Easterbrooks, S. R., et al. (2015). Reading among diverse DHH learners: What, how, and for whom? *American Annals of the Deaf*, *159*(5), 419–432.

Reading Among Diverse DHH Learners: What, How, and for Whom?

Students who are deaf and hard of hearing (DHH) face challenges in learning to read. Much has been written about the relative importance of the different factors associated with success in reading, but these factors are disputed within the literature on DHH readers. The Center on Literacy and Deafness, funded by the Institute of Education Sciences, is engaged in a nationwide project to identify child-by-instruction interactions related to instructional factors that are malleable within the classroom context. In the present article, the authors describe the project, present the conceptual model on which it is based, explain the processes and procedures used to choose assessment tools, and discuss their theoretical view of how reading and instruction might differ based on an individual student's language and level of functional hearing.

Susan R. Easterbrooks, Amy R. Lederberg, Shirin Antia, Brenda Schick, Poorna Kushalnagar, Mi-Young Webb, Lee Branum-Martin, and Carol McDonald Connor

Easterbrooks and Lederberg are both Regents' Professors of Educational Psychology, Special Education, and Communication Disorders, Georgia State University (GSU), Atlanta. Antia is the Meyerson Distinguished Professor of Disability and Rehabilitation, Department of Disability and Psychoeducational Studies, University of Arizona, Tucson. Schick is a professor, Department of Speech, Language, and Hearing Sciences, University of Colorado, Boulder. Kushalnagar is an assistant research professor, Chester F. Carlson Center for Imaging Sciences, Rochester Institute of Technology, Rochester, NY. Webb is a research scientist, Department of Educational Psychology, Special Education, and Communication Disorders, GSU. Branum-Martin is an associate professor, Department of Psychology, GSU. Connor is a professor, Department of Psychology, Arizona State University, Tempe.

Keywords: deaf, hard-of-hearing, reading, literacy fingerspelling, phonological awareness, language

Evidence that the ability to read has important implications for positive academic outcomes in learners is incontrovertible. Good reading ability is related to progress through school (Easterbrooks & Beal-Alvarez, 2012; Thagard, Hilsmier, & Easterbrooks, 2011), acceptance into postsecondary opportunities (Cuculick & Kelly, 2003), good postsecondary performance (Albertini, Kelly, & Matchett, 2011), and positive occupational outcomes (Walter & Dirmyer, 2013). Much speculation and debate have occurred regarding the relative importance of the various elements that contribute to good reading (Beal-Alvarez, Lederberg, & Easterbrooks, 2012; Dillon, de Jong, & Pisoni, 2012; Mayberry, del Giudice, & Lieberman, 2011; Miller, Lederberg, & Easterbrooks, 2012; Parault & Williams, 2010; Park, Lombardino, & Ritter, 2013; Wang, Spychala, Harris, & Oetting, 2013), and the debate over whether deaf readers' literacy acquisition is qualitatively or quantitatively different from that of hearing readers has been lively (Allen et al., 2009; Mayer, 2007; Paul, Wang, Trezek, & Luckner, 2009; Williams, 2004). However, the evidence is unclear. For example, Park et al. (2013) compared reading skills of 21 children with moderate hearing losses and found that these children differed from hearing children and children with dyslexia only in word reading rates, a result suggesting that the difference may be quantitative. Yet Allman (2002) studied the invented spellings of children who were deaf and hard of hearing (DHH)[1] who used sign language and found that their pattern of errors differed qualitatively from that of hearing children relative to vowel location in words, perhaps because the DHH children were coding visual aspects of

fingerspelling, speechreading, and signing to words rather than matching sounds to words. Further, there is a disconnection between what research suggests is effective literacy instruction in classrooms and what may happen in actual practice (Donne & Zigmond, 2008); furthermore, there is a research-to-practice gap that should be of concern to all educators (Swanwick & Marschark, 2010). In our opinion, scholarly debate is just scholarly debate if it does not positively influence instructional practices in classrooms. In the present article, we describe a conceptual model and associated assessments used to verify or refute our model, which underlies the work of the Center on Literacy and Deafness (CLAD). We describe how CLAD's outcomes might contribute to the discussion surrounding whether the processes associated with learning to read in DHH children differ qualitatively or quantitatively from those of hearing children.

The primary purpose of CLAD's first study was to investigate child-by-instruction interactions to determine whether some DHH children learn differently from others and to examine the relationship between effective instruction and various child characteristics. CLAD used the Simple View of Reading (SVR) theory (Gough & Tunmer, 1986; Hoover & Gough, 1990), as well as more complex theories on the reading of hearing children (e.g., Scarborough & Brady, 2002), as an initial theoretical basis for the development of its conceptual model. The conceptual model in turn informed the development of (a) a comprehensive battery of assessments and (b) the characterization of classroom literacy instruction. The SVR posits that reading success is based on two discrete yet complex skills that are equal and necessary, but not independently sufficient: decoding (e.g., reliance on sight words, alphabetics, and phoneme-grapheme correspondences) and linguistic comprehension (e.g., reliance on vocabulary, syntax, and background knowledge). Debates over whether one component is more important than another are not consistent with the SVR. "Either/or" perspectives belie the truly complex nature of the process of learning to read. Whereas other models of literacy acquisition may include sociocultural phenomena, our model does not because we are primarily interested in factors that are malleable within the classroom setting. For example, while mother-child language interactions are key contributors to later communication success (Geers, 2003), they are not directly malleable in the classroom setting.

Review of the Literature

Scarborough and Brady (2002) expanded on the SVR, noting that both decoding and linguistic comprehension depend on children developing multiple subskills. They defined decoding as

> the process of applying one's knowledge of the correspondences between grapheme and phoneme to determine the pronunciation, and hence the identity, of the word represented by a particular letter sequence. More broadly, it may refer also to the use of other kinds of orthographic knowledge (e.g., syllabication rules) for word identification. (p. 324)

Scarborough and Brady noted that decoding requires the development of phonological awareness, alphabetic knowledge, phoneme-grapheme correspondences, and other strategies for the parsing of orthography. In addition, children may learn to read some words by sight.

Researchers have drawn conflicting conclusions about the role of spoken phonological skills in DHH children's reading. Some conclude that DHH children do not exhibit spoken phonological awareness and that such abilities are irrelevant to their reading (Goldin-Meadow & Mayberry, 2001; Mayberry et al., 2011; McQuarrie & Parrila, 2009). Others conclude that phonological skills are critical and that their relative lack is a major source of DHH children's reading difficulties (Perfetti & Sandak, 2000; B. Schirmer & McGough, 2005). There is some evidence that DHH adults who acquire spoken language use processes similar to those used by hearing adults to read, whereas DHH adults who exclusively use sign employ different processes (Koo, Crain, LaSasso, Eden, & Flowers, 2008).

There is other evidence that spoken phonological processing skills relate to reading skills in DHH children with functional hearing, and that this relationship may be qualitatively different from that of children who have no functional hearing.[2] It was found, for example, that children's *speech perception and production abilities* 4 years after receiving a cochlear implant (CI) accounted for 59% of variance in reading abilities 8 years after implantation (L. J. Spencer & Oleson, 2008). For deaf children with CIs and those who were hard of hearing, measures of *phonological awareness skills* correlated with reading skills both concurrently and over time (Colin, Magnan, Ecalle, & Leybaert, 2007; Easterbrooks, Lederberg, Miller, Bergeron, & Connor, 2008; James et al., 2005; Moeller et al., 2007; Most, Aram, & Andorn, 2006; L. J. Spencer & Oleson, 2008; Webb & Lederberg, 2014).

There is also increasing recognition that phonological awareness and reading have a reciprocal relationship for both hearing children and DHH children with functional hearing via knowledge of phoneme-grapheme

associations. Phonics instruction (i.e., explicit instruction on how graphemes map onto phonemes) allows children to develop more precise phonological representations of words (Castles & Coltheart, 2004). Because letters provide visual support for only partially available phonemes (i.e., sounds that the child either does not have full access to acoustically or cannot discriminate among visually, such as /g/ or /k/), phonics instruction may provide an accessible representation not available through listening alone (Bergeron, Lederberg, Easterbrooks, Miller, & Connor, 2009; Lederberg, Miller, Easterbrooks, & Connor, 2014). Researchers have found knowledge of grapheme-phoneme correspondences to be strongly related to reading success (Easterbrooks et al., 2008; Kyle & Harris, 2011). DHH children's ability to decode pseudowords into spoken nonsense words has also been shown to correlate highly with word identification and comprehension (Geers, 2003; L. J. Spencer & Tomblin, 2009).

