R E P O R T R E S U M E S

ED 010 977 RE 000 014

THE RELATIONSHIP BETWEEN MEASURES OF PRE-READING VISUAL DISCRIMINATION AND FIRST GRADE READING ACHIEVEMENT--A REVIEW OF THE LITERATURE.

BY- BARRETT, THOMAS C.

PUB DATE 65

EDRS PRICE MF-$0.09 HC-$1.12 28P.

DESCRIPTORS- *READING RESEARCH, *VISUAL DISCRIMINATION, *READING ACHIEVEMENT, *PREREADING EXPERIENCE, *PRESCHOOL TESTS, LETTER RECOGNITION, WORD RECOGNITION, PICTURES, VISUAL DISCRIMINATION

A REVIEW OF THE LITERATURE CONCERNING THE RELATIONSHIP BETWEEN MEASURE OF PREREADING VISUAL DISCRIMINATION AND FIRST-GRADE READING ACHIEVEMENT IS GIVEN. THE RELATIVE PREDICTIVE POWER OF VISUAL DISCRIMINATION OF LETTERS, WORDS, GEOMETRIC DESIGNS, AND PICTURES WHEN THESE ABILITIES ARE STUDIED INDIVIDUALLY AND IN COMBINATION IS INDICATED. STUDIES INVESTIGATING VISUAL DISCRIMINATION AT THE BEGINNING OF THE FIRST GRADE AND READING ACHIEVEMENT LATER IN THE FIRST GRADE ARE INCLUDED. THE INVESTIGATIONS ARE PRESENTED UNDER THREE MAJOR CATEGORIES--THOSE THAT STUDY THE RELATIONSHIP BETWEEN VERBAL-VISUAL DISCRIMINATION, THOSE THAT RELATE NON-VERBAL-VISUAL-DISCRIMINATION, AND THOSE THAT COMPARE THE RELATIONSHIPS OF VARIOUS TYPES OF VISUAL DISCRIMINATION WITH READING ACHIEVEMENT WHEN THESE RELATIONSHIPS ARE OBTAINED UNDER SIMILAR CONDITIONS. TABLES AND REFERENCES ARE INCLUDED. (HJ)

Reading Research Quarterly, 1 (Fall 1965), 51-76.

The relationship between measures of pre-reading visual discrimination and first grade reading achievement: a review of the literature

THOMAS C. BARRETT *University of Wisconsin*

ACCUMULATED RESEARCH evidence which deals with the relationships between various types of visual discrimination abilities and first-grade reading achievement is reviewed. The relative predictive power of visual discrimination of letters, words, geometric designs, and pictures when these abilities are studied individually and in combination is indicated. The following generalizations are presented: 1] Visual discrimination of letters and words has a somewhat higher predictive relationship with first-grade reading achievement than does visual discrimination of geometric designs and pictures; 2] several tasks requiring discrimination of geometric designs and pictures have predictive possibilities and warrant additional study; 3] there is no clear-cut information as to whether discrimination of letters or discrimination of words has a superior relationship with early reading achievement; 4] There is a need for investigations that employ statistical designs which utilize multivariate analysis.

La relation entre les mesures du discernement visuel avant d'apprendre à lire et le succès d'apprendre à lire en première année: une revue de la littérature

UN COMPTE rendu est donné de l'évidence des recherches accumulées qui traitent les relations entre les différents types de capacité en discernement visuel et le succès d'apprendre à lire en première année. Egalement indiqué est le pouvoir relatif qui prédit le discernement visuel des lettres, des mots, des desseins géométriques et des images quand ces capacités sont étudiés individuellement et en groupe. Les généralités suivantes sont présentées; 1] Le discernement visuel des lettres et des mots a une relation plus grande que l'on peut prédire avec la capacité de lire en première année qu'avec le discernement visuel de desseins géométriques et des images. 2] Plusieurs tâches qui demandent le discernement

des desseins géométriques et des images ont des possibilités que l'on peut prédire et dont on peut justifier d'autres études. 3] Il n'y a pas d'information exacte qui montre si le discernement des lettres ou le discernement des mots a une plus grande relation avec la capacité de lire tôt. 4] Il y a besoin de recherches qui emploient des structures statistiques avec des analyses à plusieurs variables.

La relación entre varios tipos de habilidades con discriminación visual y el rendimiento en lectura de primer grado: se examina la literatura

SE REVISA, aquí, la evidencia en la investigación reunida que se refiere a la relación entre varios tipos de habilidades con discriminación visual y rendimiento en lectura de primer grado. Se indica, además, el relativo poder predictivo de discriminación visual de letras, palabras, diseños geométricos y figuras, cuando estas habilidades son estudiadas combinadas e individualmente. Se hacen las siguientes generalizaciones: 1] La discriminación visual de letras y palabras tiene una relación predictiva un poco mayor con el rendimiento en lectura de primer grado, que la discriminación visual de diseños geométricos y figuras; 2] varias tareas que requieren discriminación en diseños geométricos y figuras, tienen posibilidades predictivas y justifican el estudio adicional; 3] no hay una clara y precisa información respecto a si la discriminación de letras o la discriminación de palabras tiene una relación mejor con el rendimiento en la lectura inicial; 4] es necesario que los investigadores empleen diseños estadísticos que requieran análisis multivariados.

For the past forty years research workers have been studying various aspects of reading readiness. One of their objectives during this time has been to isolate understandings and abilities which are predictively related to first grade reading achievement. Visual discrimination apparently possesses this characteristic, evidenced by the fact that all available reading readiness tests devote attention to it.

Although visual discrimination appears to have universal acceptance as an index of reading readiness and as a predictor of success in learning to read, a number of questions about the relative merits of various measures of visual discrimination continue to exist. Is a child's ability to see likenesses and differences in letters more significant than his ability to see likenesses and differences in words? Are pictures and geometric designs valid content for reading readiness tests? Do *pure* visual discrimination tasks (seeing similarities, differences, or details in visuals) have a higher degree of relationship with early reading achievement than do tasks which combine visual discrimination with cognition or motor skills (naming letters or copying geometric designs)? Is there an optimum combination of visual discrimination tests for predicting first-grade reading achievement?

