Schema learning without a prototype

ED M. EDMONDS AND SELBY H. EVANS

TEXAS CHRISTIAN UNIVERSITY

In a reproduction task, Ss benefitted more from training with patterns having a common schema than with random patterns, even though Ss saw no prototype. This schema learning occurred with knowledge of results.

A number of investigators (e.g., Attneave, 1954, 1957; Oldfield, 1954) have emphasized the economy of information storage offered by a schema which encodes the redundant aspects of the environment, and they have emphasized the necessity for such an economy of data reduction in a model for human memory. Experimental evidence supporting the existence of this encoding mechanism has been reported by Attneave (1957). He found that redundant patterns were reproduced more accurately than random patterns containing the same number of elements, and suggested that the redundant patterns were encoded into simpler forms. Other investigators (e.g., Rappaport, 1957), however, have concluded that redundancy is detrimental to performance.

These disparate conclusions can be attributed to an inadequate conceptualization of the relationship between constraint redundancy and nature of the perceptual task (Evans, Edmonds, & Mueller, 1966). Constraint redundancy (R_c) results from the imposition of statistical constraints on the sampling process and produces patterns which are similar and less discriminable. As compared to constrained patterns, random patterns are thus less similar and have a larger number of attributes which differ between pairs of patterns. Therefore, random patterns provide more information for a discrimination task such as used by Rappaport (1957). However, in a reproduction task S is required to store all the information contained in the pattern. Redundant patterns should thus be reproduced more accurately than random patterns containing the same number of elements, because less information must be remembered to effect reproduction. This result was obtained by Attneave (1957).

In summary, schema learning (redundancy encoding) appears primarily to facilitate tasks involving memory. However, no evidence presently exists concerning schema learning in a task where S is not given a prototype but must abstract the schema from a set of varying examples. A transfer design was used in the present study to determine whether schema learning occurred under these conditions.

Method

A computer program, VARGUS 7 (Evans, 1964) was used to generate 0% and 67% redundant patterns for the present investigation. VARGUS 7 uses a seven element Markov process to select successive column heights for the construction of histogram patterns. The schema in patterns produced by VARGUS 7 is composed of the

most probable sequence (MPS) of column heights as determined by the transitional probabilities of the Markov process. The probability of each step of the MPS was .14286 (all heights equiprobable) for 0% redundancy and .86500 for 67% redundancy. The MPS was 4, 3, 5, 6, 7, 2, 1.

For a given level of channel capacity the number of columns per pattern increases with redundancy because 0% and 67% redundant patterns contain an average uncertainty of 2.807 and .8397 bits per column, respectively. Therefore, 9 and 30 columns produced 0% and 67% redundant patterns containing 25.2 bits of information. The two levels of redundancy are referred to by the symbols 0% and 67%, while sets of patterns at a given redundancy level are identified by the digits 1 and 2. Specifically, 0%-1 refers to a set of 0% redundant patterns while 67%-1 and 67%-2 refer to two different sets of 67% redundant patterns containing the same MPS.

The transfer design was as follows:

Group	Train	Test
Experimental	10 Ss- 67%-1	67%-2
	10 Ss- 67%-2	67%-1
Control	20 Ss- 0%-1	10 Ss- 67%-2
		10 Ss- 67%-1

The Ss, run in groups of four, reproduced 15 different patterns in the train phase and 15 in the test phase. A Kodak "Carousel" projector exposed each of the patterns, mounted on a 2 x 2 in. slide, onto a 3 x 4 ft. white screen for 20 sec. After each exposure, Ss turned to the appropriate sheet in a mimeographed answer booklet where the pattern was printed with three columns omitted. The Ss were allowed 20 sec. to draw the three omitted columns in each pattern. The presentation order of the patterns was randomized for each group of Ss. The intertrial interval was 20 sec. A change in slide trays was made between the two phases.

Results and Discussion

All group comparisons were made between trials 1-5 of the train phase and trials 2-6 of the test phase in order to minimize the effect of schema learning (in the test phase) in the control group. In the experimental group, performance on trial one of the test phase was markedly inferior to performance on prior and immediately succeeding trials. This performance decrement appeared to have resulted from a temporary interference with performance produced by changing slide trays between the train and test phases. Trial one of the test phase was therefore omitted from the comparisons.

The experimental groups performed significantly better, $t = 3.26$, $df = 19$, $p < .001$, in the test phase than in the

train phase. The experimental group also performed better, $t=2.26$, $df=38$, $p<.05$, in the test phase than did the control group. However, the control group reproduced patterns significantly more accurately in the test phase than did the experimental group in the train phase, $t=2.23$, $df=38$, $p<.01$. These comparisons show that general familiarity with the task leads to some improvement in performance with constrained patterns, but greater improvement is obtained when experience provides an opportunity to learn the relevant schema.

A trend analysis for repeated measures was performed, using all 30 trials for the experimental group, to determine the relationship describing reproduction accuracy (Y) as a function of number of trials (X). The 30 reproduction trials were grouped into blocks of five trials each. The results showed significant differences,

Fig. 1. Block means and best-fitting curves for experimental group in train and test phases.

$F=10.05$, $df=5/95$, $p<.001$, between the block means. A graph of the block means is given in Fig. 1. The linear trend accounted for 91% of the variance in the trial blocks and had the form $Y=.10X+.94$. Figure 1 shows that the observed curve appears to be approaching an asymptote at 30 trials. In any event, there is an upper limit relationship between X and Y (the quadratic trend might have been more evident if block four had been free of the influence of the first test trial). A trend analysis was also performed using trial blocks 1-3. The linear trend accounted for 95% of the variation in the three block trials and had the form $Y=.22X+.66$ (see Fig. 1).

The results confirm the conclusions of Attneave (1954, 1957) and Oldfield (1954) concerning the use of schema in reducing information storage requirements. The Ss in the experimental group were interviewed immediately after participating in the experiment and none reported that they were aware of using any type of rule to reproduce the pattern columns. Schema learning thus appears to occur without awareness and without external reinforcement.

References

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