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An Analysis of Deaf Students' Spelling Skills during a Year Long Instructional Writing Approach

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Abstract

Numerous studies have shown that spelling presents unique challenges for children who are deaf or hard of hearing (d/hh) and most do not develop age appropriate spelling skills. However, it is critical that these skills are acquired in order to use written language for academic or vocational purposes. Spelling errors from the writing samples of 29 middle school students in a state school for the Deaf were analyzed to examine changes over time. Samples were gathered before, during, and after a year-long writing intervention using Strategic and Interactive Writing Instruction (SIWI). When using SIWI, students are exposed to proper spelling during guided writing instruction; however, spelling is not a specific focus of each lesson. In this study, a linguistic analysis of spelling errors was used to assess each child's understanding of the phonological, morphological, orthographic, semantic and visual imagery rules that apply to written words. No significant improvements in spelling were noted and the results indicate that spelling should be targeted during writing lessons. The results provide important information on the acquisition of spelling skills with this unique population and the use of narrative samples to assess spelling.

It is well established that children born with an educationally significant hearing loss typically show early delays in acquiring both spoken or sign language and written language skills. As these children grow, language and literacy skill deficits profoundly impede academic achievement (Davis, 1974; Davis & Blasdell, 1975; Kyle & Harris, 2006; King & Quigley, 1985; Marschark, 1993; Mayer, 2007; McEvoy, Marschark, & Nelson, 1999; Nittrouer, Caldwell, Lowenstein, Tarr & Holloman, 2012). These well-documented language and literacy deficits usually include significant problems with spelling (Aaron, Keetay, Boyd, Palmatier, & Wacks, 1998; Alamargot, Lambert, Thebault, & Dansac, 2007; Allman, 2002; Geers & Hayes, 2011; Leybaert & Alegreia, 1995; Olson & Caramazza, 2004; Padden, 1993; Sutcliffe, Dowker & Campbell, 1999).

The area of spelling among children who are deaf or hard of hearing (d/hh) has received little attention. We know from the breadth of literature focusing on participants with typical hearing that while spelling was once considered a skill to be learned through repetitive drill and practice, research has shown that spelling involves knowledge of a rule-based system that requires the integration of sound, pattern, and meaning relationships to generate orthographic output (Ehri, 1986; Masterson & Apel, 2000). This is supported by research demonstrating that English words generally conform to predicable letter patterns (Bear, Invernizzi, Templeton, & Johnson, 2000), which represent the underlying phonological representations of sound and letter combinations. These are the combinations that early writers with typical hearing rely on when spelling (Treiman & Bourassa, 2000).

Studies of spelling acquisition have shown that children with typical hearing first develop an awareness of the sound system of a language (phonological awareness), and then knowledge of the sound-letter correspondences that form the orthography of a language (Ehri, 2000; Ehri &

Wilce, 1980). As orthographic skills mature, children begin to construct mental graphemic representations (MGRs), or mental images of words (Apel, 2011; Apel & Masterson, 2001). MGRs help in spelling words that do not conform to regular orthographic patterns. Knowledge of morphology and semantics further contribute to spelling development (Apel, Wilson-Fowler, Brimo & Perrin, 2011; Verhoeven & Van Leeuwe 2008; Wasowicz, 2007; Wolter, Wood & D'zatko, 2009). Phonological awareness, orthographic awareness, mental graphemic representations, morphological awareness and semantic knowledge together serve as the linguistic basis of mature spelling skills.

Although far less is known about the developmental process of spelling with children who are d/hh, it is clear that they demonstrate areas of weakness in spelling not typical of their hearing peers (Allman, 2002; Colombo, Arfe´ & Bronte, 2011; Harris & Moreno, 2004; Leybaert & Alegria, 1995; Sutcliffe et al., 1999). In particular, children who are d/hh do not easily acquire the phonological awareness skills that serve as the foundation for spelling development because these skills are usually learned through audition (Aaron et al., 1998; Alamargot et al., 2007; Sterne & Goswami, 2000). Studies that have examined the importance of phonological knowledge to spelling for children who are d/hh present equivocal results. As reported by Leybaert and Alegria (1995), students who were d/hh exhibited more difficulty with non-phonologically transparent words than those that had salient sound/letter representations. This may indicate some use of phonological knowledge because words with transparent phonological properties were easier to spell. In a related study by Sutcliffe et al. (1999), children from signing schools appeared to use orthographic knowledge more in their spelling than phonological information, as evidenced by their spelling errors. Similarly, Harris and Moreno (2004) found that children who were deaf between 8 and 14 years of age did not demonstrate any significant

reliance on phonological coding during a picture spelling task. Based on these results, it is clear that limited phonological awareness skills are likely to be one reason that children who are d/hh use spelling strategies that are different from their hearing peers.