This paper discusses selected research reports that bear on the above questions.[1] To aid in focusing on this objective, only those studies which measure 1] visual discrimination at the beginning of first grade and, 2] reading achievement later in first grade, are included. Thus, the investigations are presented in three major categories: 1] those that study the relationship between verbal visual discrimination, i.e., letters and/or words, and first-grade reading achievement; 2] those that relate non-verbal visual discrimination, i.e., pictures and geometric designs, with later reading achievement in first grade; and 3] those that compare the relationships of various types of visual discrimination with reading achievement when these relationships were obtained under similar conditions.

Verbal visual discrimination and first-grade reading achievement

Visual discrimination of letters. One of the earliest studies to consider visual discrimination of letters as an avenue to predicting later

1. For more general information on reading readiness, the reader is referred to the reviews of literature by Inglis (1948), Smith (1950), Williams (1953), and Gunderson (1964).

reading achievement was conducted by Smith (1928). Letter matching ability measured by an individual test during the first week of first grade was correlated with the results from the Detroit Word Recognition Tests administered twelve weeks later. An analysis of the data on 200 children revealed a correlation coefficient of .87, which prompted Smith to conclude that letter matching could be used as a measure of reading readiness.

One can only hypothesize about the possible reasons for such an unusually high correlation coefficient. However, Smith did point out that the Detroit method of teaching reading required children to use picture dictionaries to locate words that they did not recognize in reading lessons. Such a requirement may have placed a high premium on letter matching as a prerequisite to learning to read under this system.

Smith's study led Lee, Clark, and Lee (1934) to consider the predictive possibilities of a group reading readiness test which employed various letter matching tasks. They constructed a test with four subtests which required children to demonstrate ability to: 1] match capital letters, 2] match lower case letters, 3] locate and cross out the capital letter that did not belong in a series of four letters, and 4] find and delete an extra letter in a word that made it different from a stimulus word.

After the components of the readiness test were completed, the authors conducted predictive validity studies on two undescribed samples of children. Sample one, composed of 164 subjects, took the readiness test at the beginning of first grade and the Lee-Clark Primer Test toward the end of the school year. The same testing procedures were used with the second sample, which included 100 subjects, except the Gates Primary Reading Tests were substituted for the Lee-Clark Test. After the data were collected, scores on the readiness test were correlated with scores on the reading tests for each sample. The coefficients obtained were .49 and .54 for samples one and two, respectively.

Two years after Lee, Clark, and Lee published their findings, Wright (1936) reported results from a study in which he averaged correlation coefficients obtained for each of eight first-grade classrooms from scores on the Lee-Clark Reading Readiness Test with first semester results on the Gates Primary Reading Tests. His analysis resulted in a mean correlation coefficient of .513, which supported the findings of Lee, Clark, and Lee.

Further information related to the importance of visual discrimination of letters as an index of reading readiness was provided by Wilson and Flemming (1940). However, their interest was not in simple letter matching; they studied the naming and writing of letters. Their findings were based on three to six first-grade classrooms of children who took one or all of the visual discrimination tests and the Gates Primary Reading Tests. Rank order correlation coefficients between the readiness tests and reading achievement tests were obtained for each classroom and then averaged. In this way, reading achievement was found to correlate .630 with naming small letters, .625 with naming capital letters, .619 with writing capital letters, and .478 with writing small letters.

Since these mean rank order correlation coefficients were relatively high when compared with findings from studies using other readiness measures, the investigators concluded that the beginning stages of mastering the mechanics of reading primarily concentrated on the forms, names, and sounds of letters.

Two parallel studies, published by Olson (1958) and Gavel (1958), have a direct bearing on the question posed by the investigations discussed up to this point: What are the relative merits of letter matching tasks as predictors of first-grade reading achievement when compared with visual discrimination and knowledge of letters tests utilized for similar purposes? Olson related the results from the September-administered Boston University Letter Knowledge Tests to the scores from a self-constructed oral reading test, given to 1,172 children in February. Using the same population from which Olson obtained his sample, Gavel (1958) extended his work by correlating the September test results for 1,506 of the children with their June reading achievement, as measured by a word classification test and a paragraph meaning test of her own design.

The results of the two studies, as presented in Table 1, illustrate the predictive superiority of the five tests which required knowledge of letter names in part. Olson indicated that this superiority occurred partially because the four letter matching tests were too easy for the children. Although tests of significance between correlation coefficients were not reported, the respective investigators concluded that readiness tests requiring visual discrimination and knowledge of letters were better predictors of first-grade reading achievement than tests requiring the ability to match letters directly or from memory.

This conclusion, if not on demonstrated statistical grounds, appears to be warranted on practical grounds.

Table 1 Correlation coefficients between the Boston University Letter Knowledge Tests and first grade reading achievement measured in February by Olson (1958) and in June by Gavel (1958)

Letter tests	*Correlation coefficients between letter tests and later reading achievement*	
	February reading achievement	*June reading achievement*
Identifying capital letters named	.55	.56
Writing letters	.55	.60
Naming capitals	.55	.58
Identifying lower-case letters named	.54	.56
Naming lower-case letters	.53	.54
Identifying lower-case letters shown	.37	.35
Identifying capitals shown	.33	.32
Matching capital letters	.25	.22
Matching lower-case letters	.23	.22

Visual discrimination of words compared with visual discrimination of letters under similar conditions. In a carefully designed investigation, Steinbach (1940) set out to determine the relative contributions visual discrimination of letters and visual discrimination of words made to predicting first-grade reading achievement. Preliminary to analysis, she administered to her subjects the Lee-Clark Reading Readiness Test, which measured the ability to see likenesses and differences in letters, and the Stone-Grover Reading Readiness Test, which tested the ability to discriminate between words. Reading achievement was measured in January and June with alternate forms of the Metropolitan Primary Reading Tests and the Progressive Reading Tests. Complete test data were obtained for 300 first-grade pupils, composed of 147 boys and 153 girls.

The statistical treatment of the data was conducted in two phases. First, scores for each reading readiness test and the combined grade-scores on the two reading achievement tests were submitted to a correlation analysis. The results revealed that the Lee-Clark Test correlated with reading achievement .432 in January and .416 in June, while the Stone-Grover Test correlated with reading achievement .438 and .398 in January and June, respectively. Second, a multiple regression equation, including the readiness variables apparently most closely related to reading achievement as indicated by the cor-

relation coefficients, revealed the relative importance of each of the readiness factors with respect to predicting first-grade reading achievement in January and June. In January, the Stone-Grover Test contributed slightly more to the variance of reading achievement than did the Lee-Clark Tests; however, in June, the position of the variables with respect to their relative importance was reversed, as indicated by the partial regression coefficients.

