DOCUMENT RESUME

ED 040 011 RE 002 718

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TITLE Visual Recognition Memory, Paired-Associate Learning, and Reading Achievement.
PUB DATE Mar 70
NOTE 16p.; Paper presented at the American Educational Research Association conference, Minneapolis, Minn., Mar. 2-6, 1970

EDRS PRICE EDRS Price MF-$0.25 HC-$0.90
DESCRIPTORS *Associative Learning, Intelligence, *Memory, *Paired Associate Learning, *Reading Ability, Recognition, *Visual Learning, Visual Perception

ABSTRACT

The relationship between visual recognition memory and performance on a paired-associate task for good and poor readers was investigated. Subjects were three groups of 21, 21, and 22 children each, with mean IQ's of 98.2, 108.1, and 118.0, respectively. Three experimental tasks, individually administered to each subject, measured visual recognition memory (VRM), paired-associate learning (PAL), and association ability (PA). The Gibson letter-like stimuli were used in the VRM and PAL tests, and colors were used with vowels in the PA test. A 2x3 analysis of variance on the PAL data indicated that visual recognition memory was a significant main effect. This result supported the hypothesis that children with high visual recognition memory will do better on a PAL task than children with low visual recognition memory. Visual recognition memory was found to be independent of IQ, and as hypothesized, good readers scored higher on the VRM tasks than did poor readers. However, differences between good and poor readers on the PA and PAL tasks were not found. Tables and references are included. (Author/CM)

Visual Recognition Memory,
Paired-Associate Learning, and Reading Achievement[1]

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1 Paper read at American Education Research Association Annual Convention; Minneapolis, Minn.; March 2-6, 1970.

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The early stages in learning to read resemble paired-associate learning (PAL) in which oral responses have to be associated with visual stimuli. Investigators who have studied reading achievement and PAL have typically found a strong positive relationship between the two (Otto, 1961). Across the variety of paired-associate (PA) tasks employed, it has been suggested that poor readers have trouble with reading because of their difficulty in associating responses with stimuli, i.e., they have low association ability. Such an interpretation ignores other components of the PA task which may be contributing factors in low reading achievement.

Models of PAL have gone through a series of changes. For a long time it was thought that PAL could be explained by a single stage, the association of a stimulus with a single response. More recently, Underwood and Schultz (1960, p. 271) described PAL as a two stage process. The first stage required that the response become readily available in that the subject (S) is able to recall it. Stage two consists of associating the response with the stimulus. McGuire (1961) separated the PA process into three components, stimulus learning, response learning, and stimulus-response association.

Expanding on the concept of stimulus learning, both Bernbach (1967) and Martin (1967) have demonstrated with adults that PA performance is determined by S's ability to recognize the PA stimuli as having been previously encountered in the PA task. If S does not recognize a PA stimulus as one which he has seen before in the list, the probability of his giving the correct response is at the chance level regardless of how many times he has given the correct response to the stimulus on previous trials.

Money (1966) suggests that one factor which may be associated with low reading achievement is poor visual memory. Benton (1962) claims that every case of "specific dyslexia" has shown some degree of visual form agnosia (loss of ability to recognize objects in the visual field). Rabinovitch (1962) has stated that visual recognition memory is an important factor in reading, and that disabled readers are deficient in this component. None of these claims regarding reading disability have been supported by empirical data.

The two hypotheses to be tested stem from the findings of Bernbach and Martin as well as the ideas of Money and Rabinovitch. First, it is hypothesized that children with high Visual Recognition Memory will do better on a PA task which simulates the learning to read process than will children with low Visual Recognition Memory. Second, it is hypothesized that poor readers are weaker in Visual Recognition Memory than are good readers, and that this difference will manifest itself in PA tasks which require S to recognize initially unfamiliar stimuli.

Method

Subjects. Sixty-four second-grade children were selected from a suburban public school by use of a stratified random sampling procedure with intelligence the blocking variable. Three groups of 21, 21, and 22 children resulted with mean IQs of 98.2, 108.1, and 118.0 respectively as measured by the California Test of Mental Maturity (CTMM). Each of the Ss had recently been given the California Achievement Test (CAT). The Vocabulary and Comprehension subtests of the CAT yielded grade placement scores for correlational analysis. The teachers' reading group assignments within the classroom were used to split the entire sample into Good Readers and Poor Readers. The large differences between the grade levels of these two groups on Vocabulary and Comprehension in favor of the Good Readers indicates that the teachers' judgments of reading ability were good. As seen in Table one, the difference between the reading achievement scores for the good and poor readers was significant at the $p < .01$ level.