Key to the development of reading is word identification, and sight word reading has long been a primary path through which teachers have instructed DHH children to read. While not typical, some DHH adults without functional hearing are good readers yet do not demonstrate spoken phonological awareness skills (Koo et al., 2008), and so may be directly mapping a whole word to its meaning either directly or through mediation by a related sign (Morford, Wilkinson, Villwock, Piñar, & Kroll, 2011; Siedlecki, Votaw, Bonvillian, & Jordan, 1990). However, this kind of mediation is ineffective for a majority of hearing children (Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001). According to Ehri (2014), children enter a *partial alphabetic phase* during which they form partial but inefficient and unuseful strategies (Cunningham & Stanovich, 1997). Efficient sight word reading is a result of children's knowledge of how to map letters to phonemes, that is, acquisition of the alphabetic principle. In other words, whole word reading is based on knowing how to map letters onto the sublexical features of words. Likewise, experimental research suggests that learning new written words through associations with sign can be a slow process for DHH children (Reitsma, 2009).

A possible alternative to sight word reading and spoken phonology is the use of fingerspelling. The definition of phonological awareness from the perspective of fingerspelling is currently being explored, with little research available at this point. CLAD is presently investigating whether fingerspelling can be an alternative to spoken phonology processing (e.g., spoken phonological awareness, grapheme-phoneme representations). This type of visual phonological representation differs from traditional American Sign Language (ASL) phonology, which is defined from the perspective of the components of signs—that is, palm orientation, configuration, location, and movement (Corina & Emmorey, 1993; Corina & Hildebrandt, 2002).

Fingerspelling, which consists of a manual alphabet representing the English alphabet, is a natural part of ASL, and may provide a nonauditory phonological system that can be used to represent the internal structure of written words (Haptonstall-Nykaza & Schick, 2007; Hirsh-Pasek, 1987) and aid decoding and memory (Chamberlain & Mayberry, 2000; Haptonstall-Nykaza & Schick, 2007; Hirsh-Pasek, 1987; Padden & Ramsey, 2000). Fluent fingerspelling contains some syllable structure, and chunking of frequently co-occurring letter sequences aids comprehension (Brentari & Padden, 2001; Keane, Brentari, & Riggle, 2013). For example, consonantal clusters (bl, sl, cl, str) or common affixes (-tion, -ness, pre-) are produced as smooth, coarticulated sequences, not distinct letters.

Strong correlations have been found between deaf children's fingerspelling skills and English reading vocabulary (Haptonstall-Nykaza & Schick, 2007; Hile, 2010; Padden & Ramsey, 2000; Puente, Alvarado, & Herrera, 2006; Sedey, 1995). Hirsh-Pasek (1987) found that elementary school children who were native ASL users could perform phonological awareness tasks with fingerspelled words (e.g., responding to the question "What is left when you delete the first letter?"), and that such abilities correlated with reading abilities. Intervention studies have shown that using fluent fingerspelling helps DHH children learn new written words, with positive effects evident even with young children; these effects are particularly strong for deaf children of hearing parents (Haptonstall-Nykaza & Schick, 2007).

How much DHH children are exposed to fluent fingerspelling is unknown, although we know that Deaf[3] parents fingerspell to infants and toddlers (Padden, 2006). Hearing individuals fingerspell far less to Deaf children than do Deaf adults (Akamatsu & Stewart, 1989; Humphries & MacDougall, 2000; Padden & Ramsey, 2000). Thus, signing DHH children's fingerspelling abilities may vary considerably depending on the school and home communicative environments.

Linguistic comprehension is the second discrete component of the SVR. Scarborough and Brady (2002) have noted that linguistic comprehension is necessary for reading development and includes vocabulary knowledge, language structures (grammar, morphosyntax), and verbal reasoning. Others (Silverman, Speece,

Harring, & Ritchey, 2013) suggest that fluency plays a role in the SVR as well. Researchers have found that DHH children's expressive vocabulary (spoken or signed) abilities significantly predict their level of reading achievement (Easterbrooks et al., 2008; Kyle & Harris, 2006). Connor and Zwolan (2004) identified vocabulary as a strong predictor of reading comprehension skills for DHH children with CIs, after controlling for socioeconomic status (SES), duration of implant use, and age of implantation. Because many DHH students arrive at school with weaker vocabulary knowledge than their hearing peers (see review, Lederberg & Beal-Alvarez, 2011), they often must learn written representations for previously unknown words. DHH students also often fail to understand multiple meanings of words (P. E. Spencer & Marschark, 2010). On average, across instructional program types, DHH children use less diverse vocabulary (spoken, written, or signed), and overuse familiar verbs and concrete nouns (Burman, Evans, Nunes, & Bell, 2008; Nittrouer, 2010; Singleton, Morgan, DiGello, Wiles, & Rivers, 2004). For children learning ASL, there is a complex relationship between sign and reading. While these children may be able to connect a sign to a single written word, they may not develop a complete understanding of the morphological variations or syntactical use of the written word; this can make fluent reading difficult (Hermans, Knoors, Ormel, & Verhoeven, 2008; Hermans, Ormel, & Knoors, 2010).

When DHH children know a word, they often know only partial meanings and lack knowledge of how to use it syntactically. Like hearing children, DHH children are able to learn new words from the reading context, although this may be a less effective strategy when many words in a passage are unknown. For example, de Villiers and Pomerantz (1992) found that both oral and signing DHH children were able to infer the meaning of novel words in written passages, but they were not sensitive to the words' grammatical functions. In a finding consistent with that of de Villiers and Pomerantz, it was observed by McAfee, Kelly, and Samar (1990) that deaf college students used mature vocabulary (in speech and writing) that was semantically correct, but often incorrect in form (e.g., "He tried to suicide himself").

Snow, Burns, and Griffin (1999) identified reading fluency as one of three key areas (alphabetic principle, fluency, comprehension) in the acquisition of literacy; if taught appropriately, they might help prevent or remedy reading problems even in adolescence (Kamil, 2003). Fluency has been likened to the glue that holds structure and meaning together (B. Schirmer, Therrien, Schaffer, & T. Schirmer, 2009). Reading with prosody has been described as reading with "expression approximating normal speech" (Young & Greig Bowers, 1995, p. 435), reading with "the musical quality of language" (Benjamin & Schwanenflugel, 2010, p. 388), and reading with "appropriate expression or intonation coupled with phrasing that allows for the maintenance of meaning" (Kuhn, Schwanenflugel, & Meisinger, 2010, p. 233). For students whose primary language is ASL, there may be a corresponding element of visual fluency required for readers to express print English in fluent, signed renderings (Easterbrooks & Huston, 2008), suggesting a requisite level of fluency with visual prosody, or the supralexical grouping of words into the larger phrases or thought units they represent. Regarding spoken language, Daane, Campbell, Grigg, Goodman, and Oranje (2005) found that 61% of the hearing fourth graders assessed on the oral fluency measure of the National Assessment of Educational Progress (National Reading Panel, 2000) scored in the fluent range (i.e., Levels 3 and 4), with only 10% scoring in the top level of prosodic fluency (i.e., Level 4). Approximately 40% of students scored in the nonfluent range (i.e., Levels 1 and 2), with 8% scoring in the lowest level of prosodic fluency (i.e., Level 1), an outcome that indicated that the mastery of skills required to meet grade-level expectations was partial or absent.

