Hypothesis sampling in conjunctive concept identification

IRWIN D. NAHINSKY AND F. DUDLEY McGLYNN,
DEPARTMENT OF PSYCHOLOGY, UNIVERSITY OF
MISSOURI, Columbia, Mo. 65201

The experiment entailed two 2 by 2 Latin square designs, each of which involved two conjunctive concept attainment problems balanced with respect to presentation order over two groups. Three blank trials followed an initial instance for each problem, and each blank trial stimulus overlapped the instance by exactly two attribute values. Analysis of patterns of blank trial Rs indicated that Ss sampled hypotheses about combination rather than single attribute values independently of each other.

Bourne & Restle (1959) and Trabasso & Bower (1964) presented evidence to show that the four category concept identification (CI) problem is solved as two independent part-problems. That is, each of the two relevant attributes is learned independently of the other. As an example, if color and form are relevant, category one may contain all orange circles, category two all orange triangles, category three all blue circles, and category four all blue triangles where stimuli vary on binary dimensions. Thus the color subproblem solution is that orange patterns are in classes one or two and blue patterns are in classes three or four. Likewise the form subproblem solution is that circular patterns are in classes one or three and triangular patterns are in classes two or four. Other attributes would be irrelevant to classification.

In contrast to the four-category problem, a conjunctive CI task requires classification into only two categories, i.e., instance vs noninstance. For example, all orange circles might be instances of the concept with all other stimuli noninstances. Although the conjunctive problem differs from the four-category problem, the evidence cited suggests that conjunctive CI involves independent learning of two component tasks. In the experiment reported, E used conjunctive CI tasks to see how the relationship among attribute values on stimuli influenced responding. If the solution is learned as a pair of independent part-problems, responses to any attribute value should be independent of other attribute values of a stimulus.

Method. The experiment entailed two 2 by 2 Latin square designs, each of which involved two concepts balanced with respect to presentation order over two groups. The Ss in each condition were asked to learn two conjunctive concepts in succession in which two of the three attributes varied were relevant. Feedback and "blank" trials were interspersed in a manner to be described. The first design used stimuli on feedback trials such that the two instances and the two noninstances had no attribute values in common. The second design used stimuli such that each of the two feedback instances overlapped just two of the four feedback noninstances on the irrelevant attribute value with no overlap on relevant attribute values. These specifications do not apply to blank-trial stimuli.

A series of three blank-trial stimuli were presented in random order following each instance. Each blank-trial stimulus overlapped the first instance presented by exactly one pair of attribute values, and the three stimuli represented all three possible overlapping pairs. No blank-trial stimulus duplicated any of the feedback stimuli. The first stimulus for each problem was an instance, and E so stated.

The stimuli, 3 in. x 5 in. cards, varied in three dimensions: (a) shape of figures—crosses, circles, or squares; (b) shading of figures—black, shaded, or white; and (c) number of figures—one, two, or three. Concepts to be learned were shaded circles and three crosses for the no-overlap design and shaded circles and two black figures for the overlap design.

The Ss were 60 students. They were assigned upon appearance to conditions on a rotating basis, with one replication of the four conditions for the two Latin squares before each succeeding replication. A screen separated E and S during the session. All Ss were presented initially with the same practice problem which involved an instance presented on trial one followed by six stimuli presented in random order. The S was told to guess whether or not each stimulus was an instance, whereupon he was told if he was right or wrong. After all stimuli were presented, S was asked to guess the concept, one

square. If S learned, E proceeded to the experimental problems. He was told that some Rs would receive no feedback, and it was explained that this lack signified nothing about R correctness. (Only one S was eliminated because of failure to learn the practice problem.)

