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Development of phonological, morphological, and orthographic knowledge in young spellers: The case of inflected verbs

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Abstract. This study was designed to simultaneously investigate the influence of phonological, morphological, and orthographic awareness skills on the ability to spell inflected verbs in structured spelling tasks. Children in grades 1, 2, and 3 ($n = 103$) spelled inflected past and progressive tense verbs and completed awareness tasks. Developmental changes occurred in the ability to include the inflected ending, to spell the ending consistently reflecting the correct morphological unit, and to affix the ending using the correct orthographic pattern. The contributions of phonological, morphological, and orthographic awareness to spelling development varied across the three grades but were similar for each sub-component, suggesting a developmental relationship between the ability to spell inflected verbs and linguistic and orthographic awareness.

Key words: Morphological awareness, Orthographic awareness, Phonological awareness, Spelling development, Verbs

Introduction

Children's spelling has often been described as developing in stages. Although stage theories provide an overall picture of spelling development, they do not completely capture the complexities of phonological, orthographic, and morphological representations (Treiman & Bourassa, 2000). It appears that there are mutual influences between the linguistic and orthographic aspects of reading and spelling at all developmental stages (Ellis, 1997), suggesting that a more accurate portrayal of spelling development may be the use of particular processes or strategies at different points in time but not to the complete exclusion of others (Rittle-Johnson & Siegler, 1999; Treiman & Bourassa, 2000; Varnhagen, McCallum, & Burstow, 1997). Specifically, sound-based (lower level) and orthographic/morphologic (higher level) influences co-exist and as children's spelling vocabulary increases their spellings change in degree rather than kind (Treiman & Bourassa, 2000). This means an accurate portrayal of spelling should consider interactions among the various

strategies and sources of information along the developmental continuum (Rittle-Johnson & Siegler, 1999; Treiman & Cassar, 1997; Treiman & Bourassa, 2000; Varnhagen et al., 1997).

Influences of phonological, morphological, and orthographic awareness in spelling

Frith (1985) posited that orthographic strategies first emerge through reading and that only when they reach a certain level of use are they transferred to spelling. In contrast, phonological strategies are first adopted in spelling before their use in reading. As spelling develops, increases in the use of orthographic strategies result in an increase in the preservation of morphological units. Recent work on spelling development has shown that, from an early age, children integrate their knowledge of spoken language (phonological and morphological knowledge) and their knowledge about print (orthographic knowledge) in order to spell (Leong, 1999; Nunes, Bryant, & Bindman, 1997a, b; Treiman, 1993). There is also mounting evidence indicating earlier morphological and orthographic influences on spelling (Bryant, Nunes, & Bindman, 1997; Deacon & Bryant, 2001; Goswami, 1999; Rubin, 1988; Treiman, 1993; Treiman & Bourassa, 2000; Treiman & Cassar, 1997; Treiman, Cassar, & Zukowski, 1994) such that phonological knowledge not only plays a central role in early spelling (Treiman, 1993) but also that morphological and orthographic influences interact from the very beginning (Treiman, 1997; Treiman & Cassar, 1997) and continue to contribute to performance as spelling develops (Leong, 1999).

More specifically, Treiman (1993) used an orthographic constraints test to determine whether children at the kindergarten, first grade, and second grade levels were aware of legal orthographic patterns in English spelling. Her results suggest that children as young as kindergarteners have some knowledge of English basic orthographic patterns, since they performed better than chance in first grade and by second grade scored at 85% level. Cassar and Treiman (1997) continued this work by comparing children's knowledge of acceptable doublets with their level of spelling development; they found that even children classified as phonetic spellers demonstrated knowledge of the orthographic constraints on consonant and vowel doublets.

Varnhagen, Boechler, and Steffler (1999) examined the use of phonological and orthographic information on vowel spelling across grades 1, 2, and 3. Children were asked to complete a non-word spelling test and report on their strategy use. Findings indicate that the use of analogy

strategies increased with grade, from seldom use of analogy in grade 1 to the use of analogy strategies as often as phonetic strategies in grade 3. Additionally, differential performances on morphological awareness and orthographic awareness tasks (Hauerwas & Walker, 2003; Lennox & Siegal, 1998; Treiman, 1997) underscore the importance of considering the roles of morphological awareness and orthographic awareness in concert with phonological awareness in young children's ability to spell words with inflected endings.

Spelling of words with inflectional morphemes

Inflectional morphology provides a logical context within which these influences can be examined in the early elementary grades. Studying both the present progressive and past tenses allows us to consider the complex phono-morphographic nature of English spelling in two different morphologically defined units. In the present progressive, the phonological form of the ending is consistent with the morphological unit, while in the past tense there is inconsistency between the phonological form (/*d*/, /*t*/, and /*id*/) and the graphemes (-ed) used to represent the morphological unit (Juul & Elbro, 2004; Pinker, 1999).

Investigations germane to children's spelling of morphemes have reported that written language is heavily influenced by the awareness of morphemes in spoken language (Deacon & Bryant, 2001; Nunes et al., 1997a, b; Rubin, Patterson, & Kantor, 1991; Sénéchal, 2000). Children first adopt new spelling patterns (such as -ed); they later learn to apply these patterns to the correct grammatical category and finally master exceptions in a stage-like sequence (Nunes et al., 1997a, b). At the same time, they are learning the relationship between the base and inflected ending such as in walk/walked; stop/stopping. This morphological knowledge has been found to be valuable when the relationship between the forms is transparent (Derwing, Smith, & Wiebe, 1995; Fischer, Shankweiler, & Liberman, 1985).

Beers and Beers (1992) investigated the spelling of English inflectional morphology in first through sixth grade children and found that students' spellings reflected a systematic approach to learning the English spelling system. Most of the first grade children spelled the inflected ending phonetically. The second and third graders spelled the ending with a consistent morphological form, but often made errors with consonant doubling and silent -*e* – both orthographic rules. Although silent -*e* errors decreased, consonant doubling errors were still evident in 25% of the sixth grade students' spelling. Similarly, Steffler (2004) found that fifth

grade children demonstrated inconsistency in applying the doubling rule. None of these studies examined multiple inflected forms to determine if developmental patterns are specific to the past tense form or are similar for all inflected forms.

