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ABSTRACT

The effects of 2 different types of positive and negative instances in learning "non-dimensioned" concepts were investigated. "Non-dimensioned" concepts are defined only by the presence or absence of distinct attributes. One-hundred-seventy-one 8th graders were given series of all positive or alternating positive and negative instances. Series of positive instances in which successive instances shared the same irrelevant attributes and series of positive and negative instances in which the negatives lacked several attributes when compared to a preceding positive resulted in poorer performance ($p < .01$) from Ss than did series of positives in which the instances shared none of the same irrelevant attributes and series of positives and negatives in which the negative instances lacked only one attribute when compared to a preceding positive instance. The results agreed with findings with "dimensioned" concepts and indicated the Ss may be using negative instances to generate hypotheses of possible relevant attributes. (Author)

THE EFFECTS OF DIFFERENT TYPES OF POSITIVE AND NEGATIVE INSTANCES IN CONCEPT LEARNING

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In the typical conjunctive concept learning experiment, the S is presented with a series of stimulus patterns which vary on several dimensions such as shape, size and color (Bruner, 1956). In general, each of these dimensions can take on two or three different values. For example, shape could be either a square or triangle; size could be either large or small; and color could be either red or blue. The S's task is to learn which particular combination of values (e.g., red and square) define the concept and which dimension is irrelevant (size) and therefore can be ignored. In this case, the S knows that the stimulus population is finite and that any combination of values which conform to the conceptual rule could be a plausible solution.

Concepts taught in school, however, may more accurately be described in terms of the presence or absence of certain attributes, not combinations of values of particular dimensions. When a student is confronted with the problem of learning a concept in the classroom, he typically does not know the limits of the stimulus population nor does he know which attributes are critical in defining the concept. In this case, the student's task is to learn which attributes must be present in order for a particular instance to be classified as an example of a particular concept.

Experiments with typical "dimensioned" concepts, however, have yielded a number of interesting findings. For example, several investigators have demonstrated the importance of the sequence and structure of positive and negative instances within a learning series. Anderson and Guthrie (1966) and Detambel and Stolurow (1956) found that if a relevant dimension is varied between two adjacent instances, the most effective learning occurs if the irrelevant dimensions remain constant. On the other hand, if the relevant dimension does not change from one instance to the next, the most effective learning occurs if all of the irrelevant dimensions change. Furthermore, studies by Bourne, Eckstrand, and Montgomery (1969), Braley (1963), and Hovland and Weiss (1953) have demonstrated a decline in Ss' performance when they had to learn concepts inductively from a series of negative instances alone or negative instances mixed together with positive instances in comparison to series of only positive instances.

These generalizations, on the other hand, may not apply in cases where concepts are taught in a "non-dimensioned" way. If a teacher is concerned with presenting a concept in terms of a number of separate but essential characteristics, then the importance of the structures of positive and negative instances may change considerably from traditional conjunctive concept learning situations.

Specifically, the present experiment was designed to compare each of the possible conditions under which the relationship between the structures of different types of instances of "non-dimensioned" concepts may vary in a series. Two types of positive and two types of negative instances were identified, each type being determined by the relationship of one instance to the instance or instances preceding it in the learning series. Type 1 positive instances share only the relevant attributes of the concept. No irrelevant attributes are repeated among the instances. Type 2 positive instances share several of the same irrelevant attributes. Although all the positive instance share in common only the relevant attributes, any two successive positive instances may share one or more of the same irrelevant attributes.

Two types of negative instances were also identified. Type 1 negative instances share all of the attributes of a positive instance except for one of the relevant attributes, which is omitted. All of the irrelevant attributes remain constant from positive to negative instance. Type 2 negative instances are also identical to the positive instance immediately preceding it in the series, but lack not only one relevant attribute, but one or more irrelevant attributes as well.

In the case of "non-dimensioned" concepts, the following six conditions of presentation are possible and formed the basis for the experimental groups.

