DOCUMENT RESUME

ED 106 793 CS 001 843

AUTHOR Marzano, Robert J.; DiStefano, Philip
TITLE Elements of the Word Recognition Process: A Two Part Study.
PUB DATE 75
NOTE 19p.

EDRS PRICE MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS Associative Learning; Beginning Reading; *Decoding (Reading); Elementary Education; Reading Research; Reading Skills; *Sight Method; *Word Recognition

ABSTRACT

There are basically two different models for the word recognition process. One model postulates that a reader primarily uses sound/symbol cues to recognize a word; a second model states that a reader focuses mainly on whole-word characteristics. To determine which model best fits beginning and adult readers, a multiple regression analysis was conducted to determine the relative strength of sound/symbol and whole-word characteristics as predictors of word recognition difficulty. The analysis indicated that whole-word characteristics are strong predictors of recognition difficulty at all levels; sound/symbol characteristics are significant predictors up to the fourth grade. This was interpreted as evidence that beginning readers use sound/symbol and whole-word cues but gradually become less reliant on sound/symbol information. In an effort to increase the predictable variance in word recognition difficulty, another predictor (previous exposure to a word) was experimentally entered into the regression equation. It was found that exposure to a word was the strongest predictor of word recognition difficulty. This was interpreted as evidence that experience with a word is an important, if not the most important, aspect of the word recognition process. (Author)

ED106793

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ELEMENTS OF THE WORD RECOGNITION PROCESS: A TWO PART STUDY

by

Dr. Robert J. Marzano
University of Colorado at Denver

and

Dr. Philip DiStefano
University of Colorado at Boulder

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Robert Marzano is an assistant professor of education at the University of Colorado, Denver. He received his Ph.D. from the University of Washington in 1974. He had previously attended Seattle University (M.Ed., 1971) and Iona College (B.A., 1968). Dr. Marzano has worked as an elementary and as a high school teacher. He has also had considerable experience in research and measurement as it applies to reading and English education. Currently he and Dr. Di Stefano are conducting research in the reading and composing processes.

Philip Di Stefano is assistant professor of education at the University of Colorado, Boulder. He received his B.S. and Ph.D. degrees from Ohio State University (1968 and 1974). He received his M.A. from West Virginia University in 1970. Dr. Di Stefano has taught at the high school level and has conducted research for the Protocols Materials Project, Ohio State University. Currently he is conducting research in the reading and composing processes. He is also interested in undergraduate teacher education and is presently conducting a study on the effectiveness of elective programs at the high school level.

ABSTRACT

There are basically two different models for the word recognition process. One model postulates that a reader primarily uses sound/symbol cues to recognize a word; a second model states that a reader focuses mainly on whole-word characteristics. To determine which model best fits beginning and adult readers, a multiple regression analysis was conducted to determine the relative strength of sound/symbol and whole-word characteristics as predictors of word recognition difficulty. The analysis indicated that whole-word characteristics are strong predictors of recognition difficulty at all levels; sound/symbol characteristics are significant predictors up to the fourth grade. This was interpreted as evidence that beginning readers use sound/symbol and whole-word cues but gradually become less reliant on sound/symbol information. In an effort to increase the predictable variance in word recognition difficulty another predictor (previous exposure to a word) was experimentally entered into the regression equation. It was found that exposure to a word was the strongest predictor of word recognition difficulty. This was interpreted as evidence that experience with a word is an important, if not the most important, aspect of the word recognition process.

Because of the nature of the problem and the findings of the research, the following study was conducted and, hence, reported in two parts.

PART I

The "great debate" (Chall, 1967) is partially concerned with whether a reader primarily uses a whole-word approach when attacking unfamiliar words or a method in which the word is broken into smaller sound units, then sounded and blended. There is ample research evidence to support both points of view.

The results of the study by Marchbanks and Levin (1965) indicate that beginning readers prefer to use first letters, final letters, middle letters and word shape (in that order of preference) as cues to word identification. Samuels (1974) states that the results of the Marchbanks and Levin study represent "proof" that readers recognize words using sound/symbol cues rather than whole word cues. The study by Samuels and Jeffrey (1966) also supports the letter cue theory of word recognition. Unfortunately the two above mentioned studies were conducted using beginning readers. If one surveys the research conducted using experienced readers, a different conclusion about word recognition can be reached.