Results and Discussion. The analysis will be concerned with the four stimuli following the initial instance, the first three of which are blank trials. In view of the fact that no feedback occurred until after the R to the fourth of these stimuli, the Rs during this period should reflect the pattern of hypotheses that S has sampled (or the R "strength" for various cue patterns). If S sampled attribute values independently and responded positively only when two sampled values appear on a card, then positive Rs to any two blank-trial stimuli should be associated with a positive R to the third. This follows from the arrangement of value combinations on blank trials. For example, in one problem a single shaded circle is the first instance. This stimulus is followed by three stimuli which overlap it by the value pairs, shaded-circle, one-circle, and one-shaded. If S responded positively to the first two, he would have sampled the values shaded and one. Thus, the S should respond positively to the third stimulus. As Table 1 shows Ss responded positively to exactly two blank-trial stimuli for 51 of the 120 S-problems. This proportion indicates that, if we assume Ss sample cues and respond on the basis of two dimensions, they sample hypotheses rather than attribute values independently. The fact that Ss responded positively to two or more blank-trial stimuli suggests that Ss frequently sampled more than one of the likely hypotheses and perhaps eliminated unfruitful combinations during learning.

It might be argued that the above findings could result from Ss sampling randomly from the pool of all possible hypotheses rather than from those compatible with the first instance. Examination of all cases in which a noninstance immediately followed the third blank trial shows that in only eight of 114 instances did S classify the noninstance as an instance. By comparison, 195 of the 360 blank-trial presentations were classified as instances. Since each blank-trial stimulus had one value pair in common with the first instance, and no feedback noninstance overlapped an instance by more than one attribute value, the overwhelming difference indicates that Ss did not sample randomly from all possible cue combinations, but that they sampled predominantly from those combinations compatible with the known instance.

One might contend that Ss sampled only one attribute value with nonzero probability and then classified positively those stimuli which have the value. This assumption would account for the large number of times that exactly two blank-trial stimuli are called instances, because each value on the initial instance appears on exactly two of the blank-trial stimuli. The overlap condition protocols for problems on which Ss selected just two blank-trial stimuli were examined for cases in which a noninstance immediately followed the blank trials. These protocols were in turn narrowed down to nine cases for which the noninstance contained

Table 1
Number of Initial Blank Trial Stimuli Classified as Instances

Problem	Number of Stimuli Classified as Instances			
	0	1	2	3
A	2	15	11	2
B	1	13	13	3
a	0	10	16	4
β	1	13	11	5
TOTAL	4	51	51	14

an attribute value which was the same as the value common to the two preceding blank-trial stimuli selected. If Ss responded on the basis of one value, these noninstances should have been positively classified. Only one of the nine stimuli was positively classified, indicating that Ss were generally classifying stimuli on the basis of cue combinations instead of single cues.

The proportions of blank-trial stimuli classified positively were tabulated by position independently of specific stimuli for Ss' first problem and for Ss' second problem. Correlated proportions chi squares revealed a significant position effect in both instances ($X^2 = 8.60$, $df = 2$, $p < .02$ for the first problem and $X^2 = 9.18$, $df = 2$, $p < .02$ for the second problem). In both cases, the third blank-trial stimulus presented was least frequently classified as an instance, an outcome which suggests some short-term decay effect. Comparisons of proportion of positive Rs for the third stimulus with the corresponding proportion for noninstances immediately following showed overwhelming superiority for the third stimulus for both first and second problem data ($X^2 = 14.70$, $df = 1$, $p < .001$ for Problem 1 and $X^2 = 27.27$, $df = 1$, $p < .001$ for Problem 2). These results further corroborate the finding that Ss sample predominantly from combinations compatible with the initial instance.

Correlated proportions chi squares for the three blank-trial stimuli pooled over all positions were computed for each of the four concepts. Only the shaded-circles problem of the no-overlap condition yielded significant difference among stimuli ($X^2 = 6.07$, $df = 2$, $p < .05$). The other values were nonsignificant with two chi squares less than unity. Thus, the results give little support to the notion of strong differential saliency of cue combinations.

The results of the experiment strongly suggest that Ss do not learn a conjunctive CI task as two independent subtasks. These findings are contrary to those cited for the four category problem. The discrepancy may be attributable to differences between the two tasks. The four-category problem presents S with an orthogonal double classification scheme, which may induce a set to respond independently to two dimensions. Also, S is rewarded for solving one subproblem by an increase in correct R probability from $\frac{1}{4}$ to $\frac{1}{2}$. Neither of the two above conditions apply to the conjunctive CI problem.

REFERENCES

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