

# The Impact of Visual and Phonological Ability on Early Reading Acquisition: A Structural Equation Model

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## ABSTRACT

We examined the relationships among and the impact of orthographic ability (ORTH), motion sensitivity (MOTION), visual attention (VIS) and phonological awareness (PHON) on children's ability to decode single words in Grades 1 and 2. Latent variables, acquired through various measures of each of these factors, were used in a hypothesized model of best fit, pitted against an alternative model, and assessed using structural equation modeling. Participants included 135 children from schools throughout Winnipeg, tested in two separate waves, at the end of grade one, as well as at the end of grade two. While anticipated correlations among all factors of each wave were found, other hypothesized results were not. The hypothesized model did not provide a strong fit of the data. Despite this, a model of best fit was found using exploratory analysis and showed early phonological awareness and early decoding skills to be the best predictors of later reading ability.

## BACKGROUND

### Studies Report:

1. Phonological Awareness is a key factor impacting reading acquisition.
2. Poor readers likely have impairments in Orthographic Awareness.
3. Coherent Motion detection tasks are able to differentiate reliably between groups of poor and normal readers.
4. A higher order deficit in visual attention is more likely impacting reading performance than is a general motion perception deficit.

### Question

Considering developmental changes that occur between Grades 1 and 2, of PHON, ORTH, MOTION and VIS, which skills most strongly influence children's ability to decode? Is there a model that can best reflect these relationships and influences?

## HYPOTHESES

- PHON directly impacts DECODE and is strongest predictor in grade one.
- ORTH directly impacts DECODE and is strongest predictor in grade two.
- Strong interrelationships exist among ORTH and PHON.
- VIS is a mediating factor between MOTION and ORTH.
- A weak relationship exists between MOTION and PHON.
- Decode (wave 1) will directly impact PHON and ORTH as measured in wave 2.

## METHOD

**Participants:** 135 Grade One children chosen from nine public schools across Winnipeg. Testing completed in grade one and grade two spring terms.

### Measures:

**Decoding:** Woodcock Johnson Reading Mastery Test-Revised (WJRM)  
Word Identification (M=100; SD=15); Wide Range Achievement Test (WRAT) (M=100; SD=15)

