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PROGRESSIVE ACQUISITION OF RELEVANT CUES IN VISUAL PATTERN DISCRIMINATION BY MONKEYS[1,2]

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Summary.—Three monkeys, on a self-shaping regimen, learned a 6+ vs 4— simultaneous visual pattern discrimination. The stimuli were projected randomly upon translucent panels at 2 of 16 possible locations for each trial. In tabulating all panel presses during acquisition, it is shown that decreased preference for non-illuminated (blank) panels is attended by an increased preference for *both* the positive *and* the negative stimuli. Criterion-level preference exclusively for the positive stimulus thus does not occur until a markedly increased preference for the negative stimulus is eliminated.

A recent study by Blehert (1966) showed that, in a 5-alternative visual discrimination task (the letter "M" positive; the letters "A," "H," "K," and "N" negative), responses to the 4 incorrect patterns are eliminated in a progressive and mathematically predictable manner. The present experiment confirms this finding and demonstrates, in addition, that this aspect of visual discrimination learning by monkeys may be clearly shown in a 2-alternative task providing that data collected during shaping procedures are not cast away as irrelevant.

METHOD

Three young adult rhesus monkeys *(macaca mulatta)*, naive in laboratory-controlled visual discrimination tasks, were conditioned to discriminate a numeral "6" (positive stimulus) from a numeral "4" (negative stimulus). Although inexperienced in visual learning tasks, each *S* had, during the 3 preceding months, undergone auditory discrimination training (Dewson, 1966). This training involved an entirely separate testing apparatus in which *S* pressed the appropriate one of two levers in response to one of two auditory signals presented via loudspeaker.

The testing appartus used for the present visual discrimination experiments has been described in detail elsewhere (Pribram, *et al.*, 1962). Briefly, *S*'s task was to press one of 16 translucent panels (placed in a 4 × 4 array with a centrally-located food cup) which was illuminated from behind by the positive stimulus and to avoid pressing the single panel upon which the negative stimulus was projected. Additionally, in the present experiment, *S*s had to learn not to press any of the 14 non-illuminated panels ("blanks"); reinforcement, a peanut, could be gained only through response to the positive stimulus. *S*s were essentially on a self-shaping regimen. Presses on either of the two illuminated panels (besides yielding peanut or no peanut, as appropriate) caused a 5-sec. time-out, at the end of which the "6" and the "4" were reprojected at two randomly-programmed locations. Presses on blank panels were recorded but were not accompanied by any programmed contingencies. A press on either of the illuminated panels was counted as a "trial." When *S*s had learned (with reasonable efficiency) to press the illuminated panels

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[2]This experiment was conducted according to the APA statement of "Guiding principles for the humane care and use of animals," December 15, 1962.

in preference to the non-illuminated ones, they were trained for 50 trials per day. Prior to that time, they were run in sessions of approximately one hour's duration, once per day. The entire experiment for each *S* was conducted on consecutive days and was terminated when *S* had achieved 45 correct responses out of 50 trials in 2 consecutive sessions.

Ss were individually housed and maintained on a daily diet of 8 to 12 standard size Purina monkey chow pellets with access to water at all times. They were brought from their home cages to the laboratory for training at the same time each day. Initially, they were habituated to the testing apparatus and shaped to emit a press anywhere on the main display panel; all experimenter-controlled shaping ceased at the event of the first recorded panel press, and the monkey was on his own from then until criterion performance occurred.

RESULTS

The data were evaluated in terms of total presses emitted per *S* over the entire experiment and divided, for convenience, into 16 equal blocks. For each *S*, presses on "blanks," "6s," and "4s" were tabulated and expressed as the per cent