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Insert Table 1 here

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Materials and Procedure. Three experimental tasks were individually administered to each S measuring Visual Recognition Memory, PAL, and Association Ability. The tasks will be described in the order in which they were presented to each S.

Careful attention must be given to the nature of the visual stimuli used in the experimental tasks. They must share the physical properties of letters, but they cannot be letters or other stimuli which are familiar or easily identified. The Gibson (1962) letter-like stimuli were used in the Visual Recognition Memory and PAL tasks to meet these requirements. It is important also that the stimuli used to measure PAL be chosen from the same population as the stimuli used in the Visual Recognition Memory task, but they must not be identical to them.

The Visual Recognition Memory task was composed of a series of Gibson letter-like forms (See Figure 1) to which S had to indicate whether or not he had seen a

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Insert Figure 1 here

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particular form before in the list. The series began with six standards shown on 3 x 5 cards at a rate of one every three seconds. Then, without interruption, the six standards and five transformations in a random order were presented to S. His response was made by pointing to a card which indicated whether or not he recognized a form as one he had seen before. This procedure was repeated for a total of six trials, using the same standards with different transformations on each trial. A practice session with simple visual stimuli was held to insure familiarity with all required procedures.

The PA task which measured association ability used colors as the stimuli. These colors were red, blue, green, yellow, and orange, each one drawn on a 3 x 5 card, and the responses were the five vowels. Only one set of color-vowel combinations was used, although some effort was made to avoid combining a color with a vowel which either began the color word or was said if the color was named. Ten trials were given at a 3:3 rate, with a different sequence of the set used on each trial and no color was presented twice in sequence. This task was given on the same day approximately two hours after the Visual Recognition Memory task was administered. The investigator administered both the Visual Recognition Memory and Association Ability tasks to all Ss.

In order to insure that the results from the PAL tasks were not unique to the particular stimuli used, three different sets of stimuli were used with approximately 20 children taking each one. Each PAL task was composed of four Gibson figures (See Figure 1) presented on 3 x 5 cards at a 2:2 rate. The responses were the CVCs "Bat," "Cup," "Dog," and "Pen." To minimize the need for response learning on the PAL task, the Ss had to say the responses to two consecutive perfect trials before the PAL task was begun. Immediately following this, the PAL task was given. Criterion was reached after three consecutive correct trials or twenty total trials, whichever came first.

Design. In order to insure that PAL differences are only due to differences in Visual Recognition Memory, differences in response learning and association ability must be controlled. The former can be controlled experimentally by using well-known responses such as "Bat" and "Cup" in the PAL task, and the latter can be controlled statistically by giving a second PA task (Association Ability) with stimulus and response learning minimized, thereby yielding a measure of association ability which can then be used as a covariate in the analysis.

To test the hypothesis that Visual Recognition Memory is important in PAL with elementary school children, a 2 x 3 analysis of covariance was run with Visual Recognition Memory and Intelligence the independent variables, Association Ability the covariate, and PAL the dependent variable. The three levels of IQ correspond to the three levels used in the stratified random sampling procedure, and the two levels of Visual Recognition Memory were created by splitting the Ss into those who had obtained a score on the Visual Recognition Memory task which was significantly greater ($p < .05$) than chance (Visual Recognition Memory > 46, $N = 42$), and those whose score was at the chance level (Visual Recognition Memory ≤ 46, $N = 22$).

Results

The original plan was to use Association Ability as a covariate in the analysis of the PAL task data. However, this plan had to be discarded because Association Ability was not independent of either Visual Recognition Memory ($r = .26$, $p < .05$) or IQ ($r = .25$, $p < .05$). This makes Association Ability an inappropriate covariate because it violates the assumption in analysis of covariance that the covariate be independent of the treatments. The correlation between Visual Recognition Memory and Association Ability should have been anticipated for it was naive to assume that any PA task could be designed where the need to recognize the stimuli, no matter how familiar or well-known, has been eliminated.

A 2 x 3 analysis of variance on the PAL data indicated that Visual Recognition Memory was a significant main effect ($F = 4.06$, $df = 1/50$, $p < .05$). This result supported the first hypothesis that children with high Visual Recognition Memory will do better on a PAL task than children with low Visual Recognition Memory.