In addition to phonological awareness, the acquisition of mature spelling ability requires knowledge and recognition of the orthographic patterns in a language (e.g., *ng* is a legal word ending in English but cannot be used to start a word). An understanding of orthographic rule patterns allows young children to establish increasingly accurate representations of the words that they spell (Deacon, Conrad, & Pacton, 2008). In a study by Padden (1993), children between the ages 4 and 9 who were severely or profoundly deaf provided writing samples for analysis of single word spelling. As age increased, spelling attempts demonstrated a growing knowledge of orthographic patterns. Related studies looking at orthographic knowledge of students who are d/hh generally confirm that improvements are made with instruction and age (Aaron et al., 1998; Alvarado, Punete & Herrera, 2008; Miller, 2005). Research also shows that their spelling attempts typically follow orthographically legal patterns (Olson & Caramazza, 2004), indicating orthographic awareness may be a strength in the development of spelling skills for children who are d/hh.

As orthographic knowledge is acquired, young spellers also develop knowledge of MGRs. This allows a speller to retrieve stored images of words or parts of words (Apel, 2009, 2011). This is important because it facilitates the ability to spell words that do not follow regular orthographic rules (e.g., yacht). Studies with individuals who are d/hh indicate that when attempting to spell words that do not follow regular spelling patterns (i.e., MGRs), students will still employ orthographically acceptable attempts even if their attempt is wrong (Hanson, Shankweiler & Fischer, 1983). Results of the study by Sutcliff et al. (1999) suggest that children

who are d/hh exhibit considerable delays in spelling words they deemed as “low frequency” words, or words those students would not have had much, if any, exposure to previously.

While phonological and orthographic information, including MGRs, serve a primary function in spelling development, research has also demonstrated that accurate spelling is facilitated by an understanding of morphology (Trieman & Cassar, 1996). Knowledge of morphological rules allows a speller to apply the spelling of a known word or morpheme to another word (e.g., scene to scenic). In a study by Leybaert and Alegria (1995) students who were d/hh made almost twice as many morphological errors as a hearing control group; however, the authors suggested that transparent morphological properties of spelling improve with increased exposure to written language. A related study by Olson and Caramazza (2004) showed that students who were deaf (hearing loss of at least 85dB in their better ear) produced 12% of words as morphological variants of the target words, as compared to only 1% by students with typical hearing. However, even though these studies show that children who are d/hh make considerably more morphological errors in spelling than their hearing peers, they do use morphological information productively. Breadmore, Olson, and Krott (2012) found that, unlike their hearing peers, children who are deaf use morphological knowledge independent of phonological knowledge, indicating that morphology can be learned through orthography. Given the restrictions placed on phonological acquisition due to the inability to access the auditory signal, this result suggests that writing programs that emphasize morphology may serve to improve spelling.

Studies of children with typical hearing have shown that semantic knowledge is significantly correlated with spelling ability even after controlling for phonological awareness, alphabet knowledge, and letter writing fluency (Apel, et al., 2011; Kim, Otaiba, Puranik, Folsom,

& Gruelich, 2013; Verhoeven & Van Leeuwe, 2008; Wasowicz, 2007; Wolter, et al., 2009). Recent research by Kyle and Harris (2010) indicates that semantics (i.e., vocabulary knowledge) plays as significant role in reading achievement and was the strongest predictor of later reading abilities for children who are d/hh; however, spelling was not specifically examined. If word knowledge facilitates spelling accuracy, and children who are d/hh are known to exhibit vocabulary deficits (Kyle & Harris, 2010), there is reason to be concerned that deficits in vocabulary are likely to have a negative impact on their spelling ability. Thus, this is an area that requires additional studies to show how semantic knowledge and spelling are related in this population.

