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Learning a second language *via* print: On the logical necessity of a fluent first language

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How Deaf children should be taught to read has long been debated. Severely or profoundly Deaf children, who face challenges in acquiring language from its spoken forms, must learn to read a language they do not speak. We refer to this as learning a language *via* print. How children can learn language *via* print is not a topic regularly studied by educators, psychologists, or language acquisition theorists. Nonetheless, Deaf children can do this. We discuss how Deaf children can learn a written language *via* print by mapping print words and phrases to sign language sequences. However, established, time-tested curricula for using a signed language to teach the print forms of spoken languages do not exist. We describe general principles for approaching this task, how it differs from acquiring a spoken language naturalistically, and empirical evidence that Deaf children's knowledge of a signed language facilitates and advances learning a printed language.

KEYWORDS

deafness, signed languages, American sign language, deaf education, literacy

Introduction

Can people learn a language from print? Some older students and adults can learn many aspects of a foreign language using study guides, computer tools, and intensive reading (Krashen, 2004). Scholars may deduce the grammar and vocabulary of ancient languages from studying written texts, using methods from historical linguistics (Sauveur, 1878). But can children acquire a language from exposure to print?

Whether and how children can learn language *via* print is not a topic studied by educators, psychologists, or language acquisition theorists (see review in Caldwell-Harris, 2021). Yet consider a specific group of Deaf children, those Deaf children who are profoundly deaf or otherwise unable to acquire fluency in a spoken language *via* audition or lip-reading. These Deaf children are able to learn to read English. When they do, they are learning a language *via* reading, a difficult and mostly unheralded human achievement (see e.g., Hoffmeister and Caldwell-Harris, 2014; Hrastinski and Wilbur, 2016; Koulidobrova et al., 2018; Howerton-Fox and Falk, 2019). These theorists (and others cited in those journal articles) agree that the acquisition route for Deaf children relies on the same skills recruited by those scholars of ancient languages and adults taking intensive foreign language reading courses: fluency in a first language.

Who are the deaf learners?

We focus on people who must learn the written form of a language, without full access to spoken instruction or conversational interaction, due to deafness. It is useful to differentiate two categories of deaf learners.

- Those for whom amplification and/or cochlear implants supports learning a spoken language, *via* naturalistic interaction or oral speech training.
- Those for whom amplification and cochlear implants are insufficient to allow proficiency in a spoken language.

The second group are the topic of the paper. This is the group who typically learns and uses a signed language as their primary method of communication. For convenience the term Deaf¹ will be used for this group.

To understand pathways to learning English from print, these Deaf children can be divided into two further categories:

- Children exposed to signed language from early childhood due to parental or family use of signed language, or have other exposure (e.g., enrollment in signed language early intervention or preschool program).
- Children with hearing parents who do not have systematic exposure to a signed language in early childhood.

For descriptive convenience we frequently refer to the written language as English and the Deaf persons' native signed language as American Sign Language (ASL), but our concepts apply to the written form of any spoken language and the natural signed language of that community.

Challenges in learning a language *via* print

We review here three broad difficulties in learning a written language *via* print.

- Human languages didn't evolve to be learned *via* print. The result is that the route to typical first language acquisition, naturalistic learning *via* social interaction, cannot be employed.
- Deaf educators lack time-tested teaching methods for this difficult, little-studied language learning challenge. An implication is that even those Deaf children with signed language fluency will have difficulty in learning an unknown written language.

1 The capital "D" in Deaf is typically used to refer to those who identify as members of the Deaf Community and in most cases use a Signed Language.

- Deaf children who grow up with hearing parents may arrive at school to confront English print without a fully developed language.

We discuss each of these challenges in the next three sections.

How naturalistic language learning succeeds

To demonstrate the extreme difficulties of language learning *via* print, we briefly detour to the case where language learning appears to be the easiest and most automatic: naturalistic first language acquisition *via* social learning.

First language acquisition is marked by rapidity, apparent automaticity, and seeming unstopability (Lee et al., 2009). Everyday observations of this by authors in the 20th century fueled decades of theorizing about innate language-specific mechanisms (Pinker, 2003). Subsequent research and theorizing allowed the magic of childhood language learning to be unpacked into ideas that hold for either a first or second language. The required innate component is the interactional instinct—motivation to attend to communicative signals from caregivers (Lee et al., 2009) and rich social learning (Bates, 1976). The general-purpose cognitive abilities are statistical learning from repeating patterns (Saffran et al., 1996), the mentalizing ability of attending and inferring other's goals, possibly aided by the mirror neuron systems; and the ability to map symbols to meanings (Bates, 1976). These are summarized in the left-hand panel of Table 1.