Treiman and Cassar (1996) considered children's ability to spell final clusters in words with one (*sand*) and two (*rained*) morphological units. They reported that first and second grade children were more likely to omit the first part of the final cluster when spelling a one-morpheme unit in both sentence composing and list conditions. Their results indicate that young children use morphological knowledge, in addition to phonological knowledge, when spelling final clusters, whereas Treiman (1993) found that first grade children's spelling seemed unaffected by morphology.

In her study, Treiman (1993) examined children's spellings of inflected words through their naturalistic writing. Most children at the first grade level did not attempt many past tense words. Phonemic spellings of the past tense marker were common. Additionally, children performed better when spelling words with plural endings in contrast to spelling words with past tense endings, the spelling of which additionally requires knowledge of morphemes. Similarly, Varnhagen et al. (1997) investigated children's ability to spell words with the past tense marker *-ed* using a naturalistic approach. Participants across the grades produced a writing sample based on a given topic. Spellings were then scored according to the characteristics associated with the developmental stages. While the researchers reported that their evidence did not support stage theory, they did find qualitative spelling differences in past tense words ending in /*t*/ as children move from phonetic to correct spellings.

The present study

Based on the results of the Treiman (1993) and Cassar and Treiman (1996) studies, Treiman and Cassar (1997) reported that morphological knowledge plays a role in first and second graders' spellings, but that the influence may be task or structure specific in the very beginning stages of spelling development. They suggested that there are differences in the demands of tasks requiring that words be generated without restrictions as in naturalistic writing and composing a sentence built around a given word. Limitations associated with a naturalistic approach further emphasize task differences; for instance, in naturalistic studies the researcher has little control over the types of words or the number of types of words the children spell (Treiman, 1993) word frequency or

word length (Varnhagen et al., 1997). Additionally, it is unclear whether developmental spelling patterns are consistent for all inflection morphological forms or are specific to each morphological form (Juul & Elbro, 2004).

This study was designed to analyze the development of children's spelling of both inflected present progressive and past verbs. Previous research posits a role for phonological strategies in young spellers, but is inconsistent regarding the influence of morphological and orthographic strategies in early elementary school students. Thus, to further our understanding of the influences on spelling development of morphologically complex forms, the developmental patterns of specific sub-components of each spelling were addressed: (1) inclusion of the ending; (2) inclusion of the ending with the morphologically preserved form; and (3) orthographic affixation pattern. The relationship between each of these developmental sub-components and their phonological, morphological, and orthographic awareness skills were also considered. Given the findings associated with naturalistic studies, and unlike the Treiman (1993) and Varnhagen et al. (1997) studies, which also investigated children's spelling of inflected forms, this study examines influences simultaneously through a series of linguistic tasks. These tasks were chosen to allow for researcher control over word type, number of types of words, word frequency, and word length. The use of controlled linguistic tasks and the analysis of specific developmental sub-components of the children's spelling permit us to both examine multiple spellings of two inflected forms and compare performance on each form to ascertain a clearer picture on the role of morphology in spelling development. They also offer a means for comparing task differences.

Hypotheses and predictions

It is hypothesized that if the morphological features of the inflected verbs influence children's spelling, then the developmental patterns for the present progressive and past forms should be similar. Specifically, similar development patterns are expected in both the present progressive and past forms for the three sub-components: (1) inclusion of the inflected ending, (2) inclusion of inflected ending in the morphological preserved form, and (3) application of the orthographic pattern to affix the inflected ending. Based on previous findings regarding the transparency of the relationships between the phonological form and the morphological features, it is expected that the children will show earlier mastery of the sub-component when spelling the present progressive verbs. This is

because the phonological form of present progressive verbs is consistent with the morphological and orthographic forms, whereas in the past tense verbs the relationship between the phonological and orthographic forms is dependent on knowledge of the morphological form, which makes it less transparent.

Additionally, given the differing findings regarding the role of morphological and orthographic skills in the development of spelling in younger elementary students, it is unclear whether developmental differences or sub-component differences better explain the relationship between developing phonological, morphological, and orthographic strategies and the children's spelling of the inflected morphological forms. Based on previous research regarding the development of spelling morphologically-complex words, it is predicted that differences will be related to the sub-components: for all students (1) the ability to include the inflected form is related to children's phonemic awareness and morphological awareness, (2) the ability to consistently spell the inflected morpheme is related to morphological awareness and orthographic awareness, and (3) the ability to apply the orthographic pattern to affix the inflected ending is related to orthographic awareness in the older students and orthographic awareness and linguistic awareness in the younger children. Given the linguistic differences between the present progressive and past forms, it is expected that the influence of linguistic awareness skills will be stronger for the past tense because of its less transparent nature.

Method

Participants

A total of 103 participants across three groups took part in this study. They were: (a) 28 first graders, (b) 35 second graders, and (c) 39 third graders. Groups consisted of approximately the same number of females and males. Participants were recruited from suburban middle-class communities in the northeastern United States where less than 5% of the students receive free or reduced lunch. These children were considered to be normally achieving students by their teachers and had no history of receiving special education or related speech or language services. All children who participated in the study were monolingual speakers of English, demonstrated adequate vision and hearing, had average or above verbal ability as measured by the Peabody Picture Vocabulary Test-III (Dunn & Dunn, 1997; PPVT-III), SS≥85, and average or above reading and spelling skills as measured by the Wide Range Achievement Test-3

(Wilkinson, 1993; WRAT-3). Of the original 104 teacher-nominated students, one child did not meet the selection criteria and was eliminated from the study resulting in 103 participants. See Table 1 for subject characteristic data.

Measures

Spelling

The ability to spell inflected verb forms was assessed on two tasks: spelling of inflected verbs in list form and spelling of inflected verbs in sentence context. On the list form task children spelled 24 inflected verb forms in a list format. Each verb was first stated, used in a sentence, and then restated. The children wrote only the inflected verb. In contrast, on the spelling in sentence context task, children were asked to write sentences from dictation that included the inflected verb. Sentences were repeated as requested. To ensure the task was developmentally appropriate, children were asked to write only 12 sentences. For both tasks the selected verbs were controlled for the frequency of the base and inflected form (Carroll, Davies, & Richman, 1971), phonetic representation of the inflection, and the orthographic spelling pattern governing the addition of the inflection. (See Appendix A for list of verbs used.)