Steinbach gave no explanation for this shift and, unfortunately, no tests of significance were computed to determine whether the partial regression coefficients were significantly different from zero, nor was it determined whether partial regression coefficients for the same independent variable were significantly different for January and June. If Steinbach had developed stable equations by casting out the least significant variables, it is possible that the partial regression coefficients for the Stone-Grover and Lee-Clark Tests would have been altered. Nevertheless, under the conditions that prevailed the results for June suggest that visual discrimination of letters was a slightly better predictor of reading achievement than was visual discrimination of words.

A second study, permitting a comparison of the relative merits of letters and words as predictors of early reading achievement, was reported by Weiner and Feldmann (1963). They personally developed the Reading Prognosis Test and their investigation set out to determine its predictive validity for youngsters from middle and lower socioeconomic status levels (SES).

The Reading Prognosis Test was built around three constructs: 1] Language, 2] Perceptual Discrimination, and 3] Beginning Reading Skills. The language area was divided into a Word Meaning subtest and a Story Telling subtest. Some of the subtests in the other two areas are most relevant to this discussion. Under Perceptual Discrimination, subtests entitled Visual Similarities and Visual Discrimination, required the student to match three and four letter words. The subtests Small Alphabet Letters and Capital Alphabet Letters, under Beginning Reading Skills, required children to identify letters.

Weiner and Feldmann administered the Reading Prognosis Test in October and the Gates Primary Reading Tests, Sentence Reading (PSR), and Paragraph Reading (PPR), in June to a balanced sample of 138 subjects. The sample was selected on the basis

SES, race, and sex. Complete test results were obtained for 126 students.

The data were analyzed in a variety of ways. First, stepwise multiple regression was utilized to determine the predictive validity of the three predetermined constructs of the Reading Prognosis Test for the total group, the middle SES, and the low SES. Second, intercorrelation coefficients were derived between the total score on the Reading Prognosis Test and the Gates Primary Reading Tests for subjects by race, sex, and SES. Finally, correlations between the subtests in the Reading Prognosis Test and reading achievement were developed. A portion of these findings are presented in Table 2. Although the authors drew no conclusions with regard to these particular correlation coefficients, it appears that in the overall analysis the identification of letters had a somewhat closer relationship with later reading achievement than did the matching words.

Table 2 Correlations between selected subtests from the Reading Prognosis Test and the Gates Primary Reading Tests, PSR and PPR, as reported by Weiner and Feldmann (1963)

Subtests from the Reading Prognosis Test	*Correlations for paragraph reading*	*Correlations for sentence reading*
Capital letters	.716	.745
Small letters	.700	.756
Visual discrimination	.609	.545
Visual similarities	.687	.631

Summary of verbal visual discrimination. Table 3 summarizes the investigations which specifically focused on the relationships between visual discrimination of letters and/or words and first-grade reading achievement.

The nature of the studies reviewed, with a few notable exceptions, makes it extremely hazardous to develop firm generalizations concerning the relative value of particular verbal visual discrimination tasks as predictors of first-grade reading achievement. Nevertheless, two tentative hypotheses can be expressed at this juncture.

First, it appears that the visual discrimination and knowledge of letters is somewhat superior to direct letter matching or letter matching from memory. This phenomenon is particularly evident in the

Table 3 Summary of verbal visual discrimination investigations

Study	*N*	*Reading tests*	*Prereading tests*	*Correlation coefficients*
Smith (1928)	200	Detroit Word Recognition Test	Letter-matching	.87
Lee, Clark and Lee (1934)	164	Lee-Clark Primer Test	Lee-Clark reading readiness (letters)	.49
	100	Gates Primary Reading Tests	Lee-Clark reading readiness (letters)	.54
Wright[a] (1936)	203	Gates Primary Reading Tests	Lee-Clark (letter)	.51
Wilson and Flemming[b] (1940)	142	Gates Primary Reading Tests	Naming small letters	.63
	142		Naming capital letters	.62
	84		Writing capital letters	.62
	59		Writing small letters	.48
Olson (1958)	1,172	Self-constructed oral reading test	Identifying capital named	.55
			Writing letters	.55
			Naming capitals	.55
			Identifying lower-case letters named	.54
			Naming lower-case letters	.53
			Identifying lower-case letters shown	.37
			Identifying capitals shown	.33
			Matching capital letters	.25
			Matching lower-case letters	.23
Gavel (1958)	1,508	Self-constructed word classification test and paragraph meaning test	Writing letters	.60
			Naming capitals	.58
			Identifying capitals named	.56
			Identifying lower-case letters named	.56
			Naming lower-case letters	.54
			Identifying lower-case letters shown	.35
			Identifying capitals shown	.32
			Matching capital letters	.22
			Matching lower-case letters	.22
Steinbach (1940)	300	Metropolitan Reading	Lee-Clark (letters)	.43 (January)
		Progressive Reading		.42 (June)
		Metropolitan Reading	Stone-Grover (words)	.44 (January)
		Progressive Tests		.40 (June)
Weiner and Feldmann (1963)	126	Gates Primary (PR)	Capital alphabet letters (identification)	.72
			Small alphabet letters (identification)	.70
			Visual similarities (word matching)	.69
			Visual discrimination (word matching)	.61
			Small alphabet letters	.76
			Capital alphabet letters	.75
			Visual similarities	.63
			Visual discrimination	.55

[a] Average for eight correlations.
[b] Average rank-order correlations.

studies by Olson (1958) and Gavel (1953). The observation also receives additional support from the earlier study by Wilson and Flemming (1940), although their statistical methodology is certainly open to question. Moreover, the fact that a single task requiring visual discrimination and knowledge of letters, as studied by Olson and Gavel, had a higher correlation with later reading achievement than the original Lee-Clark Reading Readiness Test which included four types of tasks focusing on letter matching, cannot go unnoticed (Lee, Clark & Lee, 1934; Wright, 1936).