The now famous Cattell studies (1947) were the first to indicate that readers use whole-word rather than sound/symbol cues. Cattell found that adult readers could recognize a short common word in slightly less time than it takes to recognize a single letter. Cattell interpreted these results as an indication that readers do not engage in letter-by-letter processing. If they did, then the time for recognizing a word would be the sum of the time necessary for recognizing each of the letters. More recently Erdmann and Dodge, in their study using skilled readers (1968), found that word length is a primary cue used in word recognition.

What is clearly lacking in the word recognition research is a study which utilizes data from beginning readers and skilled readers. Unfortunately an experimental study of such a nature is by definition extremely difficult; because skilled and beginning readers can not be given the same reading task. There is, however, an indirect method of determining the word recognition techniques used by beginning through adult readers. That technique can be summarized as follows:

1. Identify words that represent differing levels of word recognition ability (beginning through adult)
2. Analyze the words using indices which measure the whole-word characteristics and sound/symbol characteristics of the words.
3. Perform a regression analysis on the various indices using word recognition difficulty as the criterion measure.

If beginning and adult readers primarily use whole-word cues to recognize words then those measures of whole-word characteristics (eg. length) should be better predictors of word recognition difficulty; as the length of a word increases it becomes more difficult to recognize. If readers primarily use sound/symbol cues to recognize words then those measures of sound/symbol word characteristics (eg. average number of letters per phoneme) should be better predictors of word recognition difficulty; as the letters per phoneme increase the word becomes more difficult to recognize.

The above mentioned technique was used to answer the research question: "Do readers, beginning through adult, favor sound/symbol cues or whole-word cues in the word recognition process?"

Procedure

The words from the WRAT (Jastak, 1965, Level II) were used as the criterion.

The test is widely used and is generally considered a valid measure of a reader's word recognition ability. The words in the test represent ten levels of word recognition difficulty. Based on the number of words an individual recognizes, he or she can be assigned a a grade level score in recognition ability. Hence, it was assumed that the words used in the study were representative samples from the various levels of word recognition difficulty.

The words from the WRAT test were analyzed to determine their sound/symbol and whole-word characteristics. The following indices were used to analyze the words:

1. The average number of letters per phoneme (LP)
2. The average number of consonants per phoneme (CP)
3. The average number of vowels per phoneme (VP)
4. Word length (LTH)

The first three indices are direct measures of the sound/symbol characteristics of a word. Index 1 (LP) is an indication of how much letter blending must be done to recognize a word. Indices 2 and 3 (CP and VP) are subscales of LP (CP+ VP= LP). CP is a measure of the consonant complexity of a word; VP is a measure of the vowel complexity of a word. The fourth index (LTH) is a measure of the whole-word complexity of a word. Erdmann and Dodge (1968) state that LTH measures both word length and configuration complexity. Hence it was assumed that LTH was a measure of two whole word characteristics.

The scores from the four indices were subjected to a multiple regression analysis to determine which indices were the best predictors of the criterion, word recognition difficulty (DIFF). The results of the regression analysis are

reported in Table 1.

Table 1 here

Only one index (LTH) was found to be a significant (.05) predictor of word recognition difficulty. In terms of the research question this implies that readers rely on whole-word characteristics to decode words. This supports the findings of Cattell (1947) and Erdmann and Dodge (1968) and generalizes their findings to beginning readers.

The complete lack of predictive power of the three sound/symbol indices was quite surprising. Certainly the consonant complexity or the vowel complexity of a word should have some relationship with word recognition difficulty. The possibility was considered that the regression analysis was masking a relationship that does actually exist between sound/symbol complexity and DIFF.

A regression analysis will highlight a relationship that is strong and linear. If that relationship is curvelinear then a regression analysis based on a linear model might yield misleading results. Translated into the word recognition process under investigation this means that a regression analysis based on a linear model will not show evidence of a relationship in which the sound/symbol complexity of a word is a significant predictor up to a certain difficulty level (or grade) but not a good predictor after that level.