In response to previous findings in this area, these tasks were chosen in order to compare children's spelling performance on different task structures. Although children were not generating text *per se* on the spelling in sentence context task, Hauerwas and Walker (2003) found differences in the spelling performance of children with spelling deficits in comparison to children who were typically developing spellers using these same tasks.

Table 1. Characteristics of all subjects participating in the study.

	Grade 1 ($n = 28$)		Grade 2 ($n = 36$)		Grade 3 ($n = 39$)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Years	6.9	.43	7.6	.37	8.8	.41
PPVT-III*	111	9	109	13	105	11
WRAT-3 spelling*	110	8	107	13	106	12
WRAT-3 reading*	110	11	110	13	107	12

*Score are standard scores.

Phonemic awareness

The phonemic awareness measure used was the Elision subtest from the Comprehensive Test of Phonological Processing (Wagner, Torgesen, & Rashotte, 1999). This task requires the oral deletion of a given phonological segment from a spoken word to form a new word. A phonological task that requires not only segmentation and blending, but also deletion of phonemes was chosen because it is a more sensitive measure of phonemic awareness and has been shown to be more predictive of reading growth into the school-age years (Hoien, Lundberg, Stanovich, & Bjaalid, 1995). Scores analyzed represent the percentage correct out of a possible 20 items.

Morphological awareness

The morphological awareness measure consisted of an oral non-word cloze task similar to Berko's (1958) classic *wug*, *wugs* task. Items included on this task specifically assessed children's awareness of the inflectional morphemes *-ed, -ing* and third person *-s*. In this task, subjects were presented with a non-word that they were first asked to repeat. They were then instructed to complete a cloze task using this target word. The researcher supplied the initial sound for each of the non-words. For example, the researcher stated, "Say *samp*" (child repeats). "*Today the girl samps. What did she do yesterday? Yesterday she s*_____*"* (*samped*). There were a total of 15 items. A photograph of an individual performing an action accompanied each item as an illustration of the targeted non-word. This type of task was chosen because it has a significant meta-linguistic component and, as such, was determined to be sensitive enough to detect individual differences in the children's oral morphological skills at the early school age (Carlisle, 1995; Nunes et al., 1997b). Scores analyzed represent the percentage correct out of a total of 15 items.

Orthographic awareness

A non-word choice task was designed to assess the subjects' orthographic awareness skills. In this task, children were provided with 25 non-word pairs. They were asked to identify the word in the pair that looked as though it could be a real word by choosing between non-words such as *flad* and *fbcz* and *joating* and *joatting*. Items ranging in difficulty were included on the task. Some items were taken from Treiman's (1993) orthographic choice task, which assessed common English orthographic patterns and that Treiman found first graders were able to recognize. Other items were designed to target specific orthographic patterns associated with the adding of inflectional endings: the doubling rule (doubling the final consonant of a one syllable word with a short vowel sound) and

silent *-e* (dropping the final e in a one syllable word with a long vowel sound). Prior to implementation, this task was piloted on 75 college students: items that received inconsistent responses were eliminated. Average adult performance on the final version of the task was 97% accuracy. Scores analyzed represent the percentage correct out of a total of 25 items.

Procedure

Participants were tested in one individual session and one group session. All sessions occurred during the winter of the school year within a 10-day period of time. Each session lasted no longer than 40 minutes and participants took breaks as needed. During the individual session, children were administered the Peabody Picture Vocabulary Test-III and the Wide Range Achievement Test 3 reading and spelling subtests. They also completed the phonological and morphological awareness tasks. Group sessions took place in the classroom resulting in 10–25 participants per session. In the group session, participants wrote 12 sentences from dictation that included inflected verbs; spelled 24 inflected verb forms in list format; and completed the orthographic awareness task.

Coding of the inflected form spelling measures

After data was collected, the total number of words spelled correctly on each task was calculated and turned into the percentage correct. Simply considering a response as correct or incorrect, however, does not adequately capture the developmental patterns that this study was designed to analyze. Therefore, three sub-components of the children's spelling of the inflected form were considered.

Including and preserving the ending as a morphological unit

Developmentally, the first sub-component of spelling the inflected form is the ability to include the ending. The second is to spell the inflected ending in such a way that the past tense or the present progressive tense morphological unit is preserved. Thus, for each spelled verb, the inflected ending was either (1) spelled correctly with the preserved morphologically unit (*-ed* or *-ing*); (2) included but spelled incorrectly with a phonetically accurate form (e.g. *jumped* spelled *jumpt*, *running* spelled *ranin*); (3) omitted; or (4) other – additional letters beyond the base word, but no phonetic similarity to the inflected morpheme. Across all children's spellings, fewer than 10 spellings were coded as other; therefore, no

further analysis was done with these spellings. Note that how the children spelled the base word was not considered in the coding procedure. So, all spellings that were coded as either category 1 or 2 included the ending, which is the first spelling component and all spellings that were coded as category 1 additionally preserved the ending as a morphological unit, the second spelling component.

Affixing the ending with the correct orthographic pattern

The last sub-component of spelling inflected morphological forms is applying the orthographic pattern to affix the ending. Children's spellings were coded on whether they correctly applied the orthographic pattern to add the ending (no change, doubling rule, or silent e rule). They did not necessarily have to spell the ending correctly to receive credit for correctly affixing it. For example, if a child spelled *hopped* as *hoppid* or *hiding* as *hitin*, he or she would receive credit for application of the pattern to affix an ending.

The researchers and a trained graduate assistant independently scored each participant's spellings. To determine inter-rater reliability, Pearson product-moment reliability coefficients were calculated between the scores assigned by each rater. Inter-rater reliability for the inflected form spelling measures were .96 or higher. Prior to the analysis of the data, each representation variable was converted into a percentage so that performance in context and performance in isolation could be compared.

