

# Contribution of Linguistic Knowledge to Spelling Performance in Children with and without Language Impairment

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## ABSTRACT

The purpose of this investigation was to explore systematically the relation of phonological processing, morphological knowledge, and orthographic knowledge to spelling performance independent of visual memory in elementary school children with and without language impairment. After controlling for age, nonverbal intelligence, articulation, and visual memory, orthographic knowledge and morphological knowledge contributed unique variance to spelling performance for children with typical language, but only morphological knowledge contributed unique variance to spelling performance of children with SLI. Interaction effects of linguistic variables and language group status were not statistically significant, although examination of the individual models for children with SLI and children with typical language revealed differences in the types of knowledge that predicted spelling in each group. The results indicate that spelling instruction should take into account children's linguistic knowledge and explicitly relate their linguistic knowledge to spelling. It likely is necessary to teach spelling to children with language impairment using approaches that may differ in some ways from those used to teach children with typical language.

## INTRODUCTION

More than 40 years of research has confirmed the linguistic basis of literacy (e.g., Catts et al., 2002; Mattingly, 1972). Studies that have examined the contribution of language skill to literacy have focused almost exclusively on reading skill with much less systematic focus on spelling (e.g., Catts et al., 2002). To fully understand literacy skill, there is a need to investigate the linguistic basis of spelling separately from the linguistic basis of reading.

Spelling has long been considered a skill that primarily relies on visual memory. Despite a continued focus on memorization in the teaching of spelling, there is evidence that children as early as preschool recognize that a link exists between spoken and written language and attempt to represent various linguistic properties of words in their spellings. Pre-literate children who have minimal experience with print (and thus little visual memory of words) demonstrate the ability to produce phonetically plausible spellings of words (Read, 1971, 1986). In addition, visual memory deficits do not appear to characterize poor spellers. Adults who are good readers but poor spellers do not have impaired visual memory compared to adults who are good readers and good spellers (Holmes, Malone, & Redenbach, 2008).

Researchers have begun to explore the role of linguistic knowledge in spelling, but most studies have addressed only one area of linguistic knowledge. The roles of phonological processing, morphological knowledge, and orthographic knowledge have been the focus in most studies of the development of English spelling (Bourassa & Treiman, 2001). With few exceptions (e.g., Apel et al., 2012; Walker & Hauerwas, 2006), most studies of the linguistic basis of English spelling have evaluated the role that each type of linguistic knowledge plays in isolation.

In addition, the spelling of children with SLI differs from spelling of children with typical language both quantitatively (i.e., number of spelling errors) and qualitatively (i.e., types of spelling errors). Evidence from multiple investigations suggests that these differences arise from differences in linguistic knowledge (e.g., Mackie & Dockrell, 2004; Silliman, 2006).

The purpose of this investigation was (a) to consider concurrently the contribution of phonological processing, morphological knowledge, and orthographic knowledge to spelling in children with typical language and (b) to compare the linguistic predictors of spelling for children with typical language to linguistic predictors of spelling for children with SLI.

## METHOD

### PARTICIPANTS

Participants were 32 children with SLI (M age = 8;9, SD = 12 months; 8 2nd graders, 14 3rd graders, 10 4th graders) and 40 children with typical language (M age = 9;4, SD = 12 months; 16 2nd graders, 17 3rd graders, 7 4th graders). Children with diagnoses other than speech and/or language impairment, reading impairment, and/or writing impairment (i.e., cognitive impairment, autism, hearing loss) were excluded. All children passed a hearing screening bilaterally prior to testing and spoke English as a first language. Children in the typical language group 85 or above and children in the SLI group scored below 85 on the Core Language Index of the Clinical Evaluation of Language Fundamentals-Fourth Edition (CELF-4; Semel et al., 2003).

### PROCEDURES

Participants completed a language, reading, and writing assessment battery.

