DOCUMENT RESUME

ED 268 515 CS 008 422

AUTHOR Shanahan, Timothy; Lomax, Richard G.
TITLE A Developmental Comparison of Three Theoretical Models of the Reading-Writing Relationship.
PUB DATE Apr 86
NOTE 33p.; Paper presented at the Annual Meeting of the American Educational Research Association (70th, San Francisco, CA, April 16-20, 1986).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Comparative Analysis; Elementary Education; Grade 2; Grade 5; Integrated Activities; *Models; *Reading Achievement; *Reading Comprehension; *Reading Research; *Reading Writing Relationship; *Writing Research

ABSTRACT

A study compared and evaluated alternative theoretical models of the relationship of learning to read and learning to write at beginning and advanced levels of reading development. The reading dimensions of the three models included word analysis, vocabulary, and sentence and passage comprehension components. The writing dimensions included spelling, vocabulary, sentence structure, and story organization components. The models differed with respect to the sequential orderings of relationships of the dimensions. The interactive model permitted the use of reading knowledge in writing, as well as the reverse. The other models (reading-to-writing and writing-to-reading) allowed knowledge to move only in a single direction. These models were evaluated on their ability to account for the relationships found in an extensive body of reading and writing data collected from 69 beginning (second grade) and 137 proficient (fifth grade) readers. The findings suggested that the nature of the relationships changed as a result of learning, and that the interactive model fit the data better than the other models at both levels of achievement. (Author/FL)

A Developmental Comparison of Three Theoretical Models of the Reading-Writing Relationship

Timothy Shanahan

University of Illinois at Chicago

Richard G. Lomax

Louisiana State University

Running Head: Reading-Writing Models

Abstract

This study compared and evaluated three alternative theoretical models of the reading-writing relationship at two levels of reading achievement. The reading dimensions of these models included word analysis, vocabulary, and sentence and passage comprehension components. The writing dimensions included spelling, vocabulary, sentence structure, and story organization components. The models differed with respect to the sequential orderings of relationships of the reading and writing dimensions. The interactive model permitted the use of reading knowledge in writing, as well as the reverse. The other models (reading-to-writing; writing-to-reading) only allowed knowledge to move in a single direction. These models were evaluated on their ability to account for the relationships found in an extensive corpus of reading and writing data collected from 69 beginning readers and 137 proficient readers (Shanahan, 1984). Findings suggest that the nature of the relationships changes as a result of learning, but that the interactive model fit the data better than the other models at both levels of achievement.

A Developmental Comparison of Three Theoretical Models of the Reading-Writing Relationship

This study compares and evaluates three theoretical models of the relationship of learning to read and learning to write at beginning and advanced levels of reading development. The proposed models are compared and evaluated on the basis of their ability to account for the relationships found in an extensive collection of reading and writing data. Each model includes systematic orderings of variables representing word recognition, sentence and passage comprehension, spelling, syntax, vocabulary and story structure knowledge, but differs in the ordering of the causal relationships of the variables. The models are compared across levels of reading ability in order to determine whether the nature of the relationship changes with learning.

The reading-writing relationship has received increased attention recently from theoreticions and curriculum specialists (Kucer, 1985; Spivey, 1984; Tierney & Pearson, 1983). However, most studies of the relationship of reading and writing have failed to provide information that has been useful to either theory development or curriculum design (Stotsky, 1983). This is probably because this research has tended to be atheoretical (Mosenthal, 1983); it has lacked specificity or thoroughness with regards to a number of issues. First, this research usually has emphasized general conceptions of reading and writing, or relationships between single parts of reading and writing. Second, it has usually failed to specify the ordering or sequences of relations that exist between the various components of reading and writing. Finally, this research usually has failed to consider how one influence generalizes across the components of either process, or how and when various changes in the relationships come into play.

Nevertheless, a few studies have examined the reading-writing relationship in a more comprehensive, developmental manner. Juel, Griffith & Gough (in press), for example, carried out a longitudinal analysis, from first to second grade, of the relations between word recognition, spelling, reading comprehension, and writing. That study found word recognition and spelling to rely upon similar knowledge bases, but that comprehension and story production required different, though overlapping knowledge bases. The authors concluded that word recognition and spelling relationships were implicated in later comprehension and story production development, but alternative orderings of the variables in this model were not evaluated.

Shanahan (1984), in a more extensive examination of second and fifth graders, found similar relations between reading and writing. Shanahan compared the relations across the grade level cohorts and found that the nature of the relationship was stable across cohorts, although there were large qualitative differences in the nature of the relationship when reading level cohorts were compared. In the grade level comparisons, the spelling-word recognition dimension focused on by Juel, et al. (in press), was found to be important at both levels. In the reading level comparison, vocabulary and story structure knowledge were found to increase in relative importance in the reading-writing relationship, while visual and phonemic aspects of word recognition and spelling declined in relative importance. Shanahan analyzed the relations statistically with no theoretical specification of the ordering of relations among component variables, however.