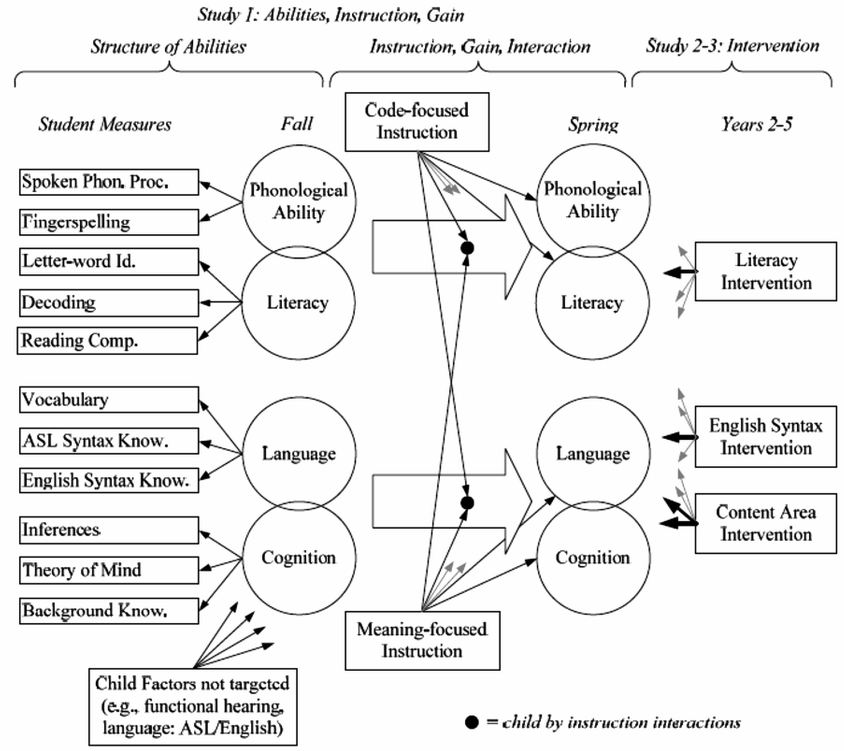
Theoretical Framework

Most educators and researchers accept that age-appropriate language skills are critical for literacy skills, yet the relative importance of general language skills (without regard to modality or specific language) as opposed to spoken English language is unclear. The argument surrounds the degree of divergence between the language of print and spoken English, signed English, and ASL, and how such divergence influences literacy development. From the perspective of the SVR (Gough & Tunmer, 1986; Hoover & Gough, 1990), there is agreement that reading success is a product of (a) the ability to decode written words efficiently into spoken or signed words and (b) language comprehension. Some professionals (Perfetti & Sandak 2000; Rayner et al., 2001; Trezek, Wang, & Paul, 2010) argue that, like hearing children, DHH students acquire literacy skills optimally by grasping the alphabetic principle. Others (Allen et al., 2009; Goldin-Meadow & Mayberry, 2001) argue that reading does not require translation into an audition-based based spoken language, and alternative strategies can be employed when language develops fluently and "on time," regardless of the receptive or expressive mode or the specific first language (e.g., spoken English vs.

ASL). Recent reviews (e.g., Easterbrooks, 2010; P. E. Spencer & Marschark, 2010) have concluded that there is inadequate evidence to resolve the issue. Hence, an important goal of the CLAD project is to identify a conceptual model that accounts for the major aspects of reading to enable us to address the questions arising from such a diverse population. Our conceptual model may allow us to answer questions about, for example, whether the patterns of skills among DHH children resemble those of hearing children, but are lower-level or delayed, versus whether those patterns suggest that DHH children learn to read in fundamentally (i.e., qualitatively) different ways from hearing children.

We hypothesize that the underlying factors and instructional approaches to reading must necessarily differ depending on DHH children's functional hearing and first or predominant language. We also hypothesize that effective interventions will be different for two very different populations: (a) those without functional hearing who primarily use sign as the foundation for reading English and require visually accessible skills for learning to read (e.g., fingerspelling), and (b) those with sufficient functional hearing to enable them to use spoken English as a foundation for reading English (whether or not they also use sign).

Figure 1
Conceptual Model



Conceptual Model

The conceptual model in Figure 1, built upon the premises of the SVR along with the model formulated by Scarborough and Brady (2002) and other, more complex models of reading (Mehta, Foorman, Branum-Martin, & Taylor, 2005; Storch & Whitehurst, 2002) and our own pilot work (Webb et al., 2014), guides CLAD's focused program of research. Given the limitations of previous research with DHH children, we fully expect that the model may change as we evaluate the results of our studies. Figure 1 represents the three major phases of our study, in order. Reading from left to right, the first two columns represent our descriptive study and are most fully described in the present article. The last column refers to the interventions we will be developing in the last 3 years of CLAD.

Our conceptual model posits that children enter each school year with four related but—at least theoretically—distinct skill sets (constructs) that may impede or support DHH children's reading growth: phonological, linguistic, literacy, and cognitive abilities.

Regarding phonological abilities, our conceptual model will allow us to investigate the malleability of phonological abilities as they relate to DHH children's reading, and how this may differ depending on children's functional hearing. We list fingerspelling separately in our model because it may offer an alternative phonological strategy for reading words, unrelated to spoken phonology, but related to both fingerspelling phonology and orthographic regularities. While fingerspelling shares articulators with ASL signs, there are important differences between the phonology and phonetics of fingerspelling and sign phonology (Keane et al., 2013).

On the left side of the model are rectangles representing types of observed measures, which indicate latent abilities (circles). Some of the circles overlap since our results may yield fewer (or more) latent abilities than shown. Language and cognitive skills are expected to be highly related

to each other but less fully integrated with reading during the early school years. This may especially be the case for DHH children, who may be learning to read a language that differs fundamentally from their first language or may be learning to read a language that they are beginning to acquire. Reading comprehension also depends on children's ability to integrate ideas across sentences and go beyond the information explicitly contained in the text. DHH children's ability to make inferences and to understand Theory of Mind (i.e., awareness of others' thought processes) and a lack of relevant academic and background knowledge may be additional sources of reading difficulties. We speculate that while these types of cognitive skills and knowledge relate to language abilities, they are equally likely to be supported by English or ASL. We also hypothesize that there are several child factors (functional hearing, family SES) that, while relevant, are not malleable within the context of a school-based intervention.

In addition to child language and literacy abilities, we seek to understand what is occurring in classrooms for DHH children, and how it relates to children's learning. In the middle column, the conceptual model suggests that classroom instruction can be broadly characterized as code based (e.g., alphabetic knowledge, phonological awareness, grapheme-phoneme correspondence, fingerspelling) and meaning based (vocabulary understanding, comprehension of connected text fluency, writing). We posit that some code-based and meaning-based instructional strategies will be unique to DHH children (e.g., making explicit links between ASL and English, using visual support). The field has insufficient evidence of how much or what kind of instruction DHH learners are receiving. Is this instruction code based or meaning based? Does this instruction follow the same pattern as that received by children with typical hearing in general education but at a more measured pace, or do different patterns of instruction predominate? By analyzing classroom instruction, we expect to find that child outcomes will be associated with amount of code-based and meaning-based instruction received, and that these associations will depend on children's initial characteristics (i.e., the latent constructs). We refer to these as child characteristics by instruction interactions (indicated in Figure 1 by the large dot).

Finally, at the far right of the diagram, interventions will be designed to influence specific factors found to be malleable. While our conceptual model contains some initial ideas of what types of intervention we will be developing, we will alter this ideas based on our findings from study 1.

Selection Process for Assessments

We designed an extensive assessment protocol and are gathering videos of teacher-child instructional interactions at three points during the year to examine the relationship between child language and literacy abilities and classroom instruction. The assessments chosen for the CLAD project were carefully examined and selected by a multidisciplinary group of experts representing such diverse backgrounds as deaf education, educational psychology, speech-language pathology, measurement, statistical modeling, and empirical testing of theory. Assessments were discussed extensively. We screened a large number of instruments, focusing on those that would answer the questions regarding the qualitative and quantitative nature of the constructs in our conceptual model: cognition, phonological awareness, language, and literacy. We implemented and, where needed, modified and made improvements to the protocol along the way. We wanted to know whether the assessments chosen in fact measured the four constructs identified in the conceptual model. We also wanted to know the nature of the relationships among the constructs, whether the assessments chosen were reliable and valid for young DHH children, and whether, under business-as-usual conditions, children made gains in these areas across a school year. Preference was given to assessments with known psychometric properties available to DHH children or with a rich history of use in research with DHH children. When standardized assessments needed modification for administration to DHH children, we engaged in extensive discussion of the necessary modifications, provided signed versions of both the instructions and the assessment items, and clarified basal and ceiling rules.

