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Abstract

Spelling is a language skill supported by several linguistic knowledge sources, including phonemic, orthographic, and morphological knowledge. Typically, however, spelling assessment procedures do not capture the development and use of these linguistic knowledge sources. The purpose of this article is to describe a new assessment system, the *Spelling Sensitivity Score* (SSS), and then demonstrate initial evidence of its usefulness for detecting developmental changes in spelling knowledge. Two studies that examined spelling knowledge across an academic year in kindergarten, first-, third-, fourth-, and fifth-grade students using the SSS and a traditional correct/incorrect scoring are reported. For all grades, the SSS system, unlike traditional scoring, was able to reveal specific increases in the children's linguistic knowledge across time. Furthermore, for the kindergarten children, the SSS metric was more sensitive than traditional scoring for noting general and specific developmental changes across the year. Collectively, the SSS appears to be a viable tool for documenting changes in underlying linguistic knowledge that children apply to their spelling.

Keywords

spelling, assessment, phonemic awareness, orthographic knowledge, morphological knowledge

Children's spelling ability is of interest to both researchers and educators alike. Researchers investigate children's spellings to gain insight into the cognitive processes and development that they signify as well as to determine how spelling relates to other developing literacy skills such as reading (Ehri, 2000; Kelman & Apel, 2004; Masterson & McLaughlin, 2009). Although educators typically devote less instructional time to spelling than reading, they still recognize the importance of this skill to academic achievement and later, vocational success (Graham et al., 2008). Popular standardized tests that are used to measure spelling development, such as the *Test of Written Spelling-4* (Larsen, Hammill, & Moats, 1999) and the *Woodcock-Johnson III* spelling subtest (Woodcock, McGrew, & Mather, 2007), are based on the traditional correct/incorrect scoring system. Unfortunately, this type of scoring does not represent what is currently known about spelling development because it does not capture linguistic knowledge that children may or may not be using when they spell. In this article, we describe the use of an analysis procedure that considers the range of linguistic knowledge children demonstrate in their spellings and contrast findings using this system to those of the more traditional, correct/incorrect scoring procedure. The impetus of the two studies reported here was to develop an assessment system that was sensitive to developmental changes in

spelling knowledge that could be used by researchers and educators alike. In the following section, we describe procedures that are typically used for analyzing students' spellings within the context of a multilinguistic framework.

Spelling Analysis Procedures

Spelling is a language phenomenon (Bear, Invernizzi, Templeton, & Johnston, 2000; Ehri, 1998; Henderson, 1990; Masterson & Apel, 2000; Moats, 2009; Treiman, Cassar, & Zukowski, 1994). When individuals write a word, they can call upon one or more sources of linguistic knowledge to spell that word. Spellers may use their knowledge of speech sounds, or *phonemic awareness*, to identify the sounds in a word that need to be represented (Ball & Blachman, 1991). When sounds are identified, spellers tap into their *orthographic knowledge* (i.e., principles for translating speech into writing) in one of two ways (Apel, in review). First, when spellers have well-established

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memories of specific written words, or *mental graphemic representations* (MGRs), they can directly access and represent these word specific spellings in their writing (Ehri, 2000; Masterson & Apel, 2000). Second, when an MGR has not been established or is not accessible, spellers can use their *orthographic pattern knowledge* to represent the sounds with one or more graphemes or orthographic patterns while also being conscious of positional rules that dictate where certain graphemes can or cannot be written (Apel & Masterson, 2001). Spellers use their *semantic knowledge* (i.e., appreciation for word meanings) to aid in spelling, particularly when choosing among homonyms (e.g., *one* vs. *won*). Multimorphemic words may cause spellers to tap into their *morphological awareness*, or their knowledge of the spelling of specific affixes and the alterations that occur to base words when those affixes are attached. This same morphological awareness ability may come into play when individuals spell derived words; they may use their knowledge of a base word spelling to guide their spelling of a related derivative or vice versa (Carlisle, 2004). Current theories of spelling development, and evidence that support those theories, suggest that these different sources of linguistic knowledge are accessible and used by young spellers early in development (Masterson & Apel, 2007; Siegler, 1996a; Treiman et al., 1994).