Results

The results of the study are presented in two sections, corresponding to the hypotheses. The first section describes development of the skill subcomponents for each of the inflected forms. The second section addresses the relationship between developmental patterns for inflected verb spelling and phonological, morphological, and orthographic awareness skills as posed in the remaining hypotheses.

Spelling development

Inflected forms

The development of children's ability to spell the present progressive and past inflected forms was assessed in both sentence and list formats. The first analysis examined the number of words spelled correctly in each of the tasks. An ANOVA with inflected ending (*-ed* and *-ing*) and task (list

vs. sentence context) as the within-subject factor and grade (1, 2, and 3) as the between-subject factor was performed. Main effects for both ending and grade were found ($F(1, 99) = 122.7$, $P < .001$; $F(2, 99) = 30.87$, $P < .001$). As expected, children's ability to spell both the present progressive and past inflected forms improved from first grade to second grade to third grade. Descriptive statistics for both the present progressive and past forms can be found in Table 2. Present progressive forms were easier than past forms for students in all grades. There also was a significant grade×ending interaction ($F(2,99) = 5.25$, $P < .007$); by third grade the difference between performance on the present progressive and past markers was less pronounced than in the first and second grades. These developmental patterns were similar on both the sentence and list tasks in that no task effects were found ($F(1, 99) = 3.05$, ns).

Present progressive and past markers

To further address developmental patterns, analyses of the children's spellings focused on the sub-components of the skill necessary to complete the spelling task: the ability to (1) include the inflected ending, (2) preserve the ending as a consistent morphological unit, and (3) affix the ending with the correct orthographic pattern. Initial analyses were completed on both tasks; in all cases the pattern of students' spelling performance was similar, which resulted in no significant task effect. Thus, composite variables were created that included children's spellings from both sentence and list tasks.

As hypothesized, developmental changes were evident in each of the sub-components of spelling inflected verb forms (see Table 3 for means and standard deviations for each component). On the first

Table 2. Mean percentage correct as a function of task, ending and grade.

	Grade					
	1 ($n = 28$)		2 ($n = 34$)		3 ($n = 36$)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Correct *-ed*						
Sentence	24	26	51	26	69	22
List	27	25	48	22	72	20
Correct *-ing*						
Sentence	55	23	74	27	81	20
List	46	26	66	22	83	18

Table 3. Percentage of spellings that included ending, preserved the morphemic unit and affixed ending with correct orthographic pattern.

	Percentage of spellings					
	Grade 1 ($n = 28$)		Grade 2 ($n = 34$)		Grade 3 ($n = 36$)	
	M	*SD*	*M*	*SD*	*M*	*SD*
-ed						
Included ending	89	15	97	4	98	6
Preserved morphemic unit	57	42	87	20	96	8
Affix with orthographic pattern	36	24	59	19	76	18
-ing						
Included ending	98	6	99	1	99	3
Preserved morphemic unit	96	6	99	2	99	3
Affix with orthographic pattern	53	22	72	19	76	18

sub-component, including an ending, first grade children's performance was significantly different from that of second and third grade children ($F(2,99) = 21.9$, $P < .001$). This developmental difference was most pronounced for the past tense marker, where first graders included the past tense ending 89% of the time while second and third graders included the ending at least 97% of the time. Mastery levels of performance on inclusion of the present progressive marker were evident even in the first graders.

The number of children's spellings that preserved the inflected ending as a morphological unit increased significantly from one grade to the next ($F(2,99) = 22.3$, $P < .001$). Similar to the first sub-component, there was a significant difference between the inflected forms ($F(1,99) = 54.6$, $P < .001$) and a significant ending×grade interaction ($F(1,99) = 18.6$, $P < .001$). The developmental changes were particularly evident for the past ending *-ed* in which first, second, and third graders spelled the past marker *-ed* 57% of the time, 87% of the time, and 96% of the time, respectively. In contrast, for the present progressive words, 96% of the first graders' spellings preserved the ending as a morphological unit *-ing*.

Last, the children's ability to affix the inflected ending using the appropriate orthographic patterns was analyzed. Similar to the ability to include and represent the inflected ending with a consistent morphological unit, all children were better able to use the correct orthographic pattern to affix the progressive tense *-ing* ending than to do the same with the past tense *-ed* ending ($F(1,99) = 49.52$, $P < .001$). Additionally, children's

ability to represent the form improved across the three grades for each of the inflected endings ($F(2,99) = 31.3$, $P < .001$). A similar ending×grade interaction ($F(2,99) = 3.5$, $P < .05$) was found in which the ending differences were less pronounced in the third grade. Further inspection of spellings revealed that few children in first grade knew to double the final consonant or drop the silent *-e*. They showed some awareness of these patterns by second grade, applying them correctly about 60% of the time. At the third grade level, most children demonstrated consistent knowledge of dropping the silent *-e*, but continued to be inconsistent with the doubling rule.

Relationship between spelling performance and awareness

Before examining the hypotheses regarding spelling performance and linguistic and orthographic awareness, analyses were performed to determine if the children's performance on the awareness measured differed by grade. Descriptive statistics for the awareness measures are found in Table 4. A 3 (grade) × 3 (awareness) analysis found a significant effect for grade ($F(6, 196) = 5.4$, $P < .001$). Follow-up Tukey tests for each of the awareness measures revealed the following significant differences ($P < .01$): third graders performed better than first graders on all three awareness measures; second graders performed better than first graders on the morphological and orthographic awareness measures; and the performance of second and third graders differed only on the orthographic awareness measures. All other differences in performance were not significant.

To determine whether there is a relationship between developing phonological, morphological, and orthographic awareness and the ability to spell inflected forms, partial correlation analyses were performed. Age and grade were used as co-variates to control for the effects of maturity and instruction. Due to ceiling effects on the present progressive spelling

Table 4. Performance on the awareness measures as a function of grade.