1) a series of only Type 1 positive instances;
2) a series of only Type 2 positives;
3) a series of alternating Type 1 positive and Type 1 negative instances;
4) a series of alternating Type 1 positive and Type 2 negative instances;
5) a series of alternating Type 2 positive and Type 1 negative instances; and
6) a series of alternating Type 2 positive and Type 2 negative instances.

Three hypotheses were investigated. First, it was hypothesized that Ss given a series of only Type 1 positive instances (Group I) would identify a greater proportion of the relevant attributes and include fewer irrelevant attributes in their definitions of the concepts than would Ss given a series of only Type 2 positive instances (Group II). Second, Ss given a series of alternating Type 1 positive and Type 1 negative instances (Group III) would similarly outperform Ss given a series of alternating Type 1 positives and

Type 2 negatives (Group IV). Finally, Ss given a series of alternating Type 2 positive instances and Type I negatives (Group V) would be expected to outperform Ss given a series of alternating Type 2 positives and Type 2 negatives (Group VI).

Method

Subjects

The Ss were 171 eighth-grade students from a small rural junior high school in Pennsylvania. The Ss were stratified according to sex and high, medium, and low ability levels, based on reading achievement scores. Each S was randomly assigned to one of six treatment groups. Group I was given series of only Type 1 positive instances; Group II was given series of only Type 2 positive instances; Group III was given series of alternating Type 1 positive and Type 1 negative instances; Group IV was given series of alternating Type 1 positive and Type 2 negative instances; Group V was given series of alternating Type 2 positive and Type 1 negative instances; and Group VI was given series of alternating Type 2 positive and Type 2 negative instances.

Attributes and Instances

Attributes of the concepts consisted of geometric figures with distinctive shadings or designs within them. Figure 1 presents examples of each type of instance presented. Positive instances contained all of the relevant figures, or attributes, of the concepts. Type 1 and Type 2 positive instances differed only in the number of irrelevant attributes they shared with other positive instances of the same concept. Type 1 positives shared no irrelevant attributes, while Type 2 positives shared as many as two irrelevant attributes with other positive instances in the learning series. Type 1 and Type 2 negative instances differed from their respective positives in that one relevant attribute was omitted. The Type 2 negative also differed in that either one or two of the irrelevant attributes from the preceding positive instance were also omitted.

Insert Figure 1 about here

Concepts

Four concepts were used. Each concept involved a different number of relevant and irrelevant attributes. Concepts A and B each had two relevant attributes, while C and D each had four relevant attributes. The positive instances of Concepts A and C each had two irrelevant attributes while those of Concepts B and D had four irrelevant attributes each. The total number of attributes in the positive instances were four for Concept A, six for Concepts B and C, and eight for Concept D. Successive Type 2 positive instances in the learning series for Concepts A and C had one shared irrelevant attribute, whereas for Concepts B and D they had two shared irrelevant attributes. Tables 1 and 2 present the number of attributes present or absent in each type of positive or negative instance used.

Insert Tables 1 and 2 about here

Procedures

Six intact classes of Ss were used. The Ss were randomly assigned to the six treatment groups within each class. All Ss were given the four different concepts to learn. The order of presentation of the concepts was determined by random assignment. The Ss were given eight instances from which to learn each concept. Thus, Groups I and II were given eight positive instances for each concept and Groups III, IV, V and VI were given four positive and four negative instances, in an alternating series, for each concept. Instances were presented in a small booklet, one instance per page. The Ss were allowed to study each instance for fifteen seconds before being told to turn to the next instance. They were not allowed to turn ahead to the next instance before time was called nor were they allowed to look back at previous instances. After all eight instances of one concept had been viewed, E asked Ss to draw the relevant figures, or attributes, of the concept. This procedure was repeated for each of the four concepts.

