

Spelling in Deaf Children with Cochlear Implants

Implications for Instruction

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The ability to spell words accurately is still important in today's world of spell-checkers and technology-inspired shorthand. An adult's spelling skills are considered important markers of literacy attainment (Figueredo & Varnhagen, 2005; Kreiner, Schnakenberg, Green, Costello, & McClin, 2002; Varnhagen, 2000). For children, spelling is crucial not only for academic progress but also for what it teaches children about their language. School-aged children and adolescents can benefit from explicit spelling instruction so that they can reap the benefits that being a good speller offers: increased reading and writing skills and more positive perceptions by others.

Good spelling skills are important not only for individuals who can hear but also for people who are deaf or hard of hearing. A recent survey of deaf college graduates from the National Technical Institute for the Deaf in the U.S. revealed that 89% were required to write on the job every day (Biser, Rubel, & Toscano, 2007). The employers of these deaf graduates were also surveyed: 93% of the employers reported that good writing skills were necessary for promotion and that poor spelling was one of the most serious problems they saw in their deaf employees.

This chapter aims to describe what we know about spelling in school-aged deaf children, with a focus on those who use cochlear implants and those who use spoken English as their primary method of communication. We concentrate on this group, in part, because cochlear implantation in very young deaf children is increasing in the United States and other countries (Kelly, 2011) due to early identification

of deafness and looser criteria for implantation. We begin by describing the English spelling system and spelling in hearing children and adolescents. We do this, in part, to remind the reader what is expected of hearing children who are often classmates of deaf children with cochlear implants. Next, we review the literature on spelling in deaf children and adolescents with cochlear implants who use spoken English. Finally, we suggest teaching strategies that can be used to improve deaf children's spelling.

THE ENGLISH SPELLING SYSTEM

The spelling system of English, the language that is the focus of this chapter, is often considered irregular, even chaotic. However, the spellings of many words are more principled than they might first appear. Many sounds have more than one possible spelling, but contextual, morphological, historical, and visually related factors often constrain the choice among them (Hayes, Kessler, & Treiman, 2005; Joshi, Treiman, Carreker, & Moats, 2008; Kessler & Treiman, 2003). Children who know about these factors do not have to guess randomly among the possible spellings of a sound. For example, although *ll* is a possible spelling of /l/, and although it often occurs at the ends of words, very few English words have double consonants at the beginnings. This is just one example of how knowledge about how letters are allowed to be arranged in words, or graphotactic constraints, is highly useful. (The exception to the rule about initial double consonants is *llama*. However, it is a Spanish word that has been adopted by English users, highlighting how knowledge about word origins informs spelling.) As an example of how morphological knowledge can aid spelling, children can learn that final /t/ is normally spelled as *ed* when /t/ is a past tense ending, as in *cracked*. The *ed* spelling does not occur when final /t/ is a part of the same unit of meaning (or morpheme) as the preceding sounds, as in *fact*. Thus, graphotactic, morphological, historical, and other information helps users of English to narrow the possibilities for spelling new words and remember the spellings of known words.

SPELLING IN TYPICALLY DEVELOPING HEARING CHILDREN AND ADOLESCENTS

Although the English writing system reflects morphology and other factors to some extent, the system is primarily alphabetic. Thus, it is most critical for beginners to learn about its phonological basis. Children need to learn that writing represents spoken language, and they need to learn to analyze speech at the level of the individual sounds or phonemes: phonemic awareness. Children who can do this, and who know the letters that are used to represent specific sounds, will be able to produce phonologically plausible spellings even for words they have not seen before. These

spellings may be wrong, in that they may not take into account such things as the context of a phoneme or the morphological structure of a word, but they will usually be readable. For example, the phonologically plausible error *scunck* for *skunk* indicates that the child analyzed the word as a sequence of phonemes and knew a plausible spelling for each phoneme. One thing the child did not know, apparently, is that *ck* cannot follow *n*, one of the more subtle graphotactic patterns of English. Difficulties in phonemic awareness can lead to spellings that do not fully represent a word's phonemes, such as *suk* for *skunk*. Such an error communicates less well than *scunck* because the reader might assume that the writer of *suk* intended to spell *suck*.