	Grade 1 ($n = 27$)		Grade 2 ($n = 36$)		Grade 3 ($n = 39$)	
Awareness	*M*	*SD*	*M*	*SD*	*M*	*SD*
Phonological	40	19	46	18	56	20
Morphological	62	19	76	13	77	12
Orthographic	74	20	82	12	90	8.8

Note: Scores represent percentage correct.

task, the relationships between the awareness measures and the spelling measures are stronger for the *-ed* marker where more variability exists in the students' performance. As seen in Table 5, performance on the phonological, morphological, and orthographic awareness measures were related significantly to the percentage of included past tense endings, spellings that preserved the past tense morphemic unit, and the ability to affix both the present progressive and past endings with the correct orthographic pattern.

To assess hypotheses regarding the impact of children's phonological, morphological, and orthographic awareness skills on various sub-components of the inflected verb spelling task, hierarchical regressions were performed at each grade level. For each regression analysis, phonological, morphological, and orthographic awareness were entered simultaneously to predict performance on those spelling tasks in which significant partial correlations were found (see Tables 6, 7, and 8).

It was hypothesized that children's linguistic awareness would be related to their ability to include the inflected ending in their spellings. The results, however, point to orthographic awareness as the significant predictor in first and second grade. Morphological awareness predicted the ability to include the inflected ending in third grade. Similarly, orthographic awareness predicted first graders' ability to preserve the morphemic unit *-ed* on past tense verbs while morphological awareness predicted third graders' ability to preserve the morphemic unit *-ed* on past tense verbs. The results for second grade were not significant. These findings were not consistent with our hypothesis regarding the role of linguistic awareness in children's ability to include the inflected ending. Instead, the results suggest an earlier role for orthographic awareness as

Table 5. Partial correlations between the spelling measures and performance on the awareness measures controlling for age and grade.

Spelling measures		Phonological awareness	Morphological awareness	Orthographic awareness
Included ending	*-ed*	.324**	.452**	.569**
	-ing	.01	.146	.076
Preserved morphemic unit	*-ed*	.302**	.342**	.466**
	-ing	.07	.25*	.17
Affix with orthographic	*-ed*	.521**	.518**	.558**
Pattern	*-ing*	.355**	.330**	.338**

Note: $n = 103$.
*$P < .01$, two-tailed. **$P < .0001$, two-tailed.

Table 6. Summary of first, second and third grade regression analysis for awareness variables predicting inclusion of the ending on past tense verbs.

Variable	*B*	SE B	β	ΔR^2
First grade[a]				
Orthographic awareness	.506	.129	.714***	.598***
Second grade[b]				
Orthographic awareness	.147	.060	.418**	.225*
Third grade[c]				
Morphological awareness	.387	.086	.786***	.566***

Note: [a]$n = 28$, [b]$n = 36$, [c]$n = 39$.
*$P < .05$. **$P < .001$, ***$P < .0001$.

Table 7. Summary of first, second and third grade regression analysis for awareness variables predicting preservation of morphemic unit -ed on past tense verbs.

Variable	*B*	SE B	β	ΔR^2
First grade[a]				
Orthographic awareness	.911	.449	.453*	.394**
Second grade[b]				
Non significant				
Third grade[c]				
Morphological awareness	.418	.091	.650**	.404**

Note: [a]$n = 28$, [b]$n = 36$, [c]$n = 39$.
*$P < .05$. **$P < .0001$.

influencing first grade children's ability to include the ending, and a role for morphological awareness at a later point in spelling development.

In regard to the relationship between the linguistic and orthographic awareness measures and the ability to affix the inflected ending with the correct orthographic pattern, it was hypothesized that both linguistic and orthographic skills would be related in younger students and orthographic skills in older students. The results reflect the pattern of relationships found in the other sub-components, that is, a significant relationship between orthographic awareness and the affixation of the ending with the correct orthographic pattern in first grade and morphological awareness and affixation of the ending in third grade. Additionally, first graders' affixation of the past tense marker was related to their phonological awareness skills.

Table 8. Summary of first, second and third grade regression analysis for awareness variables predicting affixation of ending with correct orthographic pattern on past tense verbs.

Variable	*B*	SE B	β	ΔR^2
-ed				
First grade[a]				
Phonological awareness	.431	.221	.350*	.642***
Orthographic awareness	.492	.203	.416*	
Second grade[b]				
Orthographic awareness	.489	.227	.321*	.402**
Third grade[c]				
Morphological awareness	.586	.209	.400**	.399***
-ing				
First grade				
Orthographic awareness	.710	.250	.658**	.349**
Second grade				
Non significant				
Morphological awareness	.468	.213	.337*	.307**

Note: [a]$n = 28$, [b]$n = 36$, [c]$n = 39$.
*$P < .05$. **$P < .001$, ***$P < .0001$.

In summary, when taken together, the results of the regression analyses are consistent with previous research and our hypothesis stating that at different points in development children rely on different strategies to spell. The pattern of development for both inflected forms was similar, and mastery of the sub-components proceeded in the same linear fashion: first including the ending, then including the ending with the morphologically preserved form, and lastly applying the correct orthographic pattern to affix the ending. As expected, differences emerged in the mastery of the sub-components so that those in relation to the past tense proceeded at a slower rate than for present progressive tense. We also hypothesized that different sub-components of the task would be related to different awareness skills; this was not the case. All three sub-components were related to orthographic awareness skills in first graders and morphological awareness in third graders. The lack of differences in awareness predictors for each of the sub-components did not support the hypotheses predicted. These results are consistent with a developmental hypothesis that there would be different predictors at the different grades,

but the significant role of orthographic awareness and not phonological and morphological awareness at the first grade level was a surprise.

Discussion

This study sought to confirm and extend previous findings regarding the spelling of inflectional morphology in early elementary children by simultaneously investigating the influences of phonological, morphological, and orthographic awareness skills using structured spelling tasks. Prior to undertaking the study, we posed hypotheses related to children's ability to spell verbs with present progressive and past forms and the developmental relationship between phonological, morphological and orthographic awareness, and spelling performance.

Developmental patterns in the spelling of inflected verbs

Our first hypothesis concerned developmental changes. As expected, the ability to spell inflected verbs increased with grade level. We also found that while developmental patterns for each of the inflected forms are similar in that children include the inflecting ending, then preserve the ending as a consistent morphological unit, and finally affix the ending with the correct orthographic pattern, there are differences in the rates at which these sub-components are mastered for each inflected form. We will discuss developmental patterns by considering the differences associated with each of these sub-components.