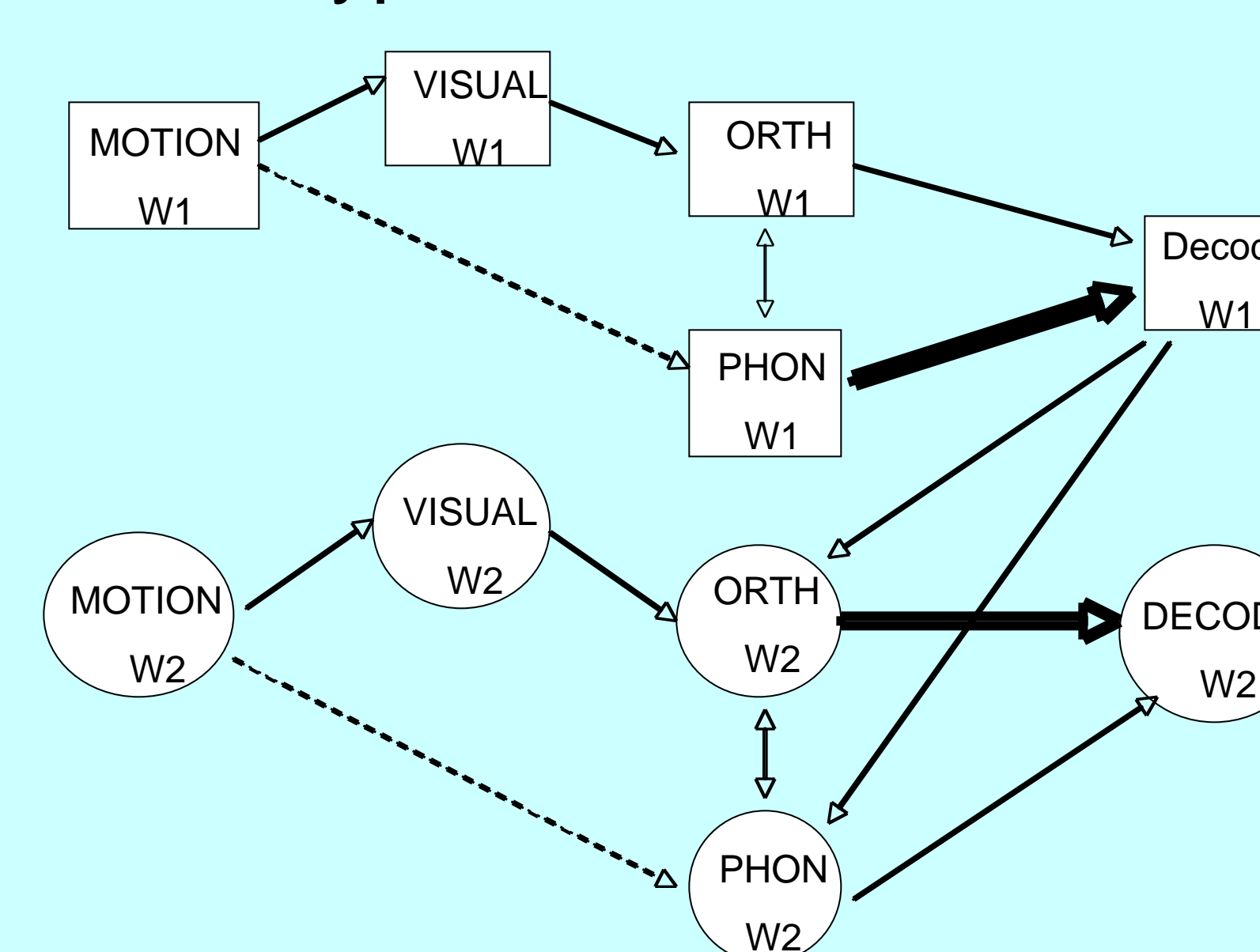
**PHON:** Comprehensive Test of Phonological Processing (CTOPP)  
Elision (M=100; SD=15)  
Blending Words (M=100; SD=15)  
Sound Matching (M=100; SD=15)

**ORTH:** Orthographic Letter Pairs Task  
Percent accuracy on 20 pairs of letter strings; word likeness judgment as indicator of ORTH  
fant - tanf – (“tanf” violates English orthography rule)  
udda - ddua (“ddua” violates English orthography rule)

**VISUAL ATTENTION:** Card Sorting Task  
Time, in seconds, required to complete task  
Set #1 16 cards [ ] 16 cards [ ]  
Set #2 16 cards [ ] 16 cards [ ]

**MOTION:** Random Dot Kinematogram (RDK)  
Percentage of dot coherence needed for 75% accuracy response rate.

## Hypothesized Model



Measurement Model for Wave 2 Decoding Outcome Variable

Measurement model	Value <sup>a</sup>	Z <sup>b</sup>
<b>Path</b>		
Phonological Awareness--> Decoding Wave 1	.99	11.45
Decoding Wave 1--> Decoding Wave 2	.89	14.86
<b>Motion Detection</b>		
Random Dot Kinematogram Trial 1	.65	21.87
Random Dot Kinematogram Trial 2	.67	20.35
<b>Orthographic Awareness</b>		
Orthographic Letter Pairs Task 1	.47	51.27
Orthographic Letter Pairs Task 2	.57	51.55
<b>Visual Attention</b>		
Card Sort Trial 1	.95	33.20
Card Sort Trial 2	.92	31.35
<b>Phonological Awareness</b>		
Elision Letter CTOPP	.79	21.55
Blending Words CTOPP	.58	35.16
Sound Matching CTOPP	.80	24.65
<b>Decoding</b>		
Wide Range Achievement Woodcock-Johnson	.93	46.70
Word Identification Woodcock-Johnson	.94	19.23
<b>Decoding Wave 2</b>		
Wide Range Achievement Wave 2	.96	64.57
Word Identification Wave 2	.96	36.87
<b>Correlations</b>		
Phonological <--> Motion Detection	-.46	-3.15
Phonological <--> Visual Attention	-.46	-4.31
Phonological <--> Orthographic	.91	4.25
Orthographic <--> Visual Attention	-.31	-2.12
Orthographic <--> Motion Detection	-.40	-2.07
Motion Detection <--> Visual Attention	.26	2.11