Hearing children often have some initial difficulties with phonemic awareness, causing them to produce errors like *suk* for *skunk* (Treiman, 1993). However, hearing children normally overcome these difficulties within the first few years of school. During this time, they also learn about the roles of morphology (Treiman & Cassar, 1996) and graphotactics (Cassar & Treiman, 1997; Hayes, Treiman, & Kessler, 2006) in choosing among alternative spellings of phonemes. Even by the age of six years, hearing children pay attention (even if not explicitly) to some of the spelling patterns in English. Becoming a good speller thus requires sensitivity to phonology, morphology, and other properties of English. Rote memorization of letter patterns is not enough for successful spelling.

As the role of language experience and phonology in spelling became better understood, some researchers and educators postulated that children can and should learn to spell through incidental learning and self-discovery (e.g., Goodman, 1967). According to this view, young children learn about spelling through observing words in books as they are being read to and by trying to spell words on their own, often referred to as invented spelling. As children read more and more, they learn many spellings incidentally, as they are exposed to them in reading. However, research suggests that incidental learning and self-discovery are not sufficient. For example, the National Reading Panel, which was created by the U.S. Congress to examine research on the most effective approaches to teaching children how to read, recommended that explicit instruction about the relationships between writing and speech should be included in every reading program (National Institute of Child Health and Human Development, 2000). The research reviewed by the National Reading Panel shows that explicit instruction—that is, direct and systematic explanation of a concept through examples and step-by-step demonstrations—is more effective than the sort of implicit or incidental instruction proposed by advocates of a self-discovery approach. Children learn some spellings incidentally, as they come across them while reading (Cunningham, Perry, Stanovich, & Share, 2002; Share, 1999), but such learning can be slow and incomplete. This happens, in part, because children's attention is not typically on spelling when they are reading for meaning.

Learning to spell, particularly in a complex writing system such as that of English, is not a simple or quick task for children who can hear, a fact that teachers of children who are deaf sometimes overlook. In the next section, we turn to the case of deaf children and adolescents who wear cochlear implants.

CURRENT UNDERSTANDING OF SPELLING IN CHILDREN AND ADOLESCENTS WHO WEAR COCHLEAR IMPLANTS

Children who are deaf and who wear cochlear implants have more auditory access and more opportunity to acquire spoken language and phonemic awareness than profoundly deaf children without cochlear implants. Thus, it is not surprising that children with cochlear implants are better readers than profoundly deaf children who do not wear implants (Vermeulen, van Bon, Schreuder, Knoors, & Snik, 2007). Many children and adolescents with cochlear implants achieve reading levels that are close to those of same-aged hearing peers (Geers, 2003; Geers & Hayes, 2011). Before the advent of cochlear implants, few deaf teenagers reached age-appropriate reading skills (Geers & Moog, 1989). The effect of cochlear implantation on the development of spoken language skills and the resultant literacy skills of deaf children is nothing short of astonishing.

Few studies have examined in detail the spelling of deaf children and adolescents with cochlear implants. The largest and most detailed study to date is that of Hayes, Kessler, and Treiman (2011). These investigators used a picture spelling task to study a group of 39 deaf children with cochlear implants who used spoken English. Children (mean age = 8.97 years) wrote the names of 80 pictured objects. The implant group spelled more poorly than hearing children of the same age (mean accuracy = 55% for deaf, 66% for hearing). However, 74% of the deaf children had accuracy rates within one standard deviation of the mean for the hearing group, indicating that many deaf children with cochlear implants spell about as well as hearing age-mates. When reading ability was held constant, differences between the groups were no longer significant.

Hayes and colleagues (2011) analyzed the children's spelling errors for what they show about the strategies that the children used. If a child makes mostly phonologically plausible errors, or those that are based on how a word sounds (e.g., *fosit* for *faucet*), then the child can be assumed to have the capacity to use a phonological spelling strategy. This is advantageous because the reader will probably be able to understand the child's intent. If the child's errors are unrelated to the sounds in the word (e.g., *rssb* for *dress*), then the child may be guessing or relying on rote memorization of letter patterns. In the study of Hayes and colleagues, hearing children were much more likely than children with implants to make plausible errors. Of the errors made by hearing children, 75% were phonologically plausible, as compared to 44% for the implanted children. Although this latter figure is relatively low, it is higher than the figure of less than 20% that was observed in a previous study of deaf children without cochlear implants (Harris & Moreno, 2004). Thus, although deaf children with cochlear implants do not make as many phonologically plausible errors as hearing age-mates, they make a higher proportion of these "good" errors than expected from previous studies of deaf children without implants. The deaf children with cochlear implants in Hayes et al. (2011) made the same proportion of transposition

