RUNNING HEAD: Children's Vowel Spelling in Derived Words

Children's Vowel Spelling in Derived Words: Item-, Word- and Child-Level Predictors

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Abstract

In spelling English words, vowels pose perhaps the greatest difficulty, especially the reduced vowels typically found in unstressed syllables. In morphologically complex words, however, the identity of reduced vowels can often be recovered by considering morphologically-related words. In this brief report, we used item-level analyses to explore predictors of 110 4th and 5th graders' vowel spelling in derived words (the *a* and *o* in *majority*) as a function of spelling performance on those same vowels in morphologically-related base words (the *a* and *o* in *major*). Variance was partitioned between child and vowel predictors. Significant child predictors were phonemic awareness, prosodic awareness, morphological awareness, and priming by the base word. The significant vowel predictor was syllable stress. Significant interactions were observed between syllable stress and prosodic awareness, and between syllable stress and phonemic awareness. We discuss insights for spelling and reading to be gleaned from linking morphology and prosodic phonology.

As words become longer and more complex, they also become more difficult for children to spell. In particular, a chief source of difficulty in spelling English words is vowels (Bebout, 1985; Treiman, 1993; Treiman, Berch, & Weatherston, 1993). A word's stress pattern has a strong effect on its vowels. When syllables bear primary or secondary stress, their vowels are likely to be fully articulated vowels where the phoneme-grapheme relationship is reliable and easy to detect. By contrast, when syllables are unstressed, their vowels are nearly always reduced; relative to full vowels, they are shorter in duration, quieter and toneless, as seen in the phoneme schwa (/ə/; as with the *o* in *melon*). Reduced vowels, typically schwa, are particularly challenging for both reading and spelling (Bahr, Silliman, Berninger & Dow, 2012; Venezky, 1999;); Treiman (1992) has pointed out that there are 16 possible spellings for schwa. Somewhat mitigating this complexity, however, is the contribution of morphology through derivational suffixation and the associated effects on vowel pronunciation; this is the focus of the current study.

The majority of multisyllabic words are morphologically complex. Derivational suffixes provide robust information about word stress. Neutral derivational suffixes (e.g., *-ness*, *-ful*, *-ment*) do not alter word stress from its placement in the base; when *-ment* is added to *aSTONish*, for example, stress remains on the second syllable of *aSTONishment*. Non-neutral derivational suffixes (*-ic*, *-ity*, *-ion*), however, drive placement of primary stress from its location in the base to the syllable before the suffix; for example, when *-ic* joins *ATom*, word stress moves from the first to the second syllable in *aTOMic*. This means that a word can provide reliable information about another morphological family member in which the identity of the phoneme is obscured

(e.g., Senechal, 2000; Treiman, Cassar & Zukowski, 1994). For example, Pacton, et al. (2018), showed that children were more successful at orthographic learning in a story condition where a target pseudoword (*coirard*) appeared with a morphologically related word that made the target's final letter phonologically salient (*coirardage*) compared to a condition where no such morphological relationship appeared. Rosa and Nunes (2010) found that Portuguese children's spelling of schwa (*o* in *tamborilar*) improved when the carrier sentence contained a base word where the vowel was overt (*tambor*). Here, we focus on the special case of vowels, where a schwa in a derivation may be recovered by considering the base (*a* in *atom* – *atomic*).

Metalinguistic abilities are also associated with individual differences in correct spelling. Phonemic awareness plays a strong role because it is foundational in mapping phonemes to graphemes in the process of spelling an alphabet (Bruck & Treiman, 1990; Bosman & Van Orden, 1997). Awareness of morphology has also been shown to be associated with the learning of conventional spellings (Deacon & Bryant, 2005; Kemp, 2006; Nagy, Berninger & Abbott, 2006, Pacton & Deacon, 2008). Although less commonly studied than the previous two factors, prosodic awareness is also associated with literacy (Jarmulowicz, Hay, Taran, & Ethington, 2007; Wade-Woolley & Heggie 2016). Indeed, evidence for the independent contribution of prosodic awareness to general spelling outcomes in children has been seen in Spanish (Defior, Gutierrez-Palma & Cano-Martin, 2012) and English (Goswami, Gerson & Astruc, 2010; Wood, 2006); both of these studies showed that, although phonemic and prosodic awareness were correlated, prosodic awareness explained unique variance in children's spelling. Given the relationship between derivational morphology and word stress outlined

above, therefore, prosodic awareness may also play be a significant factor in children's spelling.