Second, a look at the two investigations which compared discrimination of letters and words as predictors permits two limited observations: 1] there is not much difference between letter matching and word matching as predictors of reading achievement (Steinbach, 1940); and 2] visual discrimination and knowledge of letters is somewhat better than matching words as a predictor of first-grade reading achievement (Weiner & Feldmann, 1963). More information on this comparison will be presented in the third section of this paper.

Non-verbal visual discrimination and first-grade reading achievement

Visual discrimination of pictures The value of house drawings as predictors of first-grade reading achievement was examined by Beck and Beck (1960). House drawing samples were collected for 214 children. The samples were scored on the basis of the presence or absence of fifteen characteristics which previous research and experience indicated might be related to developmental level. Using the American School Achievement Test, Primary I Battery, as the criterion at the end of first grade, the correlations were .15 when house drawings were scored by the teachers, and .18 when scored by one of the investigators. Factor analysis revealed a factor for intelligence and one for achievement, but only a single drawing characteristic loaded on either of these: there was no important common factor among the drawing scores themselves. Thus, Beck and Beck concluded that the house drawing test would not be a useful instrument for determining readiness in the first grade.

Visual discrimination of geometric designs The predictive validity of the Visual Tests in the Monroe Reading Aptitude Tests was studied

by Monroe (1934) on an undescribed sample of 85 first-grade children. The Visual Tests contained three sections that, for the most part, required visual discrimination of geometric designs: 1] Recognition of Orientation called for the ability to locate a simple geometric design in a pair of designs that resembled one displayed by the examiner; 2] Ocular Motor Control and Attention required subjects to follow a black line along which a man had traveled to a particular house; and 3] Visual-Memory for Forms required the subjects to draw from memory sixteen designs that were presented four at a time for ten seconds of study.

When the total scores on the Visual Tests were correlated with later reading achievement, as measured by the Gray Oral Paragraphs and the Iota Word Test, a substantial relationship of .60 was found to exist. Unfortunately, Monroe did not report intercorrelations for the visual subtests and reading achievement that would have shed light on the relative contributions the three visual subtests made to the predictive relationship.

Robinson and others (1958) concluded from a study of 87 first graders that, although there was a low positive correlation between scores on the Children's Visual Achievement Forms (CVA)[1] and first-grade reading achievement, the CVA was not a good predictor of first-grade reading achievement. This conclusion was based on four findings: 1] correlation coefficients obtained for the CVA with the Word Discrimination Test and the Chicago Reading Test ranged from .24 to .44; 2] the partial correlation between the CVA and the Word Discrimination Test was .34 when intelligence was held constant; 3] a factor plot showed a low relationship between the CVA ratings and the reading tests; and 4] of ten children who scored below 60 on the CVA, the point below which learning to read with meaning should be difficult, five scored above and five scored below the national norms on the Chicago Reading Test.

The results of a relatively recent investigation reported by Keogh (1963) deal with the relationship between performance on the Bender Gestalt, when presented as a group test to youngsters in May of their kindergarten year and first grade reading achievement measured by the Lee-Clark Reading Test near the end of the year. Three methods were used to administer the Bender Gestalt: 1] one group

1. The CVA contains seven different forms—circle, a plus sign, a triangle, a square, etc.—which the subject is required to copy.

of subjects received the test in the prescribed individual manner, 2] a set of subjects copied each design on the lower part of a piece of paper when it was in view of the upper part of the same page, and 3] a third group of children copied the designs on blank pieces of paper as the designs were presented one at a time on large cards at the front of the room.

Keogh found that the results from the latter method of administering the Bender Gestalt correlated at the .50 level with first grade achievement for data obtained on 149 subjects. However, the other two methods used to administer the Bender Gestalt correlated with reading achievement at a lower level. Thus, she concluded that the Bender Gestalt may be a useful reading readiness screening instrument for first grade.

Visual discrimination of pictures and geometric designs In a frequently cited work, Goins (1958) attempted to determine the predictive validity of fourteen visual perception tasks which used pictures and designs for content. The initial phase of her statistical analysis produced correlation coefficients between the visual perception tests, administered during the first three months of school, and reading achievement, measured by the Chicago Reading Tests in May. The seven highest correlations reported by Goins, all of which were statistically significant from zero at the .01 level, are presented in Table 4. Of the tests that correlated the highest with reading achievement, four employed pictures for content and three were made up of geo-

Table 4 The seven visual perception tests which produced the highest correlations with first-grade reading achievement as reported by Goins (1958)

Visual test	*Correlation with reading achievement in May*
Pattern copying	.519
Reversals	.491
Figures	.390
Picture squares	.381
Pattern completion	.339
Identical pictures A	.318
Identical pictures B	.313

metric designs. The top two tests in this respect were Pattern Copying, which required the subject to make a mutilated design just like the completed design in view, and Reversal, which involved seeing likenesses and differences in the orientation of pairs of pictures. Although not shown in Table 4, it should also be noted that Goins found Pattern Copying had a higher correlation with reading than all fourteen other tests combined, .519 to .497.

Finally, Goins completed a factor analysis resulting in two factors being isolated when the correlations on the May reading test and the fourteen non-verbal visual discrimination tests were analyzed. This resulted in the isolation of a P-2 factor which was found to be common to reading and was defined as the ability to keep a figure in mind against distraction. Furthermore, the first four tests listed in Table 4 were found to possess a rather heavy P-2 factor saturation. Therefore, Goins concluded, such non-verbal visual perception tests might prove valuable additions to reading readiness tests as predictors of reading achievement.

Summary of non-verbal visual discrimination Table 5 presents a summary of the investigations which deal with the relationships between visual discrimination of pictures and geometric designs and first-grade reading achievement. Unfortunately, the studies here do not

Table 5 Summary of non-verbal visual discrimination investigations

Study	*N*	*Reading Achievement Test*	*Non-Verbal Visual Discrimination Test*	*Correlation*
Beck and Beck (1960)	214	American School Achievement Test, Reading	House drawing	
			Teacher score	.15
			Investigator score	.18
Monroe (1935)	85	Gray Oral Paragraphs and Iowa Word Test	Visual tests	.60
Robinson and Others (1958)	87	Word Discrimination Test Chicago Reading Test	Children's visual achievement form	.24
Keogh (1963)	149	Lee-Clark Reading Test	Bender gestalt	.53
Goins (1958)	120	Chicago Reading Test	Pattern copying	.519
			Reversals	.491
			Figures	.390
			Picture squares	.381
			Pattern completion	.339
			Identical pictures A	.318
			Identical pictures B	.318

provide any clear-cut answers to questions about the relative merits of the predictive validities of pictures and geometric designs.