A comparison of the Good and Poor readers on IQ and the experimental tasks is given in Table 1. As expected, Poor Readers had lower mean intelligence than Good Readers. Consistent with the second hypothesis, Good Readers scored higher on the Visual Recognition Memory task than did Poor Readers, keeping in mind that Visual Recognition Memory was independent of IQ. One of the more interesting findings of the investigation was the failure to find differences between Good and Poor Readers on the Association Ability and PAL tasks. It had been hypothesized that if Good Readers were higher in Visual Recognition Memory than were Poor Readers, as the data showed, this difference would manifest itself in PA tasks where the stimuli were initially unfamiliar to S, that is, where the stimulus learning component of the PA task is important. As Table 1 shows, in the Association Ability task where the stimuli are very familiar, the difference between Good and Poor Readers is virtually nonexistent. However, in the PA task where the stimuli are unfamiliar, the difference between the Good and Poor Readers is very large. When IQ differences are controlled, the adjusted means are still 54.8 for Poor Readers and 68.3 for Good Readers.

Comparisons were made between the transformations to find out which ones were the most bothersome for the Ss. Table 2 shows the results of the comparisons for the Visual Recognition Memory task, the PAL task, and Gibson's original discrimina-

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Insert Table 2 here

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tion (match-to-sample) task. The Visual Recognition Memory task data reflect the Ss' tendency to say that a transformation was something they had previously seen in the list. The PAL data reflect the Ss' tendency to associate a response with a stimulus which would have been appropriate for the given transformation of the stimulus. As can be seen, there is a consistent trend among the orientation transformations for them to rank, in order from most easily confused to least easily confused, Up-Down (U-D) first, Left-Right (L-R) second, and 180° rotation (180°) third. As expected, the difficulty of the line-to-curve transformations was related to the similarity between the standard and the particular transformation used. However, there was no difference in the proportion of line-to-curve errors to total transformation errors made by Good and Poor Readers. ~~although the Poor Readers made significantly more transformation errors than the Good Readers.~~ There was no relationship between the ease with which a standard was recognized and the ease with which its transformation was identified (Rank Order Correlation Coefficient, $r = .07$).

Discussion

The first hypothesis that Ss with high Visual Recognition Memory will do better on a PA task which simulates the learning to read process than will Ss low in Visual Recognition Memory was supported.

The fact that Good Readers did better on the Visual Recognition Memory task than did Poor Readers suggests that Visual Recognition Memory may be an essential component in learning to read. The question can be raised as to where the Poor Readers have their difficulty, in recognizing stimuli previously seen, or in confusing new but similar stimuli for previously-seen stimuli. For example, it is possible that the Poor Readers, after being told that a "b" is "bee," are more apt than are Good Readers to not recognize it when seen again moments later, or they may be more apt to see a similar letter (e.g., "p" or "d") and think they are seeing the "b" that they just saw. The Visual Recognition Memory task results indicate no significant difference between reading groups in their ability to identify new stimuli as new, but a large difference in favor of the Good Readers in their ability to recognize previously-seen stimuli. In terms of percentage of correct response, the percentages actually favor the Poor Readers for the transformation stimuli (67.0% v. 65.8%, $p > .10$), but greatly favor the Good Reader for the standard stimuli (84.4% vs. 76.0%, $p < .01$). The comparison just cited between Good and Poor Readers performance on the VRM standards is the more interesting of the two comparisons because it is more closely related to the beginning to read process. Reading requires a S to recognize repeated stimuli, but does not require him to identify stimuli which are similar to those he must recognize.

Gibson (1965) has proposed that good readers are good readers because they pay attention to and encode the distinctive features of written symbols (letters, words) used when reading. When a good reader encounters a written symbol, he is able to note the distinctive features of the symbol which he then uses at a later encounter to trigger the response which was associated with it.

Martin (1968) has formulated a Variability Encoding Hypothesis which can also be used to explain the results from the Visual Recognition Memory standards. His hypothesis is that a S is able to recognize a stimulus because he has encoded it consistently, i.e., the way he encoded it on the successful recognition trial is the same as the way he encoded it on his previous encounter with the stimulus. He speculates that recognition amounts to searching memory for a representation or tag which matches the one from the stimulus currently under consideration. If no match is found, there can be no recognition. Gibson's and Martin's positions appear to complement each other, with Gibson suggesting the aspects of the stimulus which are used by S and Martin suggesting how those aspects are used to effect a recognition. In other words, it is hypothesized that Good Readers are better than Poor Readers in their ability to note the distinctive features of written symbols and in their ability to consistently encode them in memory.