To date, very few studies have been designed to examine the multiple linguistic bases of spelling errors with children who are d/hh. Overall, the studies that have been conducted show that children with educationally significant hearing loss are limited in their ability to access the phonological, morphological, and semantic cues critical for literacy-related skills (Burman, Nunes & Evans, 2007; Marschark, Mouradian, & Halas, 1994; McAnally, Rose, & Quigley, 1994; Yoshinaga-Itano, Snyder, & Mayberry, 1996). One recent investigation that focused specifically on spelling skills included 20 adolescents at a state school for the Deaf (Authors, 2013). Results showed that the participants made more phonological errors than any other error type. Further, participants made more semantic errors than orthographic errors, regardless of whether the words were spelled with regular or irregular patterns. These findings are consistent with studies that show that children who are d/hh use orthographic strategies rather than phonological strategies to spell, and that their ability to spell is compromised by limited English language abilities.

In addition to studies examining the linguistic bases of spelling, it has been noted in the literature that children who are d/hh frequently represent a spelling word with only the initial sound of the target word or refuse to attempt the target word at all (Authors, 2013; Harris & Moreno, 2004). Interestingly, the spelling errors of children who are d/hh have been shown to be uniquely different from students who hear (Allman, 2002; Colombo et al., 2011; Padden, 1993; Sutcliffe et al., 1999). Some investigations have demonstrated a need to account for the use of visual or spatial information by children who are d/hh when they spell because they use pictures or sign language hand shapes to represent a word (Alvarado et al., 2008; Mayer & Moskos, 1998; Padden, 1993).

In general, it is clear that children who are d/hh struggle with spelling and this can limit their written expression. Research has shown that spelling assessments can provide considerable information about the areas of language that interfere with written expression on an individual basis. However, only a few studies have explored spelling changes across time in order to help guide instructional improvements. One study completed by Sirois, Boisclair, and Giasson (2008) measured invented spelling three times over a year of first grade, comparing a group of 31 children with severe to profound hearing loss with 25 children with typical hearing. The children with severe to profound hearing loss received two years of preschool intervention that included language and writing instruction prior to starting first grade. During their preschool instruction, the writing lessons emphasized the alphabetic principle. At the beginning of first grade, the children were tested on invented spelling and phonological awareness. Their scores did not differ significantly from the scores of their hearing peers, indicating the value of focused instruction at an early age. However, the authors cautioned that even though the preschool intervention was successful in making these children almost indistinguishable from hearing children in first grade,

there is a need for concern about future literacy success. This is because of a clear connection between their test results on measures of syntax and reading that did not appear in the test results of the children with typical hearing. This connection indicates that although the children with severe to profound hearing loss were doing well with decoding skills, there are potential problems with the language foundations that underpin written language.

In a related study by Mayer and Moskos (1998), student writing samples were examined for spelling changes over two years of academic work. The academic program used an integrated process-writing program that was holistic and emphasized the importance of meaningful communication. The study included 15 children between 5 and 9 years of age who were deaf and communicated primarily through sign, although most did not have a well-established first language. Results showed that most of the children's early spelling attempts did not necessarily exploit phonological knowledge; instead they used a variety of cues to spell unknown words, relying upon their exposure to print, sign, and speech. As the students became more aware of print, their spellings indicated a growing knowledge of orthographic patterns. However, this knowledge was not sufficient to allow them to develop the ability to spell with accuracy. As a consequence, the authors recommended caution in assuming that print exposure alone would allow children who are d/hh to develop age appropriate literacy skills.

At present, research does not provide evidence of how the spelling skills of middle school students who are d/hh might change across a year of writing instruction. This is an issue of critical importance because in middle school children should be using written expression to communicate clearly across a wide range of formats including narratives, personal narratives, persuasive writing, and expository texts. Knowledge of students' spelling errors and spelling changes over a year of instruction has the potential to inform further development of writing

curricula specially designed for d/hh students. It can also assist educators in targeting specific linguistic areas of need in order to facilitate the greatest improvements in spelling and written expression.

Examining Spelling Over a Year of Strategic and Interactive Writing Instruction

The goal of the present study was to examine the spelling errors and changes that occur in the writing of middle school students who are d/hh over one year of writing instruction. The instruction provided is called Strategic and Interactive Writing Intervention (SIWI; Author, 2007, 2008). SIWI is a writing approach that incorporates explicitly taught strategies with guided classroom writing activities (Author, 2007) for all genres of writing. Specific techniques that address the unique language needs of students who are d/hh are used. For example, there are embedded approaches for signing students aimed at developing their metalinguistic knowledge of American Sign Language (ASL) and English, and there are general language development strategies for students who are significantly delayed in their abilities to communicate concepts clearly to others.