It would appear that the value of non-verbal visual discrimination tasks as predictors may depend on the complexity of the visual and/or visual-motor abilities they require. The studies by Monroe (1935), Goins (1958), and Keogh (1963) support this conjecture. Certainly, using Goins' work as a prototype, these investigations should provide a basis for further research on the predictive validity of non-verbal visual discrimination.

Verbal visual discrimination compared with non-verbal visual discrimination under similar conditions

At least eight studies report results which permit comparison of the relative merits of various verbal and non-verbal visual discrimination tasks as predictors of first-grade reading achievement.

Deputy (1930) in a pioneering study attempted to predict first-grade reading achievement near the end of the first semester with the Pintner Cunningham Primary Mental Test and four author-constructed reading readiness tests: Visual-Visual Association, Word Selection, Visual-Auditory Association, and Content Comprehension and Recall. The first two readiness tests mentioned measured visual discrimination of words in varying degrees. The Visual-Visual Association Test required subjects to associate a picture with its written name on one side of a card and to recognize the word in isolation when the card was turned over. The Word Selection Test measured the ability to select from a group of words or letters one that matched a stimulus word or letter. The third test, which is of interest to this discussion, was the Visual-Auditory Association Test which required children to look at each of ten simple geometric designs and say a word that had been associated with it auditorally in practice sessions prior to the final testing.

Based on a sample of 103 students, Deputy found that combined scores on three reading achievement tests correlated .70 with the Pintner Cunningham Primary Mental Test, .52 with the Visual-Visual Association Test, .49 with the Word Selection Test, .39 with the Visual-Auditory Association Test, and .37 with the Content Comprehension Test. The results indicate that, although intelligence is the

best single predictor of first-grade reading achievement, the tests primarily dealing with visual discrimination of words have a closer relationship to initial reading achievement than the Visual-Auditory Discrimination Test which measures in part the visual discrimination of geometric designs.

Some time later, in one account of an investigation which was conducted over a three year period, 1933 to 1936, Wilson and Burke (1937) found that three reading readiness subtests requiring visual discrimination of words were relatively better predictors of reading achievement in the ninth month of first-grade than two reading readiness subtests which required, for the most part, visual discrimination of pictures, geometric designs and numbers.

Table 6 presents the rank order correlations between the five readiness subtests and the three reading tests. Unfortunately, since Wilson and Burke's findings were based on a sample of twenty-five children, severe restrictions are placed on any conclusions that might be inferred from their study.

Table 6 Rank order correlations between five reading readiness subtests and May reading achievement as reported by Wilson and Burke (1937)

Readiness subtests	*Rank order correlation with Gates Primary Reading Tests*		
	Word recognition	*Sentence reading*	*Paragraph reading*
Stone-Grover Part II (Word matching)	.55	.56	.46
Stone Grover Part I (Word discrimination)	.54	.51	.40
Van Wagenen Word discrimination	.50	.47	.46
Metropolitan, copying*	.40	.38	.40
Metropolitan, similarities*	.27	.20	.20

* The majority of items in these two tests dealt with pictures, designs, and numbers.

An investigation by Gates, Bond, and Russell (1939) was one of the most extensive upon which to base a comparison of the relationship when obtained under similar circumstances between various types of visual discrimination tasks and reading achievement. Before such a comparison could take place, the investigators examined the relationships between more than one-hundred tests, examinations, and ratings of reading readiness and five tests of reading achievement.

Seven of the readiness tests used by the investigators required visual discrimination of words or letters while five of them focused on pictures and geometric designs. The test of letters and/or words were: 1] Pairs of Words; 2] Word-Card Matching; 3] Visual Perception (the student located a word similar to a stimulus word among four other words); 4] Stone-Grover Test, Part I (a test similar to visual perception); 5] Stone-Grover Test, Part II (the subject was required to indicate whether pairs of words were identical or different); 6] Word Discrimination, Van Wagenen Test V (the subject located the one different word in a group of five); 7] Reading Letters of the Alphabet; and 8] Perception of Nonsense Words. The five tests requiring visual discrimination of pictures and designs were: 1] the Discrimination of Pairs of Geometric Figures Test; 2] the Discrimination of Pairs of Greek Words Test; 3] the Selection of Geometric Figures Test; 4] the Visual Perception of Digits Test; and 5] the Gates Test of Associative Learning of Geometric Figures and Pictures.

Complete test results were obtained for 97 students enrolled in four classrooms. All of the children took the readiness tests at the beginning of first-grade. Two of the four classrooms were given the reading achievement tests at the end of each of the first three semesters of school, while the other two took the reading achievement tests at the end of each of the first two semesters. For each semester a classroom participated in the study, scores from each readiness test were correlated with the mean scores of the five reading achievement tests. The correlation coefficients so derived were averaged and reported as general findings.

The mean correlation coefficients that are pertinent to this discussion are presented in Table 7. As the Table indicates, the visual discrimination of words, even in nonsense form, had a higher relationship with reading achievement in the early primary grades than visual discrimination of letters or visual discrimination of designs, numbers, or pictures. Furthermore, when compared to the mean correlation coefficients for thirty-nine readiness categories, the Stone-Grover and the six Word Perception Tests still ranked first and second. It is also interesting to note that the Visual Perception of Digits Test did somewhat better as a predictor than did the Visual Perception of Letters Test. Based on these findings, the authors concluded that the best predictors of reading achievement in the early primary grades were readi-

ness tests that measured a reading ability utilized in later reading; namely, visual discrimination of words.

Table 7 Mean correlation coefficients between visual discrimination tests and reading achievement as reported by Gates, Bond, and Russell (1939)

Visual discrimination test	*Mean correlations with reading achievement*
Stone-Grover Reading Readiness Test Total (Part I and II combined)	.62
Six word perception tests[a]	.59
Perception of nonsense words	.49
Visual perception of digits	.35
Reading letters of the alphabet	.31
Gates test of associative learning of geometric figures and pictures	.21
Perception of geometric figures[b]	.19

[a] This category included the first six visual discrimination tests listed above.
[b] This appears to be a combination of the Geometric Figures Tests and the Greek Word Test mentioned above.