Including the ending

The first sub-component is including the ending. Although children's ability to represent the form for each of the inflected endings improved across the three grades, they had more difficulty including the *-ed* ending than they did including the *-ing* ending (Rubin et al., 1991; Worthy & Viise, 1996). This finding is reflected in the rate of inclusion of the inflected endings. In each of the grades, children included all of the present-progressive endings; their rate of inclusion of the past ending increased with grade. These findings are similar to those of Treiman (1993) who reported that the omission of the *-ed* ending in written language was the more pronounced of the two affixes. She also noted that early spellers are more likely to omit consonants that are inflectional endings than to omit consonants that are not inflectional endings but appear at the end of the word (*killed* vs. *build*). Treiman suggested that omissions could occur

because children write slowly and forget they are writing in the past. While this factor may have contributed to the omission rate in the naturalistic writing of the children in Treiman's study, it does not explain the omissions in our study since the words were supplied. It seems more likely that the children were drawing on morphological knowledge, but it was not yet part of their repertoire. Hence, the differences between the words *killed* and *build* and the affixes *-ed* and *-ing* is that more morphological knowledge is needed to affix the *-ed* ending. Children may be aware of this to some degree, but not to the point that they can apply their knowledge consistently. Such an explanation of differences is consistent with Juul and Elbro's (2004) findings where children had more difficulty mastering spellings of words in which the spelling was grammatically (morphologically) defined rather than phonetically-defined.

Preserving the ending as a morphological unit

Analysis specific to this second sub-component revealed that when spelling the *-ed* ending, first graders often began by spelling the ending phonetically (e.g. /*t*/, /*d*/, or /*id*/). While children at this age are generally aware that an ending must be added to a verb in order to form the past tense, they are not always consistent in applying the knowledge as a preserved morphological unit. Treiman (1993) reported that the naturalistic writing of early spellers also showed that spelling past tense markers phonetically was common. Error analysis of children's naturalistic writing revealed that within the phonetic stage of spelling there was enough variability to suggest that some errors were related to phonological representations and others seemed to be a problem with representation of the past tense morpheme (Varnhagen et al., 1997). Together, these studies indicate that young spellers do not appear to view the ending as a discrete morpheme whose spelling is unaffected by the base word's phonetic features (Beer & Beers, 1992). Furthermore, this same pattern of difficulty emerges whether or not words are freely generated in context by the speller or specific words are elicited through structured spelling tasks; given this, early spellers' ability to use morphological information does not appear to be affected by the demands of the task, but rather seems to be stable across tasks.

One explanation for the initial difficulty that many children experience with the *-ed* ending, in contrast to that of the *-ing* ending, is that the *-ed* is the more complex due to its three phonetic forms (/*t*/, /*d*/, /*id*/) that are all spelled with the morphologically consistent form *-ed*. Thus the relationship between the phonetic representation and the orthographic representation of the past tense is ambiguous and is resolved at a morphological level of representation. This may be an initial source of confusion for children until their meta-linguistic knowledge develops to

the point that they are able to differentiate between the phonological and morphological representations of the past tense. Our finding supports work of Nunes et al. (1997a, b) and Juul and Elbro (2004) who suggest that children first have to learn about phonological letter-sound correspondences, but as they encounter a wider range of words and spelling patterns they gradually learn how to apply morphological affixes to the correct grammatical category. Thus, the lack of consistency in applying the *-ed* ending regardless of the phonetic form changes over time with spelling maturity.

Affixing the ending with the correct orthographic pattern

In our analyses we considered a third sub-component, children's ability to use the correct orthographic information in affixing the ending. Consistent with the other two subcomponents discussed, all children were better able to use the correct orthographic pattern to affix the progressive tense *-ing* ending than to do the same with the past tense *-ed* ending. Although few children in first grade knew to double the final consonant or drop the silent *-e*, they showed growing awareness of these patterns and applied them more correctly by second grade. At the third grade level, most children demonstrated consistent knowledge of dropping the silent *-e*, but continued to be inconsistent with the doubling rule. It is important to note that these patterns were similar for both the past and present-progressive endings. This pattern of results is similar to previous developmental research on the past tense that has found that children do not consistently apply the doubling rule until late elementary grades (Beers & Beers, 1992; Carlisle, 1988; Steffler, 2004).

Taken together, findings related to the three sub-components indicate that children's spelling of inflected forms follows a specific developmental pattern which improves as their knowledge of the English language and orthographic system increases. Furthermore, regardless of whether children choose the words they write as in naturalistic writing or whether the words are chosen for them as in dictation exercises, the pattern of performance remains the same. This suggests that although knowledge of inflectional forms is continually developing, children's ability to use it is relatively stable for a given point in time regardless of task demands.

Children's spelling and awareness

The second hypothesis addresses the relationship between children's ability to spell inflected verbs and their awareness skills. It was predicted that, in addition to developmental findings, performance on different

sub-components of the inflected form spelling would be related to different aspects of linguistic and orthographic awareness. For the most part, the analysis reflected the same influences across all sub-components in the spelling of inflected verbs. This is consistent with developmental predictions, but contrary to our expectation that differentiation by sub-component would provide insight into children's use of strategy when spelling morphologically-complex inflected verbs.

Developmental relationship between spelling performance and awareness

Our results show that throughout the early grades, children's ability to spell both past tense and progressive tense verbs is improving along with their phonological, morphological, and orthographic awareness skills. As in previous research, phonological awareness appears to be an important factor in their early spelling development, particularly for the past tense form (Beers & Beers, 1992; Nunes et al., 1997a, b). Of interest is the significant role of orthographic awareness evident in the spelling of the first graders in our study. Although orthographic patterns were far from being "set" in these young children, their demonstrated orthographic awareness suggests that at least some type of orthographic knowledge emerges early on in spelling acquisition (Treiman & Bourassa, 2000). Additionally, the shift in third grade from an orthographic influence to a morphological influence in the ability to include and preserve the morphological unit is consistent with Frith's (1985) developmental model in which she indicated that children must be able to use an orthographic strategy prior to considering the relevance of morphological units.