To determine whether the sound/symbol complexity of a word has a curvelinear relationship with word recognition difficulty, a trend analysis was performed on the means for LP, CP and VP. The groups from which the means were calculated were the ten levels of difficulty assigned the words on the WRAT test. The results of the trend analysis are reported in Table 2.

Table 2 here

The trend analysis indicated that the sound/symbol characteristics of a word do have a significant non-linear relationship with word recognition difficulty; VP and CP both had significant (.05) cubic trends. However, the general index of sound/symbol complexity (LP) showed virtually no relationship with DIFF. This apparent contradiction is explained if one examines the graphs of the means for LP, CP and VP. Those graphs are reported in Figures 1,2,and 3 respectively.

Figure 1

Figure 2

Figure 3

Figure 1 shows that the line joining the means for LP is almost horizontal. This indicates that there is no relationship between the number of letters per phoneme and word recognition difficulty. However, Figure 2 illustrates that CP has a strong negative linear relationship with DIFF up to difficulty level 4, and Figure 3 indicates that VP has a strong positive linear relationship with DIFF up to level 3. Thus when CP and VP are combined to form LP (CP+VP=LP) the positive and negative relationships with the criterion tend to cancel each other out. Consequently LP shows no relationship with the criterion.

In terms of the research question, the trend analysis indicates that the consonant complexity of a word and the vowel complexity of a word both have a relationship with word recognition difficulty and those relationships are linear up to the third or fourth level of difficulty (roughly third or fourth grade). In fact, when regression equations were calculated using the first four levels of DIFF as the criterion, both CP and VP were found to be significant predictors of the criterion. Therefore, it was concluded that up to the fourth level of difficulty, the more consonants per sound a word has, the easier it is to recognize; up to the third level the more vowels per sound a word has the harder it is to recognize. These last two statements actually relay the same information about word recognition. Up to the third or fourth level of difficulty, the more a word is composed of vowels (the less of consonants), the harder it is to recognize. Beyond that point (roughly third or fourth grade) readers do not key on sound/symbol cues and, hence, vowel complexity is not a factor.

Summary of Part I

Words from the WRAT test were analyzed to determine their sound/symbol and whole word characteristics. The various indices were subjected to a multiple regression analysis using the ten levels of word recognition difficulty, on the WRAT test, as the criterion. The whole word measure LTH was the only index found to be a significant predictor of the criterion. The sound/symbol indices were analyzed to determine if they have a curvelinear relationship with the criterion. The measure of consonant complexity (CP) and the measure of vowel complexity (VP) were found to have significant cubic relationships with word recognition difficulty. It was also found that up to difficulty levels 3 and 4, VP and CP, respectively, have significant linear relationships with DIFF. Thus,

the multiple regression analysis and subsequent trend analysis produced the following results:

1. When a prediction equation based on a linear model is used LTH is the only measure that is a significant predictor of word recognition difficulty.

2. CP and VP have significant cubic relationships with word recognition difficulty.

3. CP and VP have significant linear relationships (Negative and positive, respectively) with word recognition difficulty up to levels 3 and 4.

Discussion of Part I

Based on the above mentioned findings it was concluded that:

1. Beginning throught adult readers rely on whole-word characteristics to recognize words.

2. Word recognition in the early grades (up to third or fourth grade) is also a function of the vowel and consonant complexity of a word. The more a word is composed of consonants, the easier it is to decode; conversely, the more a word is composed of vowels, the harder it is to decode.

3. After the third or fourth grade, the relationship between sound/symbol complexity and word recognition ceases to be interpretable in terms of word recognition techniques.

The major implication of these conclusions is that the word recognition process appears to be different for the beginning and skilled readers. The beginning reader is concerned with breaking the sound/symbol code and, therefore, pays attention to sounding and blending. The most difficult sounding tasks are those involving vowels. The skilled reader probably meets few sound/symbol obstacles that are not immediately and quite easily overcome. Hence, the reader cues more on the length and general configuration of a word. In terms of teaching techniques, the findings of this study imply that whole-word and sounding/blending word recognition skills should be taught in the lower grades

with the emphasis shifting to whole word techniques in the upper grades.