The final piece of magic in naturalistic learning in childhood is that language directed to infants and toddlers is simple in vocabulary and grammar, repetitive, and refers to the concrete here-and-now (Bates, 1976). The communicative intent of the words (or signs) of early language is sufficiently simple that the meaning is understood from the context, such as questions about the infant's wants and needs; descriptions of on-going events. This results in what Krashen (1985) called "comprehensible input." Krashen's proposal, now widely accepted, is that for language-meaning mappings to occur, the language encountered must be comprehensible, i.e., the meaning is apparent from on-going interaction. Older children and adults have more difficulty learning a new language because the language they encounter is appropriate for their age, making it abstract and complex.

Even when the context is ambiguous, humans of all ages have a mechanism to aid in mapping language to meaning: they skillfully track interlocutors' intent (Moore et al., 2015). By using knowledge of human-typical goals, young children can frequently guess the meaning of an unknown word, as in fast-mapping. As an example (see Carey, 2010), preschoolers inferred that the novel word *chromium* must refer to the color olive, when

TABLE 1 What is necessary for naturalistic language learning; when it is present in learning *via* print.

Learning a first or second language naturalistically <i>via</i> social interaction: activities and abilities necessary for success	Learning a second language learning <i>via</i> print when and how are these same activities/abilities possible
Observing the social routines that accompany language; Inferring non-verbal behaviors; Tracking others' intentions	Watching video dramas with subtitles. These ideally begin with one-word phrase to make input comprehensible.
Interactional instinct; desire to communicate; rewards of social interaction	Mostly absent when first using print; texting <i>via</i> smart phones or online can mimic conversation and thus can bring social rewards
Learning linguistic sequences (natural language' sounds or hand movements)	General purpose pattern extraction mechanisms can apply to printed sequences
Mapping comprehensible input to mental concepts	Mapping printed words on consumer packaging to items in the package; Understanding placards on buildings; Picture books.

they were asked, “Bring me the chromium one, not the red one” (gesturing at a plate with a red and olive cup).

Learning outside of a social context

We now return to learning a second language from print. Printed forms rarely accompany social interaction. Text is symbolic and disembodied. Therefore, the meaning of print forms can't be inferred from the non-verbal social interactions. How can the meaning of printed words be inferred? There is one easy, efficient method: the logic of printed words' meanings and the grammar governing the logic of words' sequences must be explicitly explained. A fluent language can be used by bilingual parents and teachers to explain meanings, polysemic structure and grammatical structure, as occurs in class-room foreign language teaching.

If no fluent language is available to explain the meanings of print words, how can those words be linked to conceptual structures (to meanings)? How can printed forms be grounded (and thus embodied) in non-linguistic experiences? Deaf educators have grappled with this for years, while avoiding the answer of immersing Deaf children in a signed language prior to print exposure (Lane, 1992). For example, Van Staden (2013) describes a vocabulary intervention to boost Deaf children's ability to grasp and retain the meaning of English print words. Her project involved students at a residential school for the Deaf in South Africa. The school had a

bilingual signed language policy, with South African Signed Language (SASL) taught alongside written English. English print vocabulary was explicitly mapped to SASL signs, using the techniques of “sandwiching” and “chaining.” The first of these is a sequence where the printed word is ‘sandwiched’ between the signed language equivalents. Chaining is where the print form occurs repeatedly with different translation equivalents that may be meaningful to the learner, such as a signed form or a finger-spelled variant (Humphries and MacDougall, 1999). These techniques are used with the hope that children will infer meaning identity from the rapid juxtaposition of these symbols (Swanwick, 2016). Van Staden's (2013) intervention included additional multimodal methods such as tracing words on sandpaper, creating clay models of the words and their meanings, sorting vocabulary cards into different semantic categories, signing stories from a print book, and picture/word/sign matching exercises. These methods do make sense in terms of trying to press sensory-motor association onto lifeless graphemes.

From the standpoint of typical second language acquisition, these methods are time-consuming and cumbersome. Sandwiching is reminiscent of Helen Keller's insight when her teacher finger-spelled “W-A-T-E-R” into Keller's hands while holding her hands under running water. If children were fluent in ASL, teachers could directly state the meaning equivalency using learners' fluent language, as is the norm in any second language learning situation. With a fluent first language, learners could be informed of the approximate signed translation of the target printed word, along with any pragmatic differences or polysemic variations.

Can printed language be given a social-communicative context?

We've argued that the print form of a language is difficult to learn because print occurs outside of social interaction. Without words being grounded in human activities, words remain disembodied marks on paper. The key remedy, as we just remarked above, is explicitly teaching meanings of print words using a fluent language. However, print does exist in areas where its meaning can be inferred from context. Examples are printed words in picture books, on consumer goods, on placards on buildings, subtitles in movies, and in texting conversations on smart phones and computers. Educators and parents do draw on these, such as innovations in using texting to build vocabulary (e.g., Li et al., 2017), but educators could explore techniques to do more.