Interestingly, analysis of children's spelling, both for research or instructional purposes, typically has not involved a multilinguistic analysis approach. Undoubtedly, the most frequent analysis of children's spellings involves scoring words as correct or incorrect productions (e.g., the *Test of Written Spelling-4*, Larsen et al., 1999; *Saxon Spelling Curriculum*, Simmons, 2003). Although this type of scoring is quick and reliable for typical learners, it lacks the sensitivity to capture changes in children's use of the different linguistic knowledge sources when spelling. For example, one child may misspell the word *trick* as "tek" while another may misspell it as "trik." With the traditional correct/incorrect scoring procedure, both students' spellings are scored identically. However, a multilinguistic analysis of the misspelled words would suggest that the former child's spellings depicts difficulties using phonemic awareness (omission of letter representing /r/) and orthographic knowledge (orthographically illegal use of *e* to represent the "short I" and incorrect, but orthographically legal, representation of the final "k" sound), whereas the latter child's spelling suggests only a difficulty with orthographic knowledge (i.e., learning to spell a final "k" sound with "ck" after a short vowel).

In an attempt to better represent the linguistic knowledge children bring to the task of spelling and changes in that knowledge within and/or across grades, some researchers have used methods other than the traditional correct/incorrect measure to quantify children's spellings (e.g., Bain, Baillet, & Moats, 1991; Friend & Olson, 2008; Roa, Prakash,

& Joshi, 2006; Treiman & Bourassa, 2000). Most of these analysis metrics, however, have focused on one type of linguistic knowledge evidenced in children's spellings. For example, Treiman and Bourassa (2000) examined the phonological skeleton of children's spellings to determine the phonological knowledge children applied to their spellings. This analysis procedure examines whether the written form of a word represents its phonological structure (i.e., strings of consonants and vowels or CV strings). This type of analysis provides more information than the traditional right/wrong approach; however, it does not address a speller's orthographic or morphological knowledge that may be applied when spelling. Other researchers have conducted spelling analyses more focused on how children's spellings provide evidence of aspects of a child's orthographic knowledge, using procedures designed to examine spellings based on the phonological context of the word and the acceptability of specific graphemic representations (e.g., Bain et al., 1991; Friend & Olson, 2008; Roa et al., 2006). For example, some researchers have analyzed whether each letter in a word is permissible given its word position and the other phonemes in the word. Like the phonological skeleton analysis, though, they do not identify children's developmental knowledge of the other linguistic sources.

Although the analyses discussed previously were developed to describe the level of only one specific source of linguistic knowledge children may demonstrate in their spellings, they permit researchers and teachers to describe developmental changes in that knowledge across time or grades. Consequently, these analyses provide more useful information than the traditional correct/incorrect scoring procedure. Nevertheless, they do not quantify the multiple linguistic sources of knowledge that support spelling that children may utilize (Masterson & Apel, 2007; Masterson & Crede, 1999). Previously, we described a heuristic for simultaneously analyzing children's spellings for the phonological, orthographic pattern, and morphological knowledge they utilize in their spellings, as well as the MGR knowledge they can apply (Masterson & Apel, 2000). The expressed central tenet of this spelling assessment framework (SAF) was to analyze the orthographic representation of each phonological or affix segment of a spoken word for the information it provided about a child's underlying linguistic knowledge. In subsequent investigations, we used this analysis to describe the spellings of both general and clinical populations and to establish objectives for interventions (e.g., Apel & Masterson, 2001; Apel, Masterson, & Hart, 2004; Apel, Wilson-Fowler, Goldstein, & Masterson, 2008; Masterson & Crede, 1999; Masterson, Lee, & Apel, 2008). The main focus of the SAF was to facilitate prescriptive instructional or clinical goals that were attuned to the specific needs of the children being served. The SAF ultimately was used as a foundation for the *Spelling Evaluation for Language and Literacy* (SPELL;

Masterson, Apel, & Wasowicz, 2002) and recent updates SPELL-2 (Masterson et al., 2006) and (SPELL2-G; Masterson et al., 2009). The SPELL software systems are useful for recommending goals and treatment procedures; however, they do not include overall metrics to indicate baseline skills or response to intervention.

For the current study, we adapted the SAF to develop a metric that could be used to quantify developmental changes in the sources of linguistic knowledge children apply in their spellings. The system, the *Spelling Sensitivity Score* (SSS), was designed to be more sensitive to incremental increases in linguistic knowledge than the traditional correct/incorrect scoring system or other procedures that examined only one source of linguistic knowledge. When using the SSS, target words are divided into individual elements. Elements are defined as phonemes, juncture changes, and affixes. For example, when analyzing one morpheme words, *butter* would be divided into B-U-TT-ER, *dog* into D-O-G, *rain* into R-AI-N, and *flute* into F-L-UConsonantE-T. In the last word, the final *e* is paired with the vowel because of the role it plays in encoding the long vowel pattern. Exceptions to the direct correspondence between phonemes and elements included the letter *x* (pronounced with two phonemes), *qu* (always occurs as a unit even though there are two letters and two phonemes), and the various spelling of syllabic *l* and *r* (e.g., *special*, *angel*, *bottle*, *bird*, *nurse*, *her*). For multimorphemic words, the base word portion is divided into phonemic elements, but the affix and any modifications to the juncture are considered separate single elements. For example, *played* would be divided into P-L-AY-ED, *hopping* into H-O-P-P-ING, and *magician* into M-A-G-I-CIAN.