Before the actual experiment was begun, Ss were given four practice exercises. The Ss compared only positive instances in one exercise and positive and negative instances in other exercises to become familiar with the materials and the strategies for isolating the relevant attributes. Identical practice materials were used for all groups.

Design

The design of the experiment was a 2 x 3 x 6 x 4 factorial with two levels of sex, three levels of ability, six treatment conditions, and four different concepts. The factor of concepts was a repeated measures factor.

Results

Two dependent measures were obtained: 1) the percent of relevant attributes correctly identified; and 2) the number of irrelevant attributes included in Ss' drawings.

Percent Relevant Attributes

The results of the analysis of variance of percent relevant attributes correctly drawn revealed that the main effects of ability level ($F = 14.99$; $df = 2/135$; $p < .001$), sex ($F = 8.90$; $df = 1/135$; $p < .01$), treatment conditions ($F = 12.16$; $df = 5/135$; $p < .001$), and concepts ($F = 26.27$; $df = 3/405$; $p < .001$) were significant. None of the interactions were significant.

Girls identified a significantly greater percentage of relevant attributes than boys. Subsequent analysis of the significant main effect of ability indicated that high-ability Ss identified a greater percentage of relevant attributes than low-ability Ss ($p < .01$). The performance of the medium ability level Ss was intermediate and differed from low-ability Ss ($p < .01$). The mean performances for the three ability levels is presented in Table 3.

Insert Table 3 about here

In terms of treatment conditions, the Newman-Keuls analysis revealed that Ss in Group I (only Type 1 positives), III (Type 1 positives and Type 1 negatives), and V (Type 2 positives and Type 1 negatives) identified a significantly greater percentage of relevant attributes than Ss in Groups II (only Type 2 positives), IV (Type 1 positives and Type 2 negatives), and VI (Type 2 positives and Type 2 negatives; $p < .01$). The Ss in Group II also outperformed Ss in Group VI ($p < .05$).

Finally, Ss identified a significantly greater percentage of relevant attributes on Concepts A (two relevant, two irrelevant attributes) and B (two relevant, four irrelevant) than on Concepts C (four relevant, two irrelevant) and D (four relevant, four irrelevant) ($p < .01$). The mean performances for the six treatment Groups and for the four Concepts are presented in Tables 4 and 5.

Insert Tables 4 and 5 about here

Number of Irrelevant Figures

A second analysis of variance was computed using the number of irrelevant attributes Ss included in their drawings. The main effects of ability level ($F = 6.72$; $df = 2/135$; $p < .01$), treatment conditions ($F = 9.21$; $df = 5/135$; $p < .001$), and Concepts ($F = 8.53$; $df = 3/405$; $p < .001$) were also significant.

Newman-Keuls post tests revealed that high-ability Ss included fewer irrelevant attributes in their drawings than low-ability Ss ($p < .01$). Medium-ability level Ss performed at an intermediate level and did not differ significantly from either the high- or low-ability Ss. In terms of the experimental groups, Ss in Groups I, III, and V included significantly fewer irrelevant attributes than did Ss in each of Groups II, IV and VI ($p < .01$). The Ss included significantly fewer irrelevant attributes on Concepts B and D than on Concepts A and C ($p < .01$).

Discussion

The results of the present experiment demonstrate that the relationship between the structure of positive and negative instances within a learning series is also critical to concept learning when the concepts are presented in a "non-dimensioned" way. When the relevant attributes remained constant from one instance to the next, as in the case of all-positive instance series (Groups I and II) the most efficient learning occurred when all of the irrelevant attributes changed (Group I). When the relevant attribute changed from one instance to the next, as in the case of the alternating positive and negative instances series (Groups III, IV, V, and VI), the most efficient learning occurred when the irrelevant attributes remained constant (Groups III and V).