Shanahan & Lomax (in press) constructed three theoretical models of the reading-writing relationship that were explicit with regards to the orderings

of the various relations. They evaluated the usefulness of these models by testing their relative ability to summarize or describe the relations found in the Shanahan (1984) data base. Although Shanahan and Lomax's analysis resulted in a clear superiority of one model over the others, it did not consider differences between the outcomes that might result because of learning. Different results might be obtained if the models were tested with good readers-writers and poor readers-writers samples; the research presented here attempts to examine the effectiveness of the Shanahan & Lomax models with achievement level samples.

The Shanahan & Lomax Models of the Relationship

Shanahan & Lomax's first model, the interactive model, is summarized in Figure 1. The interactive model is the most complex model. It postulates that reading can influence writing development and writing can influence reading development. According to this model, reading knowledge consists of three major components or latent variables: word analysis (the ability to decode words through the use of sound-symbol relationships); word meanings; and text comprehension. The writing portion of the interactive model includes four latent variables: spelling, vocabulary diversity, syntactic complexity, and story structure complexity. More complete descriptions of the latent variables can be found in Shanahan & Lomax (in press).

Insert Figure 1 about here.

In the reading portion of this model, development is hypothesized to proceed across discourse levels in a forward manner only; roughly from letters to words to sentences to extended texts. The forward approach was adopted because children develop the ability to analyze or decode print prior to developing the higher level comprehension processes (Chall, 1983). Although the use of higher level discourse knowledge can precede or replace the use of lower level knowledge, the more typical sequence of events in children's reading seems to be that lower level processes serve as enabling devices for higher level ones (Baumann, 1983).

Writing development occurs in a similar direction in the interactive model, also. Writing was ordered in this manner in an attempt to describe writing in an analogous way to that used for reading, and not because research had justified such an ordering. Attempts to describe the cognitive events of writing are still in their infancy (Cooper & Matsuhashi, 1983; Hayes & Flower, 1980; McKutchen, 1984), and as yet, such efforts have not resulted in a clear specification of the sequence of development in children's writing. Until research indicates differently, it seems reasonable to order the components of the two processes in analogous ways in order to maximize the possibility of identifying overlaps between reading and writing.

The key element of the interactive model is the nature of the relationships <u>across</u> the reading and writing dimensions. Within a level of discourse, the influence proceeds from reading to writing. For example, word analysis could influence spelling, but spelling knowledge would not exert much influence on word recognition; or, students should be able to interpret word meanings before being able to represent these meanings in written text. On

the other hand, writing influences the reading process across discourse levels. That is, lower level writing knowledge influences higher level reading knowledge. A component of writing directly influences the component of reading that is immediately above it, and it influences higher level reading components through this immediate relation. Knowledge of spelling, for instance, could influence vocabulary knowledge in reading, and through this relation, spelling knowledge could be used in the interpretive processes of reading comprehension. The sequence of this model is consistent with those descriptions of the relationship (Freedman and Calfee, 1984; Goodman & Goodman, 1983) in which reading ability precedes writing ability, but writing is able to inform the reading process.

Shanahan & Lomax's second model (see Figure 2), the reading-to-writing model, contains the same reading and writing components, ordered in the same manner as in the interactive model. It differs from the interactive model, in that all relations between the reading and writing variables emanate from reading to writing. This model theorizes that reading knowledge can influence writing, but that little or no writing knowledge would be useful or influential in reading. This model appears to be a reasonable characterization of the many instructional programs that emphasize reading instruction with little attention to writing (NAEP, 1981). This approach to instruction guarantees that reading can exert a strong influence on writing, but it severely limits any possible effect of writing on reading.

Insert Figure 2 about here.

The third model, the writing-to-reading model (see Figure 3), again includes the same reading and writing components and the same within-process relationships as previously described. In this model, however, writing affects reading, but reading exerts no influence upon writing. Unlike the structure of the interactive model, in this model writing knowledge influences aspects of reading knowledge at equivalent and higher levels of discourse. This model attempts to capture the essence of those theories that claim that writing development can occur prior to the acquisition of reading knowledge (Chomsky, 1976; Giacobbe, 1981; Graves, 1978). Although such explanations have not been explicit with regards to either the component abilities of reading and writing or the ordering of specific relations, this writing-to-reading model attempts to characterize the general ordering of development described by these theories.

The comparison of these three models, with the grade-level stratified data, led Shanahan & Lomax (in press) to conclude that the interactive model provided the best description of the reading-writing relationship at these levels. The interactive model was superior to the other models because it was the only one that included a flow of information in both directions. Moreover, the reading-to-writing model was superior to the writing-to-reading model because it emphasized greater movement of information from reading to writing. That analysis also explored several of the specific relationships between specific latent variables within the various models.