After words have been segmented into their elements, the writer's spelling of each individual element is aligned with the target elements and scored on a scale of 0 to 3. If the element is spelled correctly, 3 points are awarded. If the element is spelled incorrectly, yet with a plausible or legal spelling (e.g., as in the *oCe* in *bote* for *boat*), 2 points are awarded. If the element is spelled incorrectly and without a plausible or legal spelling (e.g., as in the *e* in *ceke* for *cake*), 1 point is awarded. If the element is omitted (not represented by a spelling, as in the missing *t* in *sop* for *stop*), no points are given. Several additional examples of parsing target words into individual elements, aligning student spellings with each element, and assigning SSS values are shown in the appendix.

After all elements have been analyzed within a child's spelling sample, two scores are obtained. The *SSS-Elements* (SSS-E) is calculated by dividing the number of element points awarded by the total number of elements in the sample. The *SSS-Words* (SSS-W) is calculated by dividing the number of word points awarded by the total number of words in the sample. These two scores depict the types and

amount of underlying sources of linguistic knowledge evident in the child's spellings. For example, a SSS-W score less than 1.00 might suggest that a child is not representing all sounds in most of his or her spellings. A score between 1.00 and 2.00 might suggest that a child's spellings are usually phonologically accurate; however, the orthographic conventions are still deficient. An SSS-W greater than 2.00 suggests adequate orthographic skills; however, there may be remaining needs in fine-tuning mental graphic representations. Similar interpretation of individual segment spellings can be made based in the SSS-E. In addition to the SSS metrics, the SSS system allows specialists to chart the percentage of spellings used in each category (i.e., omissions, illegal, legal, correct). Development would be evidenced by progressing from omissions, to illegal, to legal, to correct spellings.

Purpose

The SSS has the potential to capture children's level of skill with and sensitivity for the different underlying sources of linguistic knowledge for spelling as well as changes in those sensitivities across time. Such a tool could prove to be helpful for researchers interested in better understanding developmental changes in spelling knowledge as well as for educators who want to tailor instruction to children's needs and then assess those children's abilities in response to that instruction. To date, however, the usefulness of this metric and any additional benefits it offers beyond the traditional correct/incorrect scoring procedure have not been documented. Therefore, there were two purposes for conducting the two studies reported here. First, we sought to determine whether the SSS held specific advantages over the traditional correct/incorrect scoring procedure in detecting developmental changes in spelling ability measured with isolated word lists and free writing between the start and end of an academic school year. Second, we were interested in whether the SSS coding system provided insight into changes in children's underlying linguistic knowledge over time.

Method

Two separate studies were conducted. The first took place in southeastern United States; the second occurred in the Midwest. The first study focused on the spelling of isolated words by children in the earliest stages of spelling acquisition, and the second study addressed spellings of words in free writing by students in the mid-elementary grades. The studies are discussed separately; however, the results are presented in common tables to facilitate comparison across the age/grade levels. Procedures common to both studies are discussed in this section, and unique features

(i.e., participants, spelling samples) are discussed in the following sections devoted to each study.

For both studies, parental consent for child participation was obtained consistent with the local university institutional review boards. Samples collected at two different times in the academic year were compared for each study. The participants' spellings were entered into an Excel file to facilitate SSS coding. Target words were divided into elements, and the children's spellings for each element were coded by a graduate student in speech-language pathology. The segments were coded as correct, legal (i.e., orthographically allowable representation but incorrect for the particular word), illegal (i.e., orthographically unallowable), or omitted. If the element was spelled correctly, 3 points were awarded. If the element was spelled incorrectly, yet with a plausible or legal spelling, 2 points were awarded. If the element was spelled incorrectly and without a plausible or legal spelling, 1 point was awarded. If the element was omitted, no points were given. The total number of element points awarded was divided by the total number of element points possible in the sample, and the result was the *Spelling Sensitivity Score–Elements*. A similar scoring system characterized the spellings of entire words as correct (3 points), legal (2 points), illegal (1 point), or containing an omission (0 points). The total number of word points was divided to by the total number of words in the sample to yield the *Spelling Sensitivity Score–Words*. The SSS-E and SSS-W scores were calculated for each sample. For comparison purposes, the percentage words spelled correctly (PWC), the traditional scoring procedure, also was calculated for each sample.