When using SIWI, students work with a classroom teacher to create 'publishable' pieces of work to present to an audience (e.g., thank you letters, reports of field trips for class newsletters). Unlike typical class writing assignments, students are encouraged to interact and collaborate during all aspects of the writing process, and the teacher gradually transfers more and more control over the writing to students. As a result of SIWI lessons, significant gains have been achieved in both discourse-level (i.e., coherence, organization, text structure elements), and sentence- or word-level (i.e., length, sentence complexity, sentence awareness) writing skills (Author, 2008; 2012). At this time, it is unclear what impact SIWI has on spelling. Although spelling is not typically a central objective of SIWI lessons, students are exposed to accurately

spelled words during guided writing sessions with the teacher. When a student suggests a word, phrase or sentence to be added to the co-constructed text, the teacher generally writes or types correctly spelled words onto the board. At times, the teacher may ask a student for help with spelling a word while she writes it, but there are no guidelines provided to teachers about when to emphasize spelling and how.

Methods

Participants and Setting

Twenty-nine 6th, 7th, and 8th grade students attending a state school for the Deaf participated in the study. Demographic information for all students is included in Table 1. The school's communication philosophy is to practice Simultaneous-Communication (i.e., spoken English and Manually Coded English) and the participants' exposure to ASL ranged from low to high. The student's pure tone averages in their better ear were calculated, with a mean of 88dB unaided, and 35dB aided. The average Stanford Achievement Test for the Hearing Impaired (SAT-HI; Trybus & Karchmer, 1977; Mitchell, Qi, & Traxler, 2007) reading comprehension score for the group was a reading level of 2.7.

INSERT TABLE 1 ABOUT HERE

Over the school year, students spent 2-2.5 hours per week in SIWI activities. All of the SIWI lessons, examinations, and writing samples were conducted by the students' language arts teacher who is fluent in English and ASL.

Written samples used for spelling analysis. Written language samples in the form of personal narratives were obtained from each participant at the beginning, middle, and end of the academic year. Each sample was coded at the word level for spelling errors. Every word spelled

incorrectly was counted once. If the same word was misspelled in the text in the same way, it was only counted once. The writing samples were coded for spelling errors by a speech-language pathologist, a teacher of the deaf, a 7th grade English teacher, and an Assistant Professor of Deaf Education.

Spelling analysis. For each writing sample, a list of all incorrectly spelled words was generated and compared within subjects. Incorrectly spelled words were examined in context to determine if the word was semantically and morphologically appropriate for the sentence. Each word identified as a spelling error was analyzed for its specific error pattern(s). A Multi-Linguistic Coding (MLC) system designed to better address the spelling errors made by children who are d/hh was used (Authors, 2013). Multi-linguistic coding has been employed in previous studies and demonstrated to be sensitive to the underlying linguistic process errors made by typically hearing children (Apel & Masterson, 2001; Masterson & Apel, 2010; Author, 2012) as well as children who are d/hh (Authors, 2013).

When using the MLC system, spelling errors from the writing samples were coded and placed into categories consistent with previous research. These included: phonemic awareness errors (PA), orthographic pattern awareness errors (OPA), mental grapheme representation errors (MGR), morphological awareness errors (MA), and semantic awareness errors (SA; Apel, 2011; Wasowicz, 2007). Phonemic awareness errors were coded when a sound was added or deleted (e.g., either "timfe" or "tie" for "time") and for all letter reversals. OPA errors were coded when a rule for combining letter or patterns governing spelling has been violated. Consistent with other published spelling assessments and current literature (Apel 2011), sound-letter correspondence errors were included in the OPA category, not as a PA error (Masterson & Apel, 2010). For example, “life” for “live” was scored as an OPA error, as all phonemes were represented (e.g.,

CVC configuration), but the student substituted "v" to represent the "f" phoneme. MGR errors were coded when a word that is non-phonetic in its spelling, such as *city*, was spelled "phonetically," (e.g., *cidy*), or the word was spelled differently on repeated attempts (i.e., the student has difficulty developing an MGR for that specific word). Morphological errors were coded when a word was spelled with an incorrect morpheme, affix, or suffix (e.g., *talkt* for *talked*). Semantic errors were coded when the wrong word was used (e.g., *two* for *to*; or *dog* for *car*). It should be noted that verb or tense agreement errors were not included as semantic errors.