It is difficult to say what accounts for the equality of Good and Poor Readers on the Visual Recognition Memory transformation. Since each S was told to say "It's new" whenever he saw a stimulus which was not among the original six, it was expected that those S's who easily recognize standards would do better identifying the transformations than would those who had difficulty recognizing the standards. This expectation was based on the assumption that accurate identification of a transformation requires accurate encoding of its standard, and that the better is S's knowledge of the standards, the better is his performance on the transformations. One possible explanation for the actual results is that Poor Readers had a bias toward saying "It's new," thereby increasing their percentage correct for new stimuli and decreasing their percentage correct for old stimuli. Unfortunately there is no way in this study to separate response bias from sensitivity to stimuli differences.

At any rate, it is hard to see how differences in the Visual Recognition Memory task alone can account for the large difference between the two reading groups on the PAL task. Recall that the Good and Poor Readers did not differ significantly on the Association Ability task even though there was a small component of Visual Recognition Memory in the Association Ability task which should have given the Good Readers a slight advantage. Even with IQ differences partialled out, it would seem that some additional or different abilities are being tapped by the PAL task which were not tapped by the Visual Recognition Memory and Association Ability tasks, and in which the Good Readers excel over the Poor Readers.

A glance at the two tasks may provide the answer. In the Visual Recognition Memory task the standard stimuli, on which the Good Readers showed their superiority, were quite dissimilar from each other. On the PA task the four stimuli, which were "standards" in the sense that they were repeatedly presented, were very similar to each other. Apparently Poor Readers had a difficult time consistently encoding the distinctive features (viz., their orientation) of these stimuli. The question of whether this difficulty would be found if the PA stimuli had been similar on non-orientational dimensions (e.g., line-to-curve) remains unanswered. The answer to this question would have been available if an additional PA task which used line-to-curve transformations of similar standards had been used.

It is interesting to note that the relative number of errors involving the three orientational transformations was the same for both the Visual Recognition Memory and PAL tasks, with U-D confusions being most common and 180° confusions being least common. This rank order is the same as that from the Gibson et al. (1962) investigation, indicating that discrimination and recognition memory tasks have something in common.

The fact that young Ss of school age have relatively less difficulty with the L-R dimension that do preschoolers (Fellows, 1966) suggests that awareness of the L-R dimension can be taught (Samuels, In Preparation). However, it appears that Poor Readers have more trouble than Good Readers in either becoming aware of the importance of orientation in recognizing stimuli (e.g., L-R, U-D), or in being able to consistently use it.

In summary, the findings from this research provide data suggesting the importance of Visual Recognition Memory in paired-associate learning and reading. Good Readers were superior to Poor Readers in Visual Recognition Memory. This superiority, which was present only for previously-presented stimuli, was interpreted to stem from the Good Readers' ability to consistently encode the distinctive features of the stimuli. Poor Readers then either have difficulty in attending to or identifying the distinctive features of stimuli, or are unable to encode them consistently. The question remains as to whether Poor Readers have a more difficult time encoding orientation and reversal features than other dimensions of difference.

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Table 1

Differences between good and poor readers
on reading achievement, IQ, and experimental tasks

Test	Reading Group				Stat.	Stat. Value	P Value
	PR (N=17)		GR (N=39)				
	$\bar{X}$	s.d.	$\bar{X}$	s.d.			
Vocab (CAT)	2.4	.50	3.8	.44	t	10.29	< .001
Comp (CAT)	2.3	.55	3.8	.32	t	12.50	< .001
IQ (CTMM)	102.3	6.7	109.7	9.2	t	3.36	< .01
VRM	47.3	8.4	50.4	6.3	t	4.60	< .001
AA	29.1	9.4	30.6	9.9	t	1.37	.05 < p < .10
PAL	54.0	12.0	69.0	9.5	t	8.00	< .01
PAL[a]	54.8		68.3		F	30.7	< .01

[a]Means adjusted for IQ differences

Table 2

Mean Number of Transformation Errors in Three Tasks

Task	Transformation					
	$L\text{-}C_1$	$L\text{-}C_2$	$L\text{-}C_3$	U-D	L-R	180°
VRM	2.00[a]	1.35[a]	.71[a]	1.78	1.59	1.45
PAL	-	-	-	1.31	.60	.48
Gibson's Discrimination Task	1.28	.53	.31	1.08	.59	.38

[a]L-C averages corrected to correspond to the VRM Orientation.

Transformational figures which are based on two fewer stimuli.