In this brief research report, we examine children's spelling of full and reduced vowels in stressed and unstressed syllables and address the following research questions:

Research Questions

1. Does vowel spelling differ as a function of word type (i.e., appearing in a morphologically simple vs complex word)?
2. Does spelling of vowels in stressed and unstressed syllables in derived words vary as a function of child factors (i.e., age, morphological, phonemic, and prosodic awareness, and priming by morphologically related words), the word's stress pattern, and vowel spelling in base words ?
3. Does the impact of syllable stress vary by child phonemic, prosodic, and morphological awareness?

Method

Participants in the study were 110 children in grades four and five from public schools in eastern Ontario, Canada, with a mean age of 10y 5m (sd = 7.17 months); 62 were female. Children with known developmental delay were excluded and written parental consent was obtained.

Vowel Spelling

This experimental task is composed of 24 base–derivation word pairs where the addition of a suffix in the derivation results in a stress shift, thereby making formerly

reduced vowels overt, and vice versa, through changes in the computation of primary or secondary stress. For example, in the word *combine*, the target letters are the *o* and *i*. The initial vowel is in an unstressed syllable, and is realized as a schwa /ə/, while the second vowel is in a stressed syllable and the resulting diphthong is fully realized as /aɪ/. This contrasts with the same target letters in the word *combination*; in this case, the *o* is in a stressed syllable, realized as /o/ and the *i* is now a schwa. In other words, for this item couplet, , the letter *o* is reduced in the base word, but overt in the derivation, while the letter *i* is overt in the base but reduced in the derivation. Following this logic, two sets of words are employed in the present study, one set with 24 two-syllable base words (e.g., *MAjor*, *comBINE*) and the other set with 24 derivations based on those bases (i.e., *maJORity*, *combiNAtion*).

Base words and derivations were presented separately, and students were randomly assigned to the condition in which the order of base words and derivations were presented. Several other measures were administered between the two word lists and the experimental design allowed the investigation of how one set of words primed the other set. In the administration of the spelling task, the experimenter read the first set of words to the participant, used that word in a sentence, and repeated the word ("*Prepare. She studied to prepare for the big test. Prepare.*"/ "*Preparation. The party required a lot of preparation.*"). The administration of the second set of words included a reference to the matched base or derivation ("*Last time you spelled prepare. Now spell preparation. The party required a lot of preparation.*"/ "*Last time you spelled preparation. Now spell prepare. She studied to prepare for the big test.*"). Thus half the sample spelled vowels in the derivation after being primed by hearing the base word; the other

half spelled vowels in the derivation without priming by the base word. No difference in overall spelling accuracy was observed as a function of whether bases or derivations were administered first ($F(1,108) = 2.771, p > .05$). Participants were given a response sheet of word frames with the target letters missing, and were asked to fill in the missing letters. For example, when asked to complete the word *prepare*, a student would see a word frame *pr__p__re*; the correct response would be to add the *e* and the *a* in the first and second slots, respectively. All words in this task appeared in grade-level material (appearing at least once in grade 3 reading materials) according to Carroll, Davies and Richman (1971). Cronbach's alpha for this task was .95.

Prosodic awareness

In this task, described more fully in Wade-Woolley (2015), students were presented with audiorecordings of single words; students were required to repeat each word and to identify the location of the word's primary stress by clapping on the syllable where they heard the strongest, or main beat. The task comprised 30 test items of words ranging from two (*receive*) to five (*organization*) syllables, and students completed all items. Cronbach's alpha for this task was .65.

Phonemic Awareness

The Phoneme Blending subtest of the Comprehensive Test of Phonological Processing (Wagner, Torgeson & Rashotte, 1999) was administered to assess phonemic awareness. In this task, children wearing headphones hear phonemes pronounced in isolation and then blend them to produce a real word. As reported in the manual, reliability for this measure was computed at $\alpha = .87$.