Although the Shanahan & Lomax analysis resulted in a clear ordering of the models in terms of their ability to summarize the relations in an extensive data set, it is possible that different results would have been

obtained from a similar analysis with achievement level samples. Shanahan (1984) reported that the relationships between the specific variables changed across achievement levels, but not across grade levels, so it is possible that the relative goodness-of-fit of the models would differ across achievement levels also. Learning could alter the order or amount of information sharing that occur between reading and writing. For this reason, the study reported here evaluates these models with the same data stratified on the basis of reading ability.

Insert Figure 3 about here.

Method

Subjects

The data were collected in twelve second grade and 9 fifth grade classes. These classes represented a heterogeneous sample with respect to race (75% Caucasian, 21% black, 4% other), sex (50% male), and SES (36% from low SES schools). Complete data were obtained from 256 second graders and 251 fifth graders. These grade level sample data were combined and sampled from in order to select the lowest (N = 69) and most proficient readers (N = 137). The analyses reported here were carried out using these achievement level data.

Test Instruments and Procedures

The measures used in this study were selected to provide maximally valid and reliable measures of those variables identified in previous studies as

being correlated across the reading-writing sets. Measures were selected to provide an equivalent measurement of components of reading and writing at the two grade levels. These measures were similar in design and required the same actions on the part of the subjects. In some cases, measures representing the same latent variable were drawn from different test batteries in order to provide the most similar measurement across grade levels. This approach was taken in order to maximize the magnitudes of the relationships and to guarantee the comparability of the results at the two grade levels.

Second graders completed the following reading tests: the Phonetic Analysis Test of the Stanford Diagnostic Reading Tests (SDRT); the Reading Comprehension Test of the Gates-MacGinitie Reading Tests (GMRT); the Vocabulary Test of the SDRT, and a limited cloze test in which subjects replaced words, from lists, that had been deleted from grade level appropriate passages. Fifth graders completed the Phonetic Analysis Test of the SDRT; the Reading Comprehension test of the SDRT; the Vocabulary test of the GMRT; and a limited cloze test. Each subject was asked to complete a grade level appropriate spelling test that was analyzed for Standard English spelling accuracy, phonemic accuracy, and visual accuracy. Subjects each wrote two stories that were analyzed for mean T-unit length, vocabulary diversity, and the existence of various story grammar features (Stein, 1978).

The latent variables included in the models are listed in Table 1. This table shows which tests or measures were used as indicator variables of the latent variables. Additional description of the actual measures (validity, reliability, etc.) and the data collection procedures is available in Shanahan (1984).

To recombine the grade level samples into samples reflecting reading achievement, it was necessary to convert the reading test scores of the second and fifth graders to equivalent measurement scales. Although different tests of reading were used at the second- and fifth-grade levels, it was considered reasonable to equate performance across grade levels on the comprehension and phonics tests because (a) the tests at both grade levels were designed to assess similar psychological constructs; (b) the correlations of these tests with the other measures used in the study did not differ significantly between the grade level samples; (c) the tests were equally reliable; and (d) the grade level samples were similar in composition in terms of race, sex, SES, and locale. Thus, the assumptions were satisfied which permit the use of linear transformations to equate test scales (Angoff, 1971).

The combination of comprehension and phonics scores into scales without regard to grade allowed reading achievement samples to be selected at two levels. The first of these samples, beginning readers, was made up of subjects whose scores on the comprehension and phonics tests both fell in the bottom 25% of the sample distribution. Subjects were classified as proficient readers if their scores on both of the tests were in the top 35% of the samples (the differences in percentages for the beginning and proficient reader selections were due to a smoothing problem with the second-grade phonics test; a large number of subjects achieved the same score on that test).

The achievement level samples differ from the Shanahan & Lomax samples in some rather important ways. First, these samples are much smaller, which lowers the the reliability of the measures; especially affected are the

estimates of the structure coefficients between the latent variables. Second, the sampling procedure introduces an artifactal reduction of variance in the phonics and reading comprehension measures. This should lead to lowered estimates of the weightings between these reading variables and other variables. It also would be expected to limit the power of both the interactive and the reading-to-writing models because of their heavy reliance on the reading measures. Interpretations of the outcomes take account of these variance reductions.

Insert Table 1 about here.

Analysis

In path analysis a model is constructed that hypothesizes the causal relationships among a set of variables. A multiple linear regression equation is derived for each dependent variable in the model and consists of those variables believed to influence that particular dependent variable. An implicit assumption of path analysis is that the variables are measured without error in terms of reliability and validity, which is unlikely for variables typically considered in educational or psychological research. Estimates obtained from models with fallible measurements may be biased. The logical solution is to obtain multiple measures of each hypothetical component or construct in the model (Lomax, 1983).

