THE DEVELOPMENT OF SPELLING IN DEAF AND HARD OF HEARING CHILDREN

by

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ABSTRACT

The purpose of the present study was to investigate the development of spelling in deaf and hard of hearing children. 16 deaf and hard of hearing children between the ages of 5 and 11 with a moderate-severe to profound hearing loss, who primarily communicated orally, formed the experimental group. 16 normal hearing children between the ages of 4 and 9 formed the control group. Both groups of children were asked to provide a spontaneous spelling sample as well as to label 20 pictures on a structured word list. In addition, they were asked to participate in 3 metalinguistic awareness tests (2 of which were phonological awareness tests). The metalinguistic measures were included in the study to examine the often reported relationship between spelling and metalinguistic awareness, in deaf and hard of hearing children. The major findings from the present study were that deaf and hard of hearing children make the same types of errors as are seen in the spelling of hearing children, but that their spelling follows a somewhat different developmental pattern. Most of the deaf and hard of hearing children were scored in a later spelling stage of the model, which is dominated by visual-orthographic errors, suggesting that the spelling development of the deaf and hard of hearing children may not fit a model of spelling development designed to describe the spelling development of hearing children (Roper, 1991). In regards to the metalinguistic abilities tested, hearing children outperformed deaf and hard of hearing children in the metalinguistic measures. In both groups there was evidence of a correlation between the 2 abilities.

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CHAPTER 1

INTRODUCTION

The purpose of the present study is to investigate the development of spelling in deaf and hard of hearing children. There has been much research into the development of spelling in hearing children (see Hodges, 1982, for a review) and a major theme in that research is the importance of acoustic information early on in the developmental process. This research raises the question of what happens when that information is severely limited? If children with a hearing loss do not have access to this source of information, or if this source is severely compromised, what does their spelling development look like?

A second large area of research in early literacy in hearing children has focused on the relationship between spelling and metalinguistic awareness. Researchers (Bradley & Bryant, 1983; Lundberg, Frost, & Petersen, 1988) have found that increased metalinguistic awareness skills are correlated with and perhaps cause an increase in spelling ability in children in the early stages of literacy.

In the present study, spelling samples were collected for an analysis of the spelling of hearing and deaf and hard of hearing children. In addition, tests of metalinguistic awareness (including two tests of phonological awareness) were included in the study to add to the small

body of literature regarding these skills in deaf and hard of hearing children. Beyond this, the relationship of metalinguistic awareness and spelling ability in deaf and hard of hearing children was of interest.

To put the present study in perspective, this first chapter will provide a review of the research that has been conducted relating to both spelling and metalinguistic awareness in both hearing and deaf and hard of hearing children. The review will begin with a discussion regarding how the English orthographic system has been viewed over time.

Before continuing, some definitions pertaining to hearing loss must be clarified. The terms 'deaf' and 'hard of hearing' have many definitions, depending on the person who is using them. For example, there is the term denoting a particular cultural group, 'Deaf', and audiologists have used the term, 'deaf', to denote a hearing loss of more than 90 dB, although they now use the functional definition that will be used in the present study. For the present study, the terms will be defined as follows:

> *deaf person*: person whose hearing is disabled to an extent ... that precludes the understanding of speech through the ear alone, with or without the use of a hearing aid.
>
> *hard of hearing person*: person whose hearing is disabled to an extent ... that makes difficult, but does not preclude, the understanding of speech through the ear alone, with or without a hearing aid (Frisina, 1974, as cited in Jamieson, 1994).

The subjects from previous studies that are mentioned in this report will be referred to using the definitions given above, regardless of the terminology used in the originating study.

Developmental spelling review

How the English orthographic system has been viewed

The research on the development of spelling in children comes primarily from the educational literature. Initially, studies focused on the optimal method for spelling instruction, and before methods could be determined, a teacher had to have formed an opinion on the nature of the orthographic system itself--whether or not it is principled. If it is perceived to be a system that is unprincipled, formed by archaic forms of English, then it could be concluded that words must be learned individually with no carryover from one word to the next. If English orthography is thought to be a principled system, then it could be taught with rules or principles which can be applied to words that share common characteristics.

Teaching methods have varied from the strict memorization rules containing six steps provided by Horn (1919, as cited in Hoemann, Andrews, Florian, Hoemann, & Jensema, 1976), which are still espoused by some today (Hillerich, 1977), to the developmentally derived teaching methods proposed by developmental spelling theorists (e.g., Beers & Henderson, 1977; Read, 1971). These proponents believe that the child should be encouraged to write creatively and that the children's invented spellings should not be changed to 'adult' spellings in that exercise. It is believed that children will follow a developmental path to conventional spelling and upon exposure to orthography through reading will mature in their spelling.

Research into optimal teaching strategies has followed two paths. Initially, researchers looked at English orthography for patterns, either on the surface or at a deeper level. In 1971, however, Charles Read shifted the focus to the manner in which the children themselves learn English orthography. The combination of those two areas of study allows for a more comprehensive understanding of the process.

The view that English orthography is unprincipled

English spelling textbooks have existed since Coote's The English School Master, published in England in 1596. Noah Webster (1758-1843), best known for his contribution to the American dictionary, published what would be commonly called the Blue-backed Speller in North America. While this textbook failed in its purpose to "'demolish those odious distinctions of provincial dialects"' (Webster, 1783, cited in Venezky, 1980, p. 13), it was immensely successful as a spelling book, having sold over 100 million copies over its first 100 years.

One of Webster's biggest contributions to the teaching of spelling was his organization of spelling lists. He organized them according to the number of syllables, as was common already, and also according to letter-sound correspondence. While he did see patterns in English orthography enough to organize it by sound-letter correspondence, he believed that it was unprincipled, so much so that he proposed (and effected) many spelling reforms in his dictionaries to rid English of its 'inconsistent' orthographic patterns.

In his spelling book, Webster had not placed an importance on the difficulty or functionality of a word to a child. As such, "rare geographic and Biblical terms" (Venezky, 1980, p. 17) were found on the same lists as common function words.

This was not the case for Horace Mann, who proposed changes in spelling instruction in the mid nineteenth century. Words were grouped according to similarity of orthographic pattern, and rote memorization was proposed as the method for learning to spell. Importantly, he put forth three principles for the selection of words on a spelling list (Mann, 1839, as cited in Venezky, 1980, p. 18):

1. the ease of their use
2. the pleasure they afforded the pupil
3. their potential for promoting progress in orthography, pronunciation and intelligence.

Along with these functional ideas in the selection of word lists, Mann advocated the use of full sentences for the teaching of spelling.

While some changes had occurred in the teaching of spelling since the time of Webster, Joseph Mayer Rice (1857-1934) complained that they did not have scientific foundation (Venezky, 1980). Previously a surgeon, Rice turned to education to minimize the waste and inefficiency that he was witnessing in the management of public education. Rice chose spelling to be the first subject that he would study in the American school systems. His major study of spelling in the schools involved the administration of spelling tests to approximately 13,000 students as well as interviews with their teachers. Rice found that the variable which had the largest effect on the learning of spelling was the teacher's method of instruction. Upon interviewing both the successful and the unsuccessful teachers, Rice provided some recommendations for the successful teaching of spelling. Among his recommendations was the use of drill ("8. Begin drill as early as possible on difficult, small

words", Venezky, 1980, p. 23), but he also acknowledged the importance of functionality and, therefore, gave precedence to learning common words early on.

The idea that English orthography was unprincipled was carried into the twentieth century by researchers such as Ernest Horn and Robert Hillerich. Horn (1957) argued against some spelling books of his day which suggested pronouncing a word carefully before spelling it so that each sound could be spelled out. He believed that sounds in English were represented by too many orthographic patterns for this to be a practical suggestion. To prove this, he chose a list of 10,000 words and, obtaining the pronunciations from various dictionaries, he compiled lists of all of the spellings of English sounds. (Note that some additional sound-letter correspondences may have been erroneously introduced by using many pronunciation sources. A child learning English orthography is generally only subjected to one pronunciation. However, it is possible, as Horn stated, that this would most likely not introduce much error). He found as many as 16 variant spellings for one vowel sound (/u/) and even the spelling of consonants and consonant blends, which tend to be more consistent, were found to vary between different positions in a word. For example, /ʃ/[1] is consistently spelled 'sh' at the beginning of a word, however, in other positions the spelling varies ('action', 'succession', etc.). Another example is the sound /k/, which is predictably spelled using a 'c' or a 'k' in word initial position. However, in word medial and final positions, there are additional possibilities (e.g., 'ck', 'que') that do not follow this pattern.

He stated "the criteria for deciding whether a phonetic generalization is possibly worth teaching are that it should apply to a large number of words and that it should have few exceptions, certainly not hundreds of exceptions" (Horn, 1957, p. 431). His final

comment was that there "seems no escape from the direct teaching of the large number of common words which do not conform in their spelling to any phonetic or orthographic rule" (Horn, p. 432).

Hillerich (1977) used Horn's (1957) study to continue the argument that English orthography must be learned one word at a time. He also cited Hanna, Hanna, Hodges, and Rudorf (1966, as cited in Hillerich) in which a computer was programmed with 203 sound to letter rules and was able to spell 17,000 English words with 49% accuracy. This poor result indicated to him that English orthography could not be learned correctly using sound-letter correspondence rules. Memorization was the only way of efficiently learning it. His own teaching strategies for learning English orthography highlighted the importance of word frequency and percentages. He stated that "a well-selected word list of 2500-3000 words will account for 96 percent of all words anyone will ever write in a lifetime" (Hillerich, p. 302) and that "(I, the, & and) account for 10% of all printed words" (Hillerich, p. 302). Therefore, he reasoned, the high frequency words should be taught first, so that the number of errors made by learners will be kept to a minimum. To account for the words that are not included in the original list of 2500-3000 words, Hillerich suggested the teaching of efficient dictionary use. This includes being able to find a word whose spelling a child is unfamiliar with, by using educated guesses of the potential spellings of a sound.

He offered the study method given in Horn (1919, as cited in Hillerich, 1977) which is a six-step procedure emphasizing looking at the word, hiding it from view, practicing the spelling in your mind and then writing it down. Hillerich does not believe that spelling is a

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[1] Note, English phonemes will be represented in / /. For a transcription key, see Appendix A.

subject as are math and science, but rather that it is "one element of mechanics in written expression" (Hillerich, p. 304).

The view that English orthography is systematic

While Horn was developing his ideas for the benefit of rote memorization, Hanna and his colleagues set out to determine a more effective method for teaching spelling with the belief that English orthography is systematic. Hanna and Moore (1953) proposed that English orthography is phonetically based with non-phonetic characteristics and that by stressing the phonetic regularities of the language, children can develop "spelling power" (Hanna & Moore).

They performed a study similar to that of Horn (1957) in which they attempted to determine the most frequent or 'regular' spellings for each sound (Hanna and Moore, 1953). They then proposed that children should learn these regularities between grapheme and phoneme. Note that the correspondences given were not always one-to-one. For example, they found that the phoneme /i/ is commonly spelled both 'ee' and 'ea'.) They maintained equally that children must be made aware that there are exceptions and that these affect both directions of the correspondence. For example, one letter can represent more than one phoneme ('g' as in 'gate' /g/ and 'rage' /dʒ/) and one phoneme can be represented by more than one letter, or sequence of letters (/f/ as in 'farm' and 'phone'). Hanna and Moore, therefore, believed that teaching spelling principles rather than memorizing word lists was more effective and that "rare spelling variants" will probably be learned "by observation and experience far better than by direct teaching" (Hanna & Moore, p. 337).

A major turning point in the study of English orthography was brought about by Venezky (1967). He proposed that reading and spelling entail more than simple sound-symbol correspondence. A truly literate person incorporates phonological and morphological levels into their reading and spelling. Hodges (1982) looked again at the Hanna et al. (1966, as cited in Hillerich, 1977) study in which their computer program achieved a 49% correct spelling rate with phoneme-grapheme correspondences. He concluded that had they included morphological rules (for affixation and forming compound words), approximately 15,000/17,000 (88%) words would have been correct. "Words, not sound-letter correspondences are the appropriate unit of orthographic analysis" (Hodges, p. 286).

Chomsky and Halle (1968) came out in response to claims that English orthography is unprincipled and continued the line of thinking proposed by Venezky (1967). They put forth that "conventional orthography is...a near optimal system for the lexical representation of English words" (Chomsky & Halle, p. 49). By this they meant that the orthographic system represents the underlying structure of English. People who are familiar with the language, who understand sentences and, therefore, know the surface structure of sentences, can use the given orthographic representation and their knowledge of the surface structure to determine the correct phonemic forms. Because orthography represents the underlying structure, it does not indicate phonetic variation that can be derived by a predictable rule (e.g., the past tense morpheme -ed). In addition, phonetic differences are often disregarded to maintain graphemic similarity between related words (e.g., 'sane' /sen/, 'sanity' /sænItij/; 'a' represents both /e/ and /æ/).

Developmental spelling

With Read's (1971) study, the manner in which the teaching of spelling was approached was changed. The focus shifted from the best way to teach English orthography and its pattern(s) or lack thereof (whether or not it is a principled system) to determining how English orthography is viewed by children and how they sort through it. Read's study found that the spelling of preschool children served as a 'window' into their developing English phonology. From this study, we are able to see the way in which children approach spelling and their development through the learning process.

In his study, Read observed the invented spellings of 20 preschool children over an extended period of time. He concluded that the children's errors systematically represented the children's implicit organization of English sounds, even though they may have looked nothing like English to their parents.

He asked us to begin our analysis of a child's spelling by imagining the plight of preschool children as they learn to spell. They are able to identify a word when it is said orally (they know its pronunciation), their pronunciation of the word most likely approximates that of an adult, and they may have mastered regular phonetic alternations (e.g., the /s/, /z/ phonemic variation for plural -s). In addition, they may know some morpho-syntactic relations between words implicitly, and they probably recognize the letters of the alphabet and know most, if not all of their names.

As they begin the learning process, Read proposed that children may see letter names as an important clue to the mystery of English orthography and spell accordingly (e.g., LAD[2] [lady]). This, however, will only help them to a certain point, as there are no alphabetic options for /θ, ð ʃ, ʒ, g, ŋ & h/. This realization could itself push them to discovering more about the orthographic system and realizing that there must be a more complex organization to the system. Read showed that children, on their own, devise sensible spellings for words based on their knowledge at different times of development. Although Read's initial study did not organize children's spelling in a developmental sequence, he discussed various aspects of English phonology (vowels, affrication, flaps, nasals, syllables and alternations) and how they were represented in children's invented spellings. This had not been done up to that point and it led other researchers to determine a developmental sequence of spelling. The next section will summarize Read's (1971) findings of the phonological representations made by children in English orthography and his conclusions as to their source.

Vowels

According to Read (1971), vowels demonstrate many states in a child's spelling development. Initially, children use letter names to spell front tense vowels (/i, e, aj/) using 'E, A, I' respectively (for example, FET [feet], DA [day] and FIT [fight]). With this system, they then use their knowledge of phonology to devise a spelling scheme for the front lax vowels (/ɪ, ɛ and ɑ/), which have no direct association with a letter name. Children associate tense and lax vowels according to articulatory proximity (/i, ɪ/, /e, ɛ/ and /aj, ɑ/) and then

[2] Note: Upper case letters will be used to represent children's spellings, unless 'case' itself is being examined. At that time, upper and lower case will be used as the child produced them.

assign the letter given to the tense vowel to its corresponding lax vowel (for example, FET [fit], PAT [pet] and PIT [pot]). While these spellings do not make sense to adults, they do make sense when it is determined that the children are relating sounds by place of articulation and ignoring other features, such as tenseness. This means that children at this level are concerned (subconsciously) with the articulatory proximity in their spellings, but do not distinguish between tense and lax vowels. In the examples provided above, no distinction is made between 'feet' and 'fit', whose vowels differ in tenseness. Both vowel phonemes are spelled with an 'e'. This process of organizing sounds according to place while ignoring other features occurs again once children have learned the correct spelling for lax vowels ('I' for /ɪ/ and 'E' for /ɛ/). In trying to maintain the relationship of proximity between high front vowels, they do almost the reverse process and assign the same letter used to spell the lax vowel to its closest tense vowel, which gives SLIP [sleep] and DE [day].

Generally, back vowels /o, u/ are represented by 'o' early on, often with a glide marker 'w' attached (to give /ow/). It has also been noted that children often spell /ʌ/ with an "I", most likely because of the vowel's proximity to the vowels /æ/ and /aj/, which are represented by "I". Similarly, the unstressed vowel /ə/ is initially spelled "E", because of its proximity to the sound /ɪ/ (which is spelled by 'E' initially because it is close to /i/). With the awareness of the correct spelling of front lax vowels, the sound /ə/ is spelled with an 'I' because the child has learned the correct spelling for lax vowels.