Table 1 lists four key activities that allow learning language *via* social interaction, with the right-hand column indicating what could occur for printed language. Social context or any non-verbal context is typically absent from print forms, with

exceptions noted in Table 1. The social rewards of conversation are key motivations for language learning (Lee et al., 2009), but these are mostly absent with print forms. However, conversational texting with smart phones provides some of these social rewards, and is motivating for students even when smart phones are used for school-related subjects (e.g., Li et al., 2017).

A drawback is that when conversing *via* smart-phone, interlocuters are usually not co-located, and thus do not share a non-verbal context. This lack of shared context reduces whether the phrases in a typical text-based context are comprehensible input, in the sense of Krashen (1985). If meaning is not comprehensible from context, that reduces opportunities for language learning.

Whether conversational texting could be a source of language learning akin to live social interaction has not been studied. One step would be to measure how frequently smart phones users provide each other with comprehensible input. Research on this topic could open doors for texting to be a vehicle for language learning for Deaf youth.

The difficulty of learning ancient languages

One well known example of learning a foreign language *via* print concerns learning an ancient language. Scholars have fulminated about the difficulty of this task for centuries. In 1867 John Stuart Mill wrote about the "...shameful inefficiency of the schools, public and private, which pretend to teach Greek and Latin, and do not... criminal idleness and supineness which wastes the entire boyhood of the pupils..." (cited in Sauveur, 1878, p. 4–5). Journals such as *The Journal of Classics Teaching* continue to lament this difficulty. Bracke (2015) celebrates the intellectual value of teaching Greek and Latin to youth, but soberly notes that few students succeed. "For, much as I love ancient languages, I do not think they are for everyone... and the impact learning any subject has on pupils more often results from the teacher than from the subject." She further asks, "Once a school is willing to commit to the ideology of Latin should it be offered to all pupils or only to the Gifted and Talented?" Similar themes occurred in Zeps (2010) essay titled *The Learning of Ancient Languages as (Super) Human Effort*. Zeps (2010, p. 2) laments how rare it was for any of his students to succeed, noting, "...students with excellent memory and other gifts, namely, they very easily go forward in language, but in the end, they lose interest and go astray."

We cite this literature as evidence of the difficulty of learning languages *via* print, not its impossibility. Students can learn ancient languages, which they do *via* carefully designed instruction and their fluent first language. But note that a Deaf student learning English *via* print has a big advantage over a hearing student learning Latin: the motivation of real-world

relevance. As occurs with immigrants, another highly motivated group, learning the written form of their country's majority language is a route into connecting with wider professional, intellectual and cultural life. The student of Latin can give up and pursue a different hobby or career goal.

Scholarship also exists on Deaf students learning ancient languages. Buchholz (2017, p.) argues: "... to better teach ancient languages to Deaf students, a new pedagogical approach is needed. Deaf ancient language students, who are naturally visual and acquire their first written language by eye, need to be exposed to ancient languages visually. Such an approach requires a lot of collaborative work among ancient language scholars and teachers who are also skilled in ASL to develop ancient language instructional materials for Deaf students." This echoes our argument, that a fluent signed language and innovative instruction are needed to teach an unknown written language. Signed language use is also advocated for teaching Deaf students foreign languages in general (Piñar et al., 2008).

How does learning proceed in the absence of a curriculum to teach language *via* print?

Our focus in this section is on children growing up with a signed language in the home, as is often the case with Deaf parents or Deaf family members.

Deaf children of Deaf parents get exposed to printed language in both uninstructed and instructed contexts. Deaf parents typically provide signs for words printed in children's books, and on consumer goods around the house, such as *cereal, popcorn, candy, cookie* (Maxwell, 1984; Schleper, 1997; Rottenberg, 2001; Berke, 2013). In classrooms, teachers frequently provide ASL translation equivalents for words and sentences in printed classroom materials.

When persons outside of the Deaf world observe Deaf children productively interacting with English print in these cases, it is natural to assume that Deaf children are conceptualizing the print forms as English and are thus learning English. This assumption is often incorrect. To make sense of inert printed sequences, those sequences must be mapped to internal meaning structures. Deaf children will frequently do what foreign language learners do everywhere: translate the foreign word to known vocabulary. Deaf children thus map printed words to signs (Maxwell, 1984). For the case of ASL, ASL is an SVO language like English. The structure represented in simple print sentences can then also be mapped to ASL grammatical structures.

We previously described three stages we observed Deaf children progressing through as they grappled with obtaining

meaning from print (Hoffmeister and Caldwell-Harris, 2014). These are:

- Stage 1: Mapping lexical signs (simple translation equivalents).
- Stage 2: From words to sentences: simple translation breakdown.
- Stage 3: Bilingual learning mode.