#### Assessment Battery

Dependent Measure	
Test of Written Spelling-4	
Control Measures	
Test of Nonverbal Intelligence-4	
Arizona Articulation Proficiency Scale-3	
Wide Range Assessment of Memory and Learning-2	
Predictor Measures	
<i>Phonological Processing</i>	
Comprehensive Test of Phonological Processing	
<i>Morphological Knowledge</i>	
Test of Morphological Structure (Carlisle, 2000)	
<i>Orthographic Knowledge</i>	
Orthographic Constraints Test (Treiman, 1993)	
Phonological Awareness and Literacy Screening: 1-3	
Peabody Individual Achievement Test-R: Spelling	

Hierarchical multiple regression analyses were used to examine the relative contributions of phonological processing, morphological knowledge, and orthographic knowledge in explaining the variance in word-level spelling for each group. For each linguistic knowledge variable, composites consisting of two to six measures were generated. To create composites, raw scores for each measure were converted to z-scores using the analysis sample, and Cronbach's alpha was used to ensure that measures contributing to each linguistic knowledge variable had shared variance.

#### Composites for Analysis

Phonological Processing	Morphological Knowledge	Orthographic Knowledge
CTOPP Elision	TMS Derivation	PIAT-R Spelling
CTOPP Blending Words	TMS Decomposition	OCT
CTOPP Memory for Digits		PALS 1-3: Letter Names*
CTOPP Nonword Repetition		
CTOPP Rapid Digit Naming		
CTOPP Rapid Letter Naming		

\*Only included in Research Question 2 Analysis

## RESULTS

### Means and Standard Deviations of Study Measures

	TL	SLI	p	d
TWS-4 Raw	16.50 (7.79)	11.16 (6.36)	.003	0.75
CELF-4 Core SS	106.30 (10.34)	71.53 (9.83)	.000	3.45
TONI-4 SS	104.40 (8.13)	97.81 (8.13)	.001	0.81
Arizona Total Score (max 100)	98.78 (2.85)	98.61 (2.27)	.790	0.07
WRAML-2 Visual Memory Index	99.13 (16.25)	93.31 (15.10)	.124	0.37
CTOPP Elision Raw	13.23 (4.98)	9.41 (4.94)	.002	0.77
CTOPP Blending Words Raw	14.83 (3.19)	12.56 (3.54)	.006	0.67
CTOPP Memory for Digits Raw	12.03 (3.42)	8.84 (1.83)	.000	1.16
CTOPP Nonword Repetition Raw	10.35 (3.28)	6.75 (2.17)	.000	1.29
CTOPP Rapid Digit Naming Raw	38.38 (8.16)	46.44 (14.82)	.005	0.67
CTOPP Rapid Letter Naming Raw	42.33 (10.86)	52.56 (21.65)	.011	0.60
TMS Derivation (max 28)	13.53 (5.37)	6.34 (5.00)	.000	1.39
TMS Decomposition (max 28)	19.20 (5.12)	10.00 (6.70)	.000	1.54
PALS 1-3 Letter Names (max 26)	25.73 (0.64)	25.50 (0.98)	.246	0.27
PALS 1-3 Letter Sounds (max 26)	24.15 (1.98)	23.84 (2.10)	.527	0.15
OCT (max 16)	13.75 (1.65)	12.78 (2.39)	.046	0.47
PIAT-R Spelling Raw	57.98 (15.27)	47.97 (13.32)	.005	0.70

## RESULTS

### Does phonological processing, morphological knowledge, and/or orthographic knowledge uniquely predict spelling in elementary school children with typical language?

Yes.  
Morphological knowledge and orthographic knowledge each uniquely predicted spelling performance for children with typical language.

#### Multiple Regression Model for Children with Typical Language

Step		B	SE B	$\beta$	t	p
1	Control Variables					
	Age in months	-.113	.103	-.173	-1.106	.227
	Nonverbal IQ	.043	.124	.044	.344	.733
	Articulation	.323	.319	.118	1.012	.319
	Visual Memory	.061	.056	.128	1.095	.282
2	Predictor Variables					
	Phonological Processing	.619	.320	.251	1.936	.062
	Morphological Knowledge	3.281	1.354	.396	2.424	.021
	Orthographic Knowledge	3.473	1.140	.388	3.045	.005

Note.  $R^2_{adj} = .146$  for Step 1;  $\Delta R^2_{adj} = .432$  for Step 2 ( $p < .001$ ).

### Does phonological processing, morphological knowledge, and/or orthographic knowledge uniquely predict spelling in elementary school children with language impairment?

Yes.  
Morphological knowledge uniquely predicted spelling performance for children with language impairment.