Consonants

Progress in consonant representation takes a similar course. Attention to phonetic detail appears throughout the spelling of preschool children and disappears as they realise

that predictable variations are not indicated in English orthography. For example, Read (1971) found that children initially represent orthographically the affrication in words beginning 'tr' /ʧr/ and 'dr' /ʤr/ as 'chr' or 'hr' (because of the letter-name 'h') and 'jr' (for example, CHRAIN, HRAIN [train] and JRAGON [dragon]). However, once they become aware of the predicted phonetic realisation of the grapheme sequences 't' vs. 'tr' and 'd' vs. 'dr' in word-initial position in North American English, they learn to ignore it and produce the conventional spellings. As adults, we must be made aware of the affrication that occurs in words such as 'train' and 'dragon', but preschool children must learn to ignore it because of the predictability of the phonetic realisations of the phoneme /t/ and /d/. Children are also guided by their phonology when representing flaps, nasal sounds and sonorant sounds. When representing flaps /D/, which occur in a predictable context (between two vowels), they represent it by a 'd', GEDACHANS [get a chance]. However, the same word ('get') will be spelled with a 't' when it does not occur between two vowels, GETSOME [get some]. Again, children eventually learn the predictability of this variation and acquire conventional spelling.

Read (1971) found that when they represent nasal sounds, children demonstrate again their implicit phonological knowledge. When nasal sounds are followed by a vowel or when they are in word final position, children tend to represent them accurately. However, when a nasal is followed by a homorganic stop (one that shares the same place of articulation), beginning spellers will tend to omit the nasal because the place of articulation is represented by the stop and the nasality is absorbed by the vowel. Eventually children learn that the nasal must be included in the spelling, as its production is not predictable (e.g., 'stop' and 'stomp' are two separate words). Notice that the issue of *which* nasal is predictable ('m' /m/ occurs

before 'p' /p/ and 'b' /b/, 'n' /ŋ/ occurs before 'k' /k/ and 'g' /g/ and 'n' /n/ occurs elsewhere), but that is a separate issue and will not be discussed in this study.

It was also noticed that children perceive a difference between more sonorant consonants (syllabics /r, l, m and n/) and stops or fricatives. Once they have passed the letter-name stage, they still tend to write syllabic consonants without a vowel, LADR [ladder], because the syllabic phoneme has a vowel quality that stops and fricatives do not. As they mature in their writing, they learn that every syllable must contain a vowel and correctly represent syllables containing syllabic consonants.

Morphological alternations

Finally, Read (1971) found that this process of learning to omit predictable phonemic variation in English orthography is well demonstrated by children's representation of English morphology. The two most common examples of this are the past tense morpheme, orthographically realised as -ed and phonetically realised as /t/, /d/ or /əd/ depending on the phonemic context, and the plural morpheme, orthographically realised as '-s' and phonetically realised as /s/, /z/ or /əz/ depending on the context. Initially, children represent the phonetic contrasts in their spelling (e.g., LAFFT [left], HOGD [hogged] and DOGZ [dogs]). As their spelling matures, they develop an awareness of the rule concerning the phonetic realisation of the morpheme and they learn that orthographically they are represented by '-ed' and '-s' respectively. There may be intermediate steps to the conventional spelling of '-ed' and '-s'. Once they gain an awareness that the spelling is predictable in its variation, some children spell the past tense morpheme with a '-d' before learning the conventional '-ed' pattern.

Stage-model approach

Read's (1971) 'landmark' study on the process of learning English orthography opened the doors to a new direction in the research of the teaching of spelling now referred to as 'developmental spelling'. Researchers began to look upon learning to spell as a process in which children play an active role (Beers, Beers, & Grant, 1977; Beers & Henderson, 1977; Chomsky, 1971; Gentry, 1978; Gentry & Henderson, 1978), much like language development. The developmental spelling perspective proposes that in learning English orthography, the errors that children make are not random (Beers et al. 1977). Children pass through a stage-like progression in which they process input to look for patterns. As they mature, they are able to incorporate more complex information into their spelling. Beers and Henderson were the first to develop a stage model of children's acquisition of spelling. Contrary to the proponents of rote memorization, Beers and Henderson believed that the process of learning to spell involves cognitive maturation, rather than simply the storage of word lists. This implies that early in development, children do not have the proper classification scheme for orthography, but that it develops as they mature cognitively and continue processing written language, eventually becoming conventional. Beers and Henderson drew this idea from two different lines of research. Initially, researchers had looked at surface patterns of English orthography for regularities such as in the Hanna et al. (1966, as cited in Hillerich, 1977) study in which the computer program was developed with sound-symbol correspondence rules. However, the next line of research (Chomsky & Halle, 1968) had found that English orthography represented an underlying structure to which

morphological and phonological rules can be applied. Analogously, Beers and Henderson argued that in the early stages of development, children are guided by the surface level of language and, therefore, make many mistakes which are, however, phonemically accurate. Once they gain the understanding that orthography represents an underlying structure, their spelling becomes more conventional.

Beers and Henderson's (1977) exploratory study analyzed spelling samples from 25 grade one children over a period of six months. Through error analysis, they found spelling sequences for different phonemic elements (tense/lax vowels, nasals, etc.), and essentially expanded on what Read (1971) had found in his study. For example, the spelling of /u/ as in 'fool' was determined to progress through two stages:

1. 'u' substituted for 'oo' PUL [pool]
2. 'uw' substituted for 'oo' KUWL [cool].

(Note that the correct form was not demonstrated in this analysis because the grade one children who were tested did not reach that stage.)

From their analysis of the various elements of English orthography, Beers and Henderson (1977) concluded that within the six months of development that were observed, the children progressed through three distinct 'levels'. While children passed through these sequences at different rates and some children skipped certain steps, the ordering of the steps was found to be constant across the children's spelling samples.

The first level was characterized by a heavy reliance on place of articulation as it relates to letter names. During this level, children assign a letter to lax front vowels, based on

their proximity to tense front vowels that were sounded out by the name of the letter (e.g., /ɛ/ is closest to /e/, so it is spelled with 'A'). Most important at this level is the surface structure of language. Subsequent theorists often refer to this stage as the 'semi-phonetic' stage.

During the second level, children seemto realise that letters are arbitrary symbols, which are assigned to phonemes, rather than representing their letter name. For example, 'A' does not necessarily represent /e/, it can represent other phonemes as well. However, this level is still dominated by the surface structure aspects of language. This stage is often referred to as the 'phonetic' stage.

Spelling errors of the third level indicate that children are beginning to see beyond the surface regularities of English. Beers and Henderson (1977) related the learning of morphophonemic rules in orthography to children's recently acquired learning of morphophonemic rules in oral language. For example, children can only learn to represent past tense by '-ed', rather than by its phonetic realisation (/t/,/d/ or /əd/) in their spelling after they have regularised the syntactic process in their speech (which incidentally requires the reverse process of using the phonetic realisation). It is the increased linguistic and orthographic knowledge base that permits the developing spellers to progress through the different levels of spelling. In addition, at this stage, children learn that semantic relationships can guide correct spelling (e.g., plastic, plasticity) rather than phonology alone being the guiding force. This stage is often referred to as the 'transitional' stage.

Nelson (1989) summed up Beers and Henderson's (1977) stage model well, describing the first stage as being dominated by an alphabetic principle in which children assign one letter to each phoneme. Finding themselves limited by this strategy, children learn to spell phonemes by patterns, some of which overlap, rather than using one letter for one

phoneme. Eventually, they are able to combine their phonologically-based strategy with a meaning-based strategy that allows them access to the 'underlying structure' that is English orthography.

In order to account for the spelling of very young children as well as that of middle grade children, two more stages, the 'pre-communicative' and 'conventional' spelling stages were added subsequently (Henderson, 1985, as cited in Nelson, 1989).

The pre-communicative spelling stage describes the period before children are aware of the correspondence between graphemes and phonemes or morphemes. At this time, they may engage in what is known as 'pretend-spelling'. During this stage, they are aware that writing is a form of communication, but they are unaware of, or do not know, the individual letters or that they represent anything. Often at this stage, children will combine letters with numbers and other symbols.

The other stage that was added is often called the 'conventional' stage. This is the final stage in children's spelling development. Familiar words are correctly spelled and new words are spelled based on analogy to known words, frequently resulting in what Roper (1991) termed 'visual-orthographic' errors. These errors are derived from the confusion between recognized orthographic patterns which can represent the same phoneme (e.g., 'ea' and 'ee' are common orthographic patterns for the phoneme /i/).

Subsequently, some authors (Beers & Beers, 1981; Gentry, 1978) have refined these stages as well as providing further examples of the errors that children produce at each stage. A brief outline of the characteristics of the different stages is given in Table 1.1.

Table 1.1: Characteristics of spelling at the five stages

Stage	Characteristics
1. Precommunicative spelling	Children know the purpose of writing, but they are unaware of any phoneme-grapheme relationship.
2. Semi-phonetic spelling	Children make use of the letter-name strategy.
3. Phonetic spelling	Children recognize that letters are arbitrary symbols and they base their 'invented' spelling on phonemic representation.
4. Transitional spelling	Children's use of a phonetic strategy decreases and they incorporate morphological information into their spelling.
5. Conventional spelling	Familiar words are conventionally spelled, and unfamiliar words are spelled using a 'visual-orthographic' strategy.

Roper (1991), in her study relating metaphonological awareness and spelling, devised a scoring scheme to determine a child's current spelling stage. Twenty-five children aged 5;6 to 8;2 were asked to provide a spelling sample from which errors were analyzed and scored. The scoring scheme is based on results from the developmental spelling literature as outlined

in the stage scheme in Table 1.1. A child's spelling level is determined by noting performance on the following six parameters:

1. sound-symbol correspondence
2. directionality
3. vowel sound representation
4. upper and lower case
5. word segmentation
6. type of spelling strategy, as evidenced by spelling errors:

    invented acoustic-articulatory vs. visual-orthographic strategies

The scoring scheme from this stage-model will be presented in its complete form (as it was in Roper, 1991), in Chapter 3.

Spelling development in deaf and hard of hearing children

The one thing common to all of the theories of spelling development is the reliance of the child on auditory input. It is important to ask what the actual role of auditory input is on a child's spelling development. What happens when children are deprived completely or partially of sound input, as in the case of deaf or hard of hearing children? Is their spelling development affected? If so, what does their spelling development look like? Do these children make the same invented spellings as their hearing peers?

It is understood that when 'listening' to oral language, people with hearing in the normal range make use of additional cues, such as lip reading (visemes[3]), hand gestures and facial expression (Hipskind, 1989). Summerfield and MacLeod (1987) found that lip reading can account for as much as a 22 dB benefit in a noise condition, for subjects with normal hearing. For people who are deaf and hard of hearing children, the amount of information that they need to obtain from these additional cues is proportional to the amount of their hearing loss (Hipskind). Evidence of visemic confusion (e.g., confusing 'p' for 'b' because the two are articulated in the same manner and, therefore, 'look' the same) could be one way of determining what information deaf and hard of hearing children are using in learning to spell. For example, if there is evidence of visemic confusion in their spelling, then it could be concluded that they are making use of lip-read information to spell. Similarly, determining if their phonology impacts their speech or not could provide clues on the type of information that deaf and hard of hearing children are using in learning to spell. For example, if they consistently produce /f/ for /θ/ in their speech, does this translate to 'f' (or 'ph') being written for 'th' in their spelling (for example, FIS being written for [this])? If it does, then it would appear that the children were paying attention to their phonological production (either according to their auditory sense or their tactile sense from their articulation). If 'f' does not replace 'th' in their spelling, then it would be assumed that the children were not paying attention to their phonological production when spelling. The following section will provide a review of research into the spelling of deaf and hard of hearing children.

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[3] A 'viseme' is defined as "the distinguishable visual characteristics of speech sounds. A viseme, therefore, is the visual correlate of a speech sound (phoneme)". (Hipskind, 1989)

Quantitative studies

For close to 80 years, researchers have been looking into the issue of spelling ability in deaf and hard of hearing children. Initially, they looked at the issue quantitatively to determine whether or not deaf and hard of hearing children made more errors than their hearing counterparts. While the general concensus of teachers of deaf and hard of hearing children is that their students' spelling is replete with errors, researchers have found evidence to the contrary. In fact, some researchers (Gates & Chase, 1926, as cited in Dodd, 1980; Hoemann et al., 1976; Templin, 1948, as cited in Hoemann et al.) have found that the spelling of deaf and hard of hearing children from ages 6 to 19 contains fewer errors than that of age-matched hearing children. Gates and Chase reasoned that hearing children were at a disadvantage since English orthography does not have a one-to-one phoneme-grapheme relationship. Therefore, because they hear the phonemes, they will be misled when spelling. When looking at Gates and Chase's reasoning, it must be asked how they propose that deaf and hard of hearing spellers are able to learn English orthography. Given the argument that deaf and hard of hearing children are not 'distracted' by the inconsistent phoneme-grapheme relationship, it could be presumed that Gates and Chase were proposing a visual memory strategy. However, Hanson, Shankweiler, and Fischer (1983) and Dodd demonstrated that deaf children made more errors on non-phonetically spelled words than on phonetically-spelled words. This seems to indicate that deaf and hard of hearing children rely on auditory information to some extent, much like their hearing counterparts, although how much of a reliance exists remains unknown.

Qualitative studies

Up until the early 1980s, research pertaining to the study of spelling in deaf and hard of hearing children presented quantitative results, or results in which errors were reported in terms of the number of omissions, substitutions, transpositions and additions (Dodd, 1980; Hoemann et al., 1976). To study this issue in more depth, researchers in the early 1980s began to compare the spelling of deaf and hard of hearing children with that of hearing children in a more detailed and descriptive manner. Questions were raised as to whether deaf and hard of hearing children use the same strategies as hearing children when learning to spell. In most of these studies, spelling error analyses were used to answer this question. It should be noted that there are two issues discussed in the literature: (a) the type of errors made and more recently, (b) the developmental pattern of these errors. Authors have generally found that deaf and hard of hearing children make the same types of errors as hearing children although perhaps in different relative quantities. However, Johnson, Podak, and Barton (1994), using a stage-model approach argued that the developmental pattern of spelling in deaf and hard of hearing children was similar to that of hearing children.

Ewoldt (1985), using an observation format, found that the spelling of deaf and hard of hearing children showed a semantic relationship which is not seen in the spelling of hearing children. For example, Ewoldt observed some children with a hearing loss write DEC for 'Christmas' and BOOOOOO for 'ghost'. Johnson et al.(1994) reported similar findings. It appears that when deaf and hard of hearing children did not know how to spell a word, they wrote a semantically similar word (e.g., BIRD for 'chirped', POLICE for

'prison'). While this is more of an avoidance strategy than a spelling strategy, it is interesting that it has not been reported in the hearing literature. Does this indicate that deaf and hard of hearing children have difficulty 'inventing' a spelling that they do not know? This could be evidence that they rely less on a phonemic strategy than do hearing children.

In looking at the type of error, Hanson et al. (1983) found that deaf spellers made a larger percentage of non-phonetic errors than their hearing counterparts. However, they also found that deaf spellers were more successful spelling 'transparent' words than words whose orthography was opaque, a pattern found to exist in the spelling of hearing children. Transparent words are ones in which the orthography follows from its pronounciation (e.g., 'zebra'), while the orthography of opaque words seems to be unrelated to its pronounciation (e.g., 'colonel'). This would seem to indicate that compared to hearing children, deaf children show some reliance on auditory information, but do so to a relatively lesser degree than hearing children.

Dodd (1980) analyzed spelling errors of deaf and hearing children and organized them into the following six categories: 'pure phonetic', 'context phonetic', 'transpositions', 'additions and deletions of 1 or 2 letters', 'refusals' and 'other'. Most of the errors made by hearing children fell into the 'pure phonetic' category (46.7%). While the majority of errors by the deaf children were 'refusals' (64.8%), the remaining errors were evenly distributed among the groups. These data must be approached cautiously, because only 35% of them are indicative of spelling strategies. With this caution in mind, it appears that the deaf subjects approached spelling differently, as their errors were spread across categories, whereas almost half of the hearing children's errors were phonetically based.

Johnson et al. (1994) extended our knowledge of the spelling of deaf and hard of hearing children by beginning to develop a stage model of spelling development, much as has been done with hearing children. In their study, they included categories used for classifying the spelling of hearing children, 'prephonemic', 'early phonemic', 'letter name', 'transitional', 'correct', as well as a sixth category, 'other'. Their subjects were divided into two groups, deaf and hard of hearing children ages 6;1 - 8;11 and deaf and hard of hearing children, ages 9- 13;6. Each group's errors were analyzed and it was found that the younger children produced errors equally among all of the different categories, while the older children made fewer prephonemic and phonemic errors. It was argued that this pattern was similar to that shown by hearing children because the relative quantity of phonetically-based errors decreased as the age of the children increased. The 'other' category comprised only 13% and 7% (younger and older groups, respectively) of the total errors. Most of these errors were semantically related words, in place of the target word, so they were not representative of a spelling strategy. This result suggests that the spelling development of deaf and hard of hearing children is similar to that of hearing children. However, no control group was used, preventing the comparison of the proportion of various error types.

Summary

The study of spelling development in deaf and hard of hearing children has progressed from a quantitative study, in which the number of errors that deaf and hard of hearing children made was compared with that of hearing children. Experimental results showed that deaf and hard of hearing made fewer errors than hearing children. This result

was explained by the fact that hearing children were at a disadvantage when learning English orthography because it does not have a one to one phoneme-grapheme relationship and, therefore, auditory information would only confuse them.