To determine whether statistically significance differences existed between Time 1 and Time 2 for each spelling procedures, we conducted *t* tests for paired samples for each grade. Specifically, the SSS-E scores, the SSS-W scores, and the PWC scores at Time 1 were compared to those measures at Time 2. Because multiple comparisons were analyzed in each study, Bonferroni corrections were applied and the alpha level was set accordingly ($.05/2 = .025$ for Study 1; $.05/3 = .0166$ for Study 2). Standard effect sizes (*d*) also were calculated on each comparison to determine the importance, or meaningfulness, of the differences between Time 1 and Time 2. According to Cohen (1977), a *d* of .25 is a small effect, .50 is a medium effect, and .80 or more is a large effect.

To describe the types of underlying linguistic knowledge the children appeared to use in their spellings, and whether use of these knowledge sources changed over time, we further characterized the children's spellings by the SSS coding categories (i.e., omitted, illegal, legal, correct) assigned to their words and the elements in the words. None of the target words administered to the kindergarten and first-grade children were multimorphemic. Consequently, the elements corresponded to phonemes in each base word. On the other hand, words from the free writing samples collected from the students in

Grades 3 to 5 included elements related to affixes and juncture modifications. By determining the specific coding categories represented in the children's spellings at each time point, the aim was to gain additional insight into the developmental changes that occurred across the school year in the underlying linguistic knowledge required for spelling for the group of participants as well as for individual participants.

Study 1

Participants

For Study 1, 22 kindergarten and 24 first-grade children were recruited. Of the 46 participants, there were 26 males. In addition, 78% were African American and 22% were White. All participants attended Title One schools in their home neighborhoods. The percentage of students at these schools qualifying for free and reduced lunch ranged from 70% to 93%. Thus, the children were considered to be from low socioeconomic status (SES) backgrounds.

Procedures

Spelling samples were collected during the academic year as part of a larger study investigating the effects of vocabulary instruction on literacy development. Undergraduate and graduate students in communication science and disorders received training from the primary researchers of the study on test administration, including administration of the spelling measure. All student experimenters were cleared for accuracy in test administration prior to any testing. In kindergarten, samples were collected during January (Time 1), when children were beginning to develop spelling skills, and May (Time 2). In Grade 1, samples were collected at the beginning of the school year (August/September; Time 1) and at its end (May; Time 2). An experimenter administered a 5 word spelling task (*cat, house, baby, when, time*) to the kindergarten children and a 10 word spelling sample (*can, fox, mask, buddy, junk, shape, lump, dollar, train, closet*) to the first-grade children. For four of the kindergarten words (*cat, house, when, time*), there were three elements. The fourth word (*baby*) contained four elements. On the first-grade spelling task, three words contained three elements, six words contained four elements, and one word contained five elements. The words for each grade were similar to words included in published developmental spelling inventories (e.g., Bear et al., 2000) and used in previous investigations of young children's orthographic knowledge development (e.g., Wolter & Apel, 2010). All children were provided a blank sheet of paper and pencil and were asked to write each word after it was presented first in isolation and then in a sentence.

Of the words, 15% from each grade were independently recoded (SSS) or rescored (PWC) by a graduate student trained by the second author to determine interrater reliability. Agreement for the SSS scoring was established at the

element level. Agreement scores for SSS and PWC scoring were 92% and 100%, respectively.

Results

Kindergarten. Means and standard deviations of each measure are shown in Table 1. The average PWC at Time 1 was 19%; this mean score increased to 29% at Time 2. This difference was not statistically significant but was associated with a small to moderate effect size. The mean SSS-W at Time 1 was 1.027; at Time 2 it was 1.548. The mean SSS-E at Time 1 was 1.883; it increased to 2.332 at Time 2. These latter two differences were statistically significant and associated with moderately large or large effect sizes. The average percentage of element spellings for each coding category is shown in Table 2. Review of the table indicates a decrease in omission errors (i.e., insufficient phonological awareness) and an increase in correct spellings for the kindergarten children (i.e., adequate orthographic pattern knowledge and MGRs). A large majority (18 of the 22) of the kindergarten children decreased the number of omissions/illegal spellings and increased the number of legal/correct spellings from Time 1 to Time 2.

Grade 1. Descriptive statistics for the participants in Grade 1 are shown in Table 1. The average PWC at Time 1 was 13%; this mean score increased to 24% at Time 2. This difference was both statistically significant and was associated with a large effect size. The mean SSS-W at Time 1 was 1.063; at Time 2 it was 1.738. The mean SSS-E at Time 1 was 1.889; it increased to 2.938 at Time 2. These differences also were statistically significant and associated with large effect sizes. The average percentage of element spellings for each coding category is shown in Table 2. First-grade children decreased omission errors and illegal spellings and increased legal and correct spellings. Almost all of the children (22 of 24) decreased the number of omissions/illegal spellings and increased the number of legal/correct spellings from Time 1 to Time 2.