One of the more disturbing aspects of the study was that the predictor indices accounted for very little variance in word recognition difficulty. The multiple correlation among the predictors and the criterion was .49. Although significant (.05), this correlation indicates that the predictors accounted for only 25% of the variance in DIFF. Certainly the remaining 75% can not totally be accounted for by the contextual complexity surrounding a word. The lack of predictive strength of sound/symbol and whole word measures led the researchers to postulate the existence of another significant factor in word recognition. That factor is the reader's previous experience with a given word and has been indirectly hypothesized by Smith (1971) and Goodman (1967) to be a significant aspect of the word recognition process.

PART II

Because of the relatively weak relationship among sound/symbol word characteristics, whole word characteristics and word recognition difficulty, it was hypothesized that an individual's past experience with a word is as strong or stronger a predictor of word recognition difficulty than the best predictor, LTH, as indicated in Part I. Past experience was operationally defined as the number of times a reader encounters a given word in the spoken or written language. Of course it would be impossible to determine ex post facto how many times an individual has encountered a word. Therefore, an artificial situation was established to determine the predictive strength of previous exposure (EXP) to a given word. The following procedure was used:

1. Twenty-five Italian words of varying length were selected.

2. Fifteen undergraduate education students, none of whom had any previous exposure to Italian, were selected.

3. The 25 words were randomly assigned to five groups- five words per group. The 15 students heard and saw the words in Group 1 used each day for

four consecutive days. The instructor pronounced each word and pointed to the word as the student looked on. Students were exposed to the words in Group 2 each day for three consecutive days; Group 3 for two days; Group 4 for one day and Group 5 for no days. At the end of the treatment (five days) each student was asked to pronounce the 25 words and the recognition difficulty was calculated for each word based on the proportion of correct student responses.

Each of the 25 words represented three characteristics of experimental interest: (1) recognition difficulty, the criterion measure, (2) length, the only significant predictor from Part I, and (3) the number of exposures students had to the word, the new predictor variable under investigation. If past experience with a word is an important component of the word recognition process, then the number of exposures (EXP) to the words should be a significant predictor of the criterion (DIFF).

Because the number of exposrues was randomly assigned to words, there was no relationship between EXP and LTH. The intercorrelations among the indices (Table 3) varify this.

Table 3 here

To test the predictive strength of EXP against that of LTH, a multiple regression analysis was performed using DIFF as the criterion and LTH and EXP as predictors. The results of the analysis are reported in Table 4.

Table 4 here

As in Part I of this study, LTH was found to be a significant (.01) predictor of word recognition difficulty. However, EXP was found to be an even stronger predictor than LTH. The multiple correlation among LTH, EXP and DIFF was .83. This can be logically compared with the multiple correlation calculated in Part I (.49) in which EXP was not included. Apparently EXP does

account for a good deal of the variance not previously predictable.

As a partial check that the number of exposures a student had to a given word was the factor which made the word easier to recognize, a control group of five students, who had no exposure to the words, was asked to pronounce the 25 Italian words. A two tailed t-test was run on the differences between the means for the control group and the experimental group. That difference was significant at the .01 level with the experimental group having the higher mean.

Summary of Part II

To determine the relationship between a reader's past experience with a word and word recognition difficulty, 25 Italian words were exposed to students for varying numbers of times. At the end of the treatment period, students were asked to pronounce each word and the word recognition difficulty calculated for each word. The number of exposures and the length of each word were then used as predictors of DIFF in a multiple regression analysis. Length (LTH) was again found to be a significant predictor, but exposures (EXP) was found to be an even stronger predictor. This was interpreted as an indication that a reader's past experience with a given word is an important factor in the word recognition process.