Researchers then began to examine the issue qualitatively comparing the types of errors that deaf and hard of hearing children made compared to those made by hearing children. It was found that similar types of errors were produced across groups, although the relative quantities may differ between groups. Johnson et al. (1994) began to look at the spelling of deaf and hard of hearing children at different ages in the beginnings of a 'stage model' approach to the spelling of deaf and hard of hearing children and found a pattern that is similar to that of hearing children, as reported in the literature.

The present study will attempt to continue the research of Johnson et al. (1994) by describing the spelling development of orally trained deaf and hard of hearing children (using the model developed by Roper, 1991) and comparing it to that of hearing children. While the present study is largely exploratory, it is predicted that the deaf and hard of hearing children will perform equally well on aspects of spelling that do not require the processing of auditory information. In the spelling model developed by Roper, these aspects of spelling are encoded by Parameters 2 (directionality), 4 (case) and 5 (word segmentation).

Metalinguistic awareness

In studies of spelling development, the subject of metalinguistic awareness is often discussed as a correlational or causal factor. In the present study, metalinguistic awareness was investigated in both the hearing and deaf and hard of hearing children to determine if the

two groups were similar in their metalinguistic awareness skills in and of themselves, and also in their relationship to spelling. The following section will provide a brief review of the research findings in the area of metalinguistic awareness and early literacy skills in both hearing and deaf and hard of hearing populations.

Metalinguistic awareness in hearing children

Researchers have long been investigating the relationship between metalinguistic awareness and early literacy skills. Metalinguistic awareness is the ability to consciously reflect on the form and function of language. Early examples of metalinguistic awareness are speech repairs ("I want a cracker, I mean a cookie"), rhyming, and word play, such as puns. This area of research is of interest to researchers studying early literacy because of the larger question of the relationship between oral and written language. Many studies have found a positive correlation between metalinguistic awareness and early literacy skills (Bradley & Bryant, 1983; Lundberg et al. 1988). A subset of metalinguistic awareness that is often discussed in the literature is phonological awareness. This ability involves the conscious reflection on the sounds and sound patterns of language. Examples of early phonological awareness are rhyming and playing with sounds in song (e.g., 'the name game' - a song in which a person's name is altered phonologically: "Jane, Jane Bo Bane, banana fana fo fane, mi my mo mane Jane, Jane"). Research has also found a positive correlation between phonological awareness and early literacy skills. As an example, Bradley and Bryant performed a longitudinal study in which a group of children was given phonological awareness training (e.g., identifying the odd member in a group of words [e.g., bun, hat, gun

& sun]). They found that performance on these tasks was significantly correlated with their later reading and spelling ability.

Knowing that a positive correlation exists between phonological awareness and literacy skills is important. However, there are three possible interpretations for such a correlation. It could be that increased levels of phonological awareness (or metalinguistic awareness) cause an increased level of literacy skills, or that increased levels of literacy skills cause an increased level of phonological awareness (or metalinguistic awareness) Another interpretation is that a third variable causes an increased ability in both phonological awareness (or metalinguistic awareness) and literacy skills.

Initial research tended to support the first view, that increased levels of phonological awareness (or metalinguistic awareness) cause an increase in literacy skills (e.g., Ball & Blachman, 1991; Bradley & Bryant, 1983; Castle, Riach, & Nicholson, 1994; Lundberg et al., 1988). In their training study, Bradley and Bryant found that the experimental group who were trained in phonological awareness tasks outperformed the control group in reading and spelling tasks two years later.

One confound in this study is that the children were in school during the study, so it is difficult to separate out the effects of instruction from the association between phonological awareness and reading. Lundberg et al. (1988) were able to avoid this complication because their study (with a similar design) was performed in Denmark where children do not start school until the age of seven. Therefore, their study was performed without the influence of instruction confounding the results. Without the presence of instruction at school, Lundberg et al. still found that the experimental group outperformed the control group in reading and writing tasks eight months later.

As the metaphonological literature grew, researchers began questioning the diversity of tasks that were all being labelled as phonological awareness tasks (McBride-Chang, 1995; Stahl & Murray, 1994; Yopp, 1988). For example, the following tasks[4] have all been used in studies as indices of phonological awareness:

1. sound to word matching (is there a /f/ in 'calf'?)
2. recognition or production of rhyme
3. isolation of a sound (what is the first sound in 'rose'?)
4. phoneme segmentation (what sounds do you hear in 'hot'?)
5. phoneme deletion (what word remains if /t/ is taken out of 'toad'?)
6. phoneme counting
7. phoneme reversal (say /os/ with the first sound last and the last sound first)

Critics noted that these different tasks of varying levels of difficulty were being used with the underlying assumption (stated or not) that they each measured the same construct. Additionally, within each of these tasks, the word lists were not standardized, meaning that, across similar tasks, difficulty could vary because of the words that needed to be manipulated. For example, segmenting the word 'tenth' could well be more difficult than segmenting the word 'zoo'.

In her study, Yopp (1988) chose ten tasks often cited in the literature, that tested auditory discrimination, phoneme blending, phoneme counting, phoneme deletion, phoneme segmentation, rhyming, sound isolation and word matching skills. The predictive validity of

[4] This is part of the list given by Yopp (1988).

the phonemic awareness tests (with respect to reading ability) was measured by a reading task, in which a subject's ability to decode sound to symbol correspondence in non-words (e.g., hof, dok, etc.) was tested. Ninety-six kindergarten children participated in the study, and were given all of the ten phonemic awareness tests and the learning task.

From the collection of test scores, Yopp (1988) determined test difficulty and reliability, and performed a factor analysis to determine what skills were required for phonemic awareness. She found that two factors accounted for close to 70% of the variance and that most of the phonemic awareness tasks in her study involved these two factors. The first factor was represented in five of the phonemic awareness tasks, including all of the phoneme blending, phoneme counting, phoneme segmentation and sound isolation tasks. Three of the tasks loaded heavily on the second factor, including the phoneme deletion tasks and the auditory discrimination task.

Upon investigation, Yopp (1988) concluded that the tasks heavily loaded on the first factor (Factor 1) required only one operation before arriving at a response. For example, when asked to break the word 'dog' into its component sounds, one has to say the word and separate the individual sounds /d-ɑ-g/ (first operation). Tasks which loaded heavily on the second factor (Factor 2) contained an additional step as well as a memory component. For example, when asked to say "spoon" without the /p/, one has to say the word, delete the /p/ sound (first operation), hold the rest of the sounds in memory and combine them to form the new word (second operation) "soon". Based on these findings, Yopp renamed Factors 1 and 2, Simple Phonemic Awareness Factor and Compound Phonemic Awareness Factor, respectively.

Using a regression analysis, Yopp (1988) found that the combination of one test from

each factor type led to a greater prediction of reading and spelling abilities than was possible with one test alone. This added support to her conclusion that two factors comprise phonemic awareness. She further found that the Yopp-Singer test of segmentation (herein referred to as Y-S) had the highest loading on the Simple Phonemic Awareness Factor, and the Rosner phoneme deletion task (herein referred to as Test of Auditory Analysis Skills or TAAS) had the highest loading on the Compound Phonemic Awareness factor. In addition to their sound validity, as demonstrated by the factor and regression analyses, both tests received high reliability scores: α=.95 for the Y-S and α=.78 for the TAAS.

Stahl and Murray (1994) and McBride-Chang (1995) continued to pose questions about the construct of phonological awareness. Both studies looked within the tasks that Yopp (1988) had presented to further sort out task difficulty. For example, within a phoneme segmentation task, the difficulty can vary depending on the number of phonemes in a word, the position of a phoneme and the type of phonemes in a word (e.g., stops, fricatives, sonorants). Both studies found similar results. The number of phonemes in a word was found to affect difficulty, and obstruents were more difficult to segment than liquids or nasals. However, McBride-Chang found that the latter result was only significant when a positional analysis was being considered. As well, medial phonemes were more difficult to manipulate than word initial or word final phonemes.

Once the tasks were sorted for difficulty, Stahl and Murray (1994) investigated the relationship between the different phonological awareness tasks and literacy skills. Their major finding was that some phonological awareness tasks precede literacy while some follow literacy. This result is very important to the study of metalinguistic awareness (or phonological awareness) and early literacy skills, because it underlines the fact that care must

be taken to choose both the right metalinguistic awareness (or phonological awareness) test as well as the appropriate stage in literacy development, in order to arrive at a meaningful result.

Reflecting on research concerning the importance of properly choosing metalinguistic awareness (or phonological awareness) tasks, it seems equally important to consider the measure of the literacy skill in question (in the present case, spelling ability) to get an accurate view of children's spelling. For example, the type of error is instrumental to determining a child's spelling level according to developmental spelling theory. Few studies have studied the correlation between metalinguistic awareness and spelling, using a thoroughly developed spelling measure. For this reason, the results of the studies relating metalinguistic awareness and spelling must be considered with caution since their measures of spelling ability generally focused upon the number of incorrect letters in a word, without taking into consideration the types of errors produced.

Roper (1991) studied the relationship between phonological awareness and spelling in children ages 5-8 using a test of phoneme segmentation and a test of phoneme deletion as the phonological awareness measures. One highlight of her study was her well-developed measure of spelling ability, a five-stage model based on six parameters, which will be discussed further in Chapter 2. The results of her study indicated a positive correlation between phonological awareness and spelling.

Consistent with the research to date, it is expected that there will be a correlation between the metalinguistic awareness scores and the spelling level of the hearing children in the present study. Metalinguistic awareness scores and the relationship between spelling and

metalinguistic awareness in the hearing children were measured in the present study, for the purpose of comparison with the deaf and hard of hearing children.

Metalinguistic awareness in deaf and hard of hearing children

Only a handful of studies have investigated phonological awareness or metalinguistic awareness in people who are deaf and hard of hearing. These studies have investigated this relationship using a variety of tasks with various subpopulations. Comparisons to the development of phonological awareness in hearing children have been made, with the results being mixed. Zorfass (1981) looked at the metalinguistic abilities of deaf children who were users of Signed English. She found that the development of their ability to segment Signed English sentences paralleled that of hearing children's segmentation of oral sentences. Initially the children were unable to segment any part of the sentence. Gradually they were able to segment major constituents of the sentences, but function words were unsegmented. They then progressed to segmenting both the content and function words until the entire sentence was segmented. Gartner, Trehub, and Mackay-Soroka (1993) tested deaf and hard of hearing children's awareness of a word. The subjects were asked questions which examined their concept of a word, such as "why is 'happy' a word?" (Gartner et al., p. 66). The researchers found that the deaf and hard of hearing children performed worse than hearing children. They also found that the degree of hearing loss was not a factor in level of word awareness. However, the bimodally educated deaf and hard of hearing children

performed worse on the task than the orally trained children.

Campbell and Wright (1988) and Hanson and McGarr (1989) both looked at rhyming abilities of congenitally deaf adolescents and adults. Campbell and Wright presented the deaf and hard of hearing and hearing subjects with a pair of written words or pictures and asked whether or not the words that were represented by the written or picture form, rhymed. They found that hearing subjects were significantly better in their rhyming abilities than the deaf subjects. Hanson and McGarr presented deaf college students with 50 words and asked them to produce words that rhymed. Approximately 50% of the words produced were rhyming words. Interestingly, both studies found that the subjects were influenced by orthography (e.g., 'hair/bear' was more likely not to be judged as a rhyming pair while 'fear/dear' was more likely to be judged as a rhyming pair), so much so that when the subjects were presented with only pictures in the Campbell and Wright study, they were still influenced by orthographic congruency. Hanson and McGarr however, found that 30% of the rhyming words that their deaf subjects produced were orthographically dissimilar to the target words, thus demonstrating an ability to rhyme despite the incongruent orthography. Because there was no control group in the Hanson and McGarr study, it is difficult to determine the relative abilities of the deaf subjects beyond the fact that they were able to rhyme and they were able to do so when the orthography was dissimilar.

Miller (1997) found that deaf signers were comparable to hearing children in their ability to judge the similarity of words in which there were both graphemic and phonemic cues. However, when only phonemic cues were presented, the deaf children who signed were significantly poorer at the task. Similar results were obtained for deaf subjects who communicated orally.

In the hearing literature and in clinical practice, metalinguistic awareness is used as one explanatory factor for good or poor spelling ability. Since no studies could be found that related spelling and metalinguistic awareness in deaf and hard of hearing children, the present study was designed to provide initial data on this topic. The results from the deaf and hard of hearing literature suggest that the hearing children in the present study will most likely outperform the deaf and hard of hearing children in the tasks of metalinguistic awareness. It remains to be seen whether or not a correlation will exist between the metalinguistic awareness and spelling ability of the deaf and hard of hearing children.

Summary

Research on the development of spelling has moved from a belief that English orthography is unprincipled, and therefore, must be memorized by a learner (see for example, Hillerich, 1977), to the idea that it is systematic given a native speaker's knowledge of the underlying representation of the oral language (Chomsky & Halle, 1968). The latter view has given rise to what is known as 'developmental spelling', a view that learning orthography is an active process in which children progress through stages of development as they become cognitively 'ready' (see for example, Beers & Henderson, 1977).

Research involving the spelling of deaf and hard of hearing children is just beginning to approach spelling from a developmental perspective (Johnson et al., 1994). Studies initially looked at the spelling of deaf and hard of hearing children quantitatively, finding that deaf and hard of hearing children made fewer errors than hearing children (see for example,

Hoemann et al., 1976). More recently, researchers conducted error analyses and compared the types of errors and the developmental pattern in the spelling of deaf and hard of hearing children to those of hearing children. Generally the studies demonstrated that both groups made the same types of errors, although the relative proportions differed (Dodd, 1980, Hanson et al., 1983). Johnson et al. (1994) found that the developmental pattern evidenced in deaf and hard of hearing children was similar to that of hearing children, as reported in the literature.

Research studying the relationship between metalinguistic awareness and spelling in hearing children has indicated that increased metalinguistic awareness causes an increase in spelling ability through training studies (Lundberg et al., 1988). However, caution must be exercised in the interpretation of these results due to the variability in the levels of different metalinguistic awareness tasks as well as in a general lack of attention to different spelling levels. Stahl and Murray (1994) proposed that some metalinguistic awareness tasks preceded spelling, while others followed, all of which must be determined to fully understand the relationships between spelling and metalinguistic awareness.

In terms of metalinguistic awareness in deaf and hard of hearing children, the results are still preliminary. Few studies have been performed, but they suggest that deaf and hard of hearing children performed more poorly than hearing children (see for example, Campbell & Wright, 1988). No studies discussing the relationship between spelling and metalinguistic awareness in deaf and hard of hearing children were found.

Research Questions

The following questions and hypotheses were investigated in the present study:

1) How does the spelling of the deaf and hard of hearing children compare with that of hearing children?
   a) Is their developmental pattern similar to that of hearing children?
   b) How do the errors produced by deaf and hard of hearing children compare with those of hearing children?
      - For non-acoustic aspects of speech, the deaf and hard of hearing children should perform equally well as the hearing children.
2) What is the relationship between metalinguistic awareness and spelling in deaf and hard of hearing children?
   a) What are the metalinguistic abilities of deaf and hard of hearing children (in comparison with those of hearing children)?
   b) Is there a correlation between metalinguistic awareness and spelling ability in deaf and hard of hearing children?
      - Hearing children will outperform deaf and hard of hearing children in metalinguistic awareness measures.
3) Does a disordered phonology (due to hearing loss) impact spelling directly?

CHAPTER 2

METHOD

Participants

Children were divided into two groups. The experimental group consisted of 16 prelingually deaf and hard of hearing children between the ages of 5;11 and 11;9. The children had been diagnosed with a bilateral moderate-severe to profound hearing loss (without amplification), and had been trained in an oral classroom in English. Fifteen of these children were selected from segregated oral classrooms in public schools from the Vancouver area and Victoria. The remaining deaf and hard of hearing child was in an integrated classroom in Vancouver. This particular population was chosen, because for them, English is the primary language of communication and not simply a written language, as it would be for deaf people whose primary mode of communication was a manual language. This means that orally trained deaf and hard of hearing children are required to convert an oral language to a written form, much like their hearing peers, although this achievement may

occur through different processes.

The control group consisted of 16 hearing children between the ages of 4;8 and 9;2 years old. Six of these children were recruited from a Vancouver public school. One child was recruited through a Vancouver preschool and the parents of the remaining nine children responded to a request for participation in Vancouver and Toronto. It was hoped that the spelling samples within each group would demonstrate the full range of spelling ability, from precommunicative to conventional. The range of ages in which spelling development occurs for hearing children was taken from past research (Roper, 1991). There were no systematic data to support the selection of an age range for the deaf and hard of hearing children, so the extreme ages were estimated to be slightly older than for the hearing children. It is for this reason that the age ranges vary between groups. All of the children were judged to have cognitive and language levels in the normal range, as determined by their classroom or preschool teacher or parent.