Two later investigations by Gates (1939, 1940) were, in part, designed to determine the predictive validity of some of the tests used in the previously cited work and eventually incorporated into the Gates Reading Readiness Tests.

The tests employed to measure reading achievement included a special word recognition test, a special sentence reading test, and the Gates Primary Reading Tests, Word Recognition, and Sentence Reading. All reading achievement tests were employed in the first investigation, but only the Gates Tests were used in the second. Each of the samples for the two investigations included seven first-grade classrooms, with 156 pupils in the first and 133 pupils in the second.

Gates followed standard procedures for determining predictive validity at that time. He administered the readiness tests near the beginning of first grade and the reading achievement tests near the end of the first semester. Correlation coefficients between each readiness test score and an average reading achievement score were obtained for each classroom. The classroom correlation coefficients were averaged for each study and for the two studies combined.

The findings for the two studies, summarized in the second report, are presented in Table 8. Although tests of significance were

not computed for any of the differences between correlation coefficients, it appears that tests requiring visual discrimination of words are slightly better predictors of reading achievement than are tests requiring visual discrimination of letters or pictures.

Table 8 Mean correlation coefficients between visual discrimination tests and reading achievement as reported by Gates (1939, 1940)

Readiness test	*Mean correlations for first study (7 Classes)*	*Mean correlations for second study (7 Classes)*	*Mean correlations for both classes (14 Classes)*
Word matching	.58	.45	.52
Word-card matching	.55	.47	.51
Reading letters and numbers	.43	.46	.45
Picture directions	.48	.35	.42

Wilson (1942) also examined the predictive relationships between the Gates' Word Matching Test, Word-Card Matching Test, and the Picture Directions Test and first-grade reading achievement. Three first-grade classrooms containing 53 children participated in the study. Rank order correlation coefficients were obtained between the Metropolitan Test and each of the three readiness tests for each classroom. After this phase of the analysis, the coefficients for each classroom were averaged. The results showed that first-semester reading achievement had a mean correlation of .56 with the Word Matching Test, .64 with Word-Card Matching, and .31 with Picture Directions. When these three correlations are compared to those reported by Gates (1939, 1940), they seem to provide cross validity for his findings.

In what seemed a carefully conducted investigation, Potter (1949) examined the relationships between seven visual discrimination tasks which, in some cases, also involved memory and early reading success. The seven visual tests were described as follows:

1] Part one of the Lee-Clark Reading Readiness Test consisted of two sections. Section one presented twelve lower case letters in a vertical line. The children were asked to draw a line from each letter to the same letter in a second vertical line printed parallel to it with the letters rearranged. Section two presented capital letters in the same fashion.

2] Part three of the Lee-Clark Reading Readiness Test contained

twenty word-matching items. The stimulus was exposed at the left end of the row and four options were printed beside it.

3] A Two-Letter Combination Test required the child to discriminate both the orientation of each symbol and the order of placement of the symbols.

4] A Three-Letter Combination Test required the subject to discriminate symbol orientation and a particular symbol sequence.

5] A Four-Letter Word Test required the subject to discriminate the stimulus word from four other words. (Words were selected from the Gates Primary List.)

6] The Shape Matching Test required the subject to look at a drawing and to select it from among four distractors after it was removed.

7] The Directional Drawing Test required the child to draw the stimulus from memory rather than to simply recognize it.

The method used to determine visual discrimination on tests three, four, and five involved presenting an appropriate stimulus alone on a page, withdrawing the stimulus, and presenting it again on the following page among several options. The same six representational and four geometric drawings were used as stimuli in tests six and seven.

The findings for Potter's study are presented in Table 9 in terms of correlation coefficients between the verbal visual discrimina-

Table 9 Correlation coefficients between seven visual discrimination tests and the Gates Primary Reading Tests as reported by Potter (1949)

Visual discrimination test	*Correlation coefficient with the Gates primary*
Shape matching	.47
Three-letter pattern matching	.44
Lee-Clark word matching test	.36
Four-letter word matching	.34
Lee-Clark combined letter matching	.34
Two-letter pattern matching	.32
Lee-Clark lower case letter matching	.30
Directional drawing score	.30
Lee-Clark capital letter matching	.24

tion tests and reading achievement for 176 cases, 94 boys and 82 girls. As the Table indicates, with the exception of the highest coefficient, .44, for the Three Letter Pattern Matching Test and the lowest coefficient, .24, for the Lee-Clark Capital Letter Matching Test, the remaining tests of letter and word discrimination relate equally well with reading achievement. Of greatest significance to the investigator, however, was finding that Shape Matching had the highest correlation with reading achievement. This caused Potter to conclude that items similar to those used in Shape Matching might well be incorporated in reading readiness tests.

A recent investigation by Barrett (1965) used multiple regression analysis to determine the predictive relationships between seven visual discrimination tasks and early reading achievement. The measures studied were: 1] Gates Picture Directions, 2] Gates Word Matching, 3] Gates Word-Card Matching, 4] Gates Reading Letters and Numbers, 5] Goins Pattern Copying, 6] Goins Picture Squares, and 7] Goins Reversals. Complete data were obtained for 632 subjects, 331 boys and 301 girls.

Table 10 presents the standard partial regression coefficients that made a significant contribution at the .05 level to predicting scores on the Gates Primary Reading Tests, Word Recognition and Paragraph Reading, for boys and girls combined. As the Table indicates, the Gates

Table 10 Rank order of visual discrimination tasks in terms of standard partial regression coefficients as reported by Barrett (1965)

Visual task[a]	*Regression coefficients in predicting Gates word recognition*	*Regression coefficients in predicting Gates paragraph reading*
Gates reading letters and numbers	.3876	.3354
Goins design completion	.1572	.1492
Gates word matching	.1227	.1600
Goins reversals	.1159	.1135
Goins picture squares	.0752	.1249

[a] The Picture Directions Test and the Word-Card Matching Test are not included in the Table, since their regression coefficients were not statistically significant in these analyses.

Reading Letters and Numbers Test was the best single predictor among the seven visual tasks studied. Although tests of significance between the regression coefficients were not presented, the investigator con-

cluded that, from among the tests studied, an optimum combination of visual tasks for predicting reading achievement would be Reading Letters and Numbers, Word Matching, and Design Completion.