These results support Detambel and Stolurow's (1956) and Anderson and Guthrie's(1966) findings, but they also extend the usefulness of negative instances. Braley (1963) and Schvaneveldt (1966) have presented evidence that Ss ignore the information contained in negative instances and proceed in a "positive-focusing" strategy. In this manner, negatives are used mostly to test positive hypotheses of the concept. The present results demonstrate that negative instances may be useful to Ss in conjunctive learning situations in which a limited number of hypotheses may be generated from a comparison with them of preceding positive instances in a series. Under these conditions negatives are able to eliminate more irrelevant hypotheses than series of only positive instances in which shared irrelevant attributes give rise to additional hypotheses.

The Ss given Type 1 positive instances and Type 2 positive instances together with Type 1 negative instances (Groups III and V) performed as well as Ss given only Type 1 positive instances. Since Type 1 negatives changed only one relevant attribute, the type of positive instance made no difference. Only one hypothesis of a relevant attribute could be generated from a positive-negative pair of instances. The Ss given only Type 2 positive instances (Group II), on the other hand, did significantly poorer on both dependent variables than the Ss in Group V, who were given Type 2 positives and Type 1 negatives, because the shared irrelevant attributes gave rise to several additional-irrelevant hypotheses of possible relevant attributes.

Results of the present investigation also substantially confirm earlier findings that the complexity of concepts influences learning. The Ss identified a greater percentage of relevant figures and included fewer irrelevant figures in their drawings for the concepts with fewer numbers of relevant and irrelevant attributes, respectively. An interesting finding was also that the effectiveness of the different types of instances did not vary as the complexity of the problems increased. At least up to a total of eight attributes, the effects of types of instances remained constant. The Type 1 negatives, regardless of the number of attributes contained in the positive instances, still changed only one attribute, giving rise to only one hypothesis. Thus, one may say that the desirability of using Type 1 negatives increases as the complexity of the concept increases.

The similarity of the present results to those obtained from traditional, "dimensioned" concepts seems to indicate that the processes or strategies involved in making use of information from positive and negative instances are highly similar, if not identical, in both cases. Thus, the relationship between the structures of positive and negative instances in the learning series is of major importance. It appears that it is the effectiveness of the instances, by virtue of their structure, in limiting the number of hypotheses which Ss may generate from them which determines the efficiency of learning concepts. A negative instance which limits the number of hypotheses to be considered in combination with any type of positive instance can be as efficient as a series of positive instances by themselves and can be more efficient if the positive instances share irrelevant attributes which increase the number of hypotheses to be considered. In contrast, a positive or negative instance which increases the number of hypotheses to be considered reduces the efficiency of concept learning. For the classroom teacher presenting a concept either in terms of a category system of dimensions and values of dimensions, or in terms of a set of discrete and separate, but equally necessary characteristics, a wise selection of instances would include widely different (that is, sharing few irrelevant attributes) positive instances of the concept (Type 1) and negative instances which are missing only one relevant attribute at a time when compared with those positives (Type 1 negatives). In this manner, irrelevant attributes may best be eliminated and only the critical, relevant attributes emphasized.

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Footnote

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TABLE 1

The Number of Relevant (R), Irrelevant (I), Shared Irrelevant (S) and Total (T) Number of Figures Present in the Positive Instances of Each Concept.

	Type I Positive				Type II Positive			
Concept	R.	I.	S.	T.	R.	I.	S.	T.
A	2	2	0	4	2	2	1	4
B	2	4	0	6	2	4	2	6
C	4	2	0	6	4	2	1	6
D	4	4	0	8	4	4	2	8

TABLE 2

The Number of Relevant (R), Irrelevant (I), Missing (M) and Total (T) Number of Figures Present in the Negative Instances of Each Concept.