#### Multiple Regression Model for Children with Language Impairment

Step		B	SE B	$\beta$	t	p
1	Control Variables					
	Age in months	-.017	.074	-.034	-.236	.815
	Nonverbal IQ	-.069	.090	-.088	-.771	.448
	Articulation	.692	.307	.247	2.251	.034
	Visual Memory	.086	.047	.204	1.812	.083
2	Predictor Variables					
	Phonological Processing	2.630	1.500	.271	1.753	.092
	Morphological Knowledge	2.238	1.004	.341	2.228	.036
	Orthographic Knowledge	2.243	1.323	.260	1.695	.103

Note.  $R^2_{adj} = .451$  for Step 1;  $\Delta R^2_{adj} = .237$  for Step 2 ( $p < .01$ ).

### Does linguistic knowledge interact with group membership to predict spelling?

No.  
None of the interaction terms contributed unique variance to the model.

#### Multiple Regression Model with Interaction Effects

	B	SE B	$\beta$	t	p
Control Variables					
Age in months	-.058	.058	-.095	-.997	.323
Nonverbal IQ	-.019	.074	-.021	-.254	.801
Articulation	.382	.215	.130	1.778	.080
Visual Memory	.056	.035	.117	1.617	.111
Group	3.498	1.650	.230	2.120	.038
Predictor Variables					
Phonological Processing	5.147	1.640	.488	3.139	.003
Morphological Knowledge	2.241	1.459	.285	1.536	.130
Orthographic Knowledge	3.960	.976	.451	4.059	.000
Interactions					
PP x group	-2.067	2.297	-.130	-.900	.372
MK x group	1.386	1.723	.116	.804	.424
OK x group	-2.067	1.493	-.193	-1.665	.101

Note.  $R^2_{adj} = .696$  ( $p < .001$ ).

## DISCUSSION

The present investigation was the first to examine concurrently the relative contributions of phonological processing, morphological knowledge, and orthographic knowledge to spelling performance of children with and without language impairment in the elementary grades. The results of the investigation indicate that linguistic knowledge predicts spelling in children in the elementary grades.

Overall, the multiple regression model for children with typical language explained almost 60% of the variance in spelling performance. The linguistic knowledge variables accounted for almost 50% of the variance in spelling performance for children with typical language. In contrast to the philosophy that drives much spelling instruction, visual memory did not contribute unique variance to spelling (only about 3%). Orthographic knowledge was a significant predictor of spelling performance in children in the elementary grades, accounting for almost 23% of the total variance. In addition, morphological knowledge was a unique predictor of spelling performance, accounting for almost 16% of the total variance. Somewhat surprisingly, particularly given the focus that phonological processing has received in the literature and in the classroom, it was not a unique predictor of spelling for children with typical language.

Overall, the multiple regression model for children with language impairment explained almost 70% of the variance in spelling performance. The linguistic knowledge variables accounted for almost 40% of the total variance, indicating that for children with language impairment (like children with typical language) linguistic knowledge is a strong predictor of spelling performance. The only unique linguistic predictor of spelling for children with language impairment was morphological knowledge, accounting for 17.1% of the total variance.

Contrary to our hypothesis, interactions of linguistic variables and language group membership were not significant. However, an examination of the relative contribution of each linguistic variable to spelling for each group individually suggests that there may be some differences that were not captured by our overall multiple regression interaction model. Control variables (i.e., age, nonverbal intelligence, articulation, and visual memory) accounted for 10.8% of the total variance and none of the control variables contributed significant unique variance to the spelling performance of children with typical language. In contrast, control variables accounted for 32.1% of the total variance for children with language impairment, and articulation contributed significant unique variance to the spelling performance of children with language impairment (17.4% of the total variance). Thus, children with language impairment may rely more on nonlinguistic skills when they spell than children with typical language.

At least some types of linguistic knowledge predict spelling for children with and without language impairment; however, typical spelling instruction does not guide children to explicitly connect spoken and written language (see Schlagal, 2002). Because children with language impairment are less accurate at spelling words, particular attention on how to effectively teach spelling to this population is warranted. Future research should evaluate empirically the effectiveness of linguistic spelling instruction for children with SLI. Spelling instruction for children with SLI should focus on improving linguistic knowledge that is used by children to spell words and explicitly teach about the links between spoken and written language.

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Poster presented at 2012 Convention of American Speech-Language-Hearing Association, Atlanta, GA  
References available upon request: languagelab@vanderbilt.edu  
Poster available at: www.mc.vanderbilt.edu/languagelab