Recognizing that children's placement (e.g., signing classroom, oral classroom) does not always correspond with their abilities in different modes of communication, we established procedures to ensure that children were given assessments appropriate to their functional hearing, mode of communication, and language, regardless of program type. For example, a child with functional hearing in a predominately ASL program might also have very good spoken-English skills, and we wanted to capture the range of communication the child could use. Functional hearing determination comprised three assessments described below: the Early Speech Perception Test, the Functional Hearing Scale, and the Language Modality Interview. All language assessments were carefully examined to assure equivalent forms in ASL and English. We also determined which

instruments should be administered to children who used spoken English only, ASL only, or both sign and spoken language. Our intention was to give all children maximum opportunity to demonstrate their best communication skills in a valid and reliable way. Next, we describe the assessments chosen and touch on some of the issues surrounding their choice and use. A more in-depth description of our assessment protocol may be found on our website (http://clad.gsu.edu).

Phonological Ability: Spoken or Fingerspelled

Phonological ability is one of the four constructs measured within our conceptual model. Phonological ability presented a challenge to decision making in that we needed equivalent opportunities for all children, no matter their language or mode.

Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999). We used the Elision, Blending, and Sound Matching (initial and final) subtests of the CTOPP to measure children's spoken phonological awareness ability. Directions were administered in the child's preferred modality, but items were delivered in spoken language only. The first two tasks on the CTOPP require speech perception and production ability. On the elision task, children are asked to say the remainder of a word when a sound is dropped; the blending task requires children to combine spoken sounds to form words. These two tasks were administered only to DHH children who had functional hearing (and thus could hear and produce the spoken items). The sound matching task was administered to **all** children because it did not require spoken-language abilities; children had to select the picture that matched the initial or final sound of the target picture.

Fingerspelling Ability and Phonological Awareness Test (Schwartz & Schick, 2011). This test was developed to measure fingerspelling phonological processing. The first subtest requires children to imitate a series of fingerspelled words of increasing length and difficulty. Responses are scored in two ways: correct/incorrect and degree of similarity to the targeted words. The Blending and Elision subtests were modeled after the CTOPP subtests, but were delivered in fingerspelling. For the Elision subtest, children were asked to fingerspell a new word after removing a fingerspelled "chunk" from a fingerspelled model. For the Blending subtest, children were asked to blend handshapes into a real word. These tests were administered only to children who used some form of sign language. All items were signed by a native Deaf signer and were shown to the child on video delivered on a laptop.

Language Assessments

Linguistic ability is one of the four constructs measured within our conceptual model. To measure this construct in a valid manner; careful attention to both ASL and English was required. Recognizing that many children come from homes where the language is neither ASL nor English, we determined that assessment of additional languages was (a) beyond the scope of the present study and (b) a project that could best be built upon an understanding of the validity of our conceptual model for children without this additional challenge to their literacy acquisition. Thus, we did not attempt to measure the children's use of other spoken languages such as Spanish.

Language Modality Interview. We used this researcher-created interview to help determine the child's preferred modality. By *preferred modality* we mean whether the child used ASL, English-like signing, Simultaneous Communication (SimCom), or spoken English. The evaluator engaged the child in rapport-building conversations, with questions and prompts targeted to enable judgments about the preferred mode of communication. Evaluators used the language modality interview to determine which modality to use for directions to the rest of the battery, and for certain language tests (e.g., the Word Structure subtest of the Clinical Evaluation of Language Fundamentals–4, the Test for Auditory Comprehension–3, and the Comprehensive Assessment of Spoken Language).

Expressive One-Word Picture Vocabulary Test–4 (EOWPVT-4; Martin & Brownell, 2011). We used the EOWPVT–4 to measure the children's expressive vocabulary. Directions were given and responses accepted in the child's preferred modality. Fingerspelling was required for words without an ASL equivalent. We selected this test because it was easily adaptable to regional sign variations as well as different languages and modalities. Assessors used a list of acceptable signs to score children's responses.

Expressive Vocabulary Subtest, Woodcock-Johnson–III Tests of Achievement (WJ-III; Woodcock, McGrew, & Mather, 2001). We used the Expressive Vocabulary subtest as a measure of word knowledge and language development. Directions were given and responses accepted in the child's preferred modality. As we did for the EOWPVT, we developed a list of acceptable signed and fingerspelled responses.

Word Structures Subtest: Clinical Evaluation of Language Fundamentals–4 (CELF–4; Semel, Wiig, & Secord, 2003). We used the Word Structures subtest of the CELF–4 to measure children's expressive English inflectional morphology. The test uses a cloze technique to elicit expressive morphology.

We developed a video of a sign model in which items were delivered in either English-like sign (voice off) or SimCom translations. Assessors used these models to learn to deliver test items in a consistent manner, and were required to meet a competency level prior to administering the test. Tests were scored using the test manual's list of acceptable spoken responses or our own acceptable response list for signed responses. While we debated the appropriateness of this test for children with no spoken-language abilities, we did not want to assume that signing-only children were not able to complete a test of English morphology. We therefore administered this test to all the children. Because there was no ceiling on this test, we established a discontinuation rule (at item 16 if there were 3 or fewer correct responses), so as not to stress the children.

Elaborated Phrases and Sentences Subtest: *Test of Auditory Comprehension of Language*–3 (TACL–3; Carrow-Woolfolk, 1999). We used the Elaborated Phrases and Sentences subtest of the TACL–3 to measure receptive English grammar and word order, at the sentence level. Assessors gave stimuli items in spoken English, English-like signing, or SimCom. ASL grammatical markers (e.g. classifiers, pronominal points, and role shifting) were used during administration, but English word order was used, though without English morphology. A video of a sign model was used to train assessors.

Paragraph Comprehension of Syntax Subtest: *Comprehensive Assessment of Spoken Language* (CASL; Carrow-Woolfolk, 2008). We used the Paragraph Comprehension of Syntax subtest to measure receptive through-the-air language comprehension at the paragraph level. This subtest consists of a series of increasingly complex paragraphs read aloud by the assessor. After each paragraph, the assessor asks a series of comprehension questions. The child answers the questions by selecting a picture from a set of four choices. This test was administered in the child's preferred modality—spoken English, SimCom, or ASL. We developed the ASL and SimCom versions. The ASL version was created by a team of deaf and hearing bilingual signers, and signed by a native Deaf adult. A video of the SimCom model was used in the training of the assessors. Assessors administered the spoken and SimCom versions live to the child; a video of the ASL version was presented on a laptop.

ASL Receptive Skills Test–Revised (Schick, 2013). We used the ASL Receptive Skills Test–Revised to measure the ability of DHH children to understand ASL syntax and classifiers at the sentence level. This test was given only to children who had some signing skills, as determined with the Language Modality Interview and Expressive/Receptive Communication Functional Rating Scale. Children watched a video of a model signing ASL sentences and selected a picture from a closed set of three, four, or six pictures.

Literacy Assessments

Literacy (reading) skill represents one of the four constructs measured within our conceptual model. As with all assessments, we gave careful consideration to child mode and language and required local assessors to undergo training in which they practiced the assessments and received feedback on the administration.

Woodcock Johnson–III Tests of Achievement (WJ-III; Woodcock et al., 2001). We used four subtests of the WJ-III: Letter-Word Identification (LW), Word Attack (WA), Passage Comprehension (PC), and Writing Fluency (WF). LW measures the ability of a child to identify letters and printed words of increasing difficulty. WA measures the ability to apply phonics and structural analysis rules based on spoken phonology to reading phonologically regular nonsense words. PC measures the ability to understand printed sentences; the test taker matches pictures and provides key words to complete written text (a cloze procedure). WF measures the ability to formulate and write simple sentences, with the test taker given a picture prompt and three key words. Directions for all subtests were given in spoken English or sign language, as appropriate. Responses for LW and PC were accepted in the child's preferred modality. Responses for WA were accepted in spoken language or Visual Phonics, and the appropriate mouth movements.