Morphological Awareness

Morphological awareness was assessed by a task modeled on that by Carlisle (2000), where students heard a base word and given a sentence context that required completion with a derived form of the base word (*music: The drummer is a well-known _____*). The task was comprised of 40 items and the reliability for this task was computed at $\alpha = .89$.

Data analysis

Item-response based crossed random effects models were used to partition the item-level variance across children and words. Random intercepts were included for child and word. Fixed effects were included for all child- and word-level features. A detailed description of these analyses is beyond the scope of this report, but they have been widely used in the literature (e.g., Gilbert, Compton, & Kearns, 2011; Goodwin, Gilbert, & Cho, 2013; Kearns et al., 2016; Kim, Petscher, Foorman, & Zhou, 2010; Steacy et al., 2017). See Gilbert, Compton, & Kearns (2011) for a detailed description of the technique employed in this study.

Results

Descriptive Statistics

Descriptive statistics for the child measures are provided in Table 1. Zero order correlations between the child variables are provided in Table 2. The correlations ranged from .15 (morphological awareness and phonological awareness with stress assignment) to .86 (overall vowel spelling in bases with overall vowel spelling in derived words).

The first research question explored whether there was a significant difference in vowel spelling depending on whether the vowel occurred in a morphologically simple or complex word. To answer this question, we conducted an ANOVA comparing total correct responses between bases and derived words. This ANOVA indicated that there was a significant difference in correct response rates across bases and derived words ($F(1,94) = 8.73, p = .004$). Post-hoc analyses indicated that vowels occurring in bases were spelled correctly more often than vowels occurring in derived words.

To answer the remaining two research questions outlined above, a series of crossed random effects models were conducted. The dependent measure in these models was vowel spelling in derived words. Overall, these models indicated that there were several significant child and vowel covariate main effects (see Table 2). The unconditional model had a logit intercept of 1.82 indicating an average student spelling an average vowel had a .86 probability of spelling the vowel correctly. To answer the first research question, regarding whether a child's spelling of the vowel in the base predicted the probability of spelling the vowel correctly in the derived word, an item-level predictor of vowel spelling in the base was included in the model and vowel spelling in the base was a significant predictor ($\gamma_{001} = 1.24, z=9.97$) of correctly spelling the same vowel in the derived word.

Next, we were interested in whether vowel spelling varies as a function of age, morphological awareness, phonemic and prosodic awareness. We included these variables as child covariates in the model ($\gamma_{002} - \gamma_{005}$). There was a significant main effect for child phoneme blending ($\gamma_{002} = .06, z=2.54$), morphological awareness ($\gamma_{003} = .08, z=6.00$), and stress assignment ($\gamma_{005} = .06, z=2.78$). These results indicate that students

who had higher PA skills had a higher probability of spelling the vowel correctly than their peers with lower PA. For example, students who had PA scores 1 SD above the mean had a probability .11 higher than students who had PA scores 1SD below the mean of spelling the target vowel correctly. Morphological awareness had a greater impact on vowel spelling, with students 1SD above the mean of MA having a .27 greater probability of spelling the vowels correctly in the derived words than students with MA scores 1SD below the mean. For prosodic awareness: students 1SD above the mean had a .12 higher probability of spelling the vowel correctly than students 1 SD below the mean on stress assignment. We did not find a significant main effect for age. Finally, we included condition as a covariate (γ_{006}) to explore the impact of priming with the base word on vowel spelling in the derived word. We found that students who were primed with the base word had a higher probability of spelling vowels correctly in the derived word.

To explore whether vowel spelling varies as a function of syllable stress, we included it as a vowel covariate in the model (γ_{007}) and we found a significant main effect at the word level for whether the vowel stress. Vowels that occurred in a stressed syllable had a higher probability of being spelled correctly than vowels that occurred in unstressed syllables ($\gamma_{007} = 1.62, z=3.04$).

