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EFFECTS OF DISCRIMINATION AND REPRODUCTION TRAINING ON ABILITY TO DISCRIMINATE LETTER-LIKE FORMS.

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THE EFFECTIVENESS OF TWO TRAINING METHODS TO FOCUS ATTENTION ON THE CRITICAL FEATURES OF LETTER-LIKE FORMS WAS STUDIED. SUBJECTS WERE 32 KINDERGARTEN PUPILS. SIX NONSYMETRICAL, STANDARD LETTER-LIKE FORMS AND FOUR TRANSFORMATIONS, CONSISTING OF RIGHT-LEFT AND UP-DOWN REVERSALS, 180 DEGREES AND 90 DEGREES ROTATION, WERE USED AS STIMULI TO LEARNING. VISUAL MEMORY AS AN APPROXIMATION OF THE PERCEPTUAL TASKS IN READING WAS USED WITH THREE GROUPS FOR DISCRIMINATION TRAINING. A FOURTH GROUP RECEIVED REPRODUCTION TRAINING REQUIRING THE TRACING AND COPYING OF EACH STANDARD FORM. ANALYSES OF PERFORMANCE ON THREE TESTS INDICATED THAT REPRODUCTION WAS NOT AS EFFECTIVE AS DISCRIMINATION WITH TRANSFORMATIONS. THE RIGHT-LEFT REVERSAL WAS THE MOST DIFFICULT OF THE FOUR TRANSFORMATIONS. TRAINING INVOLVING THE COMPARISON OF LETTERS WITH THEIR TRANSFORMATIONS WAS SUGGESTED FOR KINDERGARTEN PUPILS. TABLES ARE INCLUDED. THIS PAPER WAS PRESENTED AT THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION CONFERENCE (CHICAGO, FEBRUARY 6-10, 1968). (MC)

AERA

Effects of Discrimination and Reproduction Training on Ability to Discriminate Letter-Like Forms*

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To learn to differentiate and recognize letters is one of the primary steps in learning to read, and this task is often a major source of difficulty in reading instruction. Some letters are merely rotations and reversals of others, for example, lower case b and d, and p and q. It is these letters, of course, that produce the most confusion and difficulty.

Many practice materials have been designed to handle this problem. Some stress discrimination training--matching-to-sample and sorting pictures, symbols, or actual letters--whereas others emphasize reproduction training of some kind, usually either tracing or copying. Reading methods themselves vary as to the emphasis placed on instruction in writing.

There is little empirical evidence as to the relative effectiveness of discrimination training and reproduction training, and it is difficult to make rigourous predictions from theory. It is generally held that one should train directly the behavior which is to be tested. According to this principle, training in discrimination should be given if the criterion is some type of recognition skill. On the other hand, it can be argued that increasing the degree of active participation, by requiring the subject to reproduce the material in some manner, might lead to superior performance even on a recognition task.

Gibson has hypothesized that improvement of visual discrimination depends on learning the distinctive features of the forms to be discriminated, that is, those dimensions of difference that distinguish the stimuli. Precise specification of the critical features of letters of the alphabet, of course, will be a difficult task.

The present experiment is concerned not with the nature of the critical features themselves, but rather with the effectiveness of different training methods in ensuring that attention is focused on the features, whatever they may be. Maccoby suggested in a 1965 paper that a subject must take account of more attributes of a form in order to reproduce it than to discriminate it from other forms. While she presented no data directly relevant to the question of training, it seems likely that reproduction training could produce better recognition of forms because it would force one to attend to more criterial attributes. That is, if the subject must abstract more distinctive features in order to solve the training

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task, he then will have available more cues for the new discriminations presented in testing.

Furthermore, whether or not reproduction training forces closer attention to the stimuli is likely to depend on the similarity of the standard and the other stimuli from which it must be distinguished. For example, there are few critical features that differentiate between two very similar stimuli. During training, while the subject is attempting to hit upon a feature that is a distinctive one, he will focus on many features, and will be more likely to abstract faatures which are critical for differentiation of the standard in a different test situation.

32 kindergarten pupils were used as subjects in this experiment. They were tested during the first month of the school year.