Stage 1. In the initial stages of exposure to print, high frequency, short print words are mapped to their ASL equivalents. The similarity in meaning and frequency between English and ASL forms determines how easily these mappings are retained. For children with a rich L1 and patient adults who provide mappings (or access to sign print books), the initial stage of learning can be heady, with rapid acquisition of many translation equivalents (e.g., Schleper, 1997). But learners may initially make progress by perceiving print to be a system for writing ASL on paper.

Stage 2. The direct mapping strategy is inadequate because single words and signs are frequently not simple translation equivalents.

The big-picture goal is for learners to realize that English has unique methods for conveying meaning that need to be learned on their own, not as translations in ASL. This is the stage where children can stall in their reading progress because of the inherent difficulty of figuring out function words, polysemic variations and English syntax. Academic failure and dislike of reading are likely outcomes.

Individuals with innate linguistic aptitude can often grapple successfully with complex mappings. Another route is to engage Deaf parents or other mentors in dialogue about the workings of English vocabulary and grammar (Schleper, 1997).

Stage 3. Once learners understand that English print constitutes a separate language from ASL, and have a lexicon of basic mappings, they can proceed in a bilingual learning mode, such as Cummins' (2017) comparative learning process. Learners can understand translation-inequivalence, infer meaning of new words from context (Drasgow, 1993), and make analogies to ASL morphosyntactic and metalinguistic knowledge (Czubek, 2021). Perhaps most importantly, learners' fluent first language can be used as the medium of instruction for teaching English polysemy and morphosyntax (DiPerri, 2021).

Evidence for the descriptive model and implications

Evidence for direct mapping comes from longitudinal case studies of how individual Deaf children used signed language as part of learning to read (Maxwell, 1984; Rottenberg, 2001; Berke, 2013). Maxwell (1984) documented how Alice, a Deaf girl born to Deaf parents, interacted with picture books from age 2 to 6 years of age. Alice spent her early years first signing

with her parents about the content of the story. As the years went by, Alice used ASL to add her own material about the story. Alice was especially intrigued by sign print books, which are traditional picture books illustrated with signs in Signed English or in ASL (sign print books have long been published by Gallaudet University Press). Alice's father frequently pointed to print words, provided the ASL sign for them, and finger-spelled words and proper names. Alice was eventually observed doing this herself. She would sign the ASL translations for English words, reading a story by translating it into ASL.

After age 4 Alice began to read more non-signed print books and to make signs for the English print words. Her reading of both Sign print and English print tended to be word for word and labored. Enormous concentration would be marshaled as Alice centered a page in front of her and gazed at it. By this time she read in sequence, though with frequent omissions (Maxwell, 1984, p. 208).

Rottenberg's (2001) case study also noted the early importance of Deaf children mapping print words to sign language or sign print:

As Jeffrey gained proficiency in one-to-one matching of sign print to written English, he began to rely on the sign print only if he could not gain meaning from the written English (Rottenberg, 2001, p. 274).

Other evidence that print words are mapped to signed language comes from in-depth interviews with Deaf adults. Those who were categorized as good readers reported that they learned to read by translating English print to ASL (Silvestri and Wang, 2019). Many noted that even as adults they mentally translate complex English print structures to ASL.

It has become well-known that Deaf readers activate the ASL translations of written words (Morford et al., 2011). This occurs for both middle-school (Villwock et al., 2021) and adult readers (Morford et al., 2017). As Morford et al. (2011) note, mentally activating an additional language while reading a different language is a common occurrence for bi- and multi-lingual persons. Proficient Deaf signers are thus typical bilinguals in this regard.

Berke (2013) observed Deaf parents using ASL to aid their Deaf children to move beyond transparent mappings.

Deaf mothers intuitively know that words in English may not have the same connotation in ASL. Whether or not they had training in deaf education, mothers provided an explanation of how one English word could have different ASL meanings (Berke, 2013, p. 304).

This descriptive model describes the rapid success at stage 1, which is mapping translation equivalents. Where learners typically get stuck is stage 2, when simple mappings are

insufficient. We argued that this is where explicit guidance can set a learner on the path to fully learning a language from its print form. Consistent with this point are the cases studies in which Deaf parents closely guided their children (Maxwell, 1984; Rottenberg, 2001; Berke, 2013). Details are scarce about whether parents used examples of ASL morphosyntax and polysemous vocabulary to teach English morphosyntax and polysemous vocabulary (stage 3). One example comes from Schleper's (1997) summary of strategies used by Deaf parents to foster their child's literacy development. Picture books for young children typically have repeated phrases, as in "He huffed, he puffed..." in *The Three Little Pigs*. Deaf parents would vary how they signed repetitive phrases. This variation in signing allowed their Deaf child to learn that while the English text remained constant in the book, the meaning could be signed in different ways. This demonstrated linguistic creativity, while also being a strong signal that print and ASL are separate languages.