To answer the final research question regarding whether the effect of syllable stress varies by child phonemic and prosodic awareness and morphological awareness, we included these interaction terms in the model. These results are presented in the interaction model in Table 3. We found two significant interactions: one between stressed vowels and general prosodic awareness skills and the other between stressed

vowels and general phonemic awareness skills. These significant interactions are illustrated in Figures 1 and 2. Figure 1 illustrates that if students had poor prosodic awareness skills, they had a lower probability of spelling unstressed vowels correctly in derived words than students who had good prosodic awareness skills. The four graphs in Figure 1 illustrate the probability of correct vowel spelling in the derivation if: (a) the child spelled the vowel correctly in the base word and was not primed with the base, (b) the child spelled the vowel incorrectly in the base and was not primed with the base, (c) the child spelled the vowel correctly in the base and was primed with the base, and (d) the child spelled the vowel incorrectly in the base and was primed with the base. This interaction indicates that for students with lower prosodic awareness, the difference between stressed and unstressed vowel spelling was greater than for students with good prosodic awareness, particularly for students who did not spell the vowel correctly in the base word. Figure 2 includes the same four graphs outlined above for phonemic awareness. These figures illustrate that for students with good phonemic awareness, the difference between stressed and unstressed vowels was much smaller than the difference was for students with poor phonemic awareness. More specifically, students with poor phonemic awareness had particular difficulty spelling vowels when they occurred in unstressed syllables.

Discussion

It is clear that vowels are easier for children to spell when they appear in morphologically simple words compared to related words that are morphologically complex. While this finding is consistent with other research (e.g., Tsesmeli & Seymour, 2006), it was somewhat surprising here. Most studies that have reported such effects

have asked children to spell entire words; since derived words are often longer than base words, there is more scope for error. However, the effect of morphological complexity was apparent here, even when the task was restricted to spelling two vowels per item.

The crossed random effects modeling technique permitted us to include item spelling of the base word, child characteristics, and vowel characteristics in the same model. These models also permitted us to include exploratory interactions between child and vowel covariates to further explore the relationship between vowel spelling in the base words and vowel spelling in the derived words. For example, we were able to examine whether a child's spelling of *a* and *o* in *major* was directly related to her spelling of the same vowels in *majority*. This aligns with findings that derived words are rarely spelled correctly if base words are spelled incorrectly (Tsismeli & Seymour, 2006). Our results indicate that vowels may be an important driver of this relationship.

Four child factors predicted spelling of derived vowels. All three metalinguistic factors were unique predictors of both stressed and unstressed vowels. To spell vowels in multisyllabic words correctly, children must be able to manipulate both phonemic, prosodic and morphological information. This is consistent with the ample evidence linking spelling to phonemic and morphological awareness (e.g., Bruck & Treiman, 1990; Nunes, Bryant, & Bindman, 2006). It also adds to the emerging literature on the role of prosody in spelling, and, importantly, delineates the strong connection between morphology and prosody in multisyllabic words (Wade-Woolley & Heggie, 2015).

In addition, half the children were primed by hearing the base words before the derived words and in this condition, vowels were spelled more accurately than when

morphological relatedness was unprimed. This supports research showing that children draw morphological inferences from related words in spelling (Deacon & Drooge, 2010; Kemp, 2006; Pacton, et al., 2018). Our findings are particularly consistent with those of Rosa & Nunes (2010) showing improved spelling of schwa vowels when they are morphologically primed.

Several exploratory interactions examined how child metalinguistic factors vary as a function of syllable stress. That between syllable stress and phonemic awareness and that between syllable stress and prosodic awareness were significant. Overall, our findings indicate that student prosodic awareness is most related to reduced vowel spelling, particularly for students on the lower end of the distribution. This interaction was most apparent for students who did not spell the vowel correctly in the base. Furthermore, students with poor phonemic awareness had a much lower probability of spelling unstressed vowels correctly than stressed vowels. This difference was not apparent in students with high phonemic skills (see Figure 2). These finding of a main effect for morphological awareness but no interaction with syllable stress suggests that morphological awareness is significantly related to vowel spelling regardless of whether the vowel is stressed or unstressed.