Table 3

Intercorrelations Among Various Standardized

Scores, Experimental Tasks, & Intelligence

Variables	Intercorrelations								
	2	3	4	5	6	7	8	9	10[a]
1 IQ	.38**	.56**	.46**	.43**	.41**	.21	.12	.25*	.25*
2 Vocab.		.82**	.96**	.89**	.76**	.84**	.30*	.07	.53**
3 Comp.			.91**	.88**	.73**	.67**	.27*	.14	.57**
4 Total Rdg.				.93**	.78**	.81**	.31**	.13	.58**
5 Arith. Reas.					.76**	.74**	.29*	.16	.56**
6 Arith. Comput.						.66**	.13	.01	.42**
7 Spelling							.33**	.04	.57**
8 VRM								.26*	.43**
9 AA									.34**
10 PAL									

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

[a] Log_{10} used to normalize data

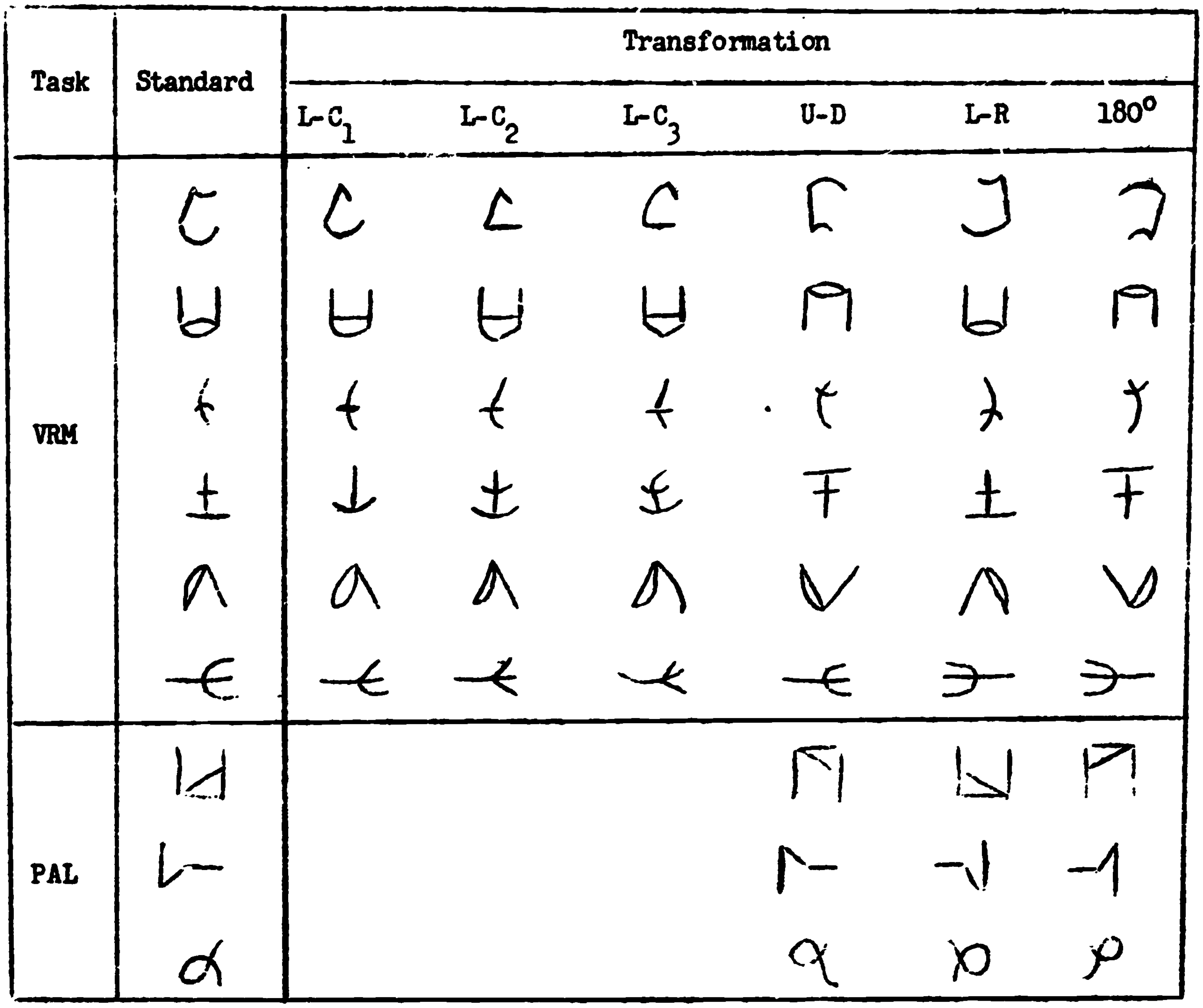

Fig. 1. VRM and PAL Stimuli. (When two transformations of a stimulus yielded identical stimuli, only one of the transformations of that stimulus was used in the VRM task. Results from such stimuli were added equally to the 2 transformations it represents.)