One limitation must be kept in mind when interpreting the results of this study. Due to ceiling effects on the present progressive spelling task, which may have occurred because the present progressive form is a linguistically less complex than past form, there is a stronger relationship between the awareness measures and the spelling measures for the *-ed* marker. The results suggest a similar developmental pattern across both inflected forms. However, additional research on even younger children with greater variability in performance on the *-ing* marker is necessary to confirm the similarity of the developmental patterns between the children's spelling of both inflected forms and their linguistic and orthographic awareness.

Relationship between spelling sub-components and awareness

Analyses related to the three sub-components suggest that orthographic and morphological knowledge are factors in determining whether children include the ending as well as spell it with the consistent morphological form *-ed*. The contribution of both morphology and orthography, at this point, indicates that children need to learn the letter

pattern as an orthographic unit and later as a consistent morphological unit that must be applied to convey the past tense. Previous research examining the spelling of inflected past tense forms has demonstrated the relationship between morphological awareness and children's spelling (Derwing et al., 1995; Nunes et al., 1997a, b; Sénéchal, 2000), but also had not considered the students' developing orthographic skills. Our findings, which included both morphological and orthographic awareness, enabled us to document a sequential relationship of orthographic awareness and then morphological awareness in the ability to include and preserve the morphological unit on past tense verbs. Although the verbs included in this study were controlled for frequency, the role of familiarity with the words as an influencing factor on the developmental relationship between the spelling of inflected forms and linguistic and orthographic awareness has been raised (Juul & Elbro, 2004; Nunes et al., 1997a, b). Future research in this area should include non-words to consider the role of frequency effects on the developmental relationship between orthographic knowledge and morphological knowledge.

Our findings also show that it is the children's phonological and orthographic knowledge that predicted their ability to affix the ending with the correct orthographic pattern. This role of orthographic awareness is consistent with previous research (Lennox & Siegal, 1998; Muter & Snowling, 1997) but the influence of phonological awareness on a later developing sub-component is more unexpected. One explanation might lie with the process children use to determine whether they need to drop a silent *-e* or double final consonants. Specifically, many children may view this as a phonological task in which they first need to determine whether the vowel is long or short before they go on to apply the rule that governs adding the ending. This is supported by recent research indicating that while use of phonological strategies is more prominent than use of orthographic strategies in young children, they are capable of employing both types (Martin, Claydon, Morton, Binns, & Pratt, 2003; Sprenger-Charolles, Siegal, Béchennec, & Serniclaes, 2003), and that a reciprocal relationship exists between the two processes prompting strategy use based on the demands of the task (Sprenger-Charolles et al., 2003). Other research related to the relationship between phonological awareness and orthographic awareness suggests that for skilled readers orthographic knowledge becomes inseparable from phonological knowledge and may be unconsciously activated by phonological input once written-word representations are firmly established (Castles, Holmes, Neath, & Kinoshita, 2003). This may also be the case, to a limited extent, for children who have some degree of orthographic knowledge albeit still developing. Clearly, further research in this area is indicated.

In conclusion, this study adds to the understanding of children's spelling of inflected verbs through an investigation of performance on the sub-components that comprise the spelling of these verbs and linguistic and orthographic awareness. To this end, children's ability to spell inflected verbs – both past and progressive tense forms – emerges during the first three years of schooling in a consistent fashion that can be better explained by developmental differences rather than by differences in the nature of the sub-components themselves.

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Appendix A

Appendix A: Inflected verbs used in spelling tasks.

	/*t*/	/*d*/	/*id*/
Past Tense Words			
No change	Jumped*	Called	Painted*
	Walked	Cleaned*	Lifted
Silent -e	Poked*	Smiled	Voted
	Shaped	Waved*	Skated*
Doubling	Dropped	Tugged*	Patted*
	Slipped*	Grabbed	Spotted
Present Progressive Tense Words			
Double	Sitting		
	Running*		
No change	Reading		
	Going*		
Silent -e	Making		
	Hiding*		

*Words that were included in the sentence task. These words were presented randomly in each task, but are organized here to illustrate the phonetic, morphological and orthographic properties that the words represent.

References

Beers, C. S., & Beers, J. W. (1992). Children's spelling of English inflection morphology. In S. Templeton & D. R. Bear (Eds.), *Development of orthographic knowledge and the foundations of literacy: A memorial festchrift for Edmund H. Henderson* (pp. 231–252). Hillsdale, NJ: Lawrence Erlbaum.

Berko, J. (1958). The child's learning of English morphology. *Word*, *14*, 150–177.

Bryant, P. E., Nunes, T., & Bindman, M. (1997). Children's understanding of the connection between grammar and spelling. In B. A. Blachman (Ed.), *Foundations of reading acquisition and dyslexia* (pp. 219–240). Mahwah, NJ: Lawrence Erlbaum.

Carlisle, J. (1988). Knowledge of derivational morphology and spelling ability in fourth, sixth, and eighth graders. *Applied Psycholinguistics*, *9*, 247–266.

Carlisle, J. (1995). Morphological awareness and early reading achievement. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 189–209). Hillsdale, NJ: Lawrence Erlbaum.

Carroll, J. B., Davies, P., & Richman, B. (1971). *Word frequency book*. New York: Harper & Row.

Cassar, M., & Treiman, R. (1997). The beginnings of orthographic knowledge: Children's knowledge of double letters in words. *Journal of Educational Psychology*, *89*(4), 631–645.

Castles, A., Holmes, V. M., Neath, J., & Kinoshita, S. (2003). How does orthographic knowledge influence performance on phonological awareness tasks? *The Quarterly Journal of Experimental Psychology*, *56A*, 445–467.

Deacon, S. H., & Bryant, P. E. (2001). *Children's use of base words to spell derived and inflected words: Beyond phonological and orthographic similarity*. Poster presented at Scientific Studies in Reading, Boulder, CO.

Derwing, B. L., Smith, M. L., & Wiebe, G. (1995). On the role of spelling in morpheme recognition: Experimental studies with children and adults. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 3–28). Hillsdale, NJ: Lawrence Erlbaum.