Discussion

Overall, the results of kindergarten children's spellings in response to a spelling dictation task revealed that the SSS system was more sensitive for noting general and specific developmental changes across the year. Because these children were in the early stages of literacy development, most of the target words were misspelled at both times of data collection. Thus, the PCW, which focuses only on complete spelling accuracy, was unable to detect improvement in overall spelling ability. However, because of its focus on the underlying linguistic knowledge children can apply to their spellings and its more fine-grained analysis procedure, the SSS captured statistically and clinically significant changes in spelling development using broad measures of spelling ability (i.e., SSS-W and SSS-E). Furthermore, by

analyzing the groups' and individual participants' spellings by the SSS coding system, the SSS was able to depict the underlying sources of linguistic knowledge that changed to help explain developmental progression. For the kindergarten children, the greatest change appeared to be an increasing appreciation for orthographic conventions. Overall, then, the findings indicate that the SSS metrics are more sensitive to developmental changes at the earliest stages of spelling than traditional right/wrong scoring.

Both metrics, the PCW and the SSS, were able to note positive developmental changes in the first-grade children's spellings at Time 2. Thus, when attempting to use a general measure of spelling ability, either scoring procedure would capture changes in spelling skill. However, the source of the changes was only revealed through the SSS scoring system. Specifically, the first-grade children appeared to increase their knowledge and use of orthographic patterns as well as increasing their bank of MGRs. These latter findings indicate that although all metrics were useful in documenting general developmental changes in first-grade children, the categories underlying the SSS measures were helpful in determining the nature of those changes.

The SSS captured general and specific changes in kindergarten and first-grade children's underlying linguistic knowledge that was applied to their spellings. Notably, these children were from low SES schools and thus considered to be at risk for poor literacy development (e.g., Craig & Washington, 2004; Snow, Burns, & Griffin, 1998). Thus, the SSS appears to be beneficial to assessing spelling ability in children who may be experiencing some initial challenges in literacy development. In addition, the SSS scoring system was sensitive to developmental changes based on a relatively small spelling sample (5 and 10 word lists for the kindergarten and first-grade children, respectively), a finding that is likely encouraging to both researchers and educators alike.

One drawback to the study was the absence of multimorphemic words in the spelling lists. It may be that had children been required to spell some multimorphemic words, greater sensitivity to developmental changes would have been found. For example, kindergarten and first-grade children are known to mark affixes above chance level when spelling, albeit in nonconventional ways (e.g., Treiman & Cassar, 1996; Treiman et al., 1994). Future studies with children in the early grades may need to include multimorphemic words to determine any additional benefits of the SSS system over PWC scoring.

Study 2

Participants

Third-, fourth-, and fifth-grade students from a laboratory school on a Midwestern university campus served as participants. There were 78 total participants, including 28 in

Table 1. Mean Performance on Measures of Spelling Accuracy for Each Grade Level.

Grade	Percentage Words Correct						Spelling Sensitivity Score—Words						Spelling Sensitivity Score—Elements					
	Time 1	SD	Time 2	SD	p	d	Time 1	SD	Time 2	SD	p	d	Time 1	SD	Time 2	SD	p	d
K	19	29	29	23	.07	.041	1.03	.87	1.55	.54	.008 ^a	.072	1.88	.59	2.33	.29	.0001 ^a	.97
1	13	20	24	22	<.0001 ^a	1.01	1.06	.06	1.74	.75	<.0001 ^a	1.00	1.89	.65	2.43	.42	<.0001 ^a	.99
3	89	9	92	7	.009 ^b	0.33	2.80	.15	2.84	.13	.029	0.26	2.92	.67	2.94	.05	.046	.26
4	90	9	95	5	.004 ^b	0.69	2.81	.19	2.89	.13	.032	0.48	2.93	.08	2.97	.05	.005 ^b	.61
5	96	2	99	1	<.0001 ^b	1.01	2.93	.05	2.97	.03	.0001 ^b	0.98	2.98	.02	2.99	.01	.016 ^b	.58

a. Significant at .025 (Bonferroni adjustment).

b. Significant at .0166 (Bonferroni adjustment).

Table 2. Mean Accuracy of Types of Element Spellings by Grade Level (%)

	Kindergarten (Word List)		Grade 1 (Word List)		Grade 3 (Free Writing)		Grade 4 (Free Writing)		Grade 5 (Free Writing)	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
Omission	47.5	21.4	37.3	21.9	1.9	2.0	2.5	2.0	0.8	0.7
Illegal	43.5	44.4	39.7	31.0	5.3	3.2	6.0	1.3	1.8	0.6
Legal	27.3	23.3	3.3	7.7	3.5	2.9	3.4	1.1	1.0	0.6
Correct	13.5	31.1	19.6	45.6	89.3	91.7	88.1	95.0	96.4	98.2

Grade 3, 26 in Grade 4, and 24 in Grade 5. There were 43 males. In addition, 4 participants were Asian American, 2 were African American, and 1 was Hispanic. The remaining children were White. All of the children were from middle- to upper-middle SES homes.