Summary. The descriptive model is not a curriculum or even advice on how to teach Deaf children the print form of a language. Instead, these stages summarize what frequently occurs without a curriculum and with only informal teaching. The sobering implication is that Deaf children are too often on their own to figure out English *via* print. Lacking advisors and instruction on the logic and purpose of grammatical markers in the written language, common outcomes are stalled and non-proficient print reading (Caldwell-Harris, 2021). For example, some orally-trained Deaf adults who had become fluent signers and proficient readers used a semantic key-word strategy for reading in which much grammatical structure was ignored (Domínguez et al., 2014). The descriptive model is thus relevant to explaining both Deaf reading success stories and the average low achievement levels of Deaf students (Lane et al., 1996).

The challenge of language deprivation

Learning a language *via* print is challenging even when Deaf children arrive at school with proficiency in a signed language. Consider the situation of Deaf children who do not have early exposure to a signed language. Even with caring family members and physical comforts, language deprivation occurs (Humphries et al., 2014). Language deprivation means fewer age-typical opportunities for cognitive and social development. The educational consequences of this have been extensively described for many decades (e.g., Lane, 1992; Drasgow, 1993). Language deprivation impacts school readiness, which in turn sets up children for disliking school, school failure, and behavioral challenges (Johnson et al., 1989), including maladaptive behavior (Stevenson et al., 2010).

Children who have been taught *via* speech training and oral methods in regular hearing school programs sometimes do not succeed in acquiring a spoken language, resulting in low

educational achievement. Parents and educators at that point see the grave need for exposure to signed language. When sent to a school for the Deaf they may be in middle childhood and delayed in all school topics (Henner et al., 2016). Deaf schools must thus teach both children with excellent language skills and those with practically none, which constitutes another challenge for these schools.

Foundational principles for teaching a written language using a signed language

The most important principle is that proficiency in a signed language must come before a child is required to learn written forms. Exposure must be as early as possible, ideally, from infancy. The primary reason is forestalling and remediating language deprivation, given the grim outcomes described in the prior section. A secondary reason is that a proficient language can efficiently scaffold teaching of a printed language. Teachers of the Deaf need to be knowledgeable and proficient in the signed language used in the classroom. More broadly, attitudes about Deaf education among professionals and society at large need to change.

Early access to signed language reduces language deprivation

The primary purpose of early exposure to a signed language is humanitarian: to forestall language deprivation (Humphries et al., 2014), as discussed earlier. A welcome side-effect of providing early language access is that the social and cognitive benefits of early language radiate out to improve every aspect of life, including having a language for classroom communication (Johnson et al., 1989; Wilkinson and Morford, 2020).

A route for ensuring early signed language is *via* programs where deaf children acquire a signed language in a natural environment as soon as possible (Snoddon, 2008; Corina and Singleton, 2009). Current policies in schools and programs serving Deaf children in the US² are guided by an audiological model where "speech" and "audition" are the focus. As soon as an infant is identified as Deaf, audiologists are notified and recruited to design and implement a treatment plan for the infant. A parallel notification system can be instituted by contacting local agencies of Deaf professionals who will reach out to the family and provide guidance regarding ASL training XXX. This was accomplished *via* the "ASL models program for families" program, which was carried out in Scranton, PA and in Philadelphia, PA and eastern Massachusetts³. Fluent ASL users

² And unfortunately throughout the world.

who were Deaf were trained to work with non-Deaf parents and their Deaf children in the home. These fluent ASL users usually worked with parents and their Deaf child for 10–20 h a week. For parents who needed to work, the program functioned in part as day care services. By allowing time each week for parents to interact with the ASL model, ASL could be learned by parents, focusing on those signed sequences useful in early parent-infant interaction.

An ASL Models Program at the Scranton State School for the Deaf was embedded within the school program and lasted seven years until the school closed. Students who participated in the program for more than 5 years made significant gains in their ASL knowledge and in reading scores (Hoffmeister et al., 2003). A corollary to the idea of Deaf signers who visit the home is to hire Deaf teachers in preschools (Shantie and Hoffmeister, 2000). Abrams et al. (1996) described a preschool class where Deaf and hearing teachers co-teach, using a whole-language approach to build student ASL vocabularies and written English skills. Snoddon (2015) and Oyserman and de Geus (2021) discuss programs to teach signed language to parents of Deaf children.

Signed language must come before print

In a bilingual program, the written language and signed language should not be introduced at the same time or taught as if they have equal status. Proficiency in a first language is necessary before learning and teaching a written language.