The stimuli consisted of 6 nonsymmetrical letter-like forms, modified from those designed by Gibson, to follow the constraints of printed upper case capitals. Four transformations of these standard stimuli were also used: right-left reversal, up-down reversal, 180° rotation, and 90° rotation. Twelve additional stimuli were also used, different from the six standards but constructed according to the same set of rules. These forms were printed on 5" x 8" cards.

The discrimination training consisted of a delayed matching to sample task, in which the subject was asked to identify the standard after it was removed from view. This visual memory task was used because it approximates the perceptual learning tasks involved in actual reading more closely than does simple discrimination training.

Three of the six standards were placed in an array in front of the subject. (Half the subjects were shown three of the standards, chosen randomly from the six (the first 3 on the handout), and the other subjects were shown the other three.) Twelve cards, on each of which were two forms (one of the standards and another form) were presented. The subject's task was to choose the form on each card which was exactly the same as one of the three standards. When the child made a correct choice, the experimenter praised him and gave him a small star. A correction procedure was used. The presentation of all twelve cards constituted one training trial. There were five such trials, with the cards presented in a different random order on each trial. The total time taken for the five trials was recorded for each subject. There were 3 discrimination training groups, with 8 subjects in each group. These 3 groups differed as to the type of comparison stimuli used:

In Group 1, the comparison stimuli were the right-left reversal and 180° rotation transformations of the standards.

In Group 2, the comparison stimuli were the up-down reversal and 90° rotation transformations.

In Group 3, the comparison stimuli were dissimilar forms, that is, different from those used as the standards.

The fourth and final group was given reproduction training. There were 8 subjects in this group. The three standards were presented in an array as in the discrimination training. However, no other forms were presented. The subject was asked to trace (twice) and copy (three or four times) each standard. The training time for each individual subject in this condition was matched with the time taken by a subject in one of the discrimination training groups.

A series of three tests was administered immediately upon the completion of training, and the same series of tests was repeated 24 hours later. Test 1 consisted of a series of cards, on each of which was drawn two forms, one standard and one other. Each of the three standards was presented four times paired with totally dissimilar forms, and once with each of its four transformations. Thus, all comparison stimuli used in all three discrimination training groups were represented in the test. The subject was required to point to the standard on each card. No knowledge of results was given on this or any of the tests.

In test 2, each item consisted of two sets of three forms, presented in the form of three-letter words. The medial position of one set contained one of the standards, and the medial position in the other set contained a transformation of that standard or a dissimilar form. The initial and final forms in the two sets were stimuli that had not previously been seen by the subject. The subject was required to choose the set that contained the standard.

In test 3, the subject had to choose a pair of forms that was made up of two standards, when the comparison stimulus was a pair containing one standard and one transformation.

Performance on each of the three tests, as measured by number of errors, was analyzed as a function of the training conditions, the particular set of standard stimuli to be discriminated, and the time of testing. On all three tests, differences among training methods were significant at the .05 level. Performance did not differ as a function of the particular training standards used, and there were no differences between performance on the original test and the retest. None of the interactions reached significance.

The next analysis concerned differences among training methods as a function of the type of transformation with which the standard was compared. Each of the three tests was analyzed separately. Because there were no significant differences between first testing and retesting, these scores were combined. There were practically no errors on those test items where comparison stimuli were totally dissimilar from the standards, so these items were excluded from the analysis. The two tables in the handout present the mean number of errors as a function of type of training and type of transformation, and a summary of the analysis of variance. Please note that Groups 1 and 2 are labelled D_1 and D_2, Group 3 is S, and Group 4 is R.

Type of training was a significant variable, of course. Specific comparisons on Test 1 indicated that Groups 1 and 2, the transformation training

groups, did not differ, but they were significantly superior to Group 3 (dissimilar forms) and the reproduction training group, Group 4 The latter two groups did not differ Exactly the same pattern was seen on the other tests The other main effect, type of transformation, also was significant on all three tests. There was no interaction.

As predicted, then, discrimination training in which the comparison stimuli were transformations was superior to discrimination training where the comparison stimuli were totally different forms. This suggests that the comparisons involving minimally different stimuli did force the subject to attend to and abstract more attributes of the standard, which were then available for new test comparisons. Reproduction training was not as effective as discrimination with transformations, but was as effective as the simple discrimination training. Thus, it is suggested that the number of attributes that will be abstracted by reproduction training as compared to discrimination training does indeed depend on the similarity of the forms used in the discrimination training.