errors (e.g., *wrom* for *worm*) as the hearing group (5%). This finding is important because, in previous studies of deaf children without cochlear implants, the proportion of transposition errors was higher in deaf children than hearing children (Aaron, Keetay, Boyd, Palmatier, & Wacks, 1998; Leybaert, 2000; Leybaert & Alegria, 1995). Transposition errors suggest the child is relying on rote memorization of letter strings (Aaron et al., 1998), and it appears that this strategy is less common in deaf children with cochlear implants than in deaf children without implants. In summary, although the deaf children with cochlear implants did not use a phonological strategy to the same extent as the hearing group, they often did use phonology to guide their spellings and did not appear to rely solely on visual rote memorization.

Phonological and spelling skills continue to develop over the school years for students with cochlear implants. Geers and Hayes (2011) studied spelling, reading, and expository writing in a group of 112 adolescents from the U.S. and Canada who had used a cochlear implant since preschool (and so had more than 10 years of experience with the implants) and 46 hearing adolescents of the same ages. Spelling accuracy, as measured by a picture spelling task, was strongly correlated with both reading comprehension and expository writing abilities, as measured by ratings from National Technical Institute for the Deaf faculty members (Schley & Albertini, 2005). Deaf teenagers with implants were significantly poorer spellers (mean = 67% correct) than teenagers with normal hearing (mean = 80% correct). They also showed more variability in spelling performance (standard deviation = 22) than their hearing age-mates (standard deviation = 10). More than half (55%) of the cochlear-implant users exhibited spelling accuracy scores that were within one standard deviation of age-matched students with normal hearing, indicating that hearing loss did not preclude the development of typical spelling skills. However, when the students' spelling errors were evaluated for phonological plausibility, only 30% of the deaf teenagers scored within one standard deviation of hearing age-mates. These results are similar to those found in younger deaf children with implants (Hayes et al., 2011)—some deaf children with implants are able to use phonological strategies to some extent during spelling, but not as well as hearing age-mates. Importantly, but perhaps not surprisingly, greater use of a phonological strategy was associated with higher reading, spelling, and expository writing scores among the deaf adolescents with implants. Furthermore, use of a phonological spelling strategy was strongly related to other measures of phonological skill, including elision (deleting phonemes in orally presented stimuli to create one word from another), nonword repetition (repeating nonsense words from an auditory model) and oral reading of nonwords, sometimes called word attack. Phonologically plausible spelling errors were significantly more likely to occur in deaf students who used spoken English than those who used signed English and speech together (sometimes referred to as total communication in the United States). Thus, use of a phonological strategy for spelling seems to be encouraged by a focus on the comprehension and production of oral language.

Harris and Terleksti (2011) reported spelling and reading results for a diverse population of 86 teenagers with severe to profound hearing loss in the United Kingdom who used either hearing aids or cochlear implants. The hearing-aid users had more residual hearing than the cochlear-implant users; however, the cochlear-implant users were more likely to be enrolled in regular classrooms with hearing teenagers. Forty-seven percent of the cochlear-implant users and 33% of the hearing-aid users preferred speech only for communication. In this study, the cochlear-implant users did not show an advantage over hearing-aid users in spelling accuracy or phonetic spelling errors. The hearing-aid users not only had greater residual hearing but started using hearing aids at a very young age (mean age at diagnosis = 12.78 months). The cochlear-implant users had less residual hearing and presumably did not receive useable auditory input until they received a cochlear implant at an average age of 3 years (early implant group) or 7 years, 5 months (late implant group). The earlier access to sound in the group with hearing aids may have promoted development of phonological skills and literacy. The importance of small amounts of aided residual hearing prior to cochlear implantation, along with implantation at young ages, has already been established for acquisition of spoken language (Nicholas & Geers, 2006). Hayes et al. (2011) examined whether age at implant predicted spelling skill or phonological plausibility of errors. Although they did not find age at implant effects in their study of spelling, the authors explain that they did not test many children who received implants at 1 or 2 years of age. It is possible that, as deaf children who receive implants at 1 or 2 years of age grow up, benefits may be seen for very early cochlear implantation.