Procedures

Writing samples were collected during August (Time 1) and April (Time 2) of the academic year. The teacher in each grade gave the students a topic and asked them to write a detailed story (e.g., write a story about a scary thing that happens to a group of friends; write a story about someone who is special to you). The students were allowed approximately 15 minutes to complete the task. Spellings from four students in each grade were independently recoded or rescored as correct/incorrect by a second graduate student to determine interrater reliability. Agreement scores were 89%, 93%, and 93%, respectively.

Because the students in Grades 3 through 5 were free to choose the words as they wrote their stories, it was possible that there were important differences in length and complexity of the samples written at the two time points of the school year. Thus, we calculated measures to characterize the length and linguistic complexity of the writing samples. Specifically, we determined the total number of words and elements to represent sample length. In addition, we calculated the percentage of multimorphemic words (i.e., words with one or more affixes and compound words) and average number of elements per word to represent linguistic complexity.

Results

Grade 3. Means and standard deviations of each measure are shown in Table 1. The average PWC at Time 1 was 89%; this mean score increased to 92% at Time 2. This difference was significantly significant and associated with a small effect size. The mean SSS-W at Time 1 was 2.803; at Time 2 it was 2.84. The mean SSS-E at Time 1 was 2.915; it increased to 2.938 at Time 2. These latter two differences were not significantly different; however, they were associated with small effect sizes. The average percentage of element spellings for

each coding category is shown in Table 2. Review of the table indicates gradual decreases in the occurrence of orthographic pattern errors (i.e., misspellings that are not plausible) and increases in correct spellings. The rates of occurrence for omitted information and legal spellings remained relatively low across samples. Despite the lack of significant change and relatively low effect sizes associated with group means, the majority of the children (17 of 26) decreased the number of omissions/illegal spellings and increased the number of legal/correct spellings from Time 1 to Time 2.

Grade 4. Means and standard deviations of each measure are shown in Table 1. The average PWC at Time 1 was 90%; this mean score increased to 95% at Time 2. This difference was significantly significant and associated with a large effect size. The mean SSS-W at Time 1 was 2.811; at Time 2 it was 2.888. This change was not significantly different, but it was associated with a moderate effect size. The mean SSS-E at Time 1 was 2.927; it increased to 2.966 at Time 2. This difference was significantly significant and associated with a large effect size. The average percentage of element spellings for each coding category is shown in Table 2. Differences between the samples written by students in Grade 4 resulted mainly from decreases in the rate of orthographic errors that were either illegal or legal (Table 2), suggesting an increase in orthographic pattern and morphological knowledge and MGRs. Most (22 of the 26) children in Grade 4 decreased the number of omissions/illegal spellings and increased the number of legal/correct spellings from Time 1 to Time 2.

Grade 5. Means and standard deviations of each measure are shown in Table 1. As with the participants in Grade 4, accuracy levels were very high at Time 1. The average PWC at Time 1 was 96%; this mean score increased to 99% at Time 2. The mean SSS-W at Time 1 was 2.927; at Time 2 it was 2.966. The mean SSS-E at Time 1 was 2.977; it increased to 2.986 at Time 2. All three metrics yielded differences between Time 1 and Time 2 that were statistically significant. The differences in PWC and SSS-W were associated with large effect sizes, and the difference in SSS-E represented a moderate effect size. The average percentage of element spellings for each coding category is shown in Table 2. The improvements in accuracy appeared to be due to decreased occurrence of orthographic pattern errors.

Table 3. Characteristics of Writing Samples Produced by Participants in Grades 3 through 5

Grade	Grade 3		Grade 4		Grade 5	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
Total elements	481	325	295	613	444	564
Total words	162	109	84	176	136	174
Percentage words multimorphemic	12	12	19	23	15	16
Average elements per word	3.0	3.0	3.5	3.6	3.3	3.2

As was the case with the third- and fourth-grade children, the majority of fifth-grade children (17 of 26) decreased the number of omissions/illegal spellings and increased the number of legal/correct spellings from Time 1 to Time 2.

Writing Sample Characteristics

Measures characterizing the length and complexity of the free writing samples are shown in Table 3. The third-grade children's Time 2 writing samples were shorter than their Time 1 sample as measured by total number of words and elements; however, the two writing samples were comparable in morphemic complexity and word length, suggesting relatively similar levels of linguistic complexity.