Summary of studies comparing verbal and non-verbal visual discrimination Table 11 presents a summary of eight investigations which consider verbal and non-verbal visual discrimination tasks under similar conditions. Although the studies included in this section have their limitations, several observations can be made. First,

able 11 Summary of the investigations which compared verbal visual discrimination nd non-verbal visual discrimination

Study	*N*	*Reading measures*	*Visual discrimination tests*	*Correlation coefficients*
eputy (1930)	103	Two special tests and the Detroit Word-Recognition Test	Visual-visual association (word)	.52
			Word selection	.49
			Visual-auditory association (geometric designs)	.39
ilson and urke[a] (1937)	25	Gates Primary Reading Tests		
		Word recognition (WR)		
		Sentence reading (SR)		
		Paragraph reading (PR)		
		WR	Stone-Grover Part I (words)	.55
		SR		.56
		PR		.46
		WR	Stone-Grover Part II (words)	.54
		SR		.51
		PR		.40
		WR	Van Wagenen, word discrimination	.50
		SR		.47
		PR		.46
		WR	Metropolitan readiness test	.40
		SR	Copying (pictures, designs and numbers)	.38
		PR		.40
		WR	Metropolitan readiness test	.27
		SR	Similarities (pictures, designs and numbers)	.20
		PR		.20
tes, Bond, d Russell[a] 939)	97	Two special reading tests and the Gates Primary Reading Tests	Stone-Grover total (words)	.62
			Six word perception tests	.59
			Perception of nonsense words	.49
			Visual perception of digits	.35
			Reading letters	.31
			Gates test of associative learning of geometric figures and pictures	.21
			Three geometric figures perception tests	.19
tes[a] (1939)	156	Two special tests and the Gates Primary Reading Tests, word recognition and sentence reading	Gates word matching	.58
			Gates word-card matching	.55
			Gates picture directions	.48
			Gates reading letters and numbers	.43
tes[a] (1940)	133	Gates Primary Reading Tests, word recognition and sentence reading	Gates word-card matching	.47
			Gates reading letters and numbers	.46
			Gates word matching	.45
			Gates picture directions	.35

Table 11 (Continued)

Study	*N*	*Reading measures*	*Visual discrimination tests*	*Correlation coefficient*
Wilson[b] (1942)	63	Metropolitan Primary Reading Test	Gates word-card matching	.64
			Gates word matching	.56
			Gates picture directions	.31
Potter (1949)	176	Gates Primary Reading Tests, sentence reading and paragraph reading	Shape matching (geometric designs and pictures	.47
			Three-letter combination	.44
			Lee-Clark, Part III (word)	.36
			Four-letter words	.34
			Lee-Clark, Part I (letters)	.34
			Two-letter combination	.32
			Lee-Clark lower case letters	30
			Directional drawing (geometric designs and pictures)	.30
			Lee-Clark capital letters	.24
Barrett[d] (1965)	632	Gates Primary Reading Tests, word recognition	Gates reading letters and numbers	.3876
			Gates design completion	.1572
			Gates word matching	.1227
			Goins reversals	.1159
			Goins picture squares	.0752
		Gates Primary Reading Tests, paragraph reading	Gates reading letters and numbers	.3354
			Gates word matching	.1600
			Goins design completion	.1492
			Goins picture squares	.1249
			Goins reversals	.1135

[a] Average correlation coefficients.
[b] Average rank-order correlation coefficients.
[c] Rank-order correlation coefficients.
[d] Standard partial regression coefficients.

there is an indication that verbal visual discrimination is a somewhat better predictor of reading achievement than is non-verbal visual discrimination. This is attested to in the studies by Deputy (1930), Wilson and Burke (1937), Gates, Bond, and Russell (1939), Gates (1939, 1940) and Wilson (1942) where it was found that discrimination of words was the best single predictor of reading achievement. Barrett (1965) found that discrimination and knowledge of letters had the highest predictive relationship with reading. Only Potter (1948) had contrary results when she discovered that shape matching had the highest correlation with reading among the variables studied.

Second, five investigations permit a comparison of the value of discrimination of words and letters as predictors of reading. Three of these studies, Gates, Bond, and Russell (1939), Gates (1939), and Gates (1940), found words to be the better of the two. However, Barrett (1965) discovered that discrimination and knowledge of letters was somewhat superior to word matching, while Potter (1949) had mixed findings with respect to letters and words.

Finally, the studies by Potter (1949) and Barrett (1965) give

some support to the notion that visual discriminations of geometric designs have possibilities as indices of readiness for reading. Certainly, the tasks considered in these studies or tasks similar to them warrant further investigation.

Summary and interpretations

This paper presents research reports which might provide answers to four questions about visual discrimination and its predictive relationship with first-grade reading. The remainder of the discussion will focus on the following questions.

Is a child's ability to see likenesses and differences in letters more significant than his ability to see likenesses and differences in words? Seven investigations provide relevant information. Of these, three indicate that discrimination of words is a somewhat better predictor of reading than is discrimination of letters (Gates, Bond, & Russell, 1939; Gates, 1939; Gates, 1940). However, the studies by Weiner and Feldmann (1963) and Barrett (1965) found that the discrimination and knowledge of letters was the better predictor. The two remaining investigations, those by Steinbach (1940) and Potter (1949), indicated that correlations between discrimination of words and reading achievement and between discrimination of letters and reading achievement were relatively similar. Unfortunately, none of the seven studies tested the differences between the correlation coefficients or the regression coefficients reported. Therefore it is difficult, if not impossible, in most cases, to attribute these differences to anything other than chance. The net result is that the question cannot be answered from the evidence reported here.

Are pictures and geometric designs valid content for reading readiness tests? Of the non-verbal visual discrimination tests utilized by the various investigators, Monroe's (1935) Visual Tests, Potter's (1949) Shape Matching Test, The Bender Gestalt studied by Keogh (1963), and Goins' (1958) Pattern Copying and Reversals Tests were relatively good predictors of first-grade reading. The correlations between reading achievement and these tests ranged from .47 for the Shape Matching Test and reading achievement to .60 for the Visual Tests. It seems that the magnitudes of these correlations support the claim that such tests, or ones similar to them, warrant further study.