Dunn, L., & Dunn, L. (1997). *Peabody Picture Vocabulary Test-III*. Circle Pines, MN: American Guidance Service.

Ellis, N. (1997). Interactions in the development of reading and spelling: Stages, strategies, and exchange of knowledge. In C. Perfetti, L. Rieban & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across the languages* (pp. 271–294). Mahwah, NJ: Lawrence Erlbaum.

Fischer, F. W., Shankweiler, D., & Liberman, I. Y. (1985). Spelling proficiency and sensitivity to word structure. *Journal of Memory and Language*, *24*, 282–295.

Frith, U. (1985). Beneath the surface of developmental dyslexia. In K. E. Patterson, J. C. Marshall & M. Coltheart (Eds.), *Surface dyslexia neuropsychological and cognitive studies of phonological reading* (pp. 301–330). Hillsdale, NJ: Lawrence Erlbaum.

Goswami, U. (1999). Integrating orthographic and phonological knowledge as reading develops: Onsets, rimes and analogies in children's reading. In R. Klein & P. McMullen (Eds.), *Converging methods for understanding reading and dyslexia: Language, speech and communication* (pp. 57–75). Cambridge, MA: MIT Press.

Hauerwas, L. B., & Walker, J. (2003). Spelling of inflected verb morphology in children with spelling deficits. *Learning Disabilities Research and Practice*, *18*, 25–35.

Hoien,T., Lundberg, I., Stanovich, K. E., & Bjaalid, I. (1995). Components of phonological awareness. *Reading and Writing: An Interdisciplinary Journal*, *7*, 171–188.

Juul, H., & Elbro, C. (2004). The links between grammar and spelling: A cognitive hurdle in deep orthographies? *Reading and Writing: An Interdisciplinary Journal*, *17*, 915–942.

Lennox, C., & Siegal, L. (1998). Phonological and orthographic processes in good and poor spellers. In C. Hulme & R. M. Joshi (Eds.), *Reading and spelling development and disorders* (pp. 395–404). Mahwah, NJ: Lawrence Erlbaum.

Leong, C. K., (1999). Phonological coding and children's spelling. *Annals of Dyslexia 49*, 195–220.

Martin, F., Claydon, E., Morton, A., Binns, S., & Pratt, C. (2003). The development of orthographic and phonological strategies for the decoding of words in children. *Journal of Research in Reading*, *26*, 191–204.

Muter, V., & Snowling, M. (1997). Grammar and phonology predict spelling in middle childhood. *Reading and Writing: An Interdisciplinary Journal*, *9*, 407–425.

Nunes, T., Bryant, P., & Bindman, M. (1997a). Spelling and grammar – The necsed move. In C. A. Perfetti, L. Rieban & M. Fayol (Eds.), *Learning to spell* (pp. 151–170). Mahwah, NJ: Lawrence Erlbaum.

Nunes, T., Bryant, P., & Bindman, M. (1997b). Morphological spelling strategies: Developmental stages and processes. *Developmental Psychology*, *33*, 637–649.

Pinker, S. (1999). *Words and rules*. New York: Perennial.

Rittle-Johnson, B., & Siegler, R. S. (1999). Learning to spell: Variability choice and change in children's strategy use. *Child Development*, *70*, 332–348.

Rubin, H. (1988). Morphological knowledge and early writing ability. *Language and Speech*, *31*, 337–355.

Rubin, H., Patterson, P. A., & Kantor, M. (1991). Morphological development and writing ability in children and adults. *Language, Speech, and Hearing Services in Schools*, *22*, 228–235.

Sénéchal, M. (2000). Morphological effects in children's spelling of French words. *Canadian Journal of Experimental Psychology*, *54*(2), 76–85.

Sprenger-Charolles, L., Siegal, L. S., Béchennec, D., & Serniclaes, W. (2003). Development of phonological and orthographic processing in reading aloud, in silent reading, and in spelling: A four-year longitudinal study. *Journal of Experimental Child Psychology*, *84*, 194–217.

Steffler, D. (2004). An investigation of grade 5 children's knowledge of the doubling rule in spelling. *Journal of Research in Reading*, *27*, 248–264.

Treiman, R. (1993). *Beginning to spell: A study of first-grade children*. New York: Oxford University Press.

Treiman, R. (1997). Spelling in normal children and dyslexics. In B. A. Blachman (Ed.), *Foundations of reading acquisition and dyslexia: Implications for early intervention* (pp. 191–218). Mahwah, NJ: Lawrence Erlbaum.

Treiman, R., & Bourassa, D. C. (2000). The development in spelling skill. *Topics in Language Disorders*, *20*(3), 1–8.

Treiman, R., & Cassar, M. (1996). The effects of morphology on children's spelling of final consonant clusters. *Journal of Experimental Child Psychology*, *63*, 141–170.

Treiman, R., & Cassar, M. (1997). Spelling acquisition in English. In C. Perfetti, L. Rieban & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across the languages* (pp. 61–80). Mahwah, NJ: Lawrence Erlbaum.

Treiman, R., Cassar, M., & Zukowski, A. (1994). What types of linguistic information do children use in spelling? The case of flaps. *Child Development*, *65*, 1310–1329.

Varnhagen, C. K., Boechler, P. M., & Steffler, D. J. (1999). Phonological and orthographic influences on children's vowel spelling. *Scientific Studies of Reading*, *3*, 363–379.

Varnhagen, C., McCallum, M., & Burstow, M. (1997). Is children's spelling naturally stage-like?. *Reading and Writing: An Interdisciplinary Journal*, *9*, 451–481.

Wagner, R, Torgesen, J., & Rashotte, C. A. (1999). *Comprehensive test of phonological processing*. Austin, TX: Pro-ED.

Wilkinson, G. (1993). *Wide range achievement test 3*. Wilmington, DE: Wide Range, Inc.

Worthy, J., & Viise, N. M. (1996). Morphological, phonological, and orthographic differences between the spelling of normally achieving children and basic literacy adults. *Reading & Writing: An Interdisciplinary Journal*, *8*, 139–159.

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