The methodology used is known as the linear structural relationship (LISREL) model developed by Jöreskog (1978). The LISREL model consists of a structural equation model and a measurement model. The structural equation

model describes the theoretical relationships among unobservable, hypothetical components or constructs, known as latent variables, through a set of general linear equations (i.e., a path analysis model). The measurement model considers latent variables as linear combinations of sets of observable indicator variables. Multiple indicator variables are used to allow for an assessment of measurement error (i.e., improved measurement of the hypthetical constructs via a factor analytic model). Subjects were tested on all of the indicator variables, and a covariance matrix of these indicator variables was generated for each grade. The LISREL VI computer program (Jöreskog & Sörbom, 1984) was then used to evaluate the hypothesized component processes models of the reading-writing relationship. The LISREL analysis results in the computation of maximum likelihood estimates of the relations between the latent variables. These structure coefficients are comparable to unstandardized regression weights.

The overall intent of the LISREL analysis is to reconstruct the observed covariance matrix as well as possible by imposing a theoretical structure on the data. The smaller the residual difference between the observed covariance matrix and the reconstructed covariance matrix based on the imposed structure, the better the fit of a particular model. One model-fitting index is the chi-square goodness-of-fit test, the result of which is a direct function of sample size. For a large sample, a "good fit" (i.e., where the chi-square value approaches the number of degrees of freedom) usually cannot be found using this index, even though the residuals may be essentially zero. For a small sample, many competing models may yield a "good fit." The utility of the chi-square statistic is in comparing models. For example, a new model may

be tested against the original model by changing parameters in the original model. The new model will be shown to be better-fitting than the original model if the drop in the chi-square value is large compared to the difference in the degrees of freedom. To permit the comparison of models with different sample sizes, the root mean square residual (RMSR), which is a measure of the average residual correlation is used as an index of comparsion because it is unrelated to sample size.

Results

The maximum likelihood estimates of the relationships between the latent variables in the interactive, reading-to-writing, and writing-to-reading models are summarized in Figures 1, 2 and 3, respectively. Of the three, the interactive model generally provided the best goodness-of-fit for this data, based on the chi-square goodness-of-fit index. It was superior to the other models in summarizing the proficient reader data (χ^2 = 79.47, $\underline{df}$ = 45, $\underline{p}$ = .001, $\underline{RMSR}$ = .041). At the beginning reading level, the interactive model (χ^2 = 68.93, $\underline{df}$ = 45, $\underline{p}$ = .012, $\underline{RMSR}$ = .125 also was superior to the reading-to-writing model, but it was about equal to the writing-to-reading model.

The writing-to-reading model (beginning reader sample: χ^2 = 69.24, $\underline{df}$ = 46, $\underline{p}$ = .015, $\underline{RMSR}$ = .122; proficient reader sample: χ^2 = 95.45, $\underline{df}$ = 46, $\underline{p}$ < .01, $\underline{RMSR}$ = .053) was superior to the reading-to-writing model (beginning reader sample: χ^2 = 72.17, $\underline{df}$ = 46, $\underline{p}$ = .008, $\underline{RMSR}$ = .131; proficient reader sample: χ^2 = 102.46, $\underline{df}$ = 46, $\underline{p}$ < .001, $\underline{RMSR}$ = .055) at both achievement levels, particularly with the proficient reader data. All three models fit the proficient reader data best.

As expected, the relations between variables within the models declined because of the variance constraints introduced by the sampling procedure. Unlike the Shanahan & Lomax (in press) study, only some of the maximum likelihood estimates of the individual paths are significant in any of the models. For this reason, and because of the limits imposed on reliability by the procedures, no attempt was made to compare the significance of differences in the estimates associated with the individual paths across models. Although the individual relations differ a great deal from the Shanahan & Lomax results, as well as across the models in this analysis, clear and generalizable evaluation of individual paths will require further research and, therefore, these paths will not be discussed here.

One exception to this concerns the relationship of the comprehension variable with the other latent variables. Despite reducing most of the variance in the standardized reading comprehension test, all but one of the paths between reading and writing that lead to or from this variable are significant in all three models at both levels. This is, in part, due to the fact that the cloze test and the comprehension test that make up this latent variable were highly correlated (second grade $r = .71$; fifth grade $r = .66$). The variance was reduced directly in the standardized measure but not in the overlapping cloze test. Thus, the relations of the comprehension measure with the other measures remain at significant levels even though the reading contribution to the models has been reduced greatly. The only non-signficant relationship between the writing dimension of the models and the reading comprehension variable concerned the story structure variable. In all previous analyses, this particular path was associated with one of the larger

weights; this highlights the within-sentence comprehension emphasis of the cloze test (Shanaha , Kamil & Tobin, 1982) and suggests that the story grammar measures are more related to question-and-answer types of comprehension tests.