<sup>a</sup> Standardized value. <sup>b</sup> Test statistic, Z + 1.96, p < .05.

Correlations among the Variables in Reading Decoding

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Visual Attention Card Sort Trial 1	1	.876**	-.078	-.227**	.165	.188*	-.401**	-.440**	-.312**	-.386**	-.356**	-.476**	-.399**
2. Visual Attention Card Sort Trial 2	.876**	1	-.079	-.175*	.157	.128	-.368**	-.381**	-.301**	-.378**	-.340**	-.476**	-.408**
3. Orthographic Letter Pairs Task 1	-.078	-.079	1	.268**	-.114	-.187*	.282**	.291**	.316**	.434**	.346**	.340**	.360**
4. Orthographic Letter Pairs Task 2	-.227**	-.175*	.268**	1	-.151	-.108	.380**	.280**	.364**	.541**	.460**	.451**	.408**
5. Random Dot Kinematogram Trial 1	.165	.157	-.114	-.151	1	.434**	-.245*	-.190**	-.225**	-.287**	-.294**	-.206*	-.216*
6. Random Dot Kinematogram Trial 2	.188*	.128	-.187*	-.108	.434**	1	-.266*	-.230**	-.247**	-.269**	-.306**	-.268**	-.287**
7. Sound Matching CTOPP	-.401**	-.368**	.282**	.380**	-.245*	-.266*	1	.551**	.600**	.707**	.711**	.743**	.734**
8. Blending Words CTOPP	-.440**	-.381**	.291**	.280**	-.190**	-.230**	.551**	1	.476**	.499**	.504**	.531**	.514**
9. Elision Letter CTOPP	-.312**	-.301**	.316**	.364**	-.225**	-.247**	.600**	.476**	1	.717**	.737**	.677**	.701**
10. Word Identification Woodcock-Johnson	-.386**	-.378**	.434**	.541**	-.287**	-.269**	.707**	.499**	.717**	1	.880**	.797**	.795**
11. Wide Range Achievement Woodcock-Johnson	-.356**	-.340**	.346**	.460**	-.294**	-.306**	.711**	.504**	.737**	.880**	1	.772**	.792**
12. Word Identification Wave 2	-.476**	-.476**	.340**	.451**	-.206*	-.268**	.743**	.531**	.677**	.797**	.772**	1	.926**
13. Wide Range Achievement Wave 2	-.399**	-.408**	.360**	.408**	-.216*	-.287**	.734**	.514**	.701**	.795**	.792**	.926**	1
Mean	53.31	49.26	6.81	7.24	53.35	43.48	13.09	8.33	7.47	25.39	20.92	46.53	26.65
Standard Deviation	19.01	18.50	1.56	1.65	25.14	23.00	5.92	2.75	3.96	15.46	5.29	14.60	4.78

Note. \*\*p<.01 (2-tailed); \*p<.05 (2-tailed)