Samples written by the fourth-grade children grew in length as evidenced by increases in the total numbers of elements and words. An increase in linguistic complexity was less clear-cut. Morphemic complexity increased between Time 1 and Time 2; however, word length (i.e., average number of elements per word) remained relatively stable.

The length of the fifth-grade children's writing samples increased from Time 1 to Time 2. Morphological complexity and word length remained comparatively constant across the samples. In general, with the possible exception of the length of the third-grade children's Time 2 samples, any marked or significant increases in spelling ability at Time 2 across the three grades did not appear to be due to less mature or lengthy writing samples.

Discussion

Unlike the results of Study 1, there were not any notable advantages in noting general or broad changes in spelling ability based on the metric used. For example, the PCW and SSS scoring systems demonstrated statistically and clinically significant changes in spelling skill at Time 2 for the fourth- and fifth-grade participants. Thus, for a general understanding of whether the children evidenced increases in spelling ability, neither metric held an advantage. This finding was likely due to the high degree of spelling accuracy on both the Time 1 and Time 2 writing samples. Because the children were free to choose the words they spelled, it is likely they chose words for which they had

prior and adequate spelling knowledge. However, because of the coding system inherent in the SSS scoring procedure, the SSS was able to identify specific changes in linguistic knowledge that explained the somewhat subtle developmental changes that occurred in their writing samples. Between Time 1 and Time 2, the fourth- and fifth-grade children appeared to apply additional orthographic pattern and morphological knowledge and MGRs for the words they attempted to spell, resulting in higher overall spelling accuracy. This improved use of linguistic knowledge occurred even when the length and complexity of the second writing sample increased.

For the third-grade children, neither the PCW nor the SSS metrics demonstrated a benefit to capturing developmental changes across the academic year. Interestingly, results using both scoring systems suggested no significant change in spelling ability using broad-level measures (i.e., PCW, SSS-W, and SSS-E). It may be that the decrease in length of the Time 2 sample, coupled with no changes in linguistic complexity, led to this finding. That is, with reduced opportunities for spelling and no increase in complexity, the third-grade children may not have provided enough opportunities to demonstrate increases in the linguistic knowledge used for spelling as measured using general metrics. However, using the SSS coding system, developmental changes were nonetheless noted. Specifically, the third-grade children appeared to further develop their knowledge of plausible and correct orthographic representations of words and elements. As a whole, then, the SSS coding system provided additional information about changes in the underlying linguistic knowledge that third- through fifth-grade children demonstrated in their free writing.

General Discussion

Across the two studies reported here, we sought to determine whether an assessment tool based on the underlying linguistic knowledge that individuals can apply to their spellings was sensitive to developmental changes in spelling knowledge across an academic year. Specifically, we wished to determine whether the SSS held any advantages over the traditional correct/incorrect scoring system often employed by researchers and educators for detecting

developmental changes in spelling over time. In addition, we were interested in whether the coding system of this new procedure was able to provide insight into the linguistic knowledge children demonstrated in their spellings. The findings from this study suggest the SSS held an advantage over the traditional scoring system to detecting broad changes in spelling ability when applied to kindergarten children's responses to a dictated spelling list. For first-, third-, fourth-, and fifth-grade children, it was similar to the traditional correct/incorrect procedure in detecting general changes in spelling ability across time. Unlike the traditional scoring system, however, the SSS was able to provide specific information about the changes in children's use of the underlying linguistic knowledge needed for spelling in each grade assessed. These findings hold promise for researchers' and educators' use of the SSS to mark developmental changes in children's spellings.

Although both scoring procedures (SSS and the traditional scoring system) were similar in their ability to note whether first-, third-, fourth-, and fifth-grade students improved in their spelling skills using general metrics (i.e., PCW, SSS-W, SSS-E), the SSS differed from the traditional scoring system when analyzing the kindergarteners' spellings. The specific advantage in detecting general changes in developmental ability for this particular grade may be due to the high amount of inaccurate spellings and the small number of exemplars on which the analysis was based. That is, the kindergartners, even at Time 2, were spelling less than a third of the words correctly (i.e., less than 2 words accurately spelled out of 5). Although the first-grade children were equally unsuccessful in spelling words correctly at Time 2, the additional exemplars may have aided in allowing the PCW to detect changes in accuracy (i.e., over 2 words spelled correctly out of 10 words). Future investigations should examine the contributions of sample length to determine its influence on the outcomes of both the traditional and SSS scoring procedures. Nevertheless, the results from Study 1 suggest that the SSS is useful in marking general developmental changes across time using a relatively small sample of spelling.

