In Phase 4 (cues added) the function also tended to appear consistently within the first 5 min. of the sessions whereas this was not the case in Phase 3 (no cues); this difference failed to attain statistical significance, however.

Group-average rate measures plotted as a function of successive periods within sessions in Phases 3-5 showed rate declines similar to those obtained by Schrier (1965, Fig. 3) for rhesus monkeys reinforced on VI 30" by varying concentrations of liquid sucrose, and there was further agreement with Schrier's data in that the amount of decline tended to be inversely related to reward magnitude. Individual plots, however, showed pronounced declines for two Ss (49 and 57) and no decline for the other two.

The data obtained in Phase 5 (cues and probes) are summarized in Fig. 1. In this figure the mean lever-pressing rates in the VI baseline periods (4 sessions and 3 10-min. periods within sessions combined for each point) are depicted by the larger symbols connected by heavy solid lines. These baseline values were similar to the rate measures obtained in Phases 2 and 3 so that this portion of Fig. 1 may be regarded as representative of the individual rate-magnitude functions found in the experiment as a whole. Analysis of variance applied to the Phase 5 data revealed a significant main effect of reward magnitude ($F=9.09$, $df=2/6$, $p<.05$).

The rate measures obtained in the 2-min. probe periods of Phase 5 are represented in Fig. 1 by the smaller symbols, with arrows indicating the baseline conditions surrounding a given probe. All 4 Ss showed response rates under probe stimuli associated with 1 and 3 pellets on 9-pellet baseline days that were higher than the baseline rates on 1- and 3-pellet days. Moreover, 3 of the 4 Ss, when given a probe stimulus associated

Fig. 1. Response rates of the 4 Ss in VI-reinforced baseline periods (larger symbols with solid connecting lines) and unreinforced probe-stimulus periods (smaller symbols) during Phase 5.

with 1 pellet on 9-pellet baseline days, displayed higher response rates during the probe stimulus than during the immediately adjacent baseline periods. This finding held up when the comparison was made with those portions of the baseline periods in which reinforcement setups occurred 2 or more minutes apart (such intervals occurred 3 times in every 20 min. of the VI tape). In other words, on 9-pellet baseline days the Ss tended to increase their rates above normal levels when given probe stimuli signifying smaller reward magnitudes, and did so to an extent which suggests that performance in the presence of a probe stimulus was determined by something more (a frustration factor?) than lack of discrimination between baseline and probe stimuli. Although variability in the data rules out support for this phenomenon in the form of statistical significance

and caution is in order, we consider the finding sufficiently interesting to warrant further study.

Because we expected that consummatory time would vary directly with reward magnitude as manipulated in this study, we gave considerable attention to the length of postreinforcement pauses in the cumulative record of lever-pressing and frequently observed consummatory behavior in the test chamber. Typically Ss took all pellets from the food cup within 2 or 3 sec. after delivery, stuffed them into their food pouches, and quickly resumed lever-pressing, such that the difference in postreinforcement pausing between 1-pellet and 9-pellet sessions was too small to warrant correction of rate measures. Squirrel monkeys apparently behave in a quite different fashion under similar circumstances. In an unpublished study (Goodrich, Rhoads, & Davenport) comparing 1-pellet and 4-pellet performance on a free-operant VI 1' schedule, 4 adult female squirrel monkeys exhibited reinforcement pause lengths and qualitative consummatory behaviors that were markedly different for the two reward magnitudes, necessitating supplementary recording and correction of rate measures.

References

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Notes

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2. Now at Macalester College.