THE EFFECT OF PRACTICE ON UTILIZATION OF INFORMATION FROM POSITIVE AND NEGATIVE INSTANCES IN CONCEPT IDENTIFICATION[1]

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THE CONCEPT IDENTIFICATION EXPERIMENT can be regarded as a communication situation in which the experimenter gives information to a subject about the concept to be identified through a series of messages (Hovland, 1952). A message typically consists of a stimulus figure involving a combination of characteristics. If all the defining characteristics of the concept are included in the stimulus figure, the message represents a positive instance of that concept. If one or more such characteristics are lacking, the message represents a negative instance of the concept.

Hovland and Weiss (1953) have conducted a well-known series of experiments on transmission of information through positive and negative instances. They used Hovland's (1952) communication model of concept attainment to calculate the minimum number of positive or negative instances logically required to communicate the concept to the subject. They then compared the performance of subjects working with only positive instances with that of subjects working exclusively with negative instances, always holding constant the *amount* of information presented to the subjects. They found that, within the time limits they used, a significantly greater percentage of subjects working with positive instances than of subjects working with negative instances were able to identify the concepts correctly. This was true even when the total number of instances presented was equal for both groups and when the memory factor was eliminated. This led the authors to conclude that "while a machine could be constructed which would arrive at the correct concept with equal ease on the basis of the positive or negative instances, the results of the present experiment clearly indicate that the human organism does not operate similarly on a strict probability basis" (Hovland and Weiss, 1953, p. 181).

This is a rather broad generalization which has found support by other investigators. Bruner, Goodnow, and Austin, for instance, also state that "subjects seem not as willing or able to use negative information—instances telling what the concept is not—in the process of attaining a concept" (1956, p. 180).

[1]This study is based on a thesis submitted by Vaira Freibergs (née Vikis) to the University of Toronto for the degree of M.A.

Hovland and Weiss seem to favour a perceptual explanation of this phenomenon, or at least an explanation that includes references to perceptual qualities of positive and negative instances. It is conceivable, however, that there are other major sources of variability which are relevant. Hovland and Weiss' experimental findings can be regarded, for instance, as reflecting transfer effects from prior, unspecified learning of concepts. Bruner, Goodnow, and Austin have suggested that "most of our environment seems to be geared to working with positive instances and with variations on these" (1956, p. 159). If this hypothesis is true, then one would not only expect that experimentally naïve subjects show differences in handling positive and negative instances, but also that these differences disappear when the subjects are given more extensive practice with negative instances. The present experiment, essentially a replication of a part of Hovland and Weiss' Experiment III, was conducted to explore the effect of repeated presentation of problems on utilization of positive and negative instances.

Method

Subjects

Twenty Ss were haphazardly drawn from the subject pool consisting of the names of all students taking general psychology courses at the University of Toronto. They were 18 women and two men, all between 18 and 26 years of age. None of them had any familiarity with concept identification tasks of any kind prior to the experiment. The Ss were alternately assigned to two groups in the order of their appearance for the experiment.

Task and procedure

The stimulus material consisted of 64 cards similar to those used in the Wisconsin Card Sorting Test (Grant, 1951). On each card there were one, two, three, or four solid geometric figures of a certain form and a certain colour. Forms used were circle, triangle, square, and diamond, and colours were blue, green, yellow, and red. Thus there were three stimulus dimensions—number, form, and colour, with four values within each dimension.

All concepts to be identified by Ss in this experiment involved three values within each of two relevant dimensions. Thus in each case one dimension was irrelevant and one value within each relevant dimension was "incorrect."[2] The Ss' task was to identify a given concept on the basis of four instances presented simultaneously. One group of Ss (P Group) worked with only positive instances, the other (N Group) had to arrive at the concepts on the basis of negative instances alone. As shown by Hovland (1952), four positive or four negative instances of the type of concept used in this experiment are logically sufficient to communicate the concept to S.