This principle was recognized by early advocates of using ASL to educate Deaf students in the US (e.g., Johnson et al., 1989; Drasgow, 1993; Hoffmeister, 2000; Wilbur, 2000; Goldin-Meadow and Mayberry, 2001; Supalla et al., 2001). Drasgow (1993) raised the question of how a bilingual program for Deaf students should be structured, reviewing three approaches. In an English-centered approach, English is the primary language, but ASL is used to clarify, to explain difficult material or to answer students' questions. In the second method, English and ASL are equal in the bilingual classroom from the earliest grade levels, with both being used and taught at the same time. Drasgow's (1993) third method is what we are recommending here: A natural signed language needs to be learned first, and learned to interactive fluency, and then used as the medium of instruction for teaching the written language.

Why isn't the second method the best? Teaching English and ASL simultaneously as equivalent languages, with equal status in the classroom, is possible after proficiency is attained

3 Many of the participants continued on to college and university. Two participants in the ASL models program in Massachusetts continued at the Learning Center for the Deaf, Framingham, MA and graduated from Princeton University. Fluent in ASL one is an architect (Mansfield, J.), and the other is pursuing a PhD in theoretical physics at the U of Illinois (Lualdi, C.).

in both languages. But equal status *in the early years* has the following drawbacks.

Children will be expected to perform the difficult (and often impossible) task discussed in the prior sections. That is, the task of extracting meaning from print, without a proficient language for basic communication and explanation of the meaning of print forms.

Treating a natural signed language and a written language as having equal status ignores how the two languages can be learned using different methods. Written English must be taught explicitly. A signed language can be learned *via* naturalistic social interaction. Not taking advantage of this means missing out on the social interaction magic that makes learning rewarding and builds native-speaker proficiency at the same time as social skills.

Granting ASL and English similar status obscures the different purpose of the two languages. The former is used to scaffold learning of the latter, and for general classroom communication. Once students have gained proficiency in the written language, it can be used as a second communication mode in the classroom, or even as the primary language for school-based information.

Avoid teaching words' sounds and focus on words' meanings

Although spoken-word phonology is crucial for learning to read (Dehaene, 2009), knowing the sounds of words and graphemes is not necessary when learning a language *via* print. Humans can read without activating words' spoken phonology, using mappings that extend directly from graphemes to lexical identity and meaning (Bowers and Bowers, 2018). Phonological activation is reduced when typical hearing readers developed high reading skill. Readers frequently skip the step of phonologically decoding difficult words, because it is more efficient to access meaning directly *via* the semantic pathway (Dehaene, 2009; Bowers and Bowers, 2018). Low or no activation of spoken phonology frequently occurs when reading Chinese, since cues to pronunciation are absent or unreliable in 2/3 of characters (Cheng and Caldwell-Harris, 2011). However, note that some Deaf learners do use signed language phonology when trying to understand print (DiPerri, 2021).

Many Deaf learners may desire speech training in order to participate in spoken conversations. But if the goal is reading and writing proficiency with little or no spoken interaction, then early, lengthy training on grapheme-to-spoken phoneme correspondences is misplaced time and effort.

Ignoring spelling-to-sound patterns is especially efficient for irregular orthographies like English. Bypassing this time-consuming part of learning to read allows more time for mapping between orthography and meaning. However, without

mapping syllables to their sounds, Deaf individuals must memorize arbitrary strings of letters, a difficult task. One strategy is to focus on subparts of words that are meaningful: the words' morphology. Learning the meaning of letter clusters like *un*, *re* and *ment*. Indeed, English privileges retaining morphology over regular spelling-to-sound rules, such that the morpheme *heal* is retained in the noun-form *health* despite the difference in pronunciation. Instructional time freed-up by ignoring spelling-to-sound patterns can be turned over to learning morphology, knowledge that will aid English mastery.

Consistent with this advice, skilled Deaf readers tend to have good command of English morphology (Clark et al., 2011). Interventions to teach Deaf children morphology have improved reading comprehension and writing skills (Nunes et al., 2010).

Fluent signing is not enough for learning a print language

Knors and Marschark (2012) observed that signed language aids Deaf children initially by building reading/print vocabularies, but long-term reading for meaning achievement remains elusive. Those authors wrote, "...stagnation occurs, and the reading skills tend to lag or asymptote..." (p. 297). The implication of this comment is that proficient signing is not the magic remedy that will confer grade-level reading skills on Deaf children. We concur. Proficient signing is necessary but not sufficient. Novel curricula are needed, not methods adapted from the hearing curriculum (Lane, 1992; Greenwald, 2021).

Additional challenges involve the knowledge and quality of signed language used at schools and programs serving Deaf students. Historically, teachers lacked basic signed language proficiency and even schools for the Deaf avoided hiring Deaf teachers (Corbett and Jensema, 1981), leading to a literature on why Deaf schools should hire Deaf teachers (e.g., Shantie and Hoffmeister, 2000; Andrews and Covell, 2006)⁴. Teachers also usually present academic material at their own level of fluency and frequently must focus on the lowest achieving students in their class. Schools have the challenge of working with children who have suffered varying levels of language deprivation, with consequent low experience of academic success, poor academic skills and dislike of school (Henner et al., 2016).