Discussion

This research evaluated three theoretical models of the reading-writing relationship that were explicit as to the sequence or order of relations that characterize the interaction of reading and writing development. It evaluated the ability of the models to summarize the actual relations found in a set of reading and writing data obtained from samples of beginning and proficient readers (Shanahan, 1984). The interactive model, in which reading knowledge could be used in writing and writing knowledge could be used in reading, provided the best description of the data. It was superior to the reading-to-writing model and equal to the writing-to-reading model with the beginning reader data. Moreover, the interactive model was clearly superior to both of the other models with the proficient reader data. These findings replicate the results reported by Shanahan & Lomax (in press).

The continued superiority of the interactive model is somewhat surprising. The sampling procedure used to select beginning and proficient readers placed great constraints on the amount of variance in two of the measures (phonics, reading comprehension). Because these two variables are of fundamental importance to the interactive and reading-to-writing models, and of somewhat less importance to the writing-to-reading model, it was assumed that the goodness-of-fit of the interactive and the reading-to-writing models would be relatively impaired. This did occur with the reading-to-writing model.

However, even with the variance constraints, the interactive model continued to outperform the writing-to-reading model. The interactive model is robust with regard to its ability to summarize data collected from diverse samples of readers and writers. Reading influences writing, and writing influences reading; theories of literacy development need to emphasize both of these characteristics. Similarly, these findings suggest that reading and writing should be taught in ways that maximize the possibility of using information drawn from both reading and writing. These results challenge the wisdom of instructional programs that provide students wwith limited opportunities to gain knowledge through writing, or that delay these opportunities until reading proficiency is well developed. Significant knowledge transfer takes place in both directions, even at relatively low levels of literacy attainment.

Shanahan & Lomax (in press) reported that the reading-to-writing model was superior to the writing-to-reading model. The reverse was found here, but this is almost certainly due to the limitations of the sampling procedures. Procedures less biased against reading would have almost certainly had a different result. The previous superiority of the reading-to-writing model was, at least partially, due to the fact that these subjects had little opportunity to write except for spelling and word writing. An instructional context with greater emphasis on writing would permit writing knowledge to be a more substantial source of reading kknowledge, and would allow the interactive and the writing-to-reading models to do relatively better.

Although the models fit the data better at the proficient reader level than at the beginning reader level, the ordering of the models in terms of

goodness-of-fit was the same at both levels. This is probably due to the limits placed on the phonics variable, which was the only indicator variable for word analysis and which is especially implicated in the development of beginning readers and writers. The constraints imposed on the standardized reading comprehension measure were less limiting because of the availability of the cloze test. While the ordering of the models was largely the same across achievement levels, the nature of the specific relations within the models did differ. The specific weightings reported here are of questionable reliability because of the low subjects-to-measures ratios, and thus, were not analyzed. Shanahan (1984) provides some information on the relative nature of the changes that do occur.

It should be noted that this study only examined product or information variables (i.e., spelling, vocabulary, etc.). Future research needs to consider process variables as well. The inclusion of measures that tap purpose-setting, problem-solving strategies, and metacognitive awareness might better characterize both the reading and writing dimensions, and could provide a better indication of the learning context under which various product components come into play. Shanahan (1984) concluded that reading and writing were separate entities, each requiring instructional emphasis. This study does not dispute that conclusion. It does, however, highlight the value of reading information in writing and writing information in reading at different levels of literacy learning. The inclusion of process variables would probably increase the magnitude of reading-writing relations and it would enhance our understanding of the nature and magnitudes of the interactions of reading and writing. The inclusion of additional or different variables, both

process variables and substrata measures of the variables used here, might alter or extend the results, but it seems doubtful that the uni-directional models would ever do as well as the interactive model.

Future research needs to consider the issue of measurement maximization, also. The models used here were constructed to define reading and writing as parallel and analogous processes so as to maximize the relations. These relations could be increased even more by taking reading and writing measurements during the performance of identical or related tasks (C. Morris, Bransford & Franks, 1977; Spivey, 1984). Conversely, it is possible that the magnitudes of relationship might be found to be smaller than estimated here if a writing model was developed that included components with little or no parallel to reading or that sequenced relations without regard to what is known about reading development. Clearly, there is a need to develop more elaborate and more appropriate measurement techniques for exploring the relations among language processes. Whether the overall magnitude of relationship is found to be greater or smaller, it seems reasonable to expect the transfer of information during development to proceed in a bi-directional manner. Theoretical models that allow for this dual transfer of information would be expected to provide the best description of actual development.

Footnote

Requests for reprints should be sent to Timotny Shanahan, University of Illinois at Chicago, College of Education, Box 4348, Chicago, Illinois 60680.