Tasks

Each child was presented with one articulation test, three tests of metalinguistic awareness (including two tests of phonological awareness) and one spelling test, and was asked to provide a spelling sample. A Marantz tape recorder with a Realistic PZM microphone was used to record performance on the articulation test as well as the children's reading of their spelling samples.

Motivation for and Creation of tests

Goldman-Fristoe Test of Articulation

The Goldman-Fristoe Test of Articulation (herein referred to as the 'GFTA') is a standardized test that is used to collect a language sample that permits a comprehensive phonological analysis of English. The 'sounds in words' subtest collects words in isolation using a book of pictures that are labelled by the child. The 'sounds in sentences' subtest of the GFTA was not administered.

The 'sounds in words' portion of the GFTA was used to assess the children's phonemic inventory and any phonological processes that occurred or were lacking in their speech. The phonological analysis was performed for all of the children to see if any phonological errors that they produced were represented in their spelling errors. For example, if they substituted /f/ for /θ/ in their speech, did the same substitution exist in their spelling (e.g., "wif" for 'with'), or if they were unable to pronounce consonant clusters, did this translate to a lack of clusters in their spelling?

Metalinguistic Awareness Tests

Sentence test

The first test of metalinguistic awareness that was administered was a test of sentence segmentation (herein referred to as the 'sentence' test). This task looked at a child's ability to count the words in a sentence when it was presented orally, thus requiring an awareness of a

'word' as an independent linguistic unit. There were 12 test sentences comprised of a variety of three- to five-word phrases (e.g., 'I have cousins', 'Susie wants to eat' and 'Allison is a smart person'). This test was created for the present study. (See Appendix B).

Motivation for the Sentence test. There has been very little investigation into the metalinguistic awareness of deaf and hard of hearing children and, therefore, it was difficult to choose appropriate tests. As reviewed in Chapter 1, Miller (1997) found that phonemic awareness was reduced in prelingually deaf students (regardless of the mode of communication) compared to hearing peers. Other researchers (Campbell & Wright, 1988; Hanson & McGarr, 1989) have come to similar conclusions regarding phonemic awareness in deaf children. Still other researchers have looked at the metalinguistic abilities of deaf children, not focusing on phonemic awareness, but rather at other linguistic units, such as words. These studies (Gartner et al., 1993; Zorfass, 1981) have found that at the least, deaf and hard of hearing children do possess an awareness of words as a unit of language.

Because a wide range of results in metalinguistic tasks was desired, the sentence segmentation task was included in this study. It was thought that the younger children would succeed at this task, even if they did not succeed at the two phonological awareness tests, thus ensuring a wider range of metalinguistic awareness scores.

Design of the Sentence test. There were 12 sentences divided into three groups of four sentences each, the first group containing three-word sentences, the second group containing four-word sentences and the third group containing five-word sentences. The sentences were written in the present tense and within each group of sentences, the words

were balanced for number of syllables, in that there was an even number of one- and two-syllable words[1]. The words in the sentences were chosen based on familiarity. The verbs were selected from a list of the 250 most frequent words in the vocabulary of white middle class and white working class children in kindergarten, as listed in Hall, Nagy, and Linn (1984). All but two of the common nouns used in the sentences were also chosen from Hall et al. To help the child understand the task, the demonstration sentences were presented in written form (72-point font) with extra spacing between the words.

Phonological Awareness tests

The first test of phonological awareness that was administered was a modified version of the Yopp-Singer (Yopp, 1988) test of phoneme segmentation (herein referred to as the 'phoneme segmentation' test). This test assesses a child's ability to identify the constituent sounds of a word in the correct order, requiring an awareness of the individual phonemes that constitute words. The task contains 22 test items ranging in difficulty from words containing two phonemes ('zoo' /z-u/) to three-phoneme words that contain a consonant cluster ('three' / θ-r-ij/). The test items contain all of the English phonemes. (See Appendix C)

The second test of phonological awareness was a modified version of the Test of Auditory Analysis Skills (Rosner, 1975), which is a test of phoneme deletion (herein referred to as the 'phoneme deletion' test). This test assesses a child's ability to delete a syllable or sound from a word and produce the resulting word. There are thirteen test items that become increasingly difficult. The first item requires the deletion of 'shine' from 'sunshine' to produce 'sun'; a later item requires the deletion of an initial phoneme, ('(m)eat'); and the

[1] note: there is one three-syllable proper noun in one of the five-word sentences.

most difficult item requires the deletion of a medial phoneme from a consonant cluster, 's(p)oon'. (See Appendix D)

Motivation for the phonological awareness tests. The phoneme segmentation test and the phoneme deletion test in the present study were chosen based on the results of Yopp's (1988) study as well as more recent analyses of the construct of phonological awareness (McBride-Chang, 1995; Stahl & Murray, 1994). Recall from Chapter 1, that the purpose of these studies was to "determine the reliability and validity of tests that have been used to operationalize the concept of phonemic awareness" (Yopp, p. 159). The authors reasoned that different tests were often given to children to measure phonemic awareness without there being any support for the validity or reliability of these tests.

In her study, Yopp (1988) reviewed ten different tasks that had been used in previous research to determine their reliability and predictive validity with respect to reading ability. In addition, she proposed to determine the number of factors involved in phonological awareness, and to propose a combination of tests that would best predict early reading acquisition. She found that two factors (which she named 'Simple phonemic awareness' and 'Compound phonemic awareness') comprised phonological awareness and that these two factors were well represented by the Yopp-Singer test of phoneme segmentation and the Rosner test of phoneme deletion, respectively. Another important factor to consider for the purpose of the present study is the difficulty of the various tests. As the age range in this study spanned five or six years depending on the group, it was important to choose tests that would provide a wide range of scores, so that the children's scores would not bottom out or ceiling out. In the Yopp study, the mean test score of the 96 kindergarten children was 53.5%

for the Y-S and 46.3% for the TAAS. Because the age range for the present study was 4;8-9;2 for hearing children and 5;11-11;9 for deaf and hard of hearing children, these tests seem to be at an appropriate difficulty level.

Stahl & Murray (1994) and McBride-Chang (1995) raised important issues about the influence of linguistic complexity when measuring phonological awareness. Stahl & Murray found that the measures of phonological awareness loaded on a single factor (contrary to the two that Yopp (1988) found) which was more closely related to task difficulty than to specific tasks. Accordingly, they proposed that difficulty level across metaphonological tasks was a better measure of phonological awareness than were specific tasks, as was suggested by Yopp. Based on this idea, both Stahl & Murray and McBride-Chang investigated the variables that affect linguistic difficulty when manipulations are being performed, namely number of phonemes, type of phoneme, position of phoneme and the presence of clusters. They found that all of these variables did in fact, affect difficulty of manipulation. For example, increasing the number of phonemes in a word increases the difficulty of an item, the manipulation of word medial phonemes is more difficult than that of word initial or word final phonemes, manipulation within a consonant cluster is more difficult than that of a single consonant, and obstruents are more difficult to manipulate than are sonorants or nasals.

McBride-Chang (1995) found different results with respect to the factors of phonological awareness. She found three component skills to phonological awareness: IQ, verbal short-term memory (perhaps similar to Yopp's, 1988, compound phonemic factor which has a memory component) and importantly for the present study, speech perception.

In making modifications to the Y-S and the TAAS for the purposes of the current

study, the variables that are thought to affect difficulty (e.g., number of phonemes, word position) were considered as much as possible. In a few cases, the visual representation of a word that was necessary for its presentation to the deaf and hard of hearing children took precedence over the optimal manipulation of linguistic complexity.

Design of the phonological awareness tests. For the two phonological awareness tasks, modifications were made to the original tests, to maximize their presentation to the deaf and hard of hearing children in the present study.

Phoneme segmentation test. The words in the original Y-S were modified in order to provide the deaf and hard of hearing children with visual cues to word meaning, to ensure that the words were correctly understood. The goal of this task was not to evaluate auditory comprehension, but rather to assess the child's phonological awareness when the target word was known. Words such as 'go' had to be replaced because they would have been difficult to lip read and to represent pictorially. The words in the original list from the Y-S were chosen "based upon both word familiarity and feature analysis" (Yopp, 1988). Therefore, as new words were chosen to be represented pictorially, word familiarity, feature analysis and word shape from the original Y-S word-list were considered. (The original word list had accounted for linguistic complexity well, so it was attempted to stay as close as possible to the original word shapes.) Words were only selected if they were found in the vocabularies of white middle class and white working class children, as listed in Hall et al. (1984). The black and white pictures (approximately 5cm x 5cm) that accompanied the word-list were Picture Communication Symbols (PCS) and were created using the Boardmaker program (Mayer-

Johnson Company, 1995). They were then mounted on 3" x 4 1/2" cue cards. To help the child understand the task, the written form of demonstration words, with exaggerated spacing between letters, were presented (72-point font).

Phoneme deletion test. The original version of the TAAS was similarly modified for this study, so that the words could be represented pictorially to facilitate comprehension of the orally presented target word. Replacement words were chosen to provide an appropriate range of linguistic complexity as much as possible. The pictures (approximately 5cm x 5cm) were again created from PCS, using the Boardmaker program (Mayer-Johnson Company, 1995). They were then mounted on 3" x 41/2" cue cards. To help the child understand the task, the words were also presented in written form (72 point font) for the demonstration items.

Spelling Tasks

Picture Description task

The first spelling task (herein referred to as the 'picture description' task) required the children to look at a colour cartoon picture of a beach scene (Amery & Cartwright, 1979) and write about it. This task was chosen to get a spontaneous spelling sample in which the children were minimally constrained in what they wrote. This task was also chosen to increase the size of the spelling sample.

Labelling task

For the second spelling task (herein referred to as the 'labelling' task), the children were presented with 20 pictures of familiar words and were asked to label each one. (See Appendix E for list.) This task was designed to provide a spelling sample that would contain typical developmental errors in spelling across the stages of development (as described in the literature review). The spelling list was presented in picture format rather than by dictation to both groups, to avoid the confound of lip-reading ability. In presenting pictures to the children, there was a greater chance of the children understanding the word.

Spelling errors were judged along six parameters, as developed by Roper (1991):

PAR 1. Sound-symbol correspondence

PAR 2. Directionality

PAR 3. Vowel sound representation

PAR 4. Upper and lower case

PAR 5. Word segmentation

PAR 6. Type of Spelling strategy evidenced by spelling errors:

invented acoustic strategies versus invented visual-orthographic strategies

The words in the spelling list were specifically chosen to induce specific errors from the children. The errors particular to the first 5 parameters can occur in all words (e.g., all words have the potential of being spelled from right to left: PAR 2, or of being spelled without any vowels: PAR 3). Therefore, these parameters could be judged from the entire sample.

However, errors pertinent to Parameters 6 can only occur in certain contexts. Therefore, the words in the spelling list were chosen to elicit phonetic and visual/orthographic strategies (e.g., "soks" for 'socks' and "zeabra" for 'zebra' respectively), as well as the visemic strategies that are predicted to appear in the spelling of the deaf and hard of hearing children (e.g., the substitution of a 'p' for an 'm' because their articulation looks the same). The words were selected so that the word itself (and not necessarily its spelling) would be known to the deaf and hard of hearing children. If the children had not known the word, then testing time would have been the first time that they had been presented with it. This would have created a situation in which lip reading skills would have been required, a confound that could be avoided by using familiar words. To ensure appropriate spelling level and familiarity, a list of words was chosen from Harris and Jacobson (1982). This study sampled eight different sets of Readers for children from ages 4-13. A measure of reading level had to be used as a spelling equivalent of these data was not found. Words belonging to this list were rated according to children's reading levels and not to their knowledge of a word. For example, children may learn a word's concept that is rated at a six-year old reading level as they are taught how to read it. Words were selected from this source at reading levels for ages 4 to 10 years old. The two words at the ten-year old level were 'banana' and 'socks'. This range in ages was desired to ensure a range of spelling difficulty so that the children's results would not ceiling out. To check that the words would be in the vocabularies of the children as young as 4 years old, words from this first list were selected if they existed in the vocabularies of white middle class and white working class children, as presented in Hall et al. (1984). The only exception to this was the word 'computer', which was not in the published vocabularies of the two groups. However, this book was produced in 1984, and it

was assumed that the word 'computer' would now be known to the children in this study. The pictures (approximately 4cm x 4cm) were created using PCS, using the Boardmaker program (Mayer Johnson Company, 1995). They were then placed on three 8 1/2" x 11" blank pages with lines underneath each word for the children to spell the word.

Procedure

Before testing began, the children were advised that they would be doing word games and some writing with the examiner. They were also shown the tape recorder and told that they would be recorded for some of the tasks.

Goldman-Fristoe Test of Articulation

The task was introduced in the following way:

> "I'm going to show you some pictures and I want you to tell me what they are".

All of the pictures in the 'word-in-isolation' portion of the test were presented to each child. Their utterances were recorded on audiotape and an analysis of their phonology was performed at a later time.

Metalinguistic Awareness Tests

The metalinguistic awareness tests were presented in the following order:

1. sentence test
2. phoneme segmentation test
3. phoneme deletion test

This order was chosen so that the first task was the easiest, and children who were unable to do the more difficult tasks would get less discouraged.

Sentence test

The sentences were presented orally, and to ensure that the children understood the task, demonstration items were accompanied by written forms (72 point font) of the sentence. The written form contained exaggerated spacing between words as a cue to make the task more salient. Training with the visual representation of the sentence was provided as needed. To begin the task, the children were given the following instructions:

> "For the next game, I want you to count the number of words that I say. We'll try one together first: John eats hamburgers. How many words did I say?"

Five more demonstration items were provided with the accompanying visual cues, as necessary. Feedback was given to the children during the demonstration phase. If an incorrect answer was given, then the experimenter worked through the answer with the child. The test sentences were presented once a child had answered three demonstration items

correctly, or once all of the demonstration items had been presented. (No visual aids were offered for the test sentences). As this test is not standardized, all of the test items were given.

Phoneme Segmentation test

This task was introduced in the following way:

> "Now we're going to play a different game. I'm going to say a word and I want you to say it back to me. Then, I want you to break the word apart. For example, if I say the word 'two', you will say 'two' and then you will tell me the sounds /t-u/".

This was then followed by seven more demonstration items. Many of the children had difficulty with the task, so training was given for the demonstration items. In such a case, a written version of the words, with spacing between the 'sounds' of the word was provided to the child (in 72 point font). For example, the child would be presented with 's a d', and the examiner would point to the letters as the corresponding sound was said orally. The child would then be asked to repeat the sounds as they were said by the examiner. To avoid any confusion between 'sound' and 'letter', written words were presented for which there is not a one-to-one phoneme-grapheme relationship (e.g., 'n o te', 'th u mb').

The testing phase began once a child had correctly answered three demonstration items, or when all of the demonstration items had been presented. During the testing phase, the written form of a word was not presented, however, the pictorial representation was still presented.

Because the original Yopp-Singer word-list was modified and is itself not standardized, all of the test items were administered.

Phoneme Deletion test

The task proceeded as follows:

> "For the next game, I'm going to say a word and I want you to say it back to me. Then I'm going to ask you to say part of the word. Let's try... say the word 'T-shirt'" (the corresponding picture was shown at the same time and the experimenter waited for a response.) After the child had repeated the word, then the experimenter continued, "Now say it again, but don't say 'T'", and waited for a response.

If the child did not understand or responded incorrectly, then the written form of the word was presented, with the part that is to be omitted, covered up. The written words were used for training the demonstration items until it was clear that the child understood the task, and then demonstration items were presented without the written words. Presentation of the test words began once the child had correctly answered three demonstration items without any assistance, or when all 10 of the demonstration items had been presented. Because the original TAAS word-list was modified and is itself not standardized, all of the test items were administered.

Spelling Tasks

Picture Description task

For the picture description task, the children were asked to write a story about what was going on in the cartoon picture. If they hesitated about writing, they were given suggestions for what they could write about. (The examiner pointed to part of the picture encouraging the child, "Maybe you could write about this".) If they still refused to write about the picture, they were asked to label parts of the picture or to write about their week-end or their last holiday. If the children claimed that they could not spell, then they were encouraged to "pretend" write.

Labelling task

The task was introduced in the following way,

> "Now I'd like you to write down what each of these pictures is."

If the child was unclear about what the picture was, then the word was given orally and the child was asked to repeat it to ensure comprehension. This occurred occasionally and in most cases the child wrote the target word. In the case of the target word 'lady', some children were determined to write 'women' or 'girls', because the picture reminded them of the picture on the washroom door. If a child hesitated to spell because the correct spelling was unknown, then encouragement ("spell it how you think it is spelled") was offered. If the children claimed that they could not spell, they were encouraged to "pretend" write.

At the end of each spelling task, the children were asked to 'read' what was written to clarify any ambiguous spellings for later analysis. This reading was recorded on audiotape using a Marantz tape recorder. In addition, words were written down by the examiner as they were said by the child to ease comprehension from the audiotape, in the case of severely unintelligible speech.

Total testing time ranged from 20 minutes to one hour.

Scoring

Goldman-Fristoe Test of Articulation

A non-linear phonological analysis was performed on each child's data. Any deviant phonological patterns were noted and later used as a check against any unconventional spelling patterns, to determine whether or not a correlation existed between phonology and spelling.