Both groups were given 20 successive problems ("trials") involving different concepts of the same general type, that is, defined by three values within each of two relevant dimensions. The particular concept assigned to a given S on each trial

[2]For a detailed discussion of such concepts, see Hovland (1952).

was drawn at random from a list of 48 concepts of the designated type within the limits of the stimulus material. For each such concept there are 36 cards in the deck of 64 that represent positive instances and 28 cards that represent negative instances of that concept. The four instances of a given concept presented to S on each trial were selected in a haphazard fashion designed to minimize any possible systematic effects attributable to particular combinations of appropriate instances, and subject to the requirement that the four instances unequivocally provide sufficient information to identify the concept.

Instructions

Extensive and detailed instructions, identical for all Ss, were given verbally by *E*. The terms "concept," "dimension," "value," "positive instance," and "negative instance" were defined and illustrated with the aid of stimulus cards.[3] The Ss were shown how one could arrive at a concept defined by three values within each of two relevant dimensions on the basis of both four positive and four negative instances. Appropriate parts of instructions were repeated until S indicated that he understood the general task. Only then was S informed whether he would be working with positive or negative instances, and that for each set of four positive instances (negative for the N Group) presented to him he should attempt to give the correct concept as fast as he could. To minimize the need to rely on memory, a chart with a diagrammatical representation of the three dimensions and the four values within each dimension was given to each S and he was permitted to refer to it throughout the experiment.

Dependent variable

The Ss' performance was measured by the time taken to specify a concept correctly on a given trial. The scores were expressed in sec. to the nearest sec. A stop-watch was started the moment the four cards representing either positive or negative instances were laid on the table in front of S. The stop-watch was stopped when S stated the three correct values within each of the two relevant dimensions, or when the time limit of 210 sec. per trial was reached. This time limit was selected on the basis of preliminary observations. The stop-watch was not stopped when a wrong answer was given within the allowed time limit. In this case S was simply informed that his answer was not correct. When S had not identified the concept correctly at the end of 210 sec. he was assigned the score "210 plus" on that trial. The *E* then presented the instances of the next problem and said, "All right, now let us try this one," but at no time did he tell S what the correct answer was.

Results

All subjects in the P Group identified all concepts correctly after the third trial, and all subjects in the N Group did so after the eleventh trial. During the early trials, however, a number of subjects in both groups could not give the correct answer within the 210 sec. time limit. For this reason, and also because the distributions of individual scores on most trials were skewed, median scores were used to compare the performance of the two groups. These data are shown graphically in Figure 1.

[3]A copy of the instructions is available from E. Tulving, Department of Psychology, University of Toronto.

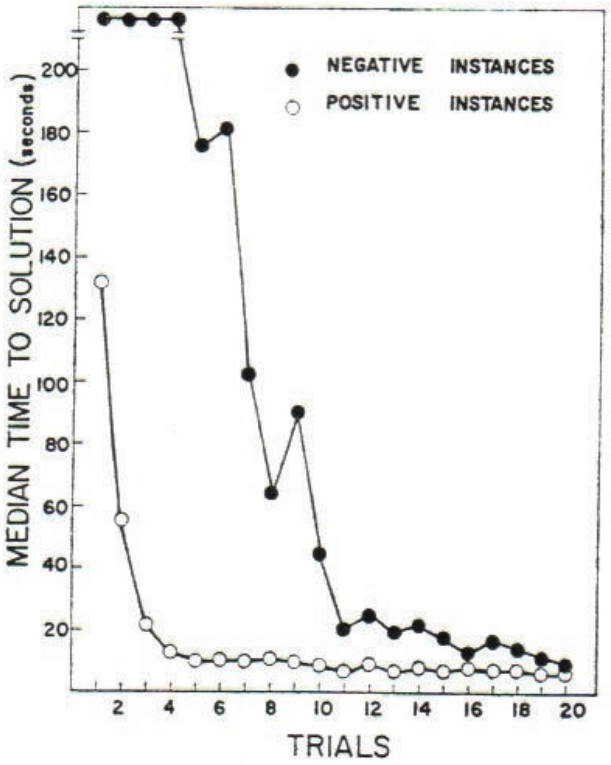

FIGURE 1. Median times to solution of concept identification problems on 20 successive "trials" for the groups working with positive and negative instances.