Innovative teaching methods must be centered around signed-language use for Deaf students. Here we note a few recent examples of these. Kourbetis and Karipi (2021) developed tools to teach Greek Signed Language to both deaf and hearing learners (see www.sign1st.eu). The Bilingual Grammar Curriculum (BGC) developed by Czubek (2021) and DiPerri

⁴ Schools are now eager to hire Deaf teachers, but Deaf teachers are in short supply (<https://www.deafjobwizard.com/post/overcoming-shortage-of-teachers-of-the-deaf-and-hard-of-hearing>).

(2021) uses ASL to teach about ASL and used ASL to teach the structure of English. Another type of innovation centers around writing systems for ASL. The ASL-phabet uses a limited set of letter-like graphemes to depict ASL phonological features (Cripps et al., 2020). Another writing tool is ASL glossing, a system of using English printed words with additional notation to write the content of an ASL sentence (Supalla and Byrne, 2018; Cripps et al., 2020). This builds on students' established L1 fluency. One goal for future research is to systematically identify, compare and evaluate novel teaching methods.

The next section sets out what evidence exists to support these principles.

Evidence about signed language use, academic achievement and reading outcomes

We first review two reasons why many researchers believe the opposite of our argument, and why many researchers believe that using a natural signed language detracts from success in reading.

High variability in hearing abilities and reading success

Some hard-of-hearing and Deaf children can acquire basic or even good English speaking and comprehension skills *via* speech training, amplification and/or cochlear implant. Educators who use traditional instruction observe many of these children succeeding in a mainstream classroom. Such powerful personal observations invite the inference that great educational effort on the part of speech pathologists, teachers and Deaf children will lead to eventual reading success. The Deaf children and their special education team just need to keep trying. People may also focus on success stories and disregard failures, especially when failing students transfer out of a mainstream school to attend a Deaf school.

As we describe below, actual studies, not just observations, also lead to powerful, incorrect inferences.

In no research are deaf children randomly assigned to a language learning method

Over the decades, researchers have frequently analyzed English reading scores for Deaf children who learned only spoken English, comparing them to children who signed and had little to no spoken English. This would seem to be the data that would settle the question of which method is the best. Lederberg et al. (2013) and Antia et al. (2020) made this

comparison in several recent studies. A third group used both spoken English and signing. The outcome was unequivocal: markedly higher reading scores for the speaking-only group at every age tested (see illustrative graphs in supplementary files in Antia et al., 2020).

The conclusion appears unassailable: get your Deaf child in a spoken English program if you want good English reading ability. Given that the speaking-only group in the research by Antia et al. (2020) had superior reading ability to the speaking + signing group, an additional inference is to disallow use of signed language. These outcomes, present in decades of data, have long influenced educational policy (Lane, 1992).

Comparisons by Harris et al. (2017) similarly compared Deaf children with different language learning methods. They reported:

Single word reading improved at each assessment point for the deaf children but there was no growth in reading comprehension from T2 to T3 [from the second to third assessment] ...orally educated children had higher scores than children who signed in the classroom. English vocabulary and speechreading were the most consistent longitudinal predictors of reading for the deaf children. Phonological awareness was the most consistent longitudinal predictor for the hearing group and also a concurrent predictor of reading at T3 for both groups (Harris et al., 2017, p. 233).

The mistake in forming policies based on such studies is that Deaf children are never randomly assigned to sign-only vs. spoken-only language treatments. Instead, some Deaf children have sufficient residual hearing or lip-reading aptitude to succeed in acquiring language from speech. Reading for these children is the traditional hearing process of first naturalistically learning the majority language used in school, and then reading *via* decoding print forms into their auditory forms. In contrast, children in the signing-only group are bilingual, and must learn their second language *via* the written modality.

Do scholars draw unwarranted conclusions from the classroom studies comparing signing-only and orally-trained learners? Consider the following quote from Zhao and Wu (2021).

A study by Harris et al. (2017) indicated that DHH [Deaf and Hard of Hearing] children who used sign language scored lower than oral language users on many reading measures (Zhao and Wu, 2021, p. 666).

Zhao and Wu (2021) then proceed to problem-solve about why sign language is inferior to oral language for reading. They speculated:

... the mismatch in grammatical structure between the sign language system and the writing system may be linked to a delay in the reading development of DHH children (Zhao and Wu, 2021, p. 666).