Metalinguistic Awareness Tests

For each of the metalinguistic awareness tasks, an item was scored as correct if a child answered correctly without any assistance. One point was given per correct answer. The raw scores were used in subsequent analyses. From the individual metalinguistic awareness test scores, a composite score (META) was determined from the three tests. (This will be discussed in more detail in Chapter 3.)

Spelling Tasks

In scoring the spelling samples, the basic unit of analysis was the error. Errors were judged to be deviations from the target word. Therefore, the orthographic units[2] of the target word were examined and any different patterns in the child's spelling are labelled as being errors. Once the errors had been identified, they were classified along the six parameters using the descriptive scoring scheme detailed below (taken verbatim from Roper, 1991).

Stage model

STAGE I: Precommunicative Spelling

PAR. 1) No apparent sound-symbol correspondence exists for most or all letters in words.

PAR. 2) Directionality of symbols is absent or inconsistent. Directionality includes that for individual symbol representation, left to right for symbols in words, and top to bottom for words in phrases.

PAR. 3) Vowel sounds are not represented in most syllables.

PAR. 4) Upper and lower case letters are indiscriminately mixed.

PAR. 5) Word segmentation is absent or inconsistent.

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[2] The term 'orthographic unit' is used in the present study to designate a letter or a combination of letters that represents a phoneme in the target word. For example, 'f' and 'ph' are two examples of 'orthographic units' used to represent the phoneme /f/ in English orthography (i.e., 'fly' and 'phone'). 'Fl' is an example of two orthographic units used to represent the two different English phonemes /f/ and /l/.

PAR. 6) No spelling strategies are evident. Symbols (including letters, numbers, and "scribble writing") are randomly strung together.

STAGE II: Semi-Phonetic Spelling

PAR. 1) Sound-symbol correspondence is evident in some 2 or 3 letter combinations, though all surface sounds are not necessarily represented (e.g., OD/old, HAB/happy).

PAR. 2) Left to right directionality is established: letter reversals do not occur, and letters in words and words in sentences progress from left to right.

PAR. 3) No changes: omission of vowel sound representation in most syllables continues.

PAR. 4) No changes: upper and lower case letters continue to be mixed.

PAR. 5) Word segmentation emerges, either correctly by spacing, or incorrectly by punctuation.

PAR. 6) "Invented" spelling strategies become evident: systematic representation of speech sounds according to articulatory and/or acoustic properties.

i) Both vowels and consonants are represented by a letter-name strategy. Children spell by the phonemic feature that is emphasized in the name of the letter.

a) long vowels are misrepresented by matching the letter-name to the sound (e.g., BOT/boat, FEL/feel)

b) short vowels are misrepresented by the letter-name that sounds the closest to pronunciation (e.g., BAD/bed, FES/fish)

c) consonants are misrepresented according to the sound of the letter-name (e.g., NHR/nature, LEFT/elephant)

ii) Nasals before same place-of-articulation consonants are omitted (e.g., PLAT/plant, AGRE/angry)

iii) R, L, M, N are used to represent syllables (e.g., TIGR/tiger, WAGN/wagon)

iv) Both /s/ and /z/ are represented by S

v) TR and DR consonant clusters are represented by CHR and JR respectively (e.g., CHRIE/try, JRGIN/dragon)

vi) -ING verb endings are represented by either IG or EG (e.g., FEHEG/fishing, SOWEMEG/swimming)

vii) Past tense -ED endings are represented by either D or T (e.g., WAKD/walked, HALPT/helped)

viii) Consonants may be spelled in accordance with developmental articulation errors (e.g., WEF/with)

STAGE III: Phonetic Spelling

PAR. 1) One to one sound-symbol correspondence (not necessarily by correct letters) is evident in most words spelled.

PAR. 2) Directionality (including top to bottom for sentences) is established.

PAR. 3) Vowel sounds are represented, either correctly or incorrectly in most syllables.

PAR. 4) Upper and lower case letters are used more consistently, though not necessarily correctly (e.g., upper case at all word beginnings).

PAR. 5) Word segmentation via spacing is established.

PAR. 6) Visual/orthographic strategies for vowels emerges at Stage III, where we see the following kinds of spelling errors:

i) Incorrectly spelled vowel digraph patterns (e.g., YOOS/use, CLAUD/cloud)

ii) Short vowel substitution by using the letter which typically represents the sound, rather than by using the letter-name strategy (e.g., SAM/some, LANDID/landed).

Reduction of invented articulatory/acoustic strategies is evident as new visual/orthographic strategies for spelling emerge, but strategies noted in Parameter 6, Stage II continue to be used.

STAGE IV: Transitional Spelling

PAR. 1) One to one sound-symbol correspondence is evident for all words spelled. Words are not necessarily conventionally spelled.

PAR. 2) No further change possible.

PAR. 3) Vowel sounds are represented, typically correctly, in all syllables.

PAR. 4) No changes: upper and lower case letters continue to be used more consistently, though not necessarily correctly.

PAR. 5) No further change possible.

PAR. 6) Visual/orthographic strategies rather than invented articulatory/acoustic strategies are evident in most spelling errors. The letter-name strategy is absent. New visual/orthographic strategies include:

i) Overgeneralization of punctuation (e.g., CONE'S/cones, ROBOT'S/robots)

ii) Overgeneralization of word segmentation (e.g., LIFT IT/lifted, A GO/ago)

iii) Surface sounds represented by commonly occurring English letter sequences (e.g., SPASHUTUL/space shuttle, PICHER/picture)

iv) E-marker incorrectly used (e.g., CLIME/climb, PUTE/put)

v) E-marker omitted in otherwise correctly spelled words (e.g., THER/there, WHER/where)

vi) Reversal of commonly occurring English letter sequences (e.g., OPNE/open, TIGRE/tiger)

STAGE V: Correct (Conventional) Spelling

PAR. 1) No further change possible.

PAR. 2) No further change possible.

PAR. 3) No further change possible.

PAR. 4) Upper and lower case letters are used correctly.

PAR. 5) No further change possible.

PAR. 6) Visual/orthographic strategies are evident for unfamiliar words. Conventional spelling is evident for familiar words. Invented articulatory/acoustic strategies are not evident.

By Stage V, all parameters except Parameter 6 are established. Whereas Parameters 1 through 5 represent the conventions of English orthography, Parameter 6 instead refer to the spelling strategies evidenced by spelling errors. Unlike the other parameters, we cannot argue that Parameter 6 is mastered at any given stage. The use of strategies to spell unfamiliar words continues into adulthood. (Roper, 1991)

As errors were put into Parameter 6, it had to be decided if they indicated the use of an 'acoustic' spelling strategy or a 'visual-orthographic' spelling strategy. Some errors were

classified in more than one category. For example, the "E" in "EgLe" (eagle) was classified as both a Parameter 4 (case) error as well as a Parameter 6 (acoustic spelling strategy) error. Similarly, the missing 'e' in LADR (ladder) was classified as a Parameter 3 (vowel sound representation) error as well as a Parameter 6 (acoustic spelling strategy) error. A majority of the errors could be easily classified into the different parameters; however, there were still a substantial number of errors that were difficult to classify. This group of errors was examined separately to look for patterns within them. Once these errors were grouped according to similar error pattern, it had to be determined for each group as a whole, which parameter and in the case of Parameter 6, which spelling strategy, the error would be classified as. After the errors had been classified, an independent observer (who is a trained Speech-Language Pathologist) scored the errors, and a reliability check was performed. There was 83% agreement between the two scorers in terms of identifying the parameter and, in the case of Parameter 6, identifying the type of strategy. In the case of disagreement between the scorers, the error classification of the first scorer was used for further analysis.

Once the errors had been classified as belonging to the different parameters, a stage value was assigned to each parameter for each child. At this stage in the scoring, there were interpretations of Roper's (1991) scoring scheme that were made for the present study. These interpretations are outlined for each parameter below.

All Parameters

- If a word was written twice, the error was only counted once and the total number of words was decreased by one. The rationale for this was that if a child had written the same error ten times, counting that ten times would not present a realistic view of the

child's error pattern. In the total word count, multiple tokens of the same correctly spelled word were counted each time they occurred.

PAR. 1

- Missing vowels were counted as sound-symbol correspondence errors since they are reflective of a sound-symbol correspondence that is not fully developed .
- Spellings like BNANA [banana] and PAGWEN [penguin], which can explained by Parameter 6 as acoustic errors were also scored as sound-symbol correspondence errors because they represent an incomplete sound-symbol correspondence.
- Additional letters in a child's spellings were not counted as a sound-symbol correspondence error, assuming that all of the surface sounds in the word were already accounted for. The extra letters were most likely due to visual-orthographic interference and were scored as a Parameter 6 error.
- If a child represented only the initial sound of words (e.g., TARPXO [tree] and LRSTO [ladder]) and even then not always correctly, then that child was assigned a Stage I value for this parameter because no sound-symbol correspondence existed for most or all letters in words.

PAR. 2

- If a child could not write sentences (and therefore only produced words in isolation), that child was not assigned a value higher than Stage II because left to right directionality of sentences could not be observed.

PAR. 3

- no additional scoring criteria

PAR. 4

- Inconsistencies in case for the 20-word sample when they occurred at the beginnings of words were not scored as errors because there is no proscriptive rule for such a format. For example, "Lady" and "book" appearing in the same spelling sample were both scored correctly for case. However, an inappropriate use of case in all other word positions for the 20-word sample were counted as Parameter 4 errors. For example, "comPtr" [computer] and "zeBra" [zebra] were each counted as containing a case error.

PAR. 5

- no additional scoring criteria

PAR. 6

- no additional scoring criteria

Determining the modal spelling score

When stage values had been assigned to each parameter, an overall spelling score (herein referred to as the 'modal spelling score') was determined. This score was determined in the following manner. The different stage values of the six parameters were determined. A minimum of two occurrences of a stage value (or a higher one) across the six parameters

was required for a child to be assigned to that value for the modal spelling score. (For example, a child with two Stage III values, one Stage IV value and three Stage II values, would be assigned a Stage III modal spelling score.) Established features were given the value of the stage at which they were established, not necessarily a Stage V value. Continued features were assigned their highest stage value. One adjustment was made to the Roper (1991) scoring scheme. In order for a child to be assigned a modal spelling score of II, it was decided that at least one of Parameters 1, 2, 5 or 6 must have a value of Stage II or higher. This adjustment was necessary because both Parameters 3 and 4 have a continued feature between Stages I and II. This means that both Parameters 3 and 4 are always assigned a minimum Stage II value, which would result in children being automatically assigned a modal spelling score of II, since only two values are required to be assigned to a level. This scoring system would result in no children being assigned a modal spelling score of I.

Summary

Sixteen deaf and hard of hearing children ranging in age from 5;11 to 11;9 formed the experimental group and 16 hearing children, ranging in age from 4;8 to 9;2, formed the control group. The groups were staggered in ages so as to gain a comprehensive view of the developmental spelling pattern in each.

The children were all asked to do a written picture description as well as a labelling task to form the spelling sample. Each child's spelling sample was analyzed using a scoring scheme developed in Roper (1991). A test of articulation was presented to all of the children,

as were three tests of metalinguistic awareness. These tests were used in the analysis stage for within and between group comparisons regarding spelling development and strategy use.

Five research questions were investigated using these tasks as follows:

1) How does the spelling of the deaf and hard of hearing children compare with that of hearing children?

a) Is their spelling development similar to that of hearing children?

- both spelling samples

b) How do the errors produced by deaf and hard of hearing children compare with those of the hearing children?

- both spelling samples

2) What is the relationship between metalinguistic awareness and spelling in deaf and hard of hearing children?

a) What are the metalinguistic abilities of the orally trained deaf and hard of hearing children?

- both spelling samples
- all three metalinguistic tests

b) Is there a correlation between their metalinguistic awareness and their spelling ability?

- both spelling samples
- all three metalinguistic tests

3) Does a disordered phonology (due to hearing loss) impact spelling ability directly?

- both spelling samples
- GFTA phonological sample

CHAPTER 3

RESULTS

The primary goal of this research was to analyze the spelling of deaf and hard of hearing children who communicate orally, to describe its development and to compare it to that of hearing children. To achieve this, we looked at spelling scores as well as metalinguistic scores, since they are often discussed together in regards to spelling development. When performing statistical analyses in the present study, non-parametric tests were chosen in place of parametric tests when ties existed in the data set, the level of measurement was merely ordinal, or the sample size being analyzed was too small. The following chapter is divided into three sections: Spelling analysis, Metalinguistic awareness analysis and Phonological Analysis.

Spelling analysis

Spelling samples were derived from the two tasks that each subject completed, the picture description task and the labelling task. Words from the two tasks were combined for

most of the analyses, but the 20-word sample was examined separately in a count of errors, since it offered a standardized sample across children.

Samples ranged in size from 6 to 95 words (mean 49 words) for the deaf and hard of hearing children and from 5 to 83 words (mean 39 words) for the hearing children. The smaller samples in each group were produced by the beginning spellers. In most cases they were making non-alphabetic symbols or randomly writing letters. It was clear to the examiner in such cases that additional tokens would not have provided additional information regarding their spelling (strategy), so they were permitted to discontinue the spelling portion of the testing. Note that the 'spellings' that they produced were nonetheless important to the subsequent analyses.

Spelling stage distribution

The primary unit of analysis in scoring the spelling samples was the error. Recall from Chapter 2, an error in a child's spelling was judged with respect to the orthographic units[1] in the target word. This method permitted the analysis of incorrect, missing and/or additional orthographic units in a child's spelling. Errors were judged along the six parameters discussed in Chapter 2 and listed below.

PAR 1: Sound-symbol correspondence

PAR 2: Directionality

[1] The term 'orthographic unit' is used in the present study to designate a letter or a combination of letters that represents a phoneme in the target word.

PAR 3: Vowel sound representation

PAR 4: Case

PAR 5: Word segmentation

PAR 6: Spelling strategy (acoustic vs. visual-orthographic)

Once all of the errors were identified, they were judged according to each of the parameters. The analysis then continued within the parameters for each child. The collection of errors within each parameter was assessed to determine the parameter stage value for that child. The distribution of children's spelling across the six parameters is presented in the following tables (see Tables 3.1 & 3.2) for each group. Asterisks indicate that no further progress is possible in that parameter. A stage value with a ">" indicates a continued feature, which means that a particular ability within a parameter exists at both that stage and the preceding one.

Once the quantitative values were gathered, each parameter was investigated in more depth. This analysis will be presented, beginning with the results of the deaf and hard of hearing children and then proceeding to those of the hearing children.

Deaf and hard of hearing children

One very important fact that must be considered when interpreting the results of the deaf and hard of hearing children is that their ages were not evenly distributed between 5;11 and 11;9. Unfortunately, there were no children in this group between the ages of 6;4 and 8;9. This imposed some limitation on the possible interpretations of the data.

Table 3.1: Distribution of children within the six parameters for the deaf and hard of hearing children

	Stage levels				
Parameter	I	II	III	IV	V
1	3	0	10	3	*
2	4	0	12	*	*
3		>3	4	9	*
4		>3		>5	8
5	1	0	13	*	*
6	2	1	3	8	2

Table 3.2: Distribution of children within the six parameters for the hearing children

	Stage levels				
Parameter	I	II	III	IV	V
1	4	1	9	2	*
2	4	2	10	*	*
3		>4	8	4	*
4		>6		>6	4
5	1	0	10	*	*
6	3	2	5	4	2

Parameter 1: Sound-symbol correspondence. The results indicate that the majority of the children demonstrated a one to one sound-symbol correspondence (although not necessarily the correct one) in most words spelled (Stage III). A few children correctly or incorrectly produced a one to one sound-symbol correspondence in all words (Stage IV), while a few children were unable to represent a sound-symbol correspondence in almost all words (Stage I). The spellings within this stage consisted mainly of drawings, symbols or randomly chosen letters with initial sounds being occasionally represented (see Figures 1 [i, ii, iii & iv][2]).

Parameter 2: Directionality. The results indicate that most of the children had established directionality in their spelling (Stage III), both letter and sentence directionality being established. Directionality of letters was incorrect for the beginning spellers, who produced a large percentage of letter reversals, including some upside-down letters: see Figure 1v (Stage I).

Parameter 3: Vowel sound representation. The results indicate that the majority of children represented vowel sounds (correctly or incorrectly) in most or all words produced (Stage III and Stage IV respectively). Once again, the beginning spellers, who randomly selected letters did not represent vowel sounds in syllables (Stage I-II).

[2] The actual spellings of the children are presented in Figure 1. Where possible the spelling was presented in text with case preserved as well.

Parameter 4: Case. The results indicate that half of the children demonstrated proper use of case (Stage V). Some of the children used case consistently, although not correctly (Stage III-IV). Most children in this category demonstrated proper use of upper case for proper nouns and the beginning of sentences; however, they also produced a few upper case letters where they were unwarranted. Again, the beginning spellers used case indiscriminately (Stage I-II) demonstrating that they had not learned the conventions of English orthography (e.g., "waSTO" [water] and "kCHehih" [computer]: see Figures 1vi, vii).