	Type I Negative				Type II Negative			
Concept	R.	I.	M.	T.	R.	I.	M.	T.
A	1	2	1	3	1	1	2	2
B	1	4	1	5	1	2	3	3
C	3	2	1	5	3	0	3	3
D	3	4	1	7	3	2	3	5

TABLE 3

Percentage of Relevant Figures and Mean Number of Irrelevant Figures Drawn by High, Medium, and Low Ability Ss

Ability Level	% Relevant	M. Irrelevant
High	72.76	.8881
Medium	64.88	1.4550
Low	52.32	1.2917

TABLE 4

Percentage of Relevant Figures and Mean Number of Irrelevant Figures Drawn by Ss in Each Treatment Group

Group	% Relevant	M. Irrelevant
I	71.55	.7069
II	56.25	1.4554
III	78.13	.8036
IV	57.26	1.6290
V	77.08	.6852
VI	44.64	1.7589

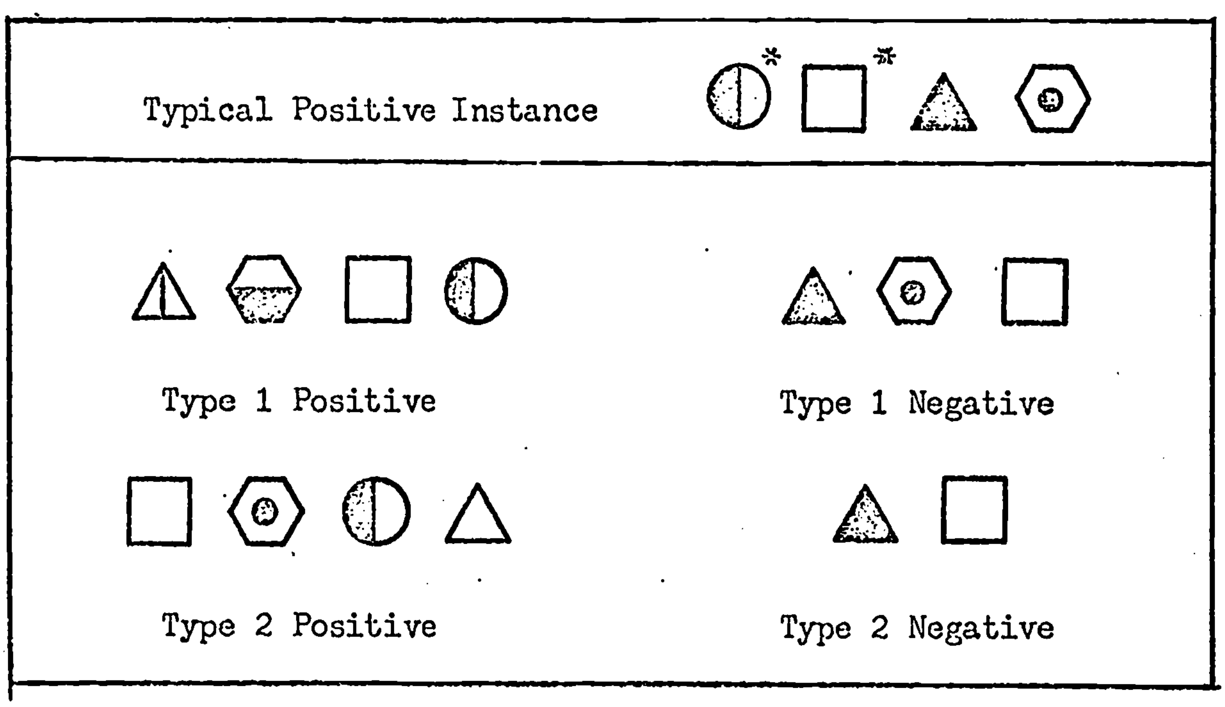
TABLE 5

Percentage of Relevant Figures and Mean Number of Irrelevant Figures Drawn by Ss on Each Concept

Concept	% Relevant	M. Irrelevant
A	74.86	1.0175
B	69.30	1.3333
C	58.33	1.0000
D	53.51	1.3743

Figure Captions

Figure 1. Examples of Instances Used.



* Relevant Attributes