DISCUSSION OF PARTS I AND II

The combined results of Parts I and II were interpreted as evidence that a reader's past experience with a word is as important, if not more important to the word recognition process than his or her awareness of the sound/symbol or whole-word characteristics of the word. The skilled reader does not have

difficulty recognizing a word because of an inadequacy in his knowledge of letter/sound relationships, word structure or configuration. The experienced reader has trouble recognizing a word if it is not in his active vocabulary.

The differing models, implied by this study, for beginning and adult readers agree with those postulated by Goodman (1967) and Smith (1971). Goodman calls reading a "psycholinguistic guessing game" in which the beginning reader scans print line by line and in doing so uses graphic, phonological, syntactic and semantic cues. In short, the reader guesses and predicts meaning from his knowledge of the language, testing and checking as he reads. The mature reader decodes print directly into meaning and does not rely heavily on syntactic and phonological cues. Smith (1971) also postulates that readers "predict" their way through text. They seek no more graphic information than they need in order to comprehend what they read. The less fluent reader depends more on graphic information than does the fluent reader.

The implications for teaching are fairly clear. An experience approach to reading would seem to be as valid as a decoding approach. Indeed, a heavy emphasis on phonics is questioned by the results of this study. Few reading programs spend as much time systematically exposing students to new words as they do instructing students in the use of sound/symbol word characteristics for decoding purposes. It would seem that teaching phonics and/or structural analysis techniques to students above the elementary school level provides little return to the reader in terms of increased skill in word recognition.

Certainly further research in the word recognition process should be conducted. Ideally studies should be conducted in which data is gathered during the reading process rather than from a secondary source. The major obstacle for such studies will undoubtedly be the identification of a common reading task that can be given to beginning and adult readers.

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THE WIDE RANGE ACHIEVEMENT TEST. J.F. Jastak and S.R. Jastak. Wilmington, Del.: Guidance Associates, 1965.

Table 1 Multiple regression analysis with LP,CP,VP and LTH as predictors and DIFF as the criterion

Index	Beta Weight	Probability
LP	.12	.44
CP	.19	.29
VP	.08	.58
LTH	.30	.01

Table 2 Trend analysis of the means for LP, VP and CP

Index	Source of Variance	DF	MS	F	Prob
LP	Between	9	.0067	.73	.68
	Linear	1	.0000	.02	.89
	Quadratic	1	.0008	.00	.95
	Cubic	1	.0078	.85	.36
VP	Between	9	.0196	1.13	.36
	linear	1	.0263	1.50	.23
	Quadratic	1	.0104	.59	.45
	Cubic	1	.0808	4.82	.03
CP	Between	9	.0564	1.93	.06
	Linear	1	.1169	3.71	.06
	Quadratic	1	.1033	3.39	.07
	Cubic	1	.1241	4.27	.04

Table 3 Intercorrelations among LTH, DIFF and EXP

LTH	.06	
DIFF	.67	.53
	EXP	LTH

Table 4 Mutliple regression analysis with EXP and LTH as predictors and DIFF as the criterion