Parameter 5: Word segmentation. The results indicate that almost all of the children had mastered the conventions or word segmentation in English orthography (Stage III). One subject (Stage I) produced JQJXLHO! (see Figure 1viii) to represent a very long sentence, thus demonstrating an absence of word segmentation in his spelling. Two children could not be scored on this parameter because they did not produce any sentences.

Parameter 6: Spelling strategy. The results indicate that most of the errors produced by the deaf and hard of hearing children demonstrated the use of a visual orthographic strategy. Ten of the children were in Stages IV and V, which indicates that most errors were of a visual-orthographic nature, and in the case of stage V, no acoustic errors were present. Children in Stage 1 produced errors that suggested that neither an acoustic nor a visual-orthographic strategy was being used. The remaining children produced errors that were primarily acoustic with a few visual-orthographic errors (Stage III) and one subject produced only acoustic errors (Stage II). Notice that across the parameters more children were scored

at the higher stages. This distribution is most likely the result of there being fewer younger children in this sample.

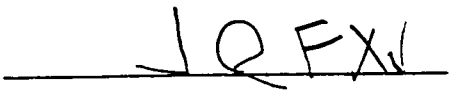
Hearing children

The age distribution within this group of children was quite even and this resulted in an even distribution of stage levels within the parameters.

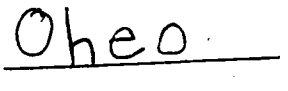
Parameter 1: Sound-symbol correspondence. The results indicate that the majority of children demonstrated a one to one sound-symbol correspondence in most or all words spelled, although the sound-symbol correspondence was not necessarily correct (Stage III and Stage IV respectively). One subject demonstrated sound-symbol correspondence in combinations of 2-3 letters (Stage II) with the correspondence not necessarily being correct (e.g., "MOSR" [monster]: see Figure 1ix). Four of the children demonstrated almost no sound-symbol correspondence in any words. These spellings ranged from non-alphabetic symbols to randomly chosen letters, with a few initial sounds being correctly represented (e.g., LUML! [socks], ∃TU∃T [flag] & sonh [ladder]: see Figures 1x, xi & xii).

Parameter 2: Directionality. The results indicate that the majority of children had mastered directionality of both letters and sentences (Stage III). Two children did not produce letter reversals, although they did confuse left to right directionality and spelled words from right to left (Stage II). Interestingly, one of these children recognized a letter combination from his name, although the target word contained that combination at the beginning of the word, where it was at the end of his name. Well aware of this, he decided

(i) 'bucket'



(ii) 'shoes'



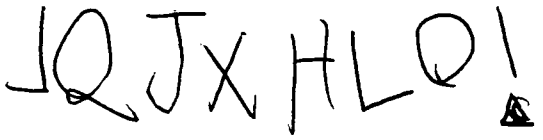
(iii) 'socks'

(iv) 'bathing suit'

(v) 'ladder'

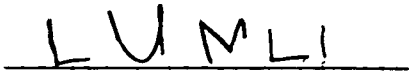
(vi) 'water'

(vii) 'computer'



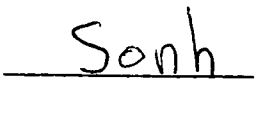
(viii) [long sentence]

(ix) 'monster'

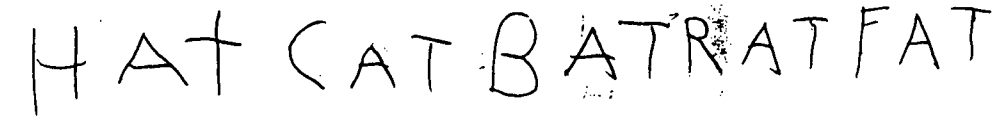


(x) 'socks'

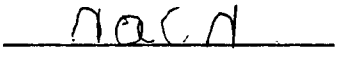
(xi) 'flag'



(xii) 'ladder'



(xiii) 'hat cat bat rat fat'



(xiv) 'ladder'

Figure 1: Examples of children's spellings

that the solution would be to spell the target word backwards (from right to left). The children in Stage I produced many letter reversals and some wrote words form right to left.

Parameter 3: Vowel sound representation. The results indicate that a few children were able to represent vowel sounds where they belonged, although not necessarily correctly (Stage IV). Half of the children represented vowel sounds in most syllables, although not necessarily correctly (Stage III) and the remaining children did not represent vowels in most syllables (Stage I-II).

Parameter 4: Case. The results indicate that four of the children had mastered the proper use of case in English orthography (Stage V). Of the remaining children, half used case indiscriminately (Stage I-II) and the other half were using case consistently, although not necessarily correctly (Stage III-IV). For example, one subject used only lower case, indicating that he was aware of the difference between the two, but that he did not know the proper use of case.

Parameter 5: Word segmentation. The results indicate that most of the children had mastered word segmentation (Stage III). One subject incorrectly segmented words (Stage I) by not leaving spaces between them "HAt CAT BATRATFAT" (see Figure 1xiii) The other children could not be judged for this parameter because they did not combine words.

Parameter 6: Spelling strategy. The results indicate a variety of spelling strategies among this group. A few children produced only visual-orthographic errors, for example "lad*ie*" and "h*ow*se" (Stage V). Four children produced mostly visual-orthographic errors with some acoustic errors (Stage IV), while five children produced the opposite pattern, primarily acoustic errors with a few visual-orthographic errors emerging (Stage III). Two children produced only acoustic errors (Stage II) and the remaining children produced errors that did not seem to be derived from an acoustic or a visual-orthographic strategy (Stage I).

Modal spelling score

Once the stage values within each parameter had been assigned, an overall modal spelling score was determined for each subject (See Table 3.3). Recall from Chapter 2, that a minimum of two stage values had to exist at a level to be assigned that value as the modal spelling score. Established features were given the value of the stage at which they were established, not necessarily a Stage V value. After the modal score had been assigned, established features took on the modal spelling score value. Continued features were assigned their highest stage value. The modal spelling score was one of the primary measures of spelling used for further analyses. Notice the even distribution of hearing children across the parameters and the uneven distribution of deaf and hard of hearing children. This skewed pattern will be discussed further in Chapter 4.

Table 3.3: Distribution of children across Modal spelling score stages

Subject group	Stage I	Stage II	Stage III	Stage IV	Stage V
Deaf and hard of hearing	1	2	0	12	1
Hearing	3	2	4	5	2

Developmental spelling pattern

To address the issue of the developmental spelling pattern in deaf and hard of hearing children, two different sets of analyses were used. The first set investigated whether or not the model developed by Roper (1991) fits the spelling of the deaf and hard of hearing children. It is argued that if the model fits the spelling of hearing children, but not that of deaf and hard of hearing children, then it suggests that the deaf and hard of hearing children have a different developmental spelling pattern. The second set of analyses looked at the age and spelling patterns of the children at Stage IV to see if there were important differences.

Does the model fit the deaf and hard of hearing children?

Throughout the present study, the data from the deaf and hard of hearing children have been analyzed using the model developed by Roper (1991). This model was developed based on the research on developmental spelling in hearing children. Therefore, it is possible that this model is inappropriate for judging the spelling of deaf and hard of hearing children. In particular, it is suspected that the scoring scheme for Parameter 6 might be inappropriate since a relative lack of 'acoustic' errors will earn a child a higher stage level assignment. To examine this issue, two different analyses were performed.

Concordance between the parameters. The first analysis asked if the stage values assigned across parameters were in concordance with each other. Roper (1991) asked this question to verify that her scoring scheme was appropriate in the scoring of spelling of hearing children. She found a significant correlation across the parameters to indicate that her model was appropriate for use in the scoring of hearing children. This analysis was performed in the present study to verify whether or not the model is appropriate for the spelling of deaf and hard of hearing children.

To examine the relationship across parameters, the Kendall coefficient of concordance was determined. This statistic is similar to the Spearman rank order correlation except that it is used for many sets of rankings at once. The results of this analysis indicated a weak concordance between the parameters for the deaf and hard of hearing children (W=.498). However, in support of Roper's (1991) stage model, a strong degree of concordance was found for the hearing children (W=.793). The discrepancy between groups is a further suggestion that the model is inappropriate for scoring the spelling of deaf and hard of hearing children.

Correlation between age and spelling parameters. The second analysis examined the correlation between age and the different facets of spelling ability, as measured by the scoring model developed by Roper (1991). In her study, Roper found that grade level in hearing children was strongly correlated with all of the parameters except Parameter 4 (Case). If this model accurately describes the spelling development of deaf and hard of hearing children,

then it would be expected that similar correlations existed for the deaf and hard of hearing subjects in the present study. The Gamma statistic[3] was used to determine the probability of a correlation because of the ties involved in the parameter variables. The results of the analyses are presented in Tables 3.4 and 3.5. Notice for the hearing children (Table 3.5) that all of the correlations (including Parameter 4) are significant which supports Roper's model. The important result in the deaf and hard of hearing children's data is the lack of suggested correlation between Parameter 6 (spelling strategy) and age. This result is especially striking since most data of this sort tend to be developmental, yet in this case, a developmental sequence does not seem to exist.

Table 3.4: Results of Gamma correlations for deaf and hard of hearing children

Variables	Gamma	p-level
PAR 1 & AGE	.634	**.008**
PAR 2 & AGE	.616	**.009**
PAR 3 & AGE	.759	**.001**
PAR 4 & AGE	.595	**.009**
PAR 5 & AGE	.922	**.001**
PAR 6 & AGE	.195	.369

[3] Gamma is a probability statistic in that it predicts the probability of a correlation existing, rather than indicating the strength of a correlation. This statistic is preferable when numerous ties exist, as they do in the modal spelling score data.

Table 3.5: Results of Gamma correlations for hearing children

Variables	Gamma	p-level
PAR 1 & AGE	.792	**.001**
PAR 2 & AGE	.737	**.000**
PAR 3 & AGE	.714	**.001**
PAR 4 & AGE	.714	**.001**
PAR 5 & AGE	.846	**.000**
PAR 6 & AGE	.798	**.000**

Stage IV children[4]

Ages of Stage IV children. The question of the children's ages at Stage IV was raised, because of a concern that deaf and hard of hearing children are behind their hearing counterparts in spelling development. (See for example, Seyfried & Kricos, 1996.) The question was examined by looking at the age of Stage IV children. This stage was chosen because within the two groups, this stage had the biggest number of children. To perform this analysis, a t-test was used comparing the ages of children at Stage IV for the two groups. The testing yielded a significant group difference[5], T=3.985; df=15; p=**.001** with means of 120.9 months for the deaf and hard of hearing children and 98.6 months for the hearing children. The deaf and hard of hearing children in stage IV were older than hearing children at the same stage. This difference in age could indicate that one group arrived later at Stage

[4] Unless specified otherwise, when children are labelled with a stage number, it is in reference to modal spelling score.

IV and/or that one group stayed longer in that Stage. Because of the small number of children at Stage V (1 child from the deaf and hard of hearing group and 2 hearing children), that median age could not be calculated to aid in the interpretation of these results.

Profiles of Stage IV children. To help with the interpretation of the difference in ages, a qualitative analysis was performed. In this analysis a profile of all of the Stage IV children was drawn up. The profiles (shown in Table 3.6) represent the parameter values that enabled children to be rated at a Stage IV modal spelling level. There are four parameters (1, 3, 4 & 6) that can raise a child to Stage IV (the remaining two parameters are already established at Stage III). It is interesting to note that one half of the deaf and hard of hearing children at Stage IV have at least three of the four possible parameters assigned a Stage IV value. In the hearing group, only one of five children has three parameters at a Stage IV value. Combined with the mean age data, this could be an indication of a qualitative difference between groups in that deaf and hard of hearing children seem to plateau at Stage IV before moving to the next level.

Error types

To address this issue, the results from the qualitative error analysis as well as the following quantitative analyses were considered. The first analysis investigated errors for aspects of orthography that do not involve the processing of phonological input by the

[5] Unless otherwise stated, a level of $p<.05$ was the acceptance criterion for the present study. P-values will be reported and any significant values of p will be highlighted.

speller. The second analysis departed from developmental spelling theory and examined errors quantitatively.

Table 3.6: Profiles of Stage IV children for both groups

Parameters assigned a Stage IV value	Number of children with this profile	
	D/hoh[6]	Hearing
3 &4	3	2
4 & 6	3	2
3,4 & 6	4	1
1, 3, 4 & 6	2	0

Quantity of non-acoustic errors (Parameters 2, 4 & 5)

For another look at the types of errors produced by both groups, errors involving non-acoustically based information were investigated. One hypothesis that was proposed at the beginning of the study was that the two groups would perform similarly with respect to Parameters 2 (Directionality), 4 (Case) and 5 (Word Segmentation). These parameters were singled out because none of them involves the analysis of phonological input by the speller. To answer this question, a two-way ANCOVA was performed with Group as the independent variable, the error percentage in the respective parameters as the dependent variables and Age as the covariate. The error percentage was calculated as the percentage of errors (of the total number of errors) that were PAR 2 (or PAR 4 or PAR 5) type errors. The means, standard

deviations (SD), and ranges for each of the three variables in the two groups are presented in Table 3.7. Notice that the values for Parameter 5 are 0. This occurred because the children were either established in this parameter, or they were beginning spellers, who could be judged as being a Stage I speller for Parameter 5, but their errors could not be scored. For example, a deaf and hard of hearing child wrote JQJXLHO! (see Figure 1viii) to represent a full sentence. In such a case, the total number of errors could not be counted, nor could the errors be subclassified into the different parameters. This meant that this subject could not be included in the Parameter 5 analysis (as well as other analyses that required an error count).

Table 3.7: Mean (SD) and range of the error percentages of PAR 2, PAR 4 & PAR 5

Subject group		%PAR2ERR	%PAR4ERR	%PAR5ERR
D/hoh:	mean (SD)	1.00 (2.57)	13.54 (21.47)	0 (0)
	range	0-8	0-64	0
Hearing:	mean (SD)	1.17 (2.75)	10.82 (11.78)	0 (0)
	range	0-8	0-36	0

Because the values were percentage values, the arcsine of each was calculated and used in the analysis. Group (2) was treated between subjects and Parameter (3) was treated as a repeated measure. We report here those effects involving the Group variable. Results failed to indicate a difference between the two groups, F=.735; df=2,42; p=.401, with respect to the likelihood of errors that did not involve phonological processing and there was no reliable Group x Parameter interaction, F=.109; df=2,42; p=.897. The accompanying

[6] Deaf and hard of hearing

regression analysis, also determined that age was not a good predictor of the error rates in Parameters 2, 4 and 5, F=.493; df=1,20; p=.491.

Quantity of Errors

This issue was examined because of anecdotal remarks made by professionals who work with deaf and hard of hearing children, who assert that deaf and hard of hearing children make many spelling errors. To investigate whether this quantity of errors exceeded that made by hearing children, two different variables for quantity of errors were used. The first variable measured the percentage of words (from the total number of words) that contained at least one error. Since percentages have a non-normal distribution, the arcsine of this variable was calculated for use in the analysis. The second variable was a count of the total number of errors in the standardized list of 20 words. Note that the beginning spellers (3 in the deaf and hard of hearing group and 4 in the hearing group) were not assigned a value, because it was too difficult to count the number of errors when there appeared to be no phoneme-grapheme correspondence in the entire word. For example, how many errors should be counted when "sohn" or "ɲacɲ" (see Figures 1xii, xiv) were produced to signify 'ladder'? Therefore, it must be remembered that this variable excludes results from beginning spellers.

In the first analysis, a one-way ANCOVA was performed with Group (2) as the independent variable, the arcsine of the percentage of words with errors as the dependent variable and Age as the covariate. Results indicated a significant difference, F=10.557; df=1, 29; p=**.003**, between groups, with deaf and hard of hearing children making more errors. (See Table 3.8 for group means adjusted for age.) Essentially similar results were obtained

when the data were adjusted for grade. A correlational analysis was performed between Age and Grade for each group, using the Gamma statistic. In both groups it proved highly probable that there was a correlation between the two (Deaf and hard of hearing group: Gamma: .978, p=**.000**, Hearing group: Gamma: .959, p=**.000**). For this reason, the remaining correlational analyses used only the age variable.

For the second analysis, a one-way ANCOVA was again used, with Group (2) as the independent variable, number of errors in the 20 word sample as the dependent variable, and Age as the covariate. The results of the analysis failed to indicate a significant group difference, F=.543; df=1,22; p=.469. (See Table 3.8 for adjusted means.)

Table 3.8: Group means for quantity of errors, adjusted for age

Group	Percentage of error words	Number of errors in 20 words
Deaf and hard of hearing	70%	11.13
Hearing	30%	8.62

Metalinguistic awareness analysis

The next set of analyses examined the children's metalinguistic abilities as measured by the three tests described in Chapter 3. Based on prior research (as discussed in Chapter 1), it would be expected that the hearing children would perform generally better than the deaf and hard of hearing children on metalinguistic tasks. Zorfass (1981) found that when asked to segment signed English sentences, deaf children who used signed English in a total

communication environment performed as well as hearing children who were asked to segment orally presented sentences. Other researchers however, (Campbell & Wright, 1988; Miller, 1997) found that hearing children performed better on phonological awareness tasks at the word level. Therefore, it might be expected that the deaf and hard of hearing children would perform as well as the hearing children on the sentence task and worse on the two phonological awareness tasks.