Although the current study focuses on spelling, we are sanguine about the implications extending to reading, as well, since morphologically-conditioned schwa is also involved in mapping letters to sounds. Our findings give empirical support to Weber's (2018) recommendation of "listening for schwa"; paying attention to reduced vowels and seeking their identity in morphologically related words may be a productive strategy for reading and spelling multisyllabic, multimorphemic words.

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Table 1

Descriptive Statistics for Child-Level Measures

Measure	M	(SD)
Age (Months)	124.96	(7.22)
Phonemic Awareness/20		
Raw Score	12.66	(3.67)
Scaled Score	9.15	(2.55)
Morphological Awareness/40	25.88	(7.11)
Prosodic Awareness/30	12.65	(4.24)
Vowel Spelling in Base Words/24	18.02	(5.08)
Vowel Spelling Derived Words/24	13.04	(5.20)

Table 2

Zero-order Correlations Between Child Variables

	1	2	3	4	5
1. Prosodic Awareness	–				
2. Morphological Awareness	.15	–			
3. Phonemic Awareness	.15	.34*	–		
4. Vowel Spelling in Bases	.30*	.65*	.40*	–	
5. Vowel Spelling in Derived Words	.22*	.62*	.37*	.86*	–

Table 3

Fixed Effects and Variance Estimates using Child and Vowel Covariates

Fixed Effects Parameter	Unconditional Model			Fixed Effects Model			Interaction Model		
	Est.	(SE)	z	Est.	(SE)	z	Est.	(SE)	z
Intercept (γ_{000})	1.82	(.28)	6.43	-.36	(.36)	.99	-.37	(.36)	1.01
Item covariate									
γ_{001} Spelling Accuracy on Base	—	—	—	1.24	(.12)	9.97	1.24	(.12)	9.97
Child covariates									
γ_{002} Phonemic Awareness	—	—	—	.06	(.02)	2.78	.11	(.03)	3.81
γ_{003} Age	—	—	—	-.01	(.01)	.97	-.01	(.01)	.99
γ_{004} Morphological Awareness	—	—	—	.08	(.01)	6.51	.08	(.01)	5.28
γ_{005} Prosodic Awareness	—	—	—	.06	(.02)	3.04	.03	(.02)	1.09
γ_{006} Primed by Base Word	—	—	—	.60	(.16)	3.74	.61	(.16)	3.80
Word covariates									
γ_{007} Stressed Syllable	—	—	—	1.62	(.40)	3.04	1.63	(.46)	3.50
Interactions									
γ_{008} Stressed Syllable × Prosodic Awareness	—	—	—	—	—	—	.05	(.02)	2.48
γ_{009} Stressed Syllable × Morphological Awareness	—	—	—	—	—	—	.01	(.01)	.69
γ_{010} Stressed Syllables × Phonemic Awareness	—	—	—	—	—	—	-.07	(.03)	2.69
Random Effects									
	Variance			Variance Explained			Variance Explained		
Person	1.52			68%			68%		
Vowel	3.02			20%			19%

Figure 1. Interaction between syllable stress and child prosodic awareness. Dark bars represent vowels in stressed syllables, light bars represent vowels in unstressed syllables. Top Left: Interaction if student spelled the vowel correctly in the stem and was not primed with base; Top Right: Interaction if student did not spell the vowel correctly in the base and was not primed with base; Bottom Left: Interaction if student spelled the vowel correctly in the base and was primed with base; Bottom Right: Interaction if student did not spell the vowel correctly in the base and was primed with base. The x-axis represents levels of prosodic awareness ranging from 2 standard deviations below the mean to 2 standard deviations above the mean.

Figure 2. Interaction between syllable stress and child phonemic awareness. Solid lines represent vowels in stressed syllables; dashed lines represent vowels in unstressed syllables. Top Left: Interaction if student spelled the vowel correctly in the base and was not primed with base; Top Right: Interaction if student did not spell the vowel correctly in the base and was not primed with base; Bottom Left: Interaction if student spelled the vowel correctly in the base and was primed with base; Bottom Right: Interaction if student did not spell the vowel correctly in the base and was primed with base. The x-axis represents levels of phonemic awareness ranging from 2 standard deviations below the mean to 2 standard deviations above the mean.