Loss of concept identification in children with change in irrelevant facial features

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In Experiment I, first and fourth graders were shown pictures of faces. Shapes of ears (relevant features) and of eyes and moustaches (irrelevant features) varied orthogonally. The task was to identify the faces according to the shape of the ears. In transfer, old or new shapes of eyes, ears, and moustaches varied independently over trials. Loss of discrimination was expected with new eyes and moustaches, and a greater loss with eyes, designated critical features (CF), than with moustaches, noncritical features (NCF). In Experiment II, first, fourth, and sixth graders were given the same task as in Experiment I. Half of each group was given 24 trials beyond criterion in acquisition. In both experiments, errors in identifying old ears increased significantly with age and with new CF and NCF. With additional training introducing one irrelevant feature increased errors more when the second one was also changed. No differential CF and NCF effects were found. The findings were consistent with a prototype model.

A controversy has arisen around the question of whether individuals acquire concepts by abstracting only distinctive relevant features, as suggested by Gibson (1969) or through the formulation of a schema or prototype which includes irrelevant aspects as well. Evidence for Gibson's distinctive-feature hypothesis (1969) was given in a study by Pick (1965). She found that when children were trained to make discriminations based on the transformations of letter-like forms, transfer was better with new forms and the same transformations than with old forms and new transformations. However, in a replication by Caldwell and Hall (1970), children performed better with the same letter-like forms and new transformations, thus providing some support for a prototype model.

The present study was designed to further determine the extent to which irrelevant aspects of the stimulus form part of concept learning in children. The study is concerned with systematic investigation of substitution of different values of an irrelevant dimension during transfer on concept loss. Pictures of faces were presented and children were required to identify them by the shape of the ear. Shapes of eyes and moustaches also varied but were irrelevant to identification. During transfer, shapes of eyes and ears were either the same as

in acquisition or were changed. If children are responding to the relevant facial features alone, then change in the irrelevant features would have no effect on performance once this concept is acquired. If the children are responding to a prototype, then change in the irrelevant features should depress performance. Since eyes are always part of the facial schema, it is expected that eyes would be more critical than a moustache to the definition of the faces. Therefore, change in the eyes would be more detrimental to performance than change in the moustache.

It was also expected that if there were a change with age in mode of concept learning, older children would respond less to irrelevant features than younger children and that older children would be more influenced by critical-feature than non-critical-feature change. Younger children would be influenced by any change in facial features.

EXPERIMENT I

Method

Subjects. Sixteen first graders and 16 fourth graders were randomly selected from the Josiah Haynes Elementary School in Sudbury, Massachusetts.

Stimulus materials. The faces were cut-out features of black construction paper pasted on poster board. Two different shapes (constituting a set) of eyes, ears, and moustaches, orthogonally combined, resulted in eight different faces for acquisition. Shapes of all other features remained constant. During transfer, new sets of eyes and moustaches, as well as the old sets, were presented. There was one new pair of ears in addition to the old set.

Design. The first and fourth grades constituted the between-subject variable (Age), and the remaining were within-subject variables. On any transfer trial, the presence of a pair of eyes from the old or the new set constituted two levels of the critical-features variable (CF). The presence of a moustache from the old or new set constituted the two levels of the non-critical-features variable (NCF). Any one transfer trial contained one of the two pairs of ears within the old set or a new pair of ears. The above features were orthogonally combined to define a face on any one

The authors thank D. Minta Notini, Joseph Foley, Jr., Helen Lenane, Timothy Nichols, Beverly McGovern, Dennis Giombetti, William Craig, and Sarah Clark, who aided in the collection of the data reported, and Leonard Flynn, who assisted in computer programming of the data. The authors also wish to thank the administrators, teachers, and students of the following elementary schools in Framingham, Sudbury, Natick, and Marlboro, Massachusetts: Centre School, St. Bridget's School, The Immaculate Conception School, and The Josiah Haynes School. A portion of this paper was presented at a meeting of the Eastern Psychological Association, New York, New York, 1975. Requests for reprints should be sent to Lorraine A. Low, Psychology Department, Framingham State College, Framingham, Massachusetts 01701.

transfer trial. The design was a 2 (Age) by 2 (CF) by 2 (NCF) mixed factorial.

Procedure. The eight faces in acquisition were randomly assigned to trials with the restriction that any block of eight trials contained all faces. Each child was given 24 acquisition trials and those children who did not reach the criterion of six correct out of the last eight trials were eliminated. During acquisition, the child was informed of all the facial features that varied and instructed to guess which facial feature was relevant by naming one set of faces "Bill" and the other "Sam." The task was therefore to identify the faces on the basis of the shape of the ears alone. The child was informed immediately following his response whether he was correct.

During transfer, each of the four conditions—old CF and old NCF, old CF and new NCF, new CF and old NCF, new CF and new NCF—was assigned randomly to a trial with the restriction that each condition was presented on each block of four trials. Within each condition, the particular pair within a set of features was assigned randomly. Each of the three pairs of ears (the old set and one new pair) was assigned randomly to a transfer trial. A total of 48 transfer trials were given; each trial contained a different combination of features.