Correlation is not causation. When naturally occurring groups are studied, researchers need to be aware that groups may differ in the abilities (such as residual hearing or speech reading talent) that promote success on the target measure (in this case, reading). Comparing the English reading ability of signing Deaf children to that of typical hearing children, or to Deaf children who have more residual hearing or better access to spoken language, is uninformative about the most helpful route for severely or profoundly Deaf children.

Early exposure to a signed language

A great deal of evidence has now accrued that early access to a signed language ensures typical child development (Corina and Singleton, 2009). Early age of exposure is also important for developing strong signed language skills (Henner et al., 2016). Strong language knowledge and fluency then aids classroom achievement including reading (e.g., Hrastinski and Wilbur, 2016; Henner et al., 2021; Sehyr and Emmorey, 2022).

Historically, much of evidence that signed language facilitates reading was indirect, in the form of superior reading achievement of Deaf children with Deaf parents, compared to Deaf children with hearing parents (e.g., Moores, 1982 for a review; Strong and Prinz, 2000).

But in the last 15 years, parental deaf/hearing status has been set aside in favor of directly measuring signing ability in children. The overall finding is that signing proficiency correlates with reading skills (see reviews in Chamberlain and Mayberry, 2008; Scott, 2021; Hoffmeister et al., 2022) and general classroom achievement (Hrastinski and Wilbur, 2016). Better reading skills were also found for earlier age of exposure to ASL and earlier entry to a school for the Deaf (Henner et al., 2016).

Establishing these findings required valid, psychometrically sound tests of signed ability which could be easily administered to large number of Deaf children in different geographic areas. Diverse tests were developed in the last two decades (Haug and Mann, 2008) but for years remained limited in coverage and applied to small samples (see review in McQuarrie and Enns, 2021). Robust tests have emerged in the last years, such as ASL-RT (McQuarrie and Enns, 2021) and the ASL Assessment Instrument (Henner et al., 2017; ASLAI, see Costello, 2021).

In the next section we focus on studies using the ASLAI.

Evidence on ASL facilitating English literacy

Considerable data now documents that ASL knowledge facilitates English literacy. In an early study, Hoffmeister (2000) assessed 78 deaf students, aged 8–15, using tests of ASL synonyms, antonyms, rare vocabulary, and plural knowledge. These vocabulary measures correlated with reading comprehension abilities, measured using the Reading Comprehension subtest of the Stanford Achievement Test (SAT-RC), and the Rhode Island Test of Language Structure (RITLS). Those early vocabulary tests were later developed into what is now the ASL Assessment Instrument (ASLAI).

The ASLAI is a receptive, computer-based testing battery for measuring ASL knowledge without using English print (Henner et al., 2017). Participants take the ASLAI in front of a computer, guided through tasks by instructional ASL videos. The general testing format is multiple choice task using an ASL video or a pictured object, or a signed stimulus and four subsequent signed ASL responses. Test takers select a response by clicking on a button or in the current iteration using a touch screen. Our team's method was to test whole populations in schools, using schools for the Deaf across the US.

A large database of test-takers allows multiple-regression to identify factors that impact reading ability (Scott, 2021; Hoffmeister et al., 2022). Novogrodsky et al. (2014) conducted multiple regression on reading comprehension scores across Deaf children aged 4–18, using predictors of ASL knowledge of antonyms, age, and parental hearing status (Deaf or Hearing parents). Antonym knowledge in ASL predicted 35% of the variability of reading comprehension scores. ASL antonym knowledge eliminated the advantage of Deaf parents for reading. This is both theoretically and practically important. It strengthens the conclusion of a causal relationship between ASL skills and reading. Hearing parents can be alerted that helping their Deaf child acquire signed language can boost cognitive development and school achievement (see Hall et al., 2019).

Many studies use measures of signed language vocabulary when testing signing-reading relationships, but a special role for knowledge of signed language syntax has recently been documented. Understanding the syntax of written languages has long been noted as a challenge for Deaf individuals (e.g., Domínguez et al., 2014; Antia et al., 2020). A group of orally-trained Spanish Deaf students were found to mostly ignore syntax, relying on semantic key words to gain meaning (Domínguez et al., 2014; see earlier mention of this study and discussion in Caldwell-Harris, 2021).

According to the ideas presented here, Deaf students growing up with strong signing skills should be better prepared to learn a written language, including its syntax. Hoffmeister et al. (2022) used knowledge of ASL vocabulary and syntax to predict knowledge of written English syntax (using the RITLS). These 517 participants were 7–18 years of age, and

34% were native signers, defined as having at least one Deaf parent. The two ASLAI vocabulary measures (Synonyms and Antonyms) correlated with English reading comprehension (SAT-RC) with r values of $r = 0.51$ and $r = 0.54$. The ASL vocabulary correlations with English syntactic ability (RITLS) were $r = 0.62$ and $r = 0.65$. Hoffmeister et al. pursued a unique analysis