Metalinguistic awareness ability

To examine this question, two different analyses were performed. The first analysis examined the test scores of the two groups on the different tasks of metalinguistic awareness. The second analysis compared the results between the two groups.

Tests scores

The mean metalinguistic test scores, the standard deviations (SD) and the range of scores for each group are listed in Table 3.9. The scores from the first three tests are raw scores. These scores were then transformed into percentages and the three percentages were added up and averaged into a final percentage (with each original score getting equal weight in the final percentage). This percentage was named the 'composite metalinguistic score'. Because percentage values have artificially imposed floor and ceiling values, arcsine transforms were again used in the statistical analyses.

Table 3.9: Means (SDs) and ranges of metalinguistic test scores for both groups

Group	Sentence (max. 12)		Phoneme segm[7] (max. 22)		Phoneme deletion (max. 13)		Composite score (max. 100%)	
	mean(SD)	range	mean (SD)	range	mean (SD)	range	mean (SD)	range
D/hoh (N=16)	8.00 (2.88)	0-12	5.59 (5.99)	0-18	8.06 (3.73)	0-13	51.56% (22.10%)	0-79%
Hearing (N=16)	7.81 (4.05)	0-12	8.81 (7.58)	0-21	9.38 (4.22)	1-13	59.13% (29.63%)	8-97%

Comparison between the two groups

In order to compare the metalinguistic scores between groups, a set of one-way ANCOVAs with Group (2) as the independent variable, metalinguistic test score as the dependent variable and Age as the covariate were conducted. Comparisons were tested at α =.01 to achieve an experimentwise α of .04. The results indicated that the hearing children scored significantly higher on all four measures of metalinguistic awareness (Sentence task: F=10.186; df=1, 29; **p=.003,** Phoneme segmentation task: F=12.448; df=1, 29; **p=.001**, Phoneme deletion task: F=22.406; df=1, 29; **p=.000**, Composite score: F=26.477; df=1, 29; **p=.000**). The adjusted means for the three metalinguistic tasks and the Composite score are given in Table 3.10.

[7] Phoneme segmentation

Correlation between metalinguistic awareness and spelling

To address this question, two different measures of spelling ability were used. The first analysis used modal spelling score as the measure of spelling ability. The second analysis, a multiple regression analysis, used percentage of words with errors as the measure of spelling ability. In both analyses, the composite metalinguistic score was used as the measure of metalinguistic ability.

Table 3.10: Group means for metalinguistic measures, adjusted for age

Group	Sentence	Phoneme segm.	Phoneme deletion	Composite score
D/hoh	6.089	2.701	5.801	36.202
Hearing	9.724	11.798	11.637	89.033

To investigate correlations between metalinguistic awareness and spelling ability, the Gamma statistic was used. Gamma was calculated for each group separately. The results indicate that for both groups, it is very probable that a correlation exists between modal spelling score and the composite metalinguistic score (Deaf and hard of hearing group: γ=.925, **p=.001**; Hearing group: γ=.755, **p=.000**).

In the next analysis, a multiple regression was performed to determine the variance accounted for by metalinguistic ability once age was controlled. While the Gamma statistic had indicated that there was a probable correlation between the Composite score and the Modal spelling score, it was clear that Age was a significant factor in that correlation. The multiple regression procedure allows us to determine how strong the correlation between

metalinguistic ability and spelling level is once age has been controlled. The percentage of error words variable was used here as the measure of spelling level, to allow for this parametric analysis. It may be a slight stretch to use a multivariate parametric model with a small data set, but the results of the test will nevertheless be presented. Both groups were combined for the analysis. A summary of the multiple regression statistic is presented in Table 3.11.

Table 3.11: Multiple regression summary statistics

Step	Variable entered	R^2	F	df	p-value
1	Age	.685	65.34	1,30	**.000**
2	Composite score	.813	63.13	2,29	**.000**

The first step of the multiple regression indicated that 69% of the variance for the spelling measure could be accounted for by age. The second step determined that another 12% of the variance could be accounted for by metalinguistic ability. Therefore, 81% of the variance of the spelling measure was accounted for by age and the composite metalinguistic score.

Phonological analysis

The final question to be answered concerned the relationship between phonology and spelling. It was asked whether children's phonology has a direct impact on their spelling, or more specifically, whether their phonological errors translate into spelling errors.

The impact of phonology on spelling was examined qualitatively using the phonological analysis from the data obtained from the 'sounds in words' subtest of the GFTA. Phonological deviations were compared to the child's spelling, to look for correspondences.

Children were excluded from the analysis if their speech was either too intelligible or completely unintelligible. Eleven children in the hearing group were excluded from the analysis because their phonology was conventional. Six deaf and hard of hearing children were excluded from the analysis because their phonology was conventional and two deaf and hard of hearing children were excluded from this analysis because their speech was completely unintelligible. In these cases, words were often untranscribable and only syllable patterns could be discerned.

In the case of the five hearing children who were included in the analysis, their phonologies deviated from the conventional by one phoneme (e.g., /θ/) or class of phonemes (e.g., fricatives). The speech of the eight deaf and hard of hearing children included in this analysis deviated in one or more ways. The most common processes included reduced clusters (e.g., /plej/ → /pej/), stopping (fricatives becoming stops, e.g., /sej/ → /tej/) and missing word final consonants (e.g., /plejt/ → /plej/). Other deviations that occurred were devoicing (a voiced consonant becomes devoiced, e.g., /bowt/ → /powt/) and the distortion or deletion of word medial consonants (/tejbəl/ → /tejəl/).

In the phonological samples, there were many cases of children missing entire classes of sounds (e.g., fricatives or voiced consonants) or word positions (e.g., word final position). However, no children evidenced missing classes of sounds or positions in their spelling. For example, one child from the deaf and hard of hearing group did not produce /s/-clusters in his

speech (e.g., /stov/ → /tov/), but in his spelling, produced SKY. Another child from the deaf and hard of hearing group produced many deviant processes in her speech, but her spelling was quite good and these processes did not occur. For example, /l/ → /n/ occurred in her speech (e.g., /næmp/ 'lamp'), but she correctly represented LADDER and LADY in her spelling sample.

There were only three cases in which it could be argued that an unconventional phonology was represented in a child's spelling. One child from the deaf and hard of hearing group produced voiced stops as voiceless stops ('bath' /bæθ/ → /pæt/) and 'wagon' /wɛgən/ → /wɛkən/) and she produced PEAKUIN [penguin]. This was judged to be a devoicing error in her speech sample. However, she did produce the rest of the voiced consonants in her spelling sample correctly (e.g., ZEBRA and BEACH).

In the hearing children's data, two of the children who substituted /f/ for /θ/ misspelled the word 'three'. One child spelled it TREE, which could be an indication that he did not have the /θ/ sound in his representation, but had seen the word written and remembered a 't' and 'tree' made sense to him. The other child did in fact spell 'three' as FREE indicating that his phonology is most likely affecting his spelling. However, in the rest of his spelling sample, there were no other occurrences of the phoneme /θ/, and /ð/ (a phoneme with the same articulation as /θ/) was correctly represented (THE). Notice that 'the' is such a common word that it has no doubt been memorized.

In summary, the data offered little evidence that nonstandard phonology necessarily leads to additional spelling challenges.

Summary of findings

Spelling analysis

1. The developmental spelling pattern of deaf and hard of hearing children does not fit the model created for hearing children (Roper, 1991).
2. A correlation exists between each of the parameters and Age in the hearing children, and for each of the parameters except for Parameter 6 in the deaf and hard of hearing children.
3. Deaf and hard of hearing children in Stage IV are on average older than the hearing children in that same Stage.
4. The profiles of Stage IV children differ between the two groups; the deaf and hard of hearing children 'amassing' more Stage IV values than the hearing children.
5. Both groups of children made the same types of errors (both acoustic and visual-orthographic errors).
6. Both groups performed similarly with errors that did not require the processing of auditory input.

Metalinguistic awareness analysis

1. The hearing children outperformed the deaf and hard of hearing children on all of the metalinguistic awareness tasks.
2. It is likely that correlations existed between metalinguistic awareness scores and spelling ability in both groups of children, as determined by the Gamma statistic. Further, some of the variance of spelling ability was accounted for by the composite metalinguistic score.

Phonological analysis

1. There is little evidence that a nonstandard phonology necessarily impacts spelling ability directly.

CHAPTER 4

DISCUSSION

The current research project was performed to find answers to the following questions:

1) How does the spelling of deaf and hard of hearing children compare with that of hearing children?
    a) Is their developmental pattern similar to that of hearing children?
    b) How do the errors produced by deaf and hard of hearing children compare with those of hearing children?
2) What is the relationship between metalinguistic awareness and spelling in deaf and hard of hearing children?
    a) What are the metalinguistic abilities of deaf and hard of hearing children (in comparison with those of normal hearing children)?
    b) Is there a correlation between metalinguistic awareness and spelling ability in deaf and hard of hearing children?
3) Does a disordered phonology (due to hearing loss) impact spelling ability directly?

The results from the experiment as they pertain to these questions and their implications will be discussed in this chapter.

1) How does the spelling of deaf and hard of hearing children compare with that of hearing children?

There are two issues to examine within this question. Both the types of errors made and the pattern of development must be analyzed. Johnson et al. (1994) proposed that deaf and hard of hearing children show similar errors as well as similar error patterns to those of hearing children. They found that deaf and hard of hearing children made both what they termed 'phonetic' and visual-orthographic errors and that the relative number of 'phonetic' errors was greater in younger children, a pattern that is seen in hearing children.

The developmental pattern

Whether or not deaf and hard of hearing children make the same spelling errors (and, therefore, the same strategies) at similar times of development (e.g., initially using letter-name strategy and moving to predominantly acoustic errors) is the first question. Unfortunately the results in this study regarding this question were unclear primarily because of the age distribution in the sample. The distribution of children in the hearing group across modal spelling scores was even across the five stages. However, in the deaf and hard of hearing group, 12 of the children were assigned a modal spelling score of IV and the

remaining four deaf and hard of hearing children were assigned to Stages I, II and V. The key to answering the question of the spelling development in deaf and hard of hearing children seems to lie in the interpretation of the numerous deaf and hard of hearing children being assigned to a Stage IV modal spelling score. The profile of a Stage IV child would be one who uses case consistently, although not necessarily correctly (PAR 4) and visual-orthographic errors would predominate over acoustic ones (PAR 6). The remaining spelling parameters would be conventional.

There are two possible interpretations of the uneven modal spelling score assignments. It could be the case that because of the uneven age distribution in the sample, not all spelling levels were represented in the group of deaf and hard of hearing children. In looking at the spelling of hearing children, it is apparent that the 6- and 7-year-old children were primarily using an acoustic strategy and were, therefore, scored at Stages II and III. In the group of deaf and hard of hearing children, there were no children between the ages of 6;4 and 8;9. It is precisely in this 'missing' age range that if acoustic errors were going to predominate in the spelling of deaf and hard of hearing children, they would do so.

The alternative to this hypothesis is that most of the deaf and hard of hearing children were assigned to Stage IV because they are more likely to produce visual-orthographic rather than acoustic errors (Hanson et al., 1983). This tendency would cause them to be automatically rated in Stage IV or V for Parameter 6, because the lower stages are ones in which acoustic strategies predominate. If this were the case, then it could be concluded that the model based on spelling development in hearing children (Roper, 1991) is inappropriate for judging the spelling of deaf and hard of hearing children, because it is not sensitive to the distinguishing parameters in the spelling of deaf and hard of hearing children. Thus, a model

which outlined the spelling of deaf and hard of hearing children would have to be developed. The appropriateness of the Roper (1991) model for the characterization of the spelling of deaf and hard of hearing children will be discussed further.

To provide insight into this unresolved question, it would be helpful to find deaf and hard of hearing children between the ages of 6 and 8 to investigate the type of spelling strategy that predominates and add this information to the information provided in the present study. If these children produced primarily visual-orthographic errors, then it would suggest that the error pattern of deaf and hard of hearing children differed from that of hearing children, because visual-orthographic errors would dominate their spelling, regardless of age. If however, the 6- and 7-year-old deaf and hard of hearing children produced primarily acoustic errors, then it could be concluded that their spelling development was similar to that of hearing children, since as a group they initially produced primarily acoustic errors and later produced mostly visual-orthographic errors.

This raises the interesting point that there were no 6- and 7-year-old children in the deaf and hard of hearing group. All of the deaf and hard of hearing children were recruited through contact with teachers of the deaf and hard of hearing in Victoria and the Vancouver area. None of these teachers were aware of any 6- or 7-year-old children who fit the profile of a child with a moderate-severe to profound hearing loss who communicates primarily using oral language. It is unlikely that this specific subpopulation of children does not exist in Southwestern British Columbia, unless six or seven years ago there developed a trend not to rely on oral communication with deaf and hard of hearing children. Assuming that this subpopulation does exist, what explanation could exist? It could be that their hearing impairment has not yet been identified without the structured scholastic environment of

kindergarten or grade 1 and as such the children are not in classes for deaf and hard of hearing children. One of the two deaf and hard of hearing children under the age of 8;9 in the present study was a younger sibling of another subject. The parents in this case would have been more aware of their child's hearing and would have most likely had their second child's hearing loss identified and had her enrolled in an appropriate educational program at an earlier age than occurs for most children. This hypothesis may not be the true reason however, because in the Vancouver area an audiological screening program exists, which would identify hearing loss in children in kindergarten classes.

The fit of the model

Above it was proposed that if the deaf and hard of hearing children progressed through a different spelling development, then the model developed by Roper (1991) would be inappropriate for judging their spelling. This possibility was further assessed by formally measuring the degree of fit between the model and each of the two groups. It was argued that if the model does not fit the spelling of deaf and hard of hearing children yet it fits that of the hearing children, as it did in Roper (1991), then that is most likely an indication that the spelling of deaf and hard of hearing children is developing in a different fashion than is seen in the hearing children.

To test the fit of the model, two analyses were performed, a Kendall coefficient of concordance across parameters as well as correlations of the individual parameters with age. For the hearing group, a strong degree of concordance was found across parameters, which suggests that the spelling of this group is well modeled by the scoring scheme, a result that is

consistent with that of Roper (1991). In the deaf and hard of hearing group, a weak degree of concordance was found, suggesting that across the six parameters, the deaf and hard of hearing children were not rated at the same stage value. This weak concordance suggests, especially when compared to the hearing group's score, that the spelling of the deaf and hard of hearing children is not well modeled by the scoring scheme. It also indicates a difference in the spelling in the two groups, although the nature of this difference is not revealed.

As a further investigation into this matter, the correlations between each of the parameters and age were calculated, for each group separately. Because the data in this analysis contained tied values, the Gamma statistic, which is appropriate for use with ties, was used. With this measure, correlations are only measured in terms of their likelihood. For the hearing children, correlations were very likely for all parameters. The important result presented itself in the data of the deaf and hard of hearing children. Correlations were very likely for all parameters, except Parameter 6 (spelling strategy). Typically, any developmental data are strongly correlated with age, as is true with all of these correlations for the hearing children. Therefore, the fact that Parameter 6 did not correlate with age in the deaf and hard of hearing children is very interesting. It can be ruled out that the lack of a correlation was due to a lack of distribution of scores, because the Parameter 6 results had a fairly broad distribution. This result is especially interesting because it has been hypothesized in the literature (Dodd, 1980; Hanson et al., 1983) that deaf and hard of hearing children differ from hearing children in the relative use of acoustic versus visual-orthographic errors--precisely the aspect of spelling that is measured by Parameter 6.

Stage IV children

A second analysis in response to the question of whether the spelling development in the two groups is the same, investigated the children who were assigned a modal spelling score of IV. The spelling of these children was analyzed in isolation for two reasons:

1. It is a large sized group of children (deaf and hard of hearing: 12 children, hearing: 5 children) who are at the same spelling level, according to the spelling scheme, which will allow a useful analysis.
2. The unexpectedly large proportion of the deaf and hard of hearing children belonging to this level (12 out of 16 children) raises questions about the homogeneity of this group.

Initially a comparison of the ages of the children was performed. It was determined that the Stage IV deaf and hard of hearing children were significantly older than the Stage IV hearing children (120.9 months compared to 98.6 months). This difference of almost two years (22.3 months) could be explained in three possible ways. Deaf and hard of hearing children could be arriving at Stage IV later than hearing children, deaf and hard of hearing children could be staying longer in this stage, or a combination of the two could be occurring.

To help with the interpretation of the data, profiles of the Stage IV children were prepared. It was determined that Stage IV deaf and hard of hearing children were assigned to Stage IV modal spelling score by having more parameters with a Stage IV value than the hearing children, suggesting a state of plateauing before moving on to Stage V. This 'plateau' pattern is surprising given the fact that there was a weak concordance across the six parameters. With the discovery of a weak concordance, it would have been expected that the

deaf and hard of hearing children would have been assigned stage values of varying levels. (However, it is possible that the weak concordance was a result of the number of ties in the data, which would mean that the conflict was the level of the data, rather than at the conceptual level.) That deaf and hard of hearing children 'amassed' more Stage IV values, coupled with the fact that they were on average older than the hearing children at Stage IV, suggests a qualitatively different progression through the stages.