Index	Beta Weight	Probability
LTH	.49	.01
EXP	.64	.00

Figure 1
Trend Analysis for LP

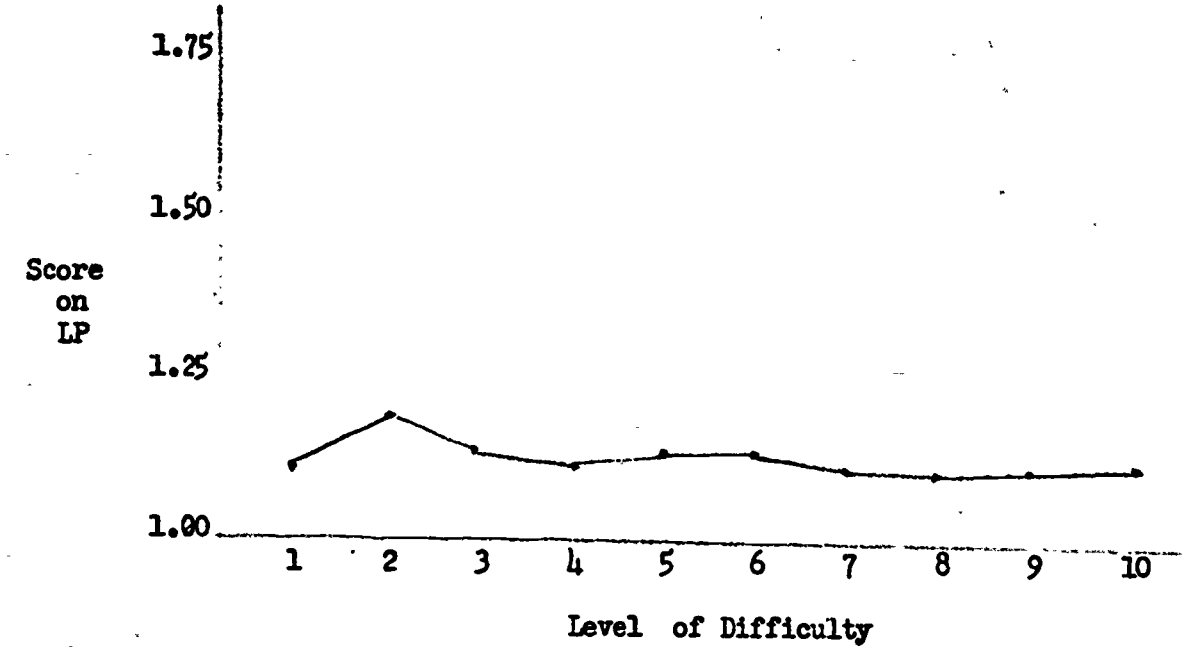

Figure 2
Trend Analysis for CP

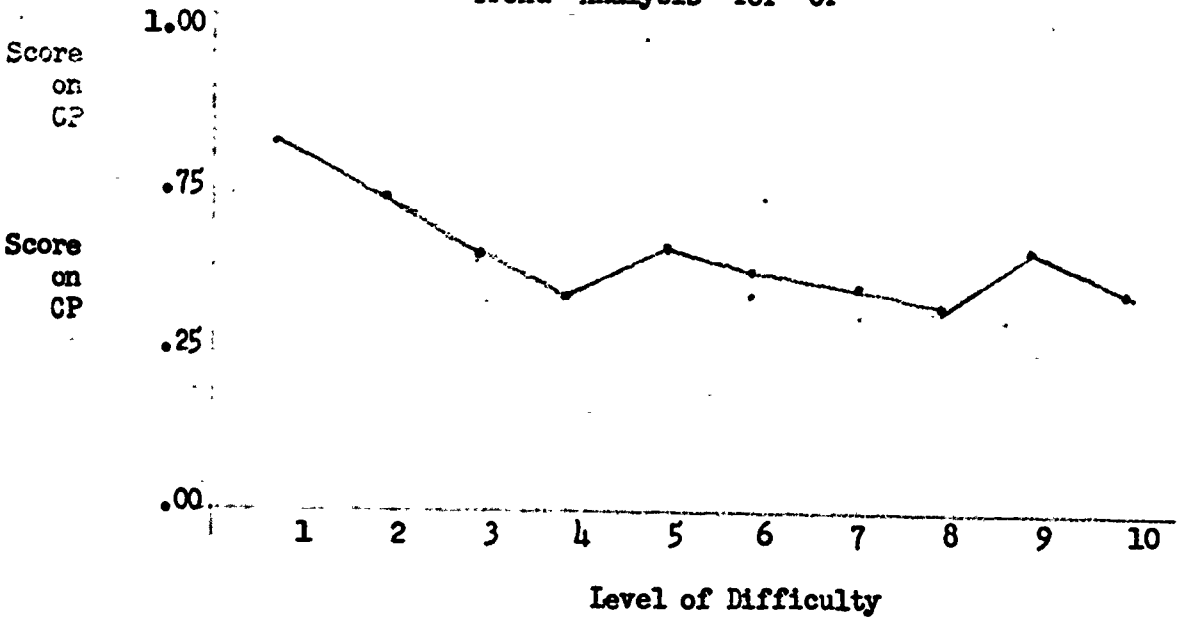

Figure 3
Trend Analysis for VP