For this study, the MLC system was extended to include an additional category for errors related to visual imagery (VI). This error category was added because a preliminary review of the pre-, mid-, and post-intervention writing samples showed a number of errors in the form of pictures represented in the text. These errors were consistent with findings by Mayer and Moskos (1998) and Padden (1993), whose studies provide evidence that children who are d/hh are more likely to use pictures in their writing to represent words than their typically hearing peers. The MLC system categories, defining characteristics and examples are shown in Table 2.

Reliability. For inter-rater reliability of spelling errors, 20% of all samples were independently coded by the first, second and fifth authors. Pearson's correlation between the raters revealed a positive, high correlation ($r=.955$, $p < .001$). A consensus was reached for all discrepancies and the agreed upon codes were used in the overall analysis. For inter-rater reliability spelling error category placement, 20% of the spelling errors were analyzed by the first and third authors. Pearson's correlation revealed a positive, high correlation ($r=.978$, $p < .001$).

INSERT TABLE 2 ABOUT HERE

Results

Spelling errors were analyzed by category (see Table 2) for all of the writing samples. Results show that the spelling error patterns stayed relatively stable for the entire year, with no statistically significant variation for any of the six categories, $F(1,28) = .279$, $p = .602$, $\eta_p^2 = .01$.

Phonological errors remained consistent through the school year, with no statistically significant variation from pre-, mid-, and post-intervention writing samples, $F(1, 28) = .293$, $p = .593$, $\eta_p^2 = .010$. Though there was no statistically significant difference in PA errors, participants were observed to make more PA errors throughout the year. Specifically, the percentage of PA errors increased from 31% at pre-intervention ($M = 1.37$ errors per writing sample), to 40% at post-intervention ($M = 1.58$).

For OPA errors, results did not significantly vary from pre-, mid-, and post-intervention writing samples, $F(1,28) = .922$, $p = .345$, $\eta_p^2 = .32$. To investigate how many sound-letter correspondence errors were included in the OPA category, these data were further analyzed. Results showed that of the pre-, mid- and post-intervention samples, 7%, 17%, and 7% of OPA errors involved sound-letter correspondence. This indicates that a substantial portion OPA errors, 39%, 62%, and 43% for pre-, mid- and post-intervention respectively, consisted of a sound-letter correspondence error (i.e., phonological mismatch of sound and letter choice; e.g., “arrate” for “arrive”), instead of other orthographic errors that are not sound but pattern and rule related (e.g., “laf” for “laugh”, “lader” for “ladder”).

The rate for MGR errors stayed consistent across participants during the school year, $F(1,28) = .000$, $p = 1.00$. Further analysis of the MGR means revealed that participants made few to no MGR errors across the school year; specifically the mean for MGR errors at pre-intervention was 0.1379 (range 0-3), with fewer errors at mid-intervention ($M = .2069$, range 0-1) and post-intervention ($M = .1379$, range 0-2).

Morphological errors, like previous errors types, did not vary across the intervention, $F(1,28) = .373$, $p = .546$, $\eta_p^2 = .013$. Examination of the means across the intervention demonstrated that MA errors stayed consistent.

Changes in semantic errors (SA) were not statistically significant across the intervention, $F(1,28) = .069$, $p = .816$, $\eta_p^2 = .002$. Examination of the samples revealed numerous SA errors, indicating a lack of understanding for word meaning. Examples include *tired* for *tried*, *read* for *real*, *mouth* for *month*, and *nerves* for *nervous*. SA error rates from pre-, mid-, and post-intervention were 18% 19%, and 18%, respectively.

As anticipated by the preliminary screening of the narrative samples, there were a number of visual image (VI) errors in the student's writing; however, changes were not statistically significant across the intervention ($F(1,28) = 1.24$, $p = .275$, $\eta_p^2 = .042$). Visual image errors occurred in the form of drawing a picture of the target word (see Figure 1) or spelling a word based on signs used in ASL (e.g., *vorival* for *funeral*, *ahh* for *scream*). At pre-, mid-, and post-intervention, VI error rates were 16%, 15%, and 11% respectively, demonstrating a larger percentage of errors than either the MGR (3%, 8%, 3%) or morphological awareness errors (11%, 14%, 9%).