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Table 1

Latent Variables and Indicator Variables for Models of Reading-Writing Relationship Indicator Variables

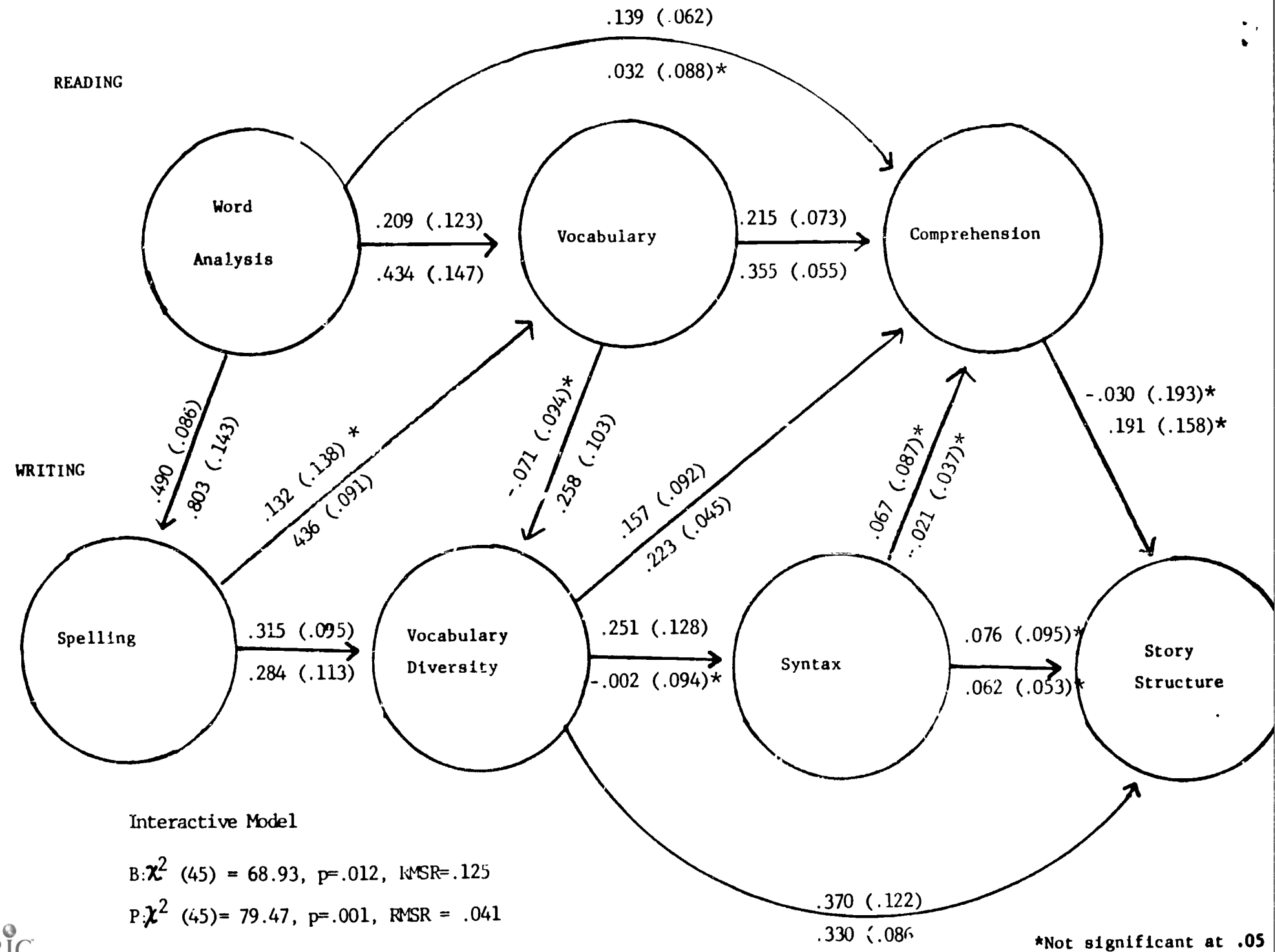
Latent Variables	2nd Grade	5th Grade
Reading:		
Word Analysis	-Stanford Diagnostic Reading Tests: Phonetic Analysis Test, Red Level	-Stanford Diagnostic Reading Tests: Phonetic Analysis Test, Brown Level
Vocabulary	-Stanford Diagnostic Reading Tests: Vocabulary Test, Red Level	-Gates-MacGinitie Reading Tests: Vocabulary Test, Level D
Comprehension	-Gates-MacGinitie Reading Tests: Comprehension, Level B -Limited Cloze Test	-Stanford Diagnostic Reading Tests: Comprehension Test, Brown Level -Limited Cloze Test
Writing:		
Spelling	-Standard spelling test -Phonemic accuracy of spelling -Visual-orthographic accuracy of spelling	-Standard spelling test -Phonemic accuracy of spelling -Visual-orthographic accuracy of spelling
Vocabulary Diversity	-Number of different words used in writing, controlling for fluency	-Number of different words used in writing, controlling for fluency
Syntax	-Average t-unit length	-Average t-unit length
Story Structure	-Number of episodes -Number of unique story grammar categories instantiated -Number of story grammar information units	-Number of episodes -Number of unique story grammar categories instantiated -Number of story grammar information units