Word Identification Strategies Test. This researcher-created tool requires children to read single words and will be used to describe the strategies children used to decode words. Responses are video-recorded and later rated for the presence or absence of specific word identification strategies (e.g., guessing, retrieval, sounding out and blending, fingerspelling Visual Phonics; Burke, 2013).

Reading Fluency Assessment. In this assessment, children must read (using speech or sign language) three passages (from Englemann & Bruner, 1995, and from the website of the Florida Center for Reading Research, www.fcrr.org) within a prescribed time, then respond to comprehension questions, which they can answer in either spoken English or sign language. The child's reading is video-recorded and later rated by means of a miscue analysis. Words per minute and correct words per minute are also calculated. The child is also rated on performance using on the Visual Fluency of Signing Deaf Children rubric when appropriate (Easterbrooks & Huston, 2008).

Spelling. Spelling ability was assessed with a subset of the materials used by Harris and Moreno (2004). This included 12 picture prompts accompanied by the spoken or signed word. The child was required to write the word. In a procedure following that described by Hayes, Kessler, and Treiman (2009), spellings were entered into the Ponto scoring analysis software (http://spell.psychology.wustl.edu/ponto) and received three values: correct standard spelling, phonologically acceptable spelling, and rule-governed spelling.

Other Literacy Assessments That Were Considered but Not Used

In fall of year 1 we gave the Test of Irregular Word Reading Efficiency (TIWRE; Reynolds & Kamphaus, 2008) and found the correlation between the WJIII–WA and the TIWRE to be high ($r = .91$). We thus concluded that use of the TIWRE in our model would be redundant. We also gave the students the Peabody Individual Achievement Test (Markwardt, 1997), but removed this assessment from the battery because only 24 children scored high enough to achieve a scaled score, indicating it was too difficult to provide a sensitive measure of reading comprehension for DHH children in our sample.

Cognition

Cognition is one of the four constructs measured within our conceptual model. Cognitive assessments were also used to confirm whether or not a child met the inclusion criterion of having no significant cognitive impairment.

Differential Ability Scales-II (DAS-II; Elliott, 2007). We used the Matrices subtest to measure nonverbal, fluid reasoning and problem solving. Directions were provided in spoken English or sign language, with a sign model used to assure consistency of the directions.

Clinical Evaluation of Language Functions-4 (CELF-4; Semel et al., 2003). We used the Number Repetition Forward and Backward subtest to measure immediate and working memory in either spoken or sign language (depending on child's preferred modality).

Theory of Mind Scale (Wellman & Liu, 2004). Based on Wellman and Liu's Theory of Mind Scale, an assessment of children's knowledge access, social pretend ability, and false belief awareness was given to measure the ability of children to attribute mental states to the self and others. Trained assessors gave the assessments in spoken English or in sign language.

Speech Perception and Production Abilities

Assessments of speech perception and production abilities were used to determine if a child had functional hearing; they were also used to test our assumption that the nature of early literacy skills would differ depending on the level of functional hearing.

Early Speech Perception Test (ESP; Moog & Geers, 1990). The ESP is an audition-only task. It requires children to discriminate among single words and/or multisyllable words with different stress patterns. Children must select the correct referent from a closed set of pictures or objects representing these words. The results are used to place children in four speech perception categories ranging from no pattern perception to consistent word identification.

Functional Rating Scales. We adapted the functional rating scales identified by Karchmer and Allen (1999) and modified by Antia, Jones, Reed, and Kreimeyer (2009) for use in CLAD. The scales assess three areas: cognition and social skills, expressive and receptive communication, and functional hearing. Administered by teachers familiar with the child, the Hearing Functional Rating Scale was one of three tools—along with the ESP and Language Modality Interview—used to identify whether the child had functional use of his or her hearing.

Arizona Articulation Proficiency Scale–3 (Arizona-3; Fundala, 2000). On the Arizona–3, children are asked to supply a spoken word for a series of pictures. Their speech is then scored for articulation accuracy. This was given only to children with at least some pattern perception as measure by the ESP.

Demographics

Information about children, parents, teachers, and schools will be used to describe our sample and as covariates, where appropriate.

Child Demographics, Teacher Demographics, and *Classroom Demographics.* These forms requested typical demographic information regarding child characteristics, teacher characteristics, and the classroom setting. Teachers filled out the child demographic forms, which were then sent home to parents for verification.

Participants

We designed our assessment protocol for use with DHH children in kindergarten through second grade (K–2). Additional eligibility for participation in the study included the requirement that the child have at least a 45 dB better-ear average (pure tone average) or a CI and no additional severe disabilities, as reported by the teacher, significant enough to prevent participation in the assessments. We gathered data on 351 participants over a 2-year period. The sample identified is not intended to be representative of the DHH population; rather, we focused on acquiring data from schools with large numbers of students to allow us to work efficiently through the com-

plex processes associated with acquiring permissions from local institutional review boards (IRBs). Participants used a variety of language modalities, from signed to spoken, and a variety of languages, from ASL, English-like signing, and SimCom to spoken English and combinations thereof.

Participating Settings

We recruited participants from nine states and British Columbia. They were from schools for the Deaf, self-contained classrooms, mainstreamed classrooms, and private and charter schools. A variety of communication modes and languages or combinations were used with the children, who were taught in a wide range of settings; some children were taught by as many as five different service providers during their English language-arts blocks.

Procedures

We applied for and received IRB approval from the lead university on this project, most notably including permission to use parent notification for video collection in classrooms and for the child assessments, if the school agreed, which most did. We established the assessment protocol and engaged in approximately 2½ hours of assessment per child in the fall and 1½ hours of assessment in the spring. (The spring battery was shorter because we did not need to repeat all the auditory, speech, and cognitive measures.) We gathered one digital video recording of each child's language and reading instruction in the fall (after fall assessments), winter, and spring (before spring assessments). We gathered sound-level ratings using the audiotools app from the Studio Six Digital website, http://www.studiosixdigital.com/audiotools/. We measured sound levels for one English language-arts instructional segment for most classrooms and asked videographers to complete a classroom acoustic characteristics checklist.

Planned Analyses and Procedures

We have only begun the analysis process, and data are too preliminary to report. Certainly, they do not permit us at this juncture to draw conclusions regarding the qualitative and quantitative differences in learning to read that we anticipate the project will yield, but they do provide a glimpse into the promise that our conceptual model will, in fact, permit us to engage in such discussion.

We will use confirmatory factor analyses (Bollen, 1989) to examine whether our assessments measure the proposed underlying constructs, and to test model fit for several different models of literacy skills. These analyses will address the qualitative question in several ways based on our hypotheses. We hypothesize that our conceptual model represents **all** DHH children's literacy skills. However, qualitative manifestations of the phonological awareness and language constructs will differ according to DHH children's functional hearing and language abilities. Specifically, we hypothesize that phonological awareness is strongly related to DHH children's reading skill. However, phonological awareness will be manifested by an awareness of spoken phonology for DHH children with functional hearing, while it will be manifested by an awareness of fingerspelled phonology by DHH children without functional hearing. We also expect that the different aspects of language (vocabulary, syntax, paragraph comprehension) will reflect one underlying language construct. However, the specifics of the skills that constitute that construct will differ according to whether the children are acquiring sign and/or spoken language. While DHH children acquiring spoken language will resemble hearing children, DHH children acquiring sign will differ qualitatively from hearing children. We hypothesize that knowledge of ASL and knowledge of English (sign, not spoken) are strongly related to each other, and that DHH children who sign are, at least to some extent, bilingual in their language capabilities, and that these language abilities are related to reading. Given that the linguistics of ASL differ in important ways from English linguistics, this would suggest that the role of language comprehension is qualitatively different for DHH children who sign as compared to hearing children learning to read.

These analyses will allow us to verify or revise our conceptual model. Either way, we may provide future researchers with a well-founded theoretical basis upon which to investigate the qualitative/quantitative argument. Our data may also permit us to establish a battery of reliable and valid assessments that may be used in future studies surrounding this discussion. (See Webb & Lederberg, 2014, for psychometric properties of one such measure.)