Further analysis was done in order to assess the differences among the various transformations. The proportion of errors made on each of the four transformations was computed for each of the six standards individually. There was indeed a reliable difference among the transformation types. Specific comparisons showed that the right-left reversal was more difficult than the other three transformations, which did not differ among themselves.

The fact that the right-left reversal was more difficult than the other transformations corroborates other findings, for example, those of Gibson. However, the difficulty of specific transformations did vary as a function of the particular stimulus: transformations other than the right-left reversal were distinctly more difficult for two of the six standards. The Gibson conclusion that the transformation types are more important as "predictors of identifiability" than are the characteristics of the standard itself does not seem warranted, on the basis of the present study. It might prove instructive to analyze a set of stimuli in order to specify the variables that determine the order of difficulty of the transformations.

It should be noted that only a rather small amount of training was given in this experiment, and yet there were significant differences among the training groups. This fact suggests that the effectiveness of readiness training does indeed depend on the particular techniques used, and that there would be wide variation in the effectiveness of typically-used readiness materials. The present experiment suggests (1) that a substantial amount of time be devoted to discrimination training that involves comparison of letters with their transformations, and (2) that this type of training might profitably be given at the start of the kindergarten year.

As a postscript, I should like to add that we are not yet ready to write off reproduction training as ineffective. Preliminary inspection of data from a study similar to this one, working with younger children, indicates--tentatively-- that reproduction training will prove at least as effective as the discrimination-with transformations training conditions. Moreover, data collected

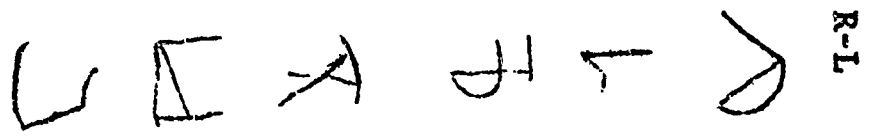
on children who had completed about two-thirds of a year in kindergarten shows reproduction training to be inferior to <u>any</u> discrimination condition. If these findings do in fact hold up, it will give further support to the notion that at early ages, one useful way of ensuring that the subject attends to the critical features of the stimulus is through reproduction training.

J. P. Williams
AERA, February , 1968

STANDARDS

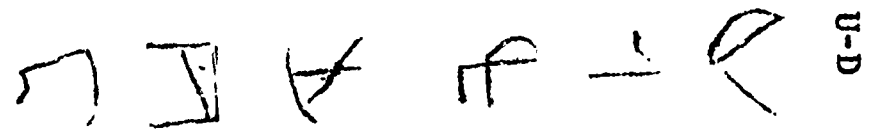
1 2 3 4 5 6

R-L



TRANSFORMATIONS

U-D



90°

180°

Table I

Number of Errors as a function of Type of Training and Type of Transformation

Transformation	Group D-1 Test & Retest 1	Test & Retest 2	Test & Retest 3	Group D-2 Test & Retest 1	Test & Retest 2	Test & Retest 3
R-L	20	20	21	14	17	23
U-D	9	15	16	10	9	15
90°	5	10	7	5	4	5
180°	11	8	8	6	11	13
	Total D-1 - 150			Total D-2 = 132		

	Group S Test & Retest 1	Test & Retest 2	Test & Retest 3	Group R Test & Retest 1	Test & Retest 2	Test & Retest 3
R-L	23	25	21	24	19	20
U-D	19	20	26	14	15	229
90°	21	19	18	15	16	7
180°	16	21	21	11	20	20
	Total S = 230			Total R = 211		

Table Ia

Analysis of Variance of Number of Errors on the Three Tests

Source	df	Test & Retest 1		Test & Retest 2		Test & Retest 3	
		ms	F	ms	F	ms	F
Type of Training (A)	m 3	12.21	4.92**	11.61	8.65**	8.20	3.78*
Error (b)	28	2.48	--	1.39	--	2.17	--
Transformation Type (B)	3	9.02	7.05**	5.65	3.12*	16.76	9.29**
A x B	9	1.04	<1	1.05	<1	2.41	1.32
Error (w)	84	1.28	--	1.81	--	1.82	--

*$p<.05$
**$p<.01$