Moreover, the investigators responsible for these findings felt that their research supported the use of such tests as reading readiness instruments.

Do pure visual discrimination tasks have a higher degree of relationship with early reading achievement than tasks which combine visual discrimination with cognition or motor skills? It is very difficult to attempt to answer this, since only a few of the investigations touch on it. However, the best information on this problem was provided by Olson (1958) and Gavel (1958). They found that early reading achievement correlated at a much higher level with tasks that required visual discrimination and knowledge of letters than it did with letter matching exercises. Such information, if cross validated, should be invaluable to future researchers in this area.

Although Goins (1958) employed visual tasks that could have provided appropriate information about non-verbal discrimination, she was not directly concerned with the question. Since none of the other studies reviewed even deals with this problem indirectly, this could be a fruitful area of inquiry. For example, there is a need to know whether the copying of words, the direct matching of words, or the matching of words from memory is the most useful for predicting reading achievement. Similar information about geometric designs and pictures would also be valuable.

Is there an optimum combination of visual discrimination tests for predicting first-grade reading achievement? Although the accumulated evidence suggests that a combination of tasks requiring visual discrimination of letters and words may generally produce the best predictive relationship with reading, it may be that, as Gates (1939) indicated in one of his investigations, no single combination of readiness tests will predict reading achievement equally well for all kinds of beginning reading programs. Nevertheless, the studies by Goins (1958), Weiner and Feldmann (1963), and Barrett (1965) took a step in this direction. In these three instances, multivariate statistical analyses were used to focus on this question. In Goins' case, factor analysis was employed to gain insight into the interrelationships of the variables she studied, while Weiner and Feldmann and Barrett approached this problem through the use of multiple regression analysis. It is obvious that more studies of this nature need to be conducted, since there is a paucity of them in literature.

Future studies should not only be concerned with multivariate analysis, but they should follow research procedures often absent in the investigations reviewed in this paper. There is a need for studies which are based on large random samples, and in which concern with the differential effects sex, socio-economic status, the measure of reading, and the reading program have on predictive relationships is stressed. Finally, investigations are needed which cross validate the findings of studies which make initial attempts to locate optimum predictive combinations of visual discrimination or, for that matter, optimum predictive combinations of reading readiness factors in general.

REFERENCES

BARRETT, T. C. Visual discrimination tasks as predictors of first grade reading achievement. *Reading Teacher*, 1965, 18 (4), 276–282.

BECK, M. S., & BECK, R. C. The house-drawing test as a predictor of first-grade school achievement. *Journal of Experimental Education*, 1960, 29, 197–200.

CALVERT, E. T. Predicting accomplishment in beginning reading. *California Journal of Elementary Education*, 1937, 6, 34–44.

DEPUTY, E. C. Predicting first-grade reading achievement. *Teacher College Contributions to Education*, 1930, No. 421.

GATES, A. I. An experimental evaluation of reading readiness tests. *Elementary School Journal*, 1939, 39, 497–508.

GATES, A. I. A further evaluation of reading readiness tests. *Elementary School Journal*, 1940, 40, 577–591.

GATES, A. I., BOND, G. L., & RUSSELL, D. H. *Methods of determining reading readiness*. New York: Bureau of Publications, Teachers College, Columbia University, 1939.

GAVEL, SYLVIA R. June reading achievements of first-grade children. *Journal of Education*, 1958, 140 (3), 37–43.

GOINS, JEAN TURNER. Visual perceptual abilities and early reading progress. 1958, *University of Chicago Supplementary Educational Monographs*, No. 87.

GUNDERSON, DORIS V. Research in reading readiness. (Bulletin, 1964, No. 8) Washington, D. C.: United States Department of Health, Education, and Welfare, Office of Education, 1964.

INGLIS, W. W. The early stages of reading: a review of recent investigations. In Scottish Council on Research in Education, *Studies in reading*, Vol. I. London: University of London Press, Ltd., 1948. Pp. 1–92.

KEOGH, BARBARA K. Form copying tests for prediction of first grade reading. In *27th Yearbook Claremont Reading Conference*. Claremont, California: Claremont Graduate School Curriculum Laboratory, 1963. Pp. 141–144.

LEE, J. M., CLARK, W., & LEE, DORIS M. Measuring reading readiness. *Elementary School Journal*, 1934, 34, 656–666.

MONROE, MARION. Reading aptitude tests for the prediction of success and failure in beginning reading. *Education*, 1935, 56 (1), 7–14.

OLSON, A. V. Growth in word perception abilities as it relates to success in beginning reading. *Journal of Education*, 1958, 140 (3), 25–36.

POTTER, MURIEL C. Perception of symbol orientation and early reading success. *Teacher College Contributions to Education*, 1959, No. 93[illegible].

ROBINSON, HELEN M., et al. An evaluation of the children's visual achievement forms at grade I. *American Journal of Optometry and Archives of American Academy of Optometry*, 1958, 35, 515–525.

SMITH, NILA B. Matching ability as a factor in first-grade reading. *Journal of Educational Psychology*, 1928, 19, 560–571.

SMITH, NILA B. Readiness for reading. *Elementary English*, 1950, 27, 31–39; 91–105.

STEINBACH, SISTER MARY NILA. An experimental study of progress in first grade reading. *Catholic University of America Educational Research Monographs*, 1940, 12, 1–118.

VERNON, M. D. *Backwardness in reading*. London: Cambridge University Press, 1958.

WEINER, M., & FELDMANN, SHIRLEY. Vali-

dation studies of a reading prognosis test for children of lower and middle socio-economic status. *Education and Psychological Measurement*, 1963, 23 (4), 804–814.

WILLIAMS, GERTRUDE M. What does research tell us about readiness for beginning reading? *Reading Teacher*, 1953, 6 (8), 34–40.

WILSON, F. T. Early achievement in reading. *Elementary School Journal*, 1942, 42, 609–615.

WILSON, F. T., & BURKE, AGNES. Reading readiness in a progressive school. *Teachers College Record*, 1937, 38, 565–580.

WILSON, F. T., & FLEMMING, CECILE W. Grade trends in reading progress in kindergarten and primary grades. *Journal of Educational Psychology*, 1940, 31, 1–13.

WRIGHT, W. W. Reading readiness: a prognostic study. *Bulletin of the School of Education*, Indiana University, 1936, 12 (3).