In transfer, the child was told that he would be seeing some old faces and some new faces, and that he was to call the face Bill or Sam exactly as he had done before. He was also informed that some of the new faces would be Bill or Sam and some would be neither Bill nor Sam. He was instructed to call the faces that were neither Bill nor Sam "Neither." He was informed of the correct response after each trial.

Results and Discussion

Acquisition. The number of correct responses in identifying Bill and Sam ears out of the total number of acquisition trials was the response measure. An analysis of variance indicated that Age was not statistically significant [$F(1,30) = 2.78$, n.s.].

Transfer. The total number of errors in identifying Bill or Sam out of 32 trials was the response measure. The mean number of responses for each age and each of the four stimulus conditions is presented in Figure 1. An analysis of variance indicated that Age was statistically significant [$F(1,30) = 4.22$, $p < .05$, $MSe = 9.86$], as was the CS effect [$F(1,30) = 4.28$, $p < .05$,

$MSe = 1.33$] and the NCF effect [$F(1,30) = 5.75$, $p < .05$, $MSe = .99$]. It can be seen in Figure 1 that number of errors decreased with age and increased with new eyes and new moustaches. The CF and NCF main effects demonstrate that the children were responding to the irrelevant features, thus providing support for a prototype model.

EXPERIMENT II

One aim of Experiment II was to extend the age range tested. A variable involving two levels of training was also introduced to determine whether the additional training might influence the style of responding.

Method

Subjects. Twenty children from each of the first, fourth, and sixth grades were randomly chosen from local elementary schools.

Stimulus materials. The stimulus materials were the same as in Experiment I.

Design. The first between-subject variable, Age, consisted of the three grade levels, first, fourth, and sixth. Half of each grade level received the same number of acquisition trials as in Experiment I; the other half received twice that number. Training was the second between-subject variable. The within-subject variables CF and NCF were the same as in Experiment I. The design was a 3 (Age) by 2 (Training) by 2 (NCF) mixed factorial.

Procedure. The children in regular training received 24 acquisition trials; those in overtraining received 48 trials. For both groups, the criterion for inclusion was six out of eight correct on the first 24 acquisition trials. In other respects the procedure was identical to that in Experiment I.

Results and Discussion

Acquisition. The number of correct responses in the first 24 trials did not differ significantly for Age [$F(2,54) = 1.53$, n.s.] or for Training [$F(1,54) = .056$, n.s.].

Transfer. The total number of errors was computed for each child and an analysis of variance was performed on the data. Age was statistically significant [$F(2,54) = 5.74$, $p < .01$, $MSe = 11.73$], indicating a systematic decrease in errors with age. The mean number of errors for regular training and overtraining over the four stimulus conditions is given in Figure 2. Differences associated with CF were statistically significant [$F(1,54) = 10.06$, $p < .01$, $MSe = 1.25$], as well as NCF [$F(1,54) = 10.00$, $p < .01$, $MSe = 1.17$]. Substituting new eyes or a new moustache during transfer increased the number of errors. Training was not statistically significant [$F(1,54) = .043$, n.s.]. The only statistically significant interaction was Training by CF by NCF [$F(1,45) = 4.74$, $p < .05$, $MSe = 1.20$]. It is evident from Figure 2 that the CF by NCF interaction can be attributed to the overtraining condition. These results indicate that increasing acquisition trials strengthened the negative effect of change in the second irrelevant feature when the first one was changed.

The findings in Experiment II essentially paralleled those of Experiment I. One important additional finding in Experiment II was the Training by CF by NCF

Figure 1. Mean number of errors in identifying Bill and Sam ears for first and fourth graders in each of the four transfer conditions in Experiment I.

Figure 2. Mean number of errors in identifying Bill and Sam ears for the two training conditions in each of the four transfer conditions in Experiment II.

interaction. This result indicates that additional training, when it does have an effect, serves to strengthen the importance of change of irrelevant features on performance. It appears that with increased training, when one irrelevant feature was changed, the child relied on the second irrelevant feature to determine Bill and Sam. When both features were changed, discrimination suffered.

GENERAL DISCUSSION

The findings in both experiments give strong support to the hypothesis that the prototype contains elements which are

irrelevant to the immediate solution of the problem. It was found that change in the irrelevant features during transfer did produce a marked decrement in identifying Bill and Sam. The failure of Age to interact with CF and NCF in either experiment provides evidence that at all ages sampled in this experiment, the children were forming prototypes. Moreover, the effect of overtraining was to magnify the number of errors in identifying Bill and Sam with new critical and noncritical features. Therefore, additional trials served to strengthen the prototype which included irrelevant features.

If, as the study has demonstrated, irrelevant features are included in the prototype, then the basic question must be raised as to which irrelevant stimuli are *not* included. It was agreed that since the eyes are invariant in determining a facial configuration whereas the moustache is not (it may or may not be present), the former, but not the latter, would be critical in the formation of the prototype. The failure of the critical-noncritical distinction to be significant weakens this argument. However, it is possible that other variables such as the salience of the moustache in the present study might have obscured any differential weighing.

The more general argument—that those irrelevant stimuli that remain invariant tend to form part of the prototype with a higher probability than those features which vary during acquisition—remains to be explored.

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(Received for publication August 4, 1976.)