We also are in the process of coding the classroom observations. We will use multilevel modeling to model the associations between children and instructional characteristics with student outcomes (fall to spring gains). This will help us identify what instructional strategies appear to promote the most gains in which children.

Limitations of the Procedures

One limitation of the present study was related to recruitment procedures: the lack of a randomized sample consistent with population demographics. However, we would argue that children with hearing loss who are not in the targeted pullout or self-contained settings may not need

the sorts of interventions that we are developing, and including these children in the sample therefore would not contribute to our understanding of children most in need of intervention.

We also recognize that our procedure does not include representatives of the entire audiological range of children who are DHH. We do not include those with milder degrees of hearing loss, who may also struggle with reading. We do not include children with multiple and severe additional disabilities. This is also intentional, in that we need to establish the veracity of the conceptual model with a typical (among the atypical) sample of the population before we can say with certainty that particular interventions will work beyond those parameters. Although we suspect that some of the assessed children may have had undiagnosed attention, learning, or behavior disorders, these were not significant enough to meet identification criteria at their age.

Summary

CLAD will be testing whether there are qualitative differences in early literacy skills in DHH children by examining relations among and between phonological, language, cognitive, and literacy skills in a large, diverse sample of DHH children. Using confirmatory factor analysis, we will test the hypothesis that our conceptual model describes the nature of these skills of DHH K–2 students. The overall conceptual model is based on theoretical and empirical research about reading development of hearing children, and thus assumes that the constructs involved in learning to read are qualitatively similar for DHH and hearing children at the level of the overall structure. However, we hypothesize that there will be qualitative differences in the nature of these constructs for DHH children and hearing children—especially for DHH children without functional hearing and who use sign language as their predominant mode of communication. These characteristics will influence what phonological and language skills children use in learning to read. We hypothesize that while all children's ability to read printed words is based on their awareness of a phonological, sublexical, representational system, the nature of that system depends on the children's access to spoken phonology. We also hypothesize that, like hearing children, DHH children with functional hearing develop awareness of the phonology for spoken words, and use this knowledge to translate print into spoken words. By contrast, DHH children who are acquiring sign language develop two visually based phonological systems—one related to sign and the other related to fingerspelling. Because fingerspelling maps directly to print, we hypothesize that it serves as an alternative to spoken phonology for DHH children without functional hearing. We will test this hypothesis by examining relations between DHH children's ability to manipulate fingerspelled words and their word reading skills. Qualitative differences will also exist in the skills that underlie language. DHH children who are acquiring sign may learn both a natural sign language (e.g., ASL) and sign that more closely resembles spoken language (e.g., conceptually based English sign), and these languages will tend to be integrated and related to reading. However, translation from signed language to printed English requires qualitatively different processes from those used by DHH and hearing children who are in the process of acquiring the spoken language that is represented by print. These proposed qualitative differences also imply that optimum instruction will differ depending on DHH children's characteristics. CLAD will investigate this implication by relating characteristics of DHH children's classroom instruction to learning gains during the school year. Teachers and administrators need specific guidance on those factors that are malleable in the classroom so that they may provide appropriate interventions.

Notes

1. By *deaf and hard of hearing* (DHH) we mean students who have a hearing loss that is sufficient to interfere with auditory-only speech perception even when audiological technology (e.g., hearing aids or cochlear implants) is being used. This typically refers to those with an unaided better-ear pure tone average of at least 45 dB. Where we mean otherwise, we provide further explanation.

2. For purposes of our study, we defined children as having functional hearing or no functional hearing based on their ability to select a referent for a spoken word through audition alone given a closed set of answers. This was defined as a score of 3 or 4 on the Early Speech Perception Test (Moog & Geers, 1990), and was verified via a functional rating scale and a language modality interview.

3. Consistent with usage employed by the author of the cited article, we refer here to individuals who are culturally Deaf.

References

Akamatsu, C. T., & Stewart, D. (1989). The role of fingerspelling in Simultaneous Communication. *Sign Language Studies, 65*, 361–374.

Albertini, J., Kelly, R., & Matchett, M. (2011). Personal factors that influence deaf college students' academic success. *Journal of Deaf Studies and Deaf Education, 17*(1), 85–101. doi: 10.1093/deafed/enr016

Allen, T., Clark, M., del Giudice A., Koo, D., Lieberman, A., Mayberry, R., & Miller, P. (2009). Phonology and reading: A response to Wang, Trezek, Luckner, and Paul. *American Annals of the Deaf, 154*(4), 338–345.

Allman, T. (2002). Patterns of spelling in young deaf and hard of hearing students. *American Annals of the Deaf, 147*(1), 46–64.

Antia, S. D., Jones, P. B., Reed, S., & Kreimeyer, K. H. (2009). Academic status and progress of deaf and hard-of-hearing students in general education classrooms. *Journal of Deaf Studies and Deaf Education, 14*(3), 293–311. doi: 10.1093/deafed/enp009

Beal-Alvarez, J., Lederberg, A., & Easterbrooks, S. (2012). Grapheme-phoneme acquisition of deaf preschoolers. *Journal of Deaf Studies and Deaf Education, 17*(1), 39–60.

Benjamin, R. G., & Schwanenflugel, P. J. (2010). Text complexity and oral reading prosody in young readers. *Reading Research Quarterly, 45*(4), 388–404.

Bergeron, J. P., Lederberg, A. R., Easterbrooks, S. R., Miller, E. M., & Connor, C. M. (2009). Building the alphabetic principle in young children who are deaf or hard of hearing. *Volta Review, 109*(2–3), 87–119.

Bollen, K. A. (1989). *Structural equations with latent variables*. New York, NY: Wiley.

Brentari, D., & Padden, C. A. (2001). Native and foreign vocabulary in American Sign Language. In D. Brentari (Ed.), *Foreign vocabulary in sign languages: A cross-linguistic investigation of word formation.* (pp. 87–119). Mahwah, NJ: Erlbaum.

Burke, V. (2013). Word reading strategy development of deaf and hard-of-hearing preschoolers. *Dissertation Abstracts International: Section A. Humanities and Social Sciences*, *74*(6-A).

Burman, D., Evans, D., Nunes, T., & Bell, D. (2008). Assessing Deaf children's writing in primary school: Grammar and story development. *Deafness and Education International, 10*(2), 93–110.

Carrow-Woolfolk, E. (1999). *Test for auditory comprehension of language* (3rd ed.). Austin, TX: Pro-Ed.

Carrow-Woolfolk, E. (2008). *Comprehensive assessment of spoken language*.Torrence, CA:Western Psychological Corporation.

Castles, A., & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read? *Cognition, 91*, 77–111.

Chamberlain, C., & Mayberry, R. I. (2000). Theorizing about the relation between American Sign Language and reading. In C. Chamberlain, J. P. Morford, & R. I. Mayberry (Eds.), *Language acquisition by eye* (pp. 221–259). Mahwah, NJ: Erlbaum.

Colin, S., Magnan, A., Ecalle, J., & Leybaert, J. (2007). Relation between deaf children's phonological skills in kindergarten and word recognition performance in first grade. *Journal of Child Psychology and Psychiatry, 48*(2), 139–146.

Connor, C. M., & Zwolan, T. (2004). Examining multiple sources of influence on reading comprehension skills of children who use cochlear implants. *Journal of Speech, Language, and Hearing Research, 47*(3), 509–526. doi: 10.1044/1092–4388/4703-0509

Corina, D. P., & Emmorey, K. (1993, November). *Lexical priming in American Sign Language.* Poster presented at the 34th annual meeting of the Psychonomic Society, Washington, DC.

Corina, D. P., & Hildebrandt, U. (2002). Psycholinguistic investigations of phonological structure in American Sign Language. In R. P. Meier, K. Cormier, & D. Quinto-Pozos (Eds.), *Modality and structure in signed and spoken languages* (pp. 88–111). Cambridge, England: Cambridge University Press.

Cuculick, J., & Kelly, R. (2003). Relating deaf students' reading and language scores at college entry to their degree completion rates. *American Annals of the Deaf, 148*(4), 279–286.

Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relation to reading experience and ability 10 years later. *Developmental Psychology*, *33*(6), 934–945.