Across all grades assessed, the SSS coding system revealed changes in the use of underlying sources of linguistic knowledge that appeared to be applied to the children's spellings. Such information is not available when using the traditional scoring procedure. Information on what linguistic knowledge is evident in children's spellings, and changes in this knowledge use across time, should prove useful for researchers and educators alike. For example, the SSS offers the potential for researchers to document the linguistic knowledge bases children use within and across grades. Given that current theories of spelling development emphasize the repertoire of linguistic knowledge children have access to as they learn to spell (Masterson & Apel, 2007; Siegler, 1996b), assessment tools such as the SSS that are sensitive to and capture changes in linguistic knowledge across time should aid researchers in better

depicting the developmental progression of spelling ability. In the future, researchers could use the SSS, as applied to a standardized spelling sample, to document how children's repertoire of linguistic knowledge increases and broadens developmentally.

The use of the SSS also should benefit educators who are interested in determining how best to instruct their students in the area of spelling. Historically, spelling instruction has not received much attention and typically has involved memorization of weekly word lists (Graham et al., 2008). This manner of instruction does not emphasize the multiple sources of linguistic knowledge that children can apply as they spell words. Furthermore, this type of instruction rarely is preceded by an assessment that allows the instructor to group students by developmental needs or abilities. Using the SSS, educators could determine children's level linguistic knowledge use and group children with similar abilities for lessons targeting their specific needs. Furthermore, the SSS could be used in curriculum-based assessment to monitor children's response to that instruction and guide educators in determining whether additional educational supports are needed to improve children's skills (Al Otaiba & Lake, 2007; Gersten et al., 2008).

Limitations and Future Research

There are several limitations to the studies that can be addressed in future studies. First, children were either provided a dictated spelling list (kindergarten and first-grade participants) or were required to write a story (third- through fifth-grade participants). For assessment purposes, there are advantages and disadvantages to both samples. With dictated spelling samples, students are restricted to the words presented. Not only is this sample not necessarily representative of typical writing, it also may limit the amount of information gleaned from the sample. For example, words on the list may be overly easy or challenging, resulting in either minimal errors to analyze or spellings that are difficult to categorize within the SSS format. In addition, the length of the sample may not permit a large number of exemplars for a variety of orthographic forms to be assessed. However, unlike free writing samples, dictated spelling lists preclude students from avoiding words they do not know how to spell. Free writing samples, by their nature, are representative of typical writing. However, in free writing samples, children can choose words they know how to spell, possibly resulting in little variety or complexity in orthographic forms. In the future, investigators should determine the comparative viability of the SSS when applied to children's spellings from both dictated spelling lists and free writing samples.

The children who participated in the two studies represented specific populations; thus, the findings from this study are limited to those populations. The kindergarten and first-grade children in Study 1 were considered to be at

risk for literacy development because of their low SES status. The children in Study 2 represented children from middle- to upper-middle-class homes. Thus, it remains to be determined whether the SSS is beneficial in noting developmental changes in the underlying linguistic knowledge required for spelling for children within the same grades from a variety of backgrounds. Furthermore, none of the children in either study were identified with spelling or other literacy deficits. The advantages of the SSS with this latter population remain to be determined.

Conclusion

Children use a number of different sources of linguistic knowledge to spell words, including phonemic, orthographic pattern, and morphological awareness and MGRs. The traditional correct/incorrect scoring system does not provide information on the developmental level and use of these different knowledge sources. The SSS appears to be a viable tool for documenting changes in underlying linguistic knowledge that children apply to their spelling.

Appendix

Examples of Spelling Sensitivity Score Element Scoring

Target	attitude	a	tt	i	t	u-C(onsonant)-e	d
Child's spelling	attitude	a	tt	i	t	uCe	d
Points		3 ^a	3	3	3	3	3
Target	bussed	b	u	s	s	ed	
Child's spelling	bust	b	u	s	—	t	
Points		3	3	3	0 ^b	1 ^c	
Target	chain	ch	ai	n			
Child's spelling	chane	ch	aCe	n			
Points		3	2 ^d	3			
Target	halves	h	a	lv	es		
Child's spelling	halfs	h	a	lf	s		
Points		3	3	1	2		
Target	knocked	kn	o	ck	ed		
Child's spelling	nakt	n	a	k	t		
Points		2	2	2	1		
Target	pennies	p	e	nn	i	es	
Child's spelling	pennys	p	e	nn	y	s	
Points		3	3	3	1	2	

a. Correct.

b. Sound, juncture, or affix is not represented with a spelling.

c. Sound, juncture, or affix is spelled in a way that is rarely, if ever, correct in other words of similar word shape.

d. Sound, juncture, or affix is spelled in a way that is correct in other words.

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