IMPLICATIONS FOR INSTRUCTION

Research on spelling in deaf children with cochlear implants who communicate orally indicates that these children can use phonological strategies to some degree, as hearing children do. This leads to the question of whether spelling instruction for these children should be any different than spelling instruction for hearing children. We believe that there is a need for modification of instruction to deaf children with implants for two reasons: poorer vocabulary and poorer phonemic awareness skills than in hearing children (Hayes, Geers, Treiman, & Moog, 2009; Johnson & Goswami, 2010). Limited vocabulary and poor phonemic awareness are related to reading difficulties, which lead to limited experiences with text. These have implications for spelling development, and thus some degree of specialized instruction is necessary for deaf children with cochlear implants.

The field of deaf education offers little to guide teachers of students with cochlear implants on spelling practices. One resource is the Laurent Clerc National Deaf Education Center at Gallaudet University in Washington, DC, which recommends a number of practices for teaching reading and writing to deaf students. For example, the Clerc Center website recommends that teachers

encourage invented spellings, or spellings that children attempt without any instructional help, during writing time (Laurent Clerc National Deaf Education Center, n.d.). Both laboratory and classroom studies suggest that inventing spellings improves children's literacy skills (Clarke, 1988; Ouellette & Sénéchal, 2008). However, the use of invented spelling is positive only if it occurs together with systematic phonemic awareness training, such as teaching children to detect, identify, and manipulate individual sounds in words, and only if the child receives feedback on the invented spellings (Rieben, Ntamakiliro, Gonthier, & Fayol, 2005). Inventing spellings not only allows children the opportunity to explore sounds and letter patterns but also provides information for teachers. In particular, teachers can analyze spellings for error types in order to guide future instruction.

Other recommendations put forward by the Clerc Center run counter to what current research suggests about best practices in teaching reading and writing to young children. For example, the Clerc Center recommends that teachers should decrease activities such as explicit, isolated instruction of grammar, vocabulary, spelling, and other literacy-related skills. These recommendations seem inconsistent with a large body of evidence, mentioned earlier in this chapter, that such activities are important and should, if anything, be increased. Explicit instruction is especially important for deaf children with cochlear implants who are at risk for developing poor phonological awareness and literacy skills.

When a child misspells a word, what sort of feedback should a teacher provide? It is not enough to simply tell the child how to spell the word or to tell the child to look it up in the dictionary. Instead, a teacher may first point out that a word is misspelled but praise the child for the attempt, such as sounding out the word or using an analogy approach. Then the teacher may show the child how his or her spelling compares to the conventional spelling, pointing out similarities or differences between the two. Depending on the type of error, the teacher may use this opportunity to explain graphotactic rules (e.g., double the *s* at the end of a word if the vowel is spelled with one letter, as in *pass*) or morphological rules (e.g., why *dirty* is not spelled *dirly*, even though that is how the child may pronounce it). A brief but meaningful lesson can encourage metalinguistic discovery and model the thinking process of a successful speller, in this case the teacher.

Of course, the ability to have a meaningful lesson or teachable moment depends on a teacher's understanding of why words are spelled the way they are. English spelling conventions seem unwieldy, sometimes forcing teachers to declare, "That word doesn't follow the rules—just memorize the spelling!" However, teachers would be well served to learn about the factors that constrain spelling and to consider why a child might have made an error. Then the teacher can determine how to guide the child to the correct spelling. Guided error analysis can be highly effective, but only if the teacher has a strong understanding of why written English works the way it does.

CONCLUSION

If teachers of deaf children with cochlear implants analyze spelling errors and use these errors to provide on-the-spot lessons or to guide future instruction, then students will have the opportunity to gain information explicitly that they otherwise have to learn incidentally and, in many cases, slowly. As mentioned earlier, hearing children do not learn the spellings of many words that they come across in reading, even words that they have come across numerous times. Deaf children do not either. Children will learn spelling patterns faster if they have explicit instruction and practice. According to this review, this instruction should begin upon school entry and continue throughout adolescence.

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