## RESULTS

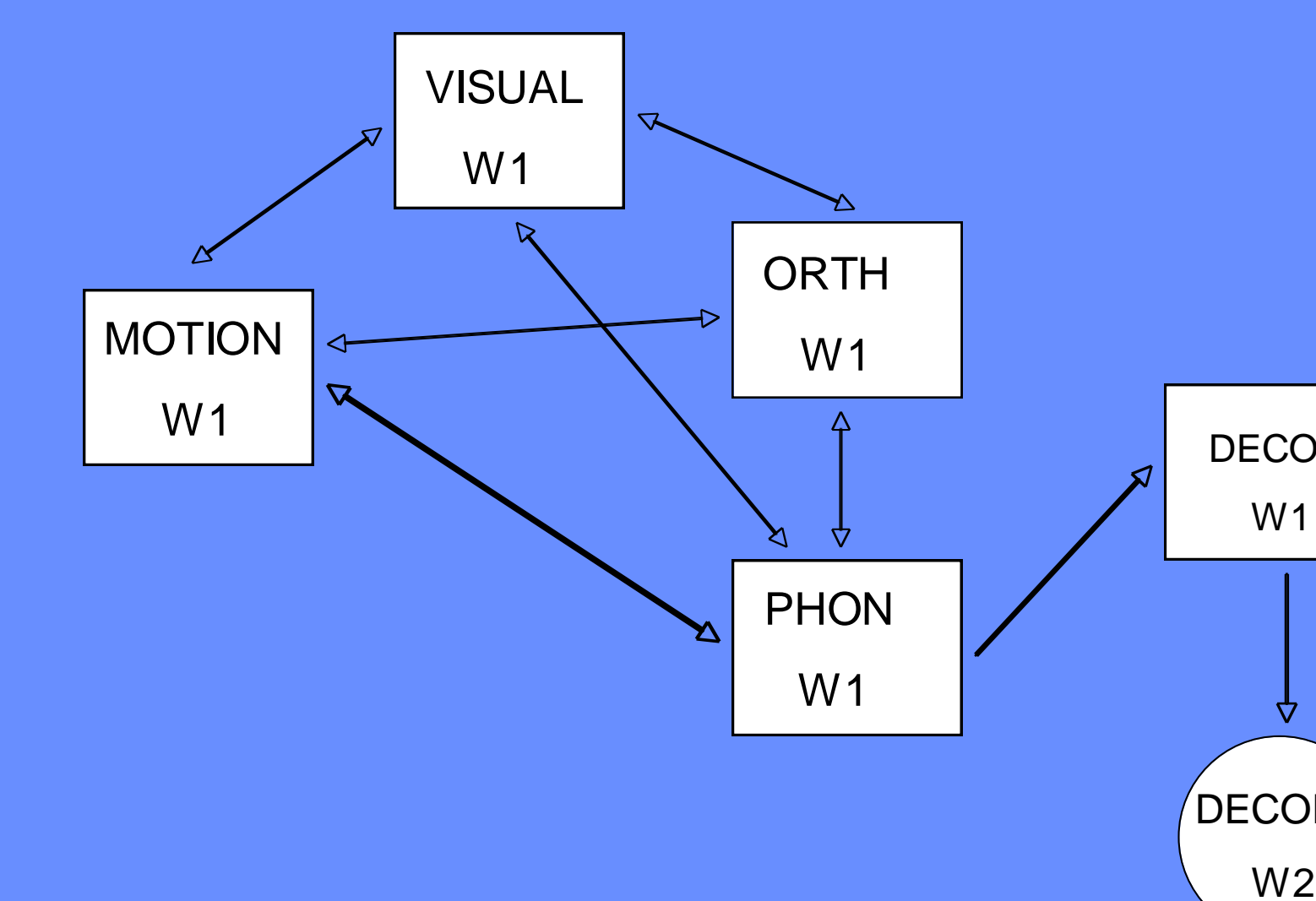
Hypothesized model emerged as a poor fit of data despite strong factor loadings, strong correlations among factors and strong correlations between each measure and final outcome variable (wave 2 decoding).

Chi-Square: 64.56 Degrees of Freedom: 184, p<.001

### Exploratory Analysis

Model created from exploratory analysis which emerged as a strong fit of the data.

Chi-Square: 64.56 Degrees of Freedom: 57, p=.230



## CONCLUSIONS

PHON emerged as core factor predicting early decoding ability.

Influence of VIS, MOTION, and ORTH on early decoding mediated by PHON.

Findings consistent with prior research suggesting that as children gain maturity in their ability to decode, need for PHON decreases.

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