Error comparison between the two groups

Now that it has been determined that the developmental spelling pattern differed between the two groups, it must be determined how that pattern differed. Various error analyses provided information to answer this issue.

Analysis of error types

The first analysis consisted of a qualitative error analysis. In the present study, it was found that the deaf and hard of hearing children made the same types of errors that have typically been reported in the developmental spelling literature. There was no need to create a separate category of errors, as was done in Johnson et al. (1994). (It must be noted that the errors in their 'other' category consisted of semantically related words, which indicate an avoidance behaviour rather than a spelling strategy.) In fact, out of all 32 children in the present study, only three errors were unclassifiable with the present scoring scheme and were attributed to 'chance' spelling (e.g., NOLS [nose]). Assuming that type of error reveals something about spelling strategy, this result suggests that deaf and hard of hearing children

used the same strategies as hearing children when spelling. However, as determined in the preceding section, the use of these errors at different stages of spelling development may vary.

Analysis of non-acoustic parameters

The second analysis regarding this question investigated whether or not the deaf and hard of hearing children were similar to the hearing children in regard to aspects of spelling that did not require the interpretation of auditory information into written language. This was measured by Parameters 2 (directionality), 4 (case) and 5 (word segmentation). The comparison between groups found no difference in the percentage of errors that belonged to these three parameters. This result is consistent with the hypothesis that deaf and hard of hearing children would be as successful with the non-acoustic aspects of spelling as the hearing children.

Quantitative error analysis

A final error analysis departed from developmental spelling theory and examined the quantity of errors across groups. Two different measures of error quantity were used ('percentage of misspelled words from both spelling tasks' and 'number of errors in the standardized list of 20 words') and different results were obtained. Both analyses were controlled for age. The analysis that used percentage of misspelled words found that the hearing group produced fewer errors and the analysis with the number of errors did not reveal a difference between groups. The primary question is, which measure of error was more

representative of the children's true spelling ability? And how is this difference in results possible?

Assuming that there was an actual difference in ability between the two groups, one reason for the difference in test results could be that the group of words in the standardized list of 20 words was too simple. This would have resulted in a ceiling effect that would not have allowed for differentiation between the two groups. Following this course of logic, the differentiation was observed when the percentage of misspelled words from the total sample was used as the measure of error.

Almost the opposite argument could also be true. Assuming that there was no difference between the groups, a reason for the difference in results of the two analyses could be a risk-taking characteristic of the deaf and hard of hearing children. Within the 20-word list, the children were limited in the spellings they produced, but in the picture description task they could produce what they wanted. This means that some children may have produced 'more difficult' words than others. If as a group, the deaf and hard of hearing children produced 'more difficult' words, then their higher percentage of errors could be explained. This production of 'more difficult' words might have occurred if the deaf and hard of hearing children, who were used to being in experimental situations, were trying impress the examiner.

Summary

The results discussed so far, suggest that deaf and hard of hearing children produce the same types of errors as hearing children. For example, they produce both acoustic and

visual-orthographic errors. However, their development seems to differ from that of hearing children. This was evidenced by the fact that Stage IV deaf and hard of hearing children were both older and had different error profiles than the hearing children. In addition, Parameter 6 scores were not correlated with age for the deaf and hard of hearing children. Taken together, these facts suggest that the developmental sequence is different for the two groups, and hence that the developmental spelling model drawn from observations of hearing children will not capture developmental trends in the deaf and hard of hearing children.

In the only study to date that has studied the spelling of deaf and hard of hearing children using a stage-model approach, Johnson et al. (1994) found that older deaf and hard of hearing children made fewer phonetic errors than younger deaf and hard of hearing children, which they found to be a similar pattern to hearing children. The result from the present study does not necessarily contradict this finding. It could be that there is a decrease in the relative percentage of 'phonetic' errors as deaf and hard of hearing children age, while at the same time, the relative percentage of 'phonetic' errors at both times differs significantly from those of hearing children.

2) What is the relationship between metalinguistic awareness and spelling in deaf and hard of hearing children?

In the present study, metalinguistic awareness was investigated because of the often-cited relationship between metalinguistic awareness and early literacy skills (see for example Bradley & Bryant, 1983). It was thought that however the spelling of deaf and hard of hearing children compared with that of hearing children, it would be interesting to see if the

same correlation between metalinguistic awareness and spelling existed for deaf and hard of hearing children. Taking, for the sake of argument, the results from this study so far, that deaf and hard of hearing children and hearing children follow through a qualitatively different spelling development, what could be expected from metalinguistic awareness results? If it were the case that metalinguistic awareness was also different between the two groups, then it could be imagined that (a) the lower metalinguistic awareness scores were due to a delayed phonological system or (b) the lower metalinguistic awareness scores were due to a phonological system which was qualitatively different from that of hearing children. In either case, deaf and hard of hearing children could still end up with conventional orthography, albeit through a longer development or a different course of development than is seen in hearing children.

If it were the case that metalinguistic awareness was similar across the two groups, then we would be left with the question of why the spelling differed between the two groups. This would be puzzling because the deaf and hard of hearing children would have made conventional metalinguistic judgments, which would suggest similar access to, and representation of linguistic and even phonological information.

Metalinguistic awareness and

The correlation between metalinguistic awareness and spelling

Results from the metalinguistic awareness tests[1] indicated that the hearing children

[1] Recall that the metalinguistic score is a combined score, consisting of one test of metalinguistic awareness and two tests of phonological awareness. This means that phonological awareness made up two-thirds of the score. This must be remembered when considering the role of the different types of metalinguistic awareness in the

were significantly better at the metalinguistic awareness measures than the deaf and hard of hearing children. However, in each group a correlation between metalinguistic awareness and spelling level was very probable. (Note that the interpretation of the correlational analyses involving the deaf and hard of hearing group must be considered with caution, because it has been determined that the model of spelling development is inappropriate for judging the spelling of deaf and hard of hearing children. Therefore, while a correlation is likely, an accurate assessment of the correlation is possible only once appropriate measures of spelling (and metalinguistic awareness) are developed. The interpretation of the results will continue with that in mind.) When the groups were combined and age was factored out, it was determined that metalinguistic awareness accounted for 12% of the variance of spelling ability. These results raise a few questions. Looking first at the between groups difference, the question is raised of why the deaf and hard of hearing children scored poorer on the tests of metalinguistic awareness. Could it simply be due to their hearing loss or could it be due to another factor, such as the deaf and hard of hearing children being given less instruction in metalinguistic analysis? In the present study, casual observation indicated a range in the amount of phonological instruction in the different classrooms. However, to answer the question of whether a lack of instruction in metalinguistic analysis was a cause of poorer spelling ability in deaf and hard of hearing children, a systematic examination would be recommended. Another possibility is, of course, that a combination of the two is occurring. McBride-Chang (1995) proposed that speech perception contributed variance to phonological awareness, which suggests that at the least the children's hearing loss was a causal factor in

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spelling of deaf and hard of hearing children.

the difficulty with phonological awareness tasks.

The results regarding the correlation between metalinguistic awareness and spelling raise the question of the nature of the correlation between the two. The issue is clouded because different tests of metalinguistic awareness and phonological awareness relate to different stages of early literacy skills (Stahl & Murray, 1994). Therefore, the question of which of the metalinguistic awareness tasks would cause the different levels of spelling would have to be thoroughly investigated to find a causal relationship. To provide some information regarding this question, training studies would be useful.

It appears as though the deaf and hard of hearing children differed from hearing children in both their spelling development and their metalinguistic awareness. If a causal relationship does exist between these two abilities in deaf and hard of hearing children, then it could be that lower metalinguistic awareness caused the delayed or different approach to spelling by the deaf and hard of hearing children. Before such a causal relationship is determined, the other two possibilities must be considered: that the different spelling development caused a decrease in performance on metalinguistic tasks or that a third variable (perhaps difficulties with speech perception) caused both.

To conclude this section, the results of the present study indicate that:

a) Hearing children performed better on measures of metalinguistic awareness.
b) There is a correlation between metalinguistic awareness and spelling in deaf and hard of hearing children.

3) Does a disordered phonology (due to hearing loss) impact spelling directly?

This question was raised because of the often severely impaired phonology of deaf and hard of hearing children. When their phonological system produces oral language so distorted that children do not produce fricatives or word-final consonants, it would seem impossible that they could have those sound classes represented in their orthography.

However, the results of the present study indicate that there is no necessary link between phonological ability and spelling. In children whose phonological output was lacking entire classes of sounds or positions (e.g., children who produced no fricatives or no word final consonants), these classes were rarely missing in their orthography (e.g., for these same children, fricatives were represented in their orthography, or their spelled words contained consonants in word-final position).

It remains possible that a link between phonology and orthography exists and that for example, when children substitute /f/ for /θ/, it will be represented in their orthography. Spellers who were observed in the present study may have had enough exposure to written language to counter such errors. Another possibility could be that these children had been receiving speech therapy for precisely these sounds, and although their oral production was incorrect, they had a heightened awareness of the sounds which lead to their being spelled conventionally.

If 6- and 7-year-old deaf and hard of hearing children with a disordered phonology system and very little exposure to written language had taken part in the study, they may have represented their phonologies accurately (and thus produced unconventional spelling), much

as hearing children do in their early spelling attempts, until they learn the conventions of English orthography (Read, 1971). In the present study, beginning spellers were observed in the hearing group and their phonologies were conventional with the exception of two children who substituted /f/ for /θ/. In his spelling, one of these children did produce FREE for 'three', indicating perhaps this link between phonology and spelling. It is important to remark that he did spell /ð/ (a sound produced with the same articulation as /θ/) correctly in 'the'. It could be argued that 'the' is such a common word that he had most likely seen its spelling numerous times, which allowed for its memorization. Therefore, a disordered phonology would not mean that a child will spell unconventionally. In fact, several children were observed to spell conventionally despite their disordered phonology. However, whether or not a disordered phonology has influences early on in spelling development could not be fully answered in this study because of the lack of young deaf and hard of hearing children.

Research Implications

In this section, the methodological limitations of the present study will be presented as well as various implications of the results and future directions that could be studied based on findings in the present study.

The major limitation of the present study is the lack of 6- and 7-year-old deaf and hard of hearing children. A study which incorporates this age group will be able to determine, more precisely, how similar or different the developmental spelling patterns between the two groups are, because a comparison could be made at each stage. It must also be remembered that the present study is not designed to provide a comprehensive stage model

of spelling development in deaf and hard of hearing children. The goal of the present study was to compare the spelling of deaf and hard of hearing children to that of hearing children and to find ways in which the spelling developments differed. In addition, it must be remembered that the present study involved deaf and hard of hearing children whose primary mode of communication was oral language. Therefore, it may not be possible to generalize the results to other subpopulations of children with a hearing loss.

"Acoustic" versus "Phonological"

One issue that was repeatedly raised during the present study was the use of the term "acoustic" when describing the spelling strategy of children. It was found that the deaf and hard of hearing children (whose auditory input was impoverished) produced so-called "acoustic" errors. However, because their auditory input was impoverished, it is likely that they relied on additional cues to the linguistic sound system, such as images of other people's articulation and the tactile sense of their own articulation. Based on this, it might be more appropriate to label these errors "phonological" errors to include these additional sources of information to which the deaf and hard of hearing children have access. It could then be asked whether or not hearing children who have access to these additional sources of information make use of it. Research has found that in everyday situations, hearing people make use of visual cues to supplement speech, such as lip reading (Hipskind, 1989), and so it may be appropriate to propose that the errors could be called "phonological" rather than "acoustic".

Future directions

The present study answered some questions relating to the spelling and metalinguistic awareness of deaf and hard of hearing children, but it also raised many more. Future directions for research involve the following areas:

1) Completion of the developmental pattern of spelling in deaf and hard of hearing children.
2) The development of a model to characterize the spelling of deaf and hard of hearing children.
3) Further investigation into the relationship between metalinguistic awareness and spelling in deaf and hard of hearing children.
4) Further investigation into the relationship between disordered phonology and spelling in deaf and hard of hearing and hearing children.
5) The role of additional phonological cues in the spelling of deaf and hard of hearing and hearing children.
6) Investigation of these different issues in the various subpopulations of deaf and hard of hearing children.

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APPENDIX A
Transcription key

Vowels

Front vowels		Mid vowels	
/i/	'key'	/ə/	'sofa' (unstressed syllables)
/ɪ/	'pit'	/ʌ/	'but'
/e/, /ej/	'day'		
/ɛ/	'pet'		
/æ/	'pat'		
/aj/	'kite'		
Back vowels			
/ɑ/	'top'		
/u/	'food'		
/ʊ/	'put'		
/o/, /ow/	'boat'		

Consonants

Stops	
/p/	'pot'
/t/	'type'
/k/	'kite'
/b/	'boy'
/d/	'dog'
/g/	'game'
/D/	'pretty' (uttered quickly)
Nasals	
/m/	'man'
/n/	'name'
/ŋ/	'sing'
Fricatives	
/f/	'fall'
/θ/	'thing'
/s/	'see'
/ʃ/	'show'
/v/	'van'
/ð/	'this'
/z/	'zoo'
/ʒ/	'garage'
/h/	'hard'
Affricates	
/ʧ/	'church'
/ʤ/	'judge'

APPENDIX B
Sentence test

Demonstration sentences:

John eats hamburgers.	_____ (3)
Roses are red.	_____ (3)
John wants new pants.	_____ (4)
Allison plays soccer.	_____ (3)
Susie likes good books.	_____ (4)
My mom has nice clothes.	_____ (5)

Test Sentences:

Susie wants to eat.	_____ (4)
Allison is a smart person.	_____ (5)
Dave is a boy.	_____ (4)
I have cousins.	_____ (3)
Sarah helps Jane.	_____ (3)
Mike likes to have fun.	_____ (5)
Adam throws very well.	_____ (4)
Michelle has two dogs.	_____ (4)
I want more candy, please.	_____ (5)
Donna is nice.	_____ (3)
Steve comes often.	_____ (3)
Joe plays hockey every winter.	_____ (5)

APPENDIX C
Phoneme segmentation test

Demonstration items:

two	/t-u/	_____	thumb	/th-u-m/	_____
sad	/s-a-d/	_____	desk	/d-E-s-k/	_____
note	/n-ow-t/	_____	bat	/b-a-t/	_____
rice	/r-ay-s/	_____	phone	/f-o-n/	_____

Test:

dog	/d-ɑ-g/	_____	cat	/k-æ-t/	_____
fan	/f-æ-n/	_____	nose	/n-o-z/	_____
shoe	/sh-u/	_____	wave	/w-ey-v/	_____
grey	/g-r-ey /	_____	that	/th-æ-t/	_____
red	/r-E-d/	_____	me	/m-iy/	_____
soap	/s-o-p/	_____	race	/r-ey-s/	_____
lap	/l-æ-p/	_____	three	/th-r-iy/	_____
zoo	/z-u/	_____	in	/I-n/	_____
jaw	/dz-ɑ/	_____	eight	/ey-t/	_____
ice	/ay-s/	_____	boy	/b-oy/	_____
top	/t-ɑ-p/	_____	day	/d-ey/	_____

APPENDIX D
Phoneme deletion test

Demonstration words:

Say 'T-shirt'. Now say it again, but don't say 'T'.	_____ (shirt)
Say 'sweatshirt'. Now say it again, but don't say 'sweat'.	_____ (shirt)
Say 'cowboy'. Now say it again, but don't say 'boy'.	_____ (cow)
Say 'hot dog'. Now say it again, but don't say 'hot'.	_____ (dog)
Say 'candy'. Now say it again, but don't say /dij/.	_____ (can)
Say 'pillow'. Now say it again, but don't say /ow/.	_____ (pill)
Say 'plate'. Now say it again, but don't say /p/.	_____ (late)
Say 'plants'. Now say it again, but don't say /l/.	_____(pants)
Say 'beach'. Now say it again, but don't say /tch/.	_____ (bee)
Say 'game'. Now say it again, but don't say /g/	_____ (aim)

Test words:

Sunshine	'shine'	_____ (sun)
Picnic	'pic'	_____ (nick)
Microwave	'micro'	_____ (wave)
Coat	/k/	_____ (oat)
Meat	/m/	_____ (eat)
Boat	/t/	_____ (bow)
Gate	/g/	_____ (ate)
Sheep	/p/	_____ (she)
Play	/p/	_____ (lay)
Clap	/k/	_____ (lap)
Plane	/p/	_____ (lane)
Spoon	/p/	_____ (soon)
Small	/s/	_____ (mall)

APPENDIX E
Labelling task word-list

Bat
Wave
Banana
Lady
Book
Fish
Penguin
Chair
Ladder
Nose
Monster
Socks
Flashlight
Telephone
Three
Shoes
Computer
Zebra
Top
Lamp