Dependent measures of children's discrimination learning¹

KEITH G. SCOTT AND MONICA CHRISTY,¹ CHILDREN'S RESEARCH CENTER, UNIVERSITY OF ILLINOIS, Champaign, Ill. 61820

Using a video camera, scanning, latency, and accuracy measures were obtained during nursery school children's discrimination learning. Similar functions were obtained for both learners and nonlearners.

While there has been much recent interest in attention theories, (Zeaman & House, 1965; Lovejoy, 1966) little research has been conducted attempting peripheral measures of the attention processes to discover their role in discrimination learning. The most informative work in this area was an exploratory study by White & Plum (1964) in which the eye movements of three and one-half to five-year old Ss responding to visual discrimination learning set problems were viewed by a special camera. On "easy" discrimination problems, Ss responded with a greater number of eye movements than on the "hard" problems. When individual learning curves were analyzed, the scanning was shown to be greater for easy problems and to occur at the onset of criterion.

There is some contradiction here for if scanning were positively related to the ease of discrimination learning, then, following criterion, eye movements would be expected to remain at a high level of occurrence and perhaps increase from trial to trial instead of decreasing.

The present study aimed to extend the work of White and Plum by collecting latency as well as scanning and accuracy measures in an attempt to extend their interpretations.

Method

Twenty-five nursery school children served as Ss.

The stimuli used for the learning task consisted of four components: circle, diamond, pink, and brown. The stimuli were rear-projected on to two 4 by 4 in. Plexiglas response windows 7 in. apart. The S responded by pressing one of the windows. Correct choices were reinforced with a bead automatically dispensed into a receptacle. Behind the screen, a Concord video camera with a F1.4, 12.5 mm lens was mounted. The lens of the camera was centered between the two response windows. The S's face appeared on a monitor in the adjoining room. The E, by viewing the monitor, could easily follow the eye movements of S by pressing either a right or left bar. A scan was recorded only when S changed his fixation from one stimulus to the other. An automatic printer recorded the number of scans, latency, and accuracy on each trial.

Each S was pretrained on a 40-trial junk problem consisting of two pictures taken from children's books. The pictures were presented following a Gellermann (1933) series. A noncorrection procedure was used through out. Ss who did not reach a 9/10 criterion on one of two junk problems were dropped from the study.

The Ss were then randomly assigned to one of two learning tasks. On one task, form was the relevant dimension with color irrelevant and variable and visa versa for the other task. On both tasks, S was given 30 trials in which to reach a 9/10 criterion. Following criterion or the 30th trial, 20 trials of overtraining were presented.

Results

The number of children learning each problem is shown in Table 1. Originally it was planned to use backward learning curves to present the accuracy data. When it was found that 9 of the 12

Fig. 1. Accuracy as a function of trials.

learners reached criterion in the first block, it was decided instead to compare this group's performance with that of the nonlearners. From these four groups, then, two groups were chosen to be compared on the dependent measures. One group consisted of 9 Ss who learned the form problem in the first block of 10 trials. The other group consisted of 10 Ss who had not learned the color problem at the end of the 30th trial. Although one group received the form problem and the other the color problem, the stimuli presented to each group were identical. The learners were simply those Ss who discovered the dimension and cue leading to 100% reinforcement. The nonlearners, on the other hand, had not discovered the relevant dimension and correct cue by the end of the 30th trial. The ages of the learners ranged from 47 to 61 months with the mean age of 54 months and the nonlearners' ages ranged from 43 to 58 months with the mean age of 52 months.

As shown in Fig. 1, the performance of the learners jumped to criterion within the first two trials of the test, whereas the nonlearners' performance remained at chance level.

Figure 2 shows that the scanning behavior was very similar for the two groups. As seen in Fig. 3, the decrease in latency somewhat similar as a function of trials followed curves for learners and nonlearners. There was a sudden drop in scanning and latencies after the first trial for both groups.

Separate mixed analyses of variance were performed on the latency and accuracy measures. For latency the only significant effects were due to Groups ($F = 5.06$, $df = 1/17$, $p < .05$) and Trials ($F = 8.88$, $df = 1/19$, $p < .001$). This groups effect is due to the slightly longer latencies displayed from the first trial on by the nonlearners. For Scans, the only significant effect was due to Trials ($F = 3.35$, $df = 1/19$, $p < .001$).

Discussion

For the learners the relations among the dependant measures latency, accuracy, and scans was much as had been expected. We

Fig. 2. Number of scans as a function of trials.

Table 1
Accuracy Results for Each Problem

Problem	Learners	Nonlearners
Color	3	10
Form	12	0

Fig. 3. Latency as a function of trials.

found the marked decrease in scanning after criterion in agreement with White and Plum. Contrary to expectations the scanning and latency measures of the nonlearners, as a function of trials, followed a similar course to that of the learners.

These results suggest two possible interpretations. First, as can be seen in Fig. 1, no errors were made in the criterion block by the learners after the second trial. An obvious interpretation is that scanning was related only to trials and that scanning decreased for both learners and nonlearners as the novelty of the problem decreased through repeated presentation. This interpretation, however, does not fit with White and Plum's analysis of the number of eye movements presented on each trial. They found that the greatest scanning occurred at the beginning of criterion, regardless of the trial on which criterion began.

The second interpretation is that once the Ss accepted a partial reinforcement schedule or a particular cue as the "solution" their

scanning behavior decreased. Two observations support this interpretation. First, it was discovered that three of the ten nonlearners responded to one of the stimuli in the form dimension consistently after either the first trial (two Ss) or the eighth trial (one S) of the test. Secondly, six of the seven remaining nonlearners were observed to disregard the visual stimuli entirely on some trials and respond on the basis of position. Both findings suggest a lack of searching for the correct dimension and cue once some stable systematic pattern of choice behavior develops.

In future studies the time spent looking at both the positive and negative stimuli on a trial will also be recorded with tasks of more intermediate difficulty. This has particular interest since long latencies were sometimes correlated with a lack of any searching possibly in turn correlated with position habits.

REFERENCES

- GELLMANN, LOUIS W. Chance orders of alternating stimuli in visual discrimination experiments. *J. genet. Psychol.*, 1933, 42, 207-208.
 LOVEJOY, ELIJAH. Analysis of the overlearning reversal effect. *Psychol. Rev.*, 1966, 73, 87-103.
 SUTHERLAND, N. S. The learning of discriminations by animals. *Endeavor*, 1964, 23, 148-152.
 WHITE, S. H., & PLUM, G. E. Eye movement photography during children's discrimination learning. *J. exp. child Psychol.*, 1964, 1, 327-338.
 ZEAMAN, D., & HOUSE, B. J. An attention theory of retardate discrimination learning. In N. R. Ellis (Ed.), *Handbook of mental deficiency*. New York: McGraw-Hill, 1963. Pp. 159-223.

NOTE

1. This research was supported in part by: Grants MH07346 and HD02898 from the National Institutes of Health, NSF undergraduate research program NSFGY2850 where the Junior author submitted the material as an undergraduate honors thesis. We thank staff, parents, and children of Children's Research Center Preschool for their cooperation.