Daane, M. C., Campbell, J. R., Grigg, W. S., Goodman, M. J., & Oranje, A. (2005). *Fourth-grade students reading aloud: NAEP 2002 special study of oral reading (NCES 2006-469).* Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics.

De Villiers, P., & Pomerantz, S. B. (1992). Hearing-impaired students learning new words from written context. *Applied Psycholinguistics, 13*, 409–431.

Dillon, C.M., de Jong, K., & Pisoni, D. B. (2012). Phonological awareness, reading skills, and vocabulary knowledge in children who use cochlear implants. *Journal of Deaf Studies and Deaf Education, 17*(2), 205–226. doi:10.1093/deafed/enr043

Donne, V., & Zigmond, N. (2008). Engagement during reading instruction for students who are deaf or hard of hearing in public schools. *American Annals of the Deaf, 153*(3), 294–303.

Easterbrooks, S. R. (2010). Evidence-based curricula and practices that support development of reading skills. In P. E. Spencer & M. Marschark (Eds.), *Oxford handbook of deaf studies, language, and education* (Vol. 2, pp. 111–126). New York: NY: Oxford University Press.

Easterbrooks, S. R., & Beal-Alvarez, J. (2012). States' reading outcomes of students who are D/deaf and hard of hearing. *American Annals of the Deaf, 157*(1), 27–40.

Easterbrooks, S. R., & Huston, S. G. (2008). The signed reading fluency of students who are deaf/hard of hearing. *Journal of Deaf Studies and Deaf Education, 13*(1), 37–54.

Easterbrooks, S. R., Lederberg, A. R., Miller, E. M., Bergeron, J. P., & Connor, C. M. (2008). Emergent literacy skills during early childhood in children with hearing loss: Strengths and weaknesses. *Volta Review, 108*(2), 91–114.

Ehri, L. C. (2014). Orthographic mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning, *Scientific Studies of Reading, 18*(1), 5–21. doi:10.1080/10888438.2013.819356

Elliott, C. D. (2007). *Differential ability scale–II (DAS–II).* New York, NY: Guilford Press.

Engelmann, S., & Bruner, E. C. (1995). *Reading mastery 1 (rainbow edition).* Columbus, OH: SRA.

Fundala, J. B. (2000). *Arizona articulation proficiency scale (Arizona–3),* 3rd rev. Torrance, CA: Western Psychological Association.

Geers, A. E. (2003). Predictors of reading skill development in children with early cochlear implantations. *Ear and Hearing, 24*(1), 59–68.

Goldin–Meadow, S., & Mayberry, R. I. (2001). How do profoundly deaf children learn to read? *Learning Disabilities Research and Practice, 16*(4), 222–229.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*(1), 6–10.

Haptonstall-Nykaza, T. S., & Schick, B. (2007). The transition from fingerspelling to English print: Facilitating English decoding. *Journal of Deaf Studies and Deaf Education, 12*(2), 172–183.

Harris, M., & Moreno, C. (2004). Deaf children's use of phonological coding: Evidence from reading, spelling, and working memory. *Journal of Deaf Studies and Deaf Education, 9*(3), 253–268.

Hayes, H., Kessler, B., & Treiman, R. (2009). Spelling of deaf children who use cochlear implants. *Scientific Studies of Reading, 15*(6), 522–540.

Hermans, D., Knoors, H., Ormel, E., & Verhoeven, L. (2008). Modeling reading vocabulary learning in deaf children in bilingual educational programs. *Journal of Deaf Studies and Deaf Education, 13*(2), 155–174.

Hermans, D., Ormel, E., & Knoors, H. (2010). On the relation between the signing and reading skills of deaf bilinguals. *International Journal of Bilingual Education and Bilingualism, 13*(2), 187–199. doi: 10.1080/13670050903474093

Hile, A. E. (2010). *Deaf children's acquisition of novel fingerspelled words.* Ann Arbor, MI: ProQuest. (ERIC Document Reproduction Service No. ED513004)

Hirsh–Pasek, K. (1987). The metalinguistics of fingerspelling: An alternate way to increase reading vocabulary in congenitally deaf readers. *Reading Research Quarterly, 22*(4), 455–474. doi: 10.2307/747702

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2*, 127–160.

Humphries, T., & MacDougall, F. (2000). "Chaining" and other links: Making connections between American Sign Language and English in two types of school settings. *Visual Anthropology Review, 15*, 84–94.

James, D., Rajput, K., Brown, T., Sirimanna, T., Brinton, J., & Goswami, U. (2005). Phonological awareness in deaf children who use cochlear implants. *Journal of Speech, Language, and Hearing Research, 48*(6), 1511–1528.

Kamil, M. L. (2003). *Adolescents and literacy: Reading for the 21st century.* Washington, DC: Alliance for Excellent Education.

Karchmer, M., & Allen, T. (1999). The functional assessment of deaf and hard of hearing children. *American Annals of the Deaf. 144*(2), 67–77. doi:10.1353/aad.2012.0468

Keane, J., Brentari, D., & Riggle, J. (2013). *Coarticulation in ASL fingerspelling*. Retrieved from Jonathan Keane website: http://pubs.jonkeane.com/pdfs/Keane2012aa.pdf

Koo, D., Crain, K., LaSasso, C., Eden, G. F., & Flowers, D. L. (2008). Phonological awareness and short-term memory in hearing and deaf individuals of different communication backgrounds. In G. F. Eden & L. Flowers (Eds.), *Learning, skill acquisition, reading, and dyslexia* (pp. 83–99). Hoboken, NJ: Wiley-Blackwell.

Kuhn, M. R., Schwanenflugel, P. J., & Meisinger, E. B. (2010). Aligning theory and assessment of reading fluency: Automaticity, prosody, and definitions of fluency. *Reading Research Quarterly, 45*(2), 232–253.

Kyle, F. E., & Harris, M. (2006). Concurrent correlates and predictors of reading and spelling achievement in deaf and hearing school children. *Journal of Deaf Studies and Deaf Education, 11*(3), 273–288.

Kyle, F., & Harris, M. (2011). Longitudinal patterns of emerging literacy in beginning deaf and hearing readers. *Journal of Deaf Studies and Deaf Education*, *16*(3), 289–304. doi: 10.1093/deafed/enq069

Lederberg, A. R., & Beal-Alvarez, J. (2011). Expressing meaning: From communicative intent to building vocabulary. In M. Marschark & P. E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education* (2nd ed., Vol. 1, pp. 258–275). New York, NY: Oxford University Press.

Lederberg, A. R., Miller, E. M., Easterbrooks, S. R., & Connor, C. M. (2014). Foundations for literacy: An early literacy intervention for deaf and hard-of-hearing children. *Journal of Deaf Studies and Deaf Education, 19*(4), 438–455.

Markwardt, F. C. (1997). *Peabody individual achievement test–revised.* Circle Pines, MN: American Guidance Services.

Martin, N., & Brownell, R. (2011). *Expressive one-word picture vocabulary test,* 4th ed. *(EOWPVT–4).* Ann Arbor, MI: Academic Therapy.

Mayberry, R., del Giudice, A., & Lieberman, A. (2011). Reading achievement in relation to phonological coding and awareness in deaf readers: A meta-analysis. *Journal of Deaf Studies and Deaf Education, 16*(2), 164–188. doi:10.1093/deafed/enq049

Mayer, C. (2007). What really matters in the early literacy development of deaf children. *Journal of Deaf Studies and Deaf Education, 12*(4), 411–431.

McAfee, M. C., Kelly, J. F., & Samar, V. J. (1990). Spoken and written English errors of postsecondary students with severe hearing impairment. *Journal of Speech and Hearing Disorders, 55*(4), 628–634.

McQuarrie, L., & Parrila, R. (2009). Phonological representations in deaf children: Rethinking the "functional equivalence" hypothesis. *Journal of Deaf Studies and Deaf Education*, *14*(2), 137–154. doi: 10.1093/deafed/enn025

Mehta, P. D., Foorman, B. R., Branum-Martin, L., & Taylor, W. P. (2005). Literacy as a unidimensional multilevel construct: Validation, sources of influence, and implications in a longitudinal study in grades 1–4. *Scientific Studies of Reading, 9*(2), 85–116.