Insert Figure 1 About Here

Once all of the samples were analyzed, it was deemed worthwhile to try and determine if the consistency in spelling errors across linguistic areas was associated with more diverse word selection as the year progressed. To do this, the average number of different words found in each writing sample was examined. Results revealed a significant main effect for change in the total number of different words ($F(2, 56) = 5.092$, $p < .001$; see Figure 2). Specifically, the average number of different words increased from 55 at pre-intervention to 72 at post-intervention. Pair-

wise comparisons show a significant increase in the total number of different words used from pre- to post-intervention ($p < 0.001$), as well as mid- to post-intervention ($p < 0.05$).

Discussion

The goal of this study was to examine the spelling error and spelling changes that occurred in the writing of middle school students who are d/hh over a year of participation in SIWI. By assessing spelling errors using multi-linguistic coding (MLC) analysis across a year of writing instruction, individual as well as group deficits can be described and the instructional approach can be evaluated on its ability to facilitate spelling improvements.

Results indicate that middle school students who are d/hh made a significant number of phonological, orthographic, and visual imagery errors at all points in the study. The types of errors they made remained relatively stable across the year, with little change in any category. It is no surprise that errors of phonological awareness predominated. These results are consistent with previous studies that show that children who are d/hh have greatest difficulty with the phonological aspect of spelling (Aaron et al., 1998; Alamargot, 2007).

The proportion of orthographic pattern errors with a phonological component and the small number of MGR errors also support the idea that phonological awareness is the primary deficit area for this group. This may indicate that the students had memorized a certain number of irregular words and used them with confidence in their writing. In other words, they had established good mental images of some words. Our findings and the literature support the conclusion that children who are d/hh use orthographic and MGR information far better than phonological information. Recent research supports the idea that MGRs and phonological awareness develop independently (Apel, 2009), suggesting that it is possible the small

percentage of MGR errors and high proportion of PA errors indicates that learning word patterns and stored mental images of words is an area of strength of D/hh students.

The category that had not been used before in multi-linguistic coding is visual imagery. The need for this category was anticipated based on previous research as well as experience with this population. Results from this study show that the students inserted pictures for words that were difficult to spell or words they did not know (e.g., picture of monkey embedded in the text). In addition, some students wrote words that were visually similar to signs found in American Sign Language. One example was the spelling of the word *funeral* as *vorival*. The use of two 'V' hand shapes to sign this word in combination with the visual image of the length and shape of the word *funeral*, makes the error understandable. In a different sample, the word '*ahhh'* spelled out was used to represent the word *scream*. Throughout the samples, students consistently made an effort to spell the whole word rather than refusing to attempt the word or putting the first letter and leaving the rest blank, which are typical errors seen in research using single word spelling tests (Author et al., 2013; Padden, 1993). Therefore, while the percentages of spelling errors in the VI category were high (16%, 15%, and 11% respectively), this can be seen as a strength of deaf writers: using the information they have available to convey their message in personal narrative writing samples. Thus, there is value in using spontaneous writing samples to investigate spelling since these attempts provide a means of determining what words individuals are attempting to use and what linguistic features are incurred in their spontaneous writing samples.

Representative samples were chosen to analyze writing samples at the word level. This analysis revealed that word selection typically involved very early spelling words. For example, in one selected sample, 15 different simple to spell words (e.g., kitty, mom) accounted for 66%

of all the words used in a 326 word narrative. Across this sample, 29% of the words are represented in the pre-primer, primer, or first grade Dolch lists (Dolch, 1948). In three other selected samples, these early Dolch words represented 61% of 187 words used, 58% of 123 words used, and 53% of 133 words used. A review of these selected samples shows that students often selected words that were simple in structure, would typically be spelled accurately by much younger children with typically hearing, and lacked diversity.

It should be noted that analyzing writing samples alone posed limitations. By using written samples alone, only words chosen by the students were available for analysis. Although the use of written narrative samples provides an authentic representation of each child's writing, future studies might combine the use of writing samples with a set of spelling words designed to elicit specific targets as a potentially more sensitive measure of determining what, if any, changes in spelling occur.

