Schematic concept formation as a function of constraint redundancy and knowledge of results¹

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The present study assessed the joint effects of schematic redundancy (Rc) and knowledge of results (KR) on performance of a modified oddity task requiring the assignment of stimuli to categories corresponding to three different schema families. A high level of Rc (70%) facilitated schematic concept formation (SCF); a low level of Rc (40%) prevented the occurrence of SCF, but didactic concept learning did occur at this level if KR was provided.

Schema theory (Attneave, 1957; Oldfield, 1954) suggests that the encoding of the schematic aspects of stimuli reduces information processing and storage requirements; the specific instances are efficiently stored in the form of schema plus correction. The natural environment, however, presents several difficulties which would tend to interfere with the abstraction of schema rules. The environment may not provide a schema prototype, and members of different schema families are frequently mixed together. In reference to the mixed schemata case, Evans (1967a) has pointed out that each schema family corresponds to an equivalence class or statistical concept. Each concept has a number of attributes associated with it. Collectively these attributes are sufficiently reliable to permit assignment of stimuli to correct categories.

Schematic concept formation has been defined by Evans (1967a) as the development of the ability to assign objects to their corresponding schema families on the basis of the information derived from perceiving the objects, without prior familiarization with the relevant schema. The SCF process has been demonstrated in human categorizing performance under the term "perceptual category formation" (Evans, 1964) and "schema discrimination" (Edmonds, Mueller, & Evans, 1966). The former study also entailed a computer simulation of the process.

In traditional concept learning, knowledge of results provides the information necessary for the selection of relevant attributes and the construction of assignment rules. Such concepts may be termed didactic concepts; they need not be associated with schemata. In SCF, on the other hand, the necessary information is extracted from the unfamiliar stimuli themselves with no external feedback. Consequently, schematic concepts are defined by objects in the environment.

The SCF process requires overdetermined equivalence classes. An overdetermined class or concept is one which has more attributes associated with it than are needed for near-perfect classification. Constraint redundancy is a measure of over-determination. The Rc measure has been discussed in detail by Evans (1967b) and represents the extent to which a population of stimuli adhere to a schema. Low levels of Rc should prevent the occurrence of SCF. However, the availability of KR during a task should permit didactic concept learning under low Rc conditions.

Several different tasks have been used to demonstrate the SCF process. Evans (1964) used a free-sorting procedure and encountered scoring difficulties in comparing subject defined categories and the categories defined by the E; furthermore, the Ss expressed dissatisfaction with the lack of structure in the task. Edmonds, Mueller, & Evans (1966) found an oddity task to be more satisfactory in regard to scoring procedures. A modified oddity task requiring the assignment of objects to categories corresponding to three or more schema families would incorporate the advantages of both free-sorting and oddity procedures.

This study was intended to achieve the following objectives: (1) to compare the effects of KR and no KR (NKR) upon concept learning; (2) to assess the effects of high and low Rc upon concept learning; and (3) to evaluate a task requiring assignment of stimuli to categories corresponding to three different schema families. The

following hypotheses were investigated: (1) a low level of Rc prevents the occurrence of SCF, but didactic concept learning occurs if KR is provided. A high level of Rc facilitates the SCF process; and (2) although high Rc facilitates SCF under both KR and NKR, performance should be higher when KR is administered.

Method. The Ss were 40 naive undergraduates enrolled in psychology courses at Texas Christian University.

The VARGUS 7 computer program (Evans, 1967c) was used to generate histogram patterns consisting of three schema families, each schema being represented by 40% and 70% Rc patterns.

The Ss were given 20 trials by means of multilithed booklets. A typical trial consisted of viewing a single pattern of a schema family for 10 sec, followed by the selection of a pattern from that same schema family from a group of three patterns of different schemata. The Ss were instructed to select the pattern most similar to the single pattern previously studied. Each S was allowed 20 sec to make a selection. The KR groups were then shown the correct answer for 10 sec; the NKR groups viewed a blank page during this interval. Precautions were taken to insure that the Ss receiving KR could not view the correct answer until a selection had been made.

All Ss received 20 trials involving the inspection of geometric forms (circles, triangles, and squares) prior to the trials with the VARGUS 7 patterns. (This procedure was followed to permit the data for the present study to be collected simultaneously with that of another experiment; the procedure has no relevance to this study.)

Results. A two-way analysis of variance was applied to the performance data; the dependent variable was the number of correct choices for all 20 trials. The Rc main effect was significant ($F = 4.81$, $df = 1/36$, $p < .05$). Performance was higher under the 70% condition than under the 40%. The Rc by KR interaction, presented in Fig. 1, was significant ($F = 4.91$, $df = 1/36$, $p < .05$). KR facilitated performance under the 40% condition and produced a decrement for the 70% Ss as compared to the NKR condition. This decrement is indicated by the significant simple main effect of KR at the 70% level ($F = 6.46$, $df = 1/36$, $p < .05$). Correspondingly, the simple main effect of Rc for the NKR condition was significant ($F = 9.23$, $df = 1/36$, $p < .01$). Compared

Fig. 1. Mean correct responses as a function of Rc and KR conditions.

to 40% Rc, the 70% condition caused an increment in performance under NKR.

Discussion. In support of the first hypothesis, high Rc (70%) facilitated the SCF process in comparison to the 40% Rc condition. Contrary to the second hypothesis, administration of KR under a high Rc condition is not necessary for concept learning in that the stimuli are overdetermined to the extent that SCF can occur. A low level of Rc (40%) prevents the occurrence of SCF. If KR is provided under a low Rc condition, then didactic concept learning is facilitated.

The distinction between schematic and didactic concept formation, as proposed by Evans (1967a), is supported by the results of this study. The SCF process requires overdetermined equivalence classes; the information necessary for the selection of relevant attributes and the construction of assignment rules is extracted from the stimuli themselves with no external reinforcement. In fact, at a high level of Rc, the presence of KR produces a performance decrement in comparison to performance without KR. On the other hand, only didactic concept formation occurs at a low level of Rc.

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