Miller, E. M.., Lederberg, A. R., & Easterbrooks, S. R. (2012). Phonological awareness: Explicit instruction of young deaf and hard-of-hearing children. *Journal of Deaf Studies and Deaf Education, 18*(2), 206–227. doi:10.1093/deafed/ens067

Moeller, M. P., Tomblin, J. B., Yoshinaga-Itano, C., Connor, C. M., & Jerger, S. (2007). Current state of knowledge: Language and literacy of children with hearing impairment. *Ear and Hearing, 28*(6), 740–753.

Moog, J. S., & Geers, A. E. (1990). *Early speech perception test for profoundly hearing-impaired children.* St. Louis, MO: Central Institute for the Deaf.

Morford, J. P., Wilkinson, E., Villwock, A., Piñar, P., & Kroll, J. F. (2011). When deaf signers read English: Do written words activate their sign translations? *Cognition, 118*(2), 286–292.

Most, T., Aram, D., & Andorn, T. (2006). Early literacy in children with hearing loss: A comparison between two educational systems. *Volta Review, 106*(1), 5–28.

National Reading Panel. (2000). *Report of the National Reading Panel: Teaching children to read.* Washington, DC: U.S. Department of Health and Human Services.

Nittrouer, S. (2010). *Early development of children with hearing loss*. San Diego, CA: Plural.

Padden, C. A. (2006). Learning to fingerspell twice: Young signing children's aquisition of fingerspelling. In B. Schick, M. Marschark, & P. E. Spencer (Eds.), *Advances in the sign language development of deaf children* (pp. 189–201). New York, NY: Oxford University Press.

Padden, C. A., & Ramsey, C. (2000). American Sign Language and reading ability in deaf children. In C. Chamberlain, J. P. Morford, & R. I. Mayberry (Eds.), *Language acquisition by eye* (pp. 165–189). Mahwah, NJ: Erlbaum.

Parault, S., & Williams, H. (2010). Reading motivation, reading amount, and text comprehension in deaf and hearing adults. *Journal of Deaf Studies and Deaf Education, 15*(2), 120–135. doi:10.1093/deafed/enp031

Park, J., Lombardino, L., & Ritter, M. (2013). Phonology matters: A comprehensive investigation of reading and spelling skills of school-age children with mild to moderate sensorineural hearing loss. *American Annals of the Deaf, 158*(1), 20–40.

Paul, P., Wang, Y., Trezek, B., & Luckner, J. (2009). Phonology is necessary, but not sufficient: A rejoinder. *American Annals of the Deaf*, *154*(4), 346–356.

Perfetti, C. A., & Sandak, R. (2000). Reading optimally builds on spoken language: Implications for deaf readers. *Journal of Deaf Studies and Deaf Education, 5*(1), 32–50.

Puente, A., Alvarado, J. M., & Herrera, V. (2006). Fingerspelling and sign language as alternative codes for reading and writing words for Chilean deaf signers. *American Annals of the Deaf, 151*(3), 299–310.

Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetsky, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest, 2*(2), 31–74.

Reitsma, P. (2009). Computer-based exercises for learning to read and spell by deaf children. *Journal of Deaf Studies and Deaf Education, 14*(2), 178–189.

Reynolds, C. R., & Kamphaus, R. W. (2008). *Test of irregular word reading*. Lutz, FL: Psychological Assessment Resources.

Scarborough, H. S., & Brady, S. A. (2002). Toward a common terminology for talking about speech and reading: A glossary of "phon" words and some related terms. *Journal of Literacy Research, 34*(3), 299–336.

Schick, B. (2013). *ASL receptive skills test–revised*. Boulder: University of Colorado.

Schwartz, L., & Schick, B. (2011). *Fingerspelling ability and phonological awareness test.* Boulder: University of Colorado.

Schirmer, B., & McGough, S. M. (2005). Teaching reading to children who are deaf: Do the conclusions of the National Reading Panel apply? *Review of Educational Research, 75*(1), 83–117.

Schirmer, B., Therrien, W., Schaffer, L., & Schirmer, T. (2009). Repeated reading as an instructional intervention with deaf readers: Effect on fluency and reading achievement. *Reading Improvement, 46*(3), 168–177.

Semel, E., Wiig, E. H., & Secord, W. A. (2003). *Clinical evaluation of language fundamen-*

tals, 4th ed. (CELF-4). Toronto, Canada: Psychological Association.

Sedey, A. (1995). *Fast mapping of novel fingerspelled words by profoundly deaf students* (Unpublished doctoral dissertation). University of Wisconsin, Madison.

Siedlecki, T., Votaw, M. C., Bonvillian, J. D., & Jordan, I. K. (1990). The effects of manual interference and reading level on deaf subjects' recall of word lists. *Applied Psycholinguistics, 11*(2), 185–199. doi: 10.1017/s0142716400008766

Silverman, R.D., Speece, D. L., Harring, J. R., & Ritchey, K. D. (2013). Fluency has a role in the simple view of reading. *Scientific Studies of Reading, 17*(2), 108–133.

Singleton, J. L., Morgan, D., DiGello, E., Wiles, J., & Rivers, R. (2004). Vocabulary use by low, moderate, and high ASL-proficient writers compared to hearing ESL and monolingual speakers. *Journal of Deaf Studies and Deaf Education, 9*(1), 86–103.

Snow, C., Burns, S., & Griffin, P. (1999). Language and literacy environments in preschools (*ERIC Digest*). Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED426818)

Spencer, L. J., & Oleson, J. J. (2008). Early listening and speaking skills predict later reading proficiency in pediatric cochlear implant users. *Ear and Hearing, 29*(2), 270–280.

Spencer, L. J., & Tomblin, J. B. (2009). Evaluating phonological processing skills in children with prelingual deafness who use cochlear implants. *Journal of Deaf Studies and Deaf Education, 14*(1), 1–21.

Spencer, P. E., & Marschark, M. (2010). *Evidence-based practices in the education of deaf and hard of hearing students*. New York, NY: Oxford University Press.

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology, 38*(6), 934–947.

Swanwick, R., & Marschark, M. (2010). Enhancing education for deaf children: Research into practice and back again. *Deafness and Education International, 12*(4), 217–235.

Thagard, E., Hilsmier, A., & Easterbrooks, S. (2011). Pragmatic language in deaf and hard of hearing students: Correlation with success in general education. *American Annals of the Deaf, 155*(5), 526–534.

Trezek, B. J., Wang, Y., & Paul, P. (2010). *Reading and deafness: Theory, research, and practice*. Clifton Park, NY: Delmar Cengage Learning.

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

Walter, G., & Dirmyer, R. (2013). The effect of education on the occupational status of deaf and hard of hearing 26-to-64-year-olds. *American Annals of the Deaf, 158*(1), 41–49.

Wang, Y., Spychala, H., Harris, R., & Oetting, T. (2013). The effectiveness of a phonics-based early intervention for deaf and hard of hearing preschool children and its possible impact on reading skills in elementary school: A case study. *American Annals of the Deaf, 158*(2), 107–120.

Webb, M. L., & Lederberg, A. R. (2014). Measuring phonological awareness in deaf and hard-of-hearing children. *Journal of Speech, Language, and Hearing Research, 57*(1), 131–142. doi:10.1044/1092-4388 (2013/12-0106

Webb, M. L., Lederberg, A. R., Branum-Martin, L., & Connor, C. M. (2014). *Evaluating the structure of early literacy skills in deaf and hard-of-hearing children*. Manuscript submitted for publication.

Wellman, H. M., & Liu, D. (2004). Scaling of Theory-of-Mind tasks. *Child Development*, *75*(2), 523–541.

Williams, C. (2004). Emergent literacy of deaf children. *Journal of Deaf Studies and Deaf Education*, *9*(4), 352–365.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson III tests of cognitive abilities*. Rolling Meadows, IL: Riverside.

Young, A., & Greig Bowers, P. (1995). Individual difference and text difficulty determinants of reading fluency and expressiveness. *Journal of Experimental Child Psychology*, *60*(3), 428–454.