As a result of participating in SIWI, a year-long writing intervention, important gains were made in written language skills (see Author et al., 2012); however, the writing intervention did not specifically target spelling. There was a significant increase in the total number of different words that students used in their writing samples, a jump from 55 different words at pre-intervention to 72 at post-intervention. While number of words produced by students in their writing significantly increased, only limited spelling improvements as evidenced by written narrative samples were noted. It is possible that different results may have been obtained if spelling lists designed to elicit different types of spelling output (e.g., words with specific orthographic patterns or including mental graphemic representations) were used. However, the absence of significant changes in the types of spelling errors across the year suggest that spelling

instruction through incidental rather than direct teaching is not adequate to significantly improve spelling skills.

In conclusion, there is no question that spelling is an educational issue that needs to be addressed in order to achieve success in writing. To improve spelling, educators must consider the types of errors that children make and create instructional programs designed to target their deficit areas, which are empirically different from the needs of hearing students (Kyle & Harris, 2006). The results of this study indicate that in order to improve the spelling skills of children who are d/hh, spelling should be targeted using a wide variety of examples as part of a sequenced curriculum. Allman (2002) noted that d/hh students use visual cues such as known spelling patterns, lipreading and sign cues when attempting to spell words. Indeed, Alamargot and his colleagues (2007) have suggested the use of signing words before a student attempts to write the word and translate to English may improve writing and spelling abilities by maximizing the use of visual-spatial processing. The MLC system used in this study might prove beneficial when used in conjunction with a writing intervention. Changing the current MLC system to a flow chart that students can use to assess what types of errors are occurring in their spontaneous writing samples may prove to be a successful intervention, as students begin to understand what types of errors they are producing in their written expression. The integration of a spelling curriculum within the structure provided by SIWI might serve to enhance both the content and form of written language.

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Table 1. *Demographic information for participants.*

N = 29	Mean	SE	min	max
Age (years, months)	13.2	1.1	11.8	14.9
Unaided Hearing	88dB	21dB	21dB	113dB
Aided Hearing	35dB	18dB	17dB	98dB**
SAT-HI Reading Comp	2.7	1.1	1.3	6.1

** 2 students used no amplification

Table 2. *Multi-Linguistic Coding (MLC) system categories, defining characteristics and examples.*

Multi-Linguistic Coding categories	Defining Characteristics and Examples
Phonological Errors (PA)	• **Errors of SOUND** • omission or addition of phonemes not in the word • all letter reversals
Orthographic Pattern Awareness Errors (OPA)	• **Errors of regular PATTERNS** • incorrect consonant substitutions (d/t; n/m; s/tch) • rules for combining letters (“kry” for “cry”; “jrum” for “drum”) • patterns that govern spelling (“ran” for “rain” ; “lader” for “ladder”) • positional constraints on spelling patterns (“ckow” for “cow”)
Mental Graphemic Representation Errors (MGR)	• **Errors of IRREGULARITY** (you just have to memorize the word) • correct “phonetic” spelling of non-phonetic words (“cidy” for “city”) • incorrect vowels preceding –ng, r, l (“reng” for “rang” ; “whil” for “wheel”) • incorrect spelling for repeated attempts (stopd, stopt, stoppd)
Morphological Awareness Errors (MA)	• **Errors of MODIFICATION** (i.e. prefix, suffix, tense change) • incorrect use of morphemes • wrong tense is represented (“walk” for “walked”)
Semantic Awareness Errors (SA)	• **Errors of MEANING** • suffix modification errors represent another word (“fry” for “fried”; “drive” for drivers”) • wrong word used (“dog” for “car”) • split compound word into two separate words
Visual Image Errors (VI)	• **Errors of VISUAL information or ASL influence** • mental image of word based on ASL sign (“vorival” for funeral”) • word reversals ("cake cup" for "cupcake”) • incorrect use of visually similar, different sounding letters (“diat dilke” for “dirt bike”) • capitalization to show emotion (HAPPY, DONE, HAPPENED NEXT) • abbreviations ("B-day" for "birthday", "Wed" for "Wednesday")

Figure 1. Example of visual image error in the form of a picture for target word.

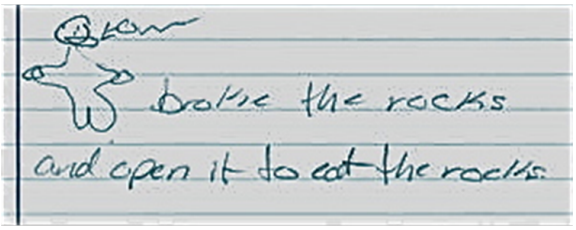

Figure 2. Total number of different words for pre- mid- and post-intervention writing samples.