Figure Captions

Figure 1. The Interactive Model, with maximum likelihood estimates and (standard errors) for beginning and proficient reader data. Beginning reader statistics are listed above proficient reader statistics.

Figure 2. The Reading-to-Writing Model, with maximum likelihood estimates and (standard errors) for beginning and proficient reader data. Beginning reader statistics are listed above proficient reader statistics.

Figure 3. The Writing-to-Reading Model, with maximum likelihood estimates and (standard errors) for beginning and proficient reader data. Beginning reader statistics are listed above proficient reader statistics.

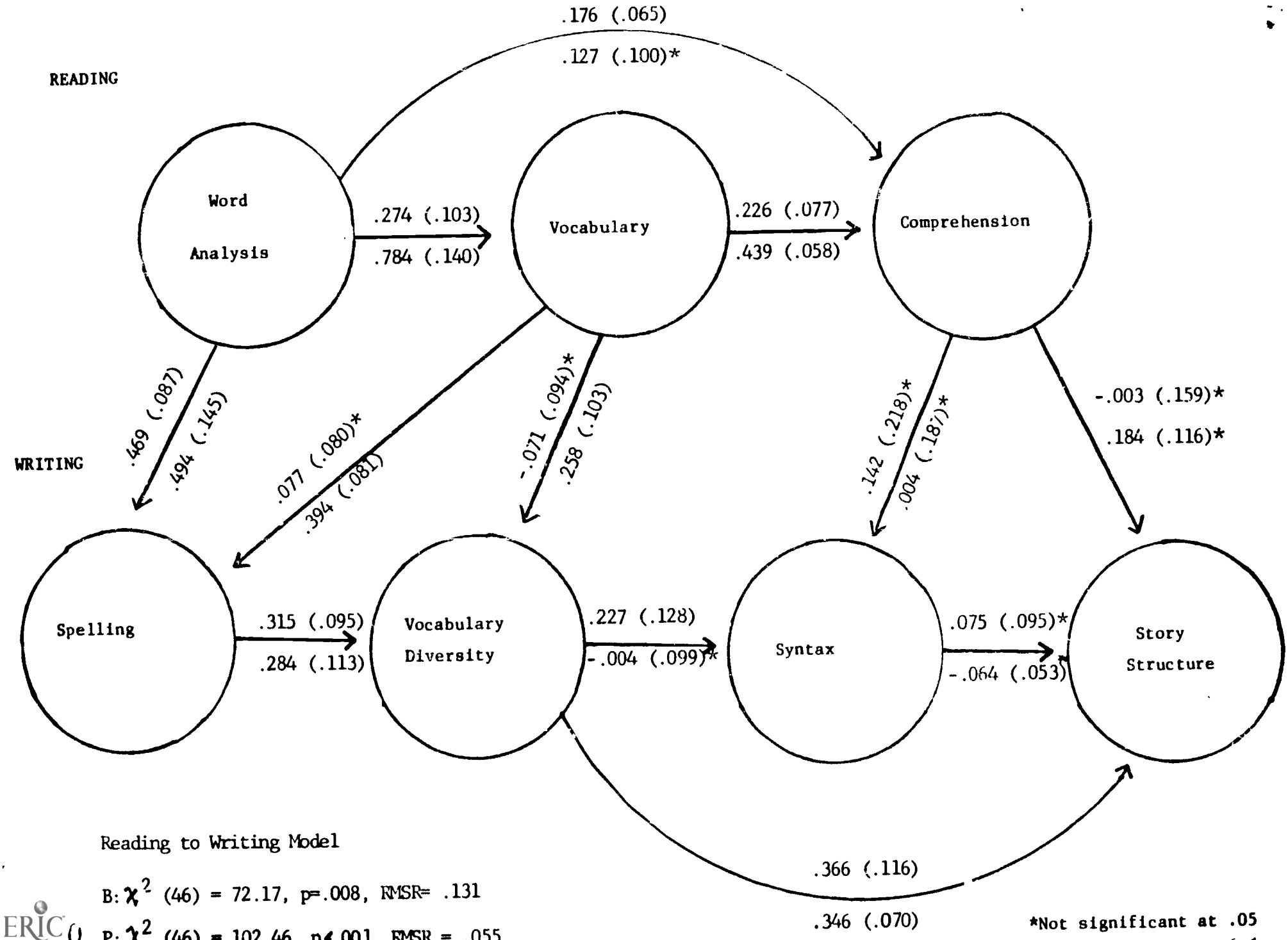


Interactive Model

B: χ^2 (45) = 68.93, p=.012, RMSR=.125

P: χ^2 (45)= 79.47, p=.001, RMSR = .041

*Not significant at .05

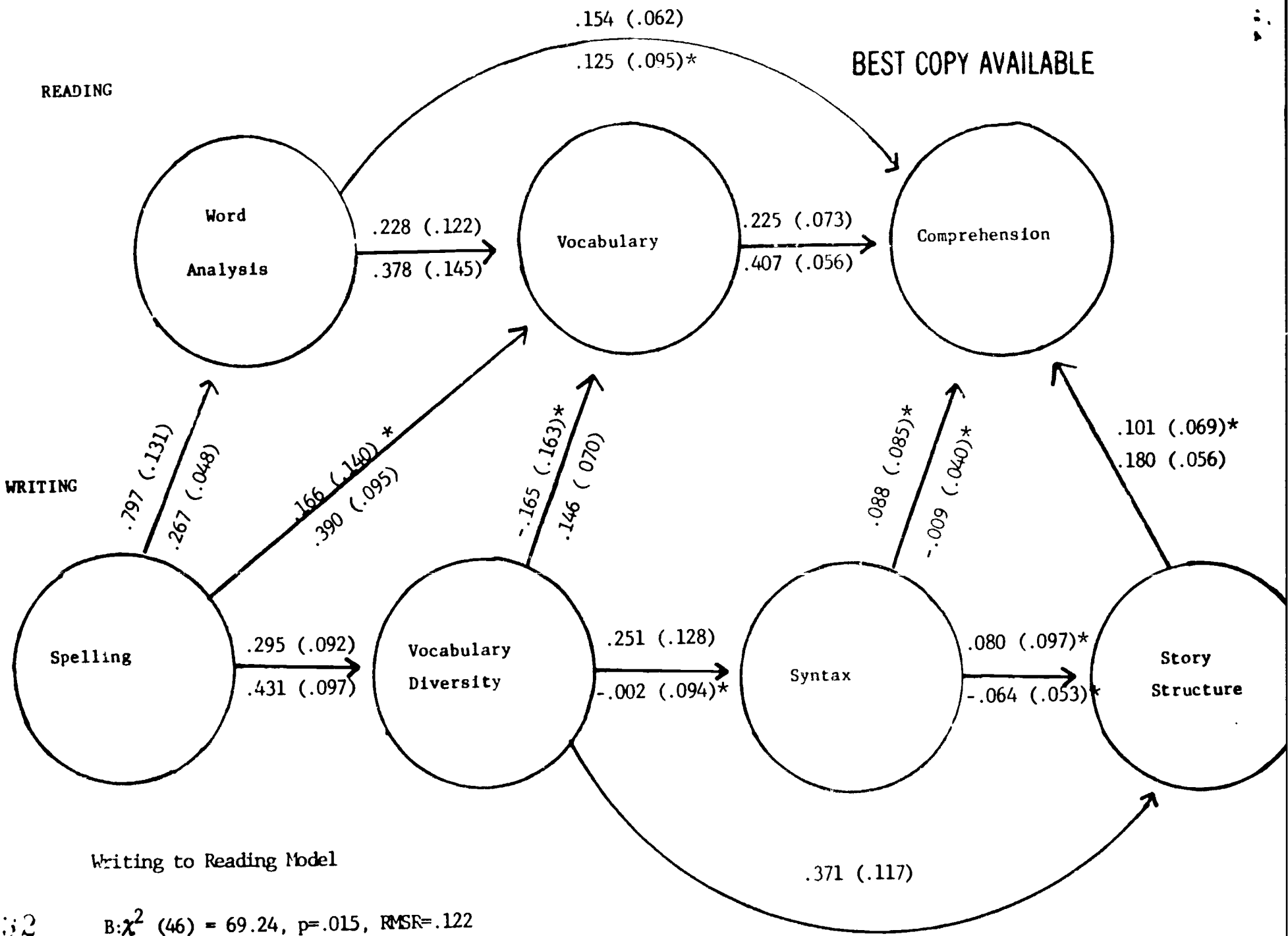


Reading to Writing Model

B: χ^2 (46) = 72.17, p=.008, RMSR= .131

P: χ^2 (46) = 102.46, p<.001, RMSR = .055

*Not significant at .05



Writing to Reading Model

B: χ^2 (46) = 69.24, p=.015, RMSR=.122

P: χ^2 (46) = 95.45, p<.001, RMSR=.053

*Not significant at .05