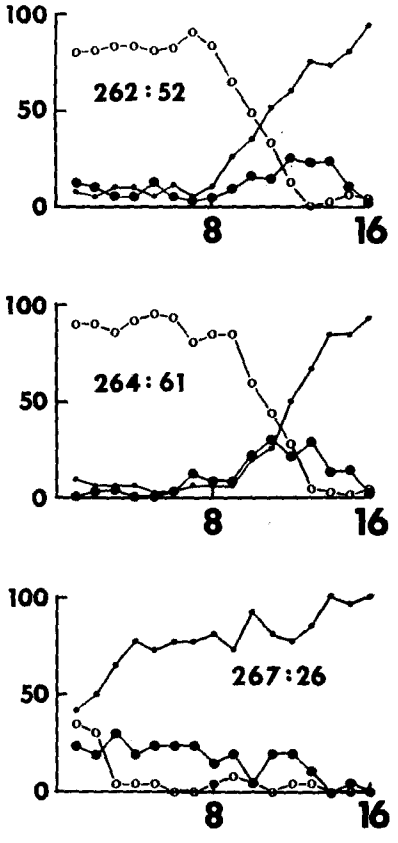

FIG. 1. Visual pattern discrimination acquisition by 3 monkeys. Total number of panel presses for each *S* during learning divided into 16 equal blocks (abscissa) and includes, for this and the following figure, per cent presses per block (ordinate) on: non-illuminated panels (open circles), the panel illuminated with the positive pattern (small filled circles), and the panel illuminated with the negative pattern (large filled circles). Appearing on each graph is *S*'s identification number and also the total number of panel presses per block for that *S*.

of the total number of presses emitted within each block. Total presses for each *S* during acquisition of the discrimination are as follows: Subject 262:832 presses (16 blocks of 52 presses per block); Subject 264:984 presses (16 blocks of 61 presses per block with 8 presses left over); Subject 267:420 presses (16 blocks of 26 presses per block with 4 presses left over). For the present analysis, the presses left over after division of the total by 16 were omitted; they were the final responses of the final session and were exclusively to the positive stimulus. The results are thus presented without special regard to either total number of presses or time needed to acquire the discrimination(s) but rather with regard to the relationships which exist between the various panel-press alternatives available to *S* during learning to criterion levels.

Fig. 1 illustrates the entire course of acquisition of the "6" vs "4" discrimination for each of the 3 *S*s. Note the similarity between the functions of Subject 262 and Subject 264 and also the difference between these 2 *S*s and Subject 267. It should be reiterated that Subject 267 needed approximately one-half the total number of presses required by the others to reach criterion, hence the number of presses per block is accordingly about one-half that of either of the other *S*s.

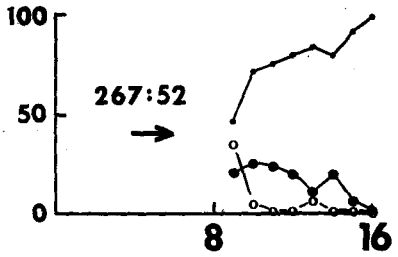

FIG. 2. Visual pattern discrimination acquisition by Subject 267. Data are the same as in the bottom graph of Fig. 1. The total number of panel presses has, in this graph, been compressed into 8 equal blocks of 52 presses each and plotted backwards from criterion. Compare these functions with the latter halves of the functions of Subjects 262 and 264 in Fig. 1.

By collapsing the total number of presses emitted by Subject 267 into 8 blocks of 52 presses each and plotting them as the final 8 blocks leading to criterion, one constructs Fig. 2, which bears striking resemblance to the final halves of the acquisition curves for the other 2 *S*s. It is noteworthy that Subject 267 showed strong preference for illuminated panels during his *initial session*. In collapsing Subject 267's presses to 8 blocks, the number of presses per block has been brought closely into alignment with those of the other 2 *S*s. Further, by displacing Subject 267's scores to the final half of the total period of acquisition, it is seen that the pattern discrimination *per se* is acquired in a similar manner and with a similar number of panel presses by all 3 *S*s.

DISCUSSION

One striking facet of these data, seen clearly in the curves of Subjects 262 and 264, is the relatively prolonged period of equal (and low) preference for the positive *and* the negative illuminated stimuli. This is reminiscent of one of

Blehert's (1966) findings, viz., that in both the 2- and the 5-alternative situations, those cues not yet eliminated are chosen randomly. In this regard, note that at the downward "break-point" on the curve for blank panel presses, preference for *both* positive *and* negative illuminated stimuli increases, although at differing rates. It is not until presses on non-illuminated panels have become stabilized at near-zero levels, however, that the once-increased preference for the negative illuminated stimulus begins its own decline.

Thus, it is demonstrated that in the acquisition of discriminations involving more than one critical element, responses to those elements are not eliminated simultaneously. It is reasonable to assume that the present method of data collection and analysis would prove powerful in assessing effects of brain lesions, pharmacological agents, or severe environmental manipulations upon the process of discrimination learning.

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