The abscissa of Figure 1 represents 20 successive problems or trials, the ordinate shows the median times to solution. The upper curve is that of the N Group, the lower shows the performance of the P Group. The median for the N Group on the first four trials is larger than 210 sec. and thus indeterminate. Hence the first four points on the curve for the N Group do not correctly represent the data and are shown only for the sake of completeness of the graph.

Both groups can be seen to improve in performance considerably during the total practice period. The two learning curves are negatively accelerated, but the curve of the P Group is much steeper than that of the N Group. The differences between the two groups during the early trials are large and obvious. At the end of the practice period, however, the difference between the two medians is quite small, especially when compared with the initial difference. On trial 20, for instance, nine subjects in the P Group and seven subjects in the N Group identified the concept in ten seconds or less. The median of the P Group on the same trial was 6.5 sec., the median of the N Group was 9.5 sec. It also looks

as if the P Group had almost reached the level of asymptotic performance, whereas the N Group still seemed to be improving by the 20th trial.

No statistical tests were performed on these data. First, we know no appropriate statistical tests that could be used with these data to test for the interaction effects between practice and type of instances, which seems to be strongly suggested by the data. Secondly, in view of the regularity of the median curves, the conclusion that the difference between positive and negative instances depends on the amount of practice the subjects have had, seems quite reasonable even without any tests.

Discussion

There are two main findings in this study and we shall briefly examine them in turn. First, a subject's ability to solve concept identification problems (ability to think?) is very greatly affected by practice. This is true for both positive and negative instances. With median time to solution as the dependent variable the performance of both relatively small samples used in this study improved approximately by a factor of 20, over something like an hour's practice. In view of such huge practice effects it is very surprising that workers in the field of concept formation have neglected this aspect of the general problem. We are aware of only one paper in which improvement in ability to solve problems of the same general type has been shown to improve with practice (Archer, Bourne, & Brown, 1955), but even that finding was incidental to the authors' main interest in the effect of irrelevant information and instructions.

This experiment sheds no light on the problem of how these practice effects are mediated. It may be that continued exposure to the stimulus cards and repeated attempts at solution bring about a certain kind of perceptual reorganization or establish a different perceptual set, but at the present stage of our ignorance this is entirely a matter of conjecture. Psychologists in general know little about the mechanism of perceptual learning (Drever, 1960), and the problem of practice effects in cognitive processes is usually not even mentioned (Leeper, 1951), let alone understood.

The second main finding of this experiment pertains to the effectiveness of positive and negative instances. Although during the early stages of practice the subjects seemed much less capable of assimilating information from negative than from positive instances, the difference was very much smaller at the end of 20 trials. Thus these data both confirm and to a certain extent circumscribe Hovland and Weiss' conclusions. Positive instances in a concept identification task are used more efficiently than negative ones by subjects who are relatively unsophisticated with respect

to concept identification tasks, but for more practiced subjects the *nature* of the information concerning concepts seems to be less relevant and presumably only the *amount* of information is important. This finding is entirely consistent with the view that the initial difference between positive and negative instances reflects transfer effects from previous learning of concepts outside the laboratory.

It is conceivable, considering the trend of data in Figure 1, that with additional practice the remaining small difference would disappear. It is equally possible, of course, that even at the asymptote positive instances would retain a small but significant advantage over negative ones. This clearly is a problem for future experiments. Until the role of practice on utilization of positive and negative instances has been more carefully investigated, however, it would seem somewhat premature to be overly concerned with the effect of other variables on the apparent difference.

Summary

A series of concept identification problems was given to two groups of Ss in order to determine the effect of practice on utilization of positive and negative instances in attaining concepts. One group worked with only positive instances, the other with only negative instances. Considerable improvement in performance was found for both groups during the practice period. While the performance of the positive group was markedly superior at the outset, by the end of 20 trials the two groups were quite similar in their median performance. The findings suggest that the effectiveness with which Ss can handle both positive and negative instances in concept attainment depends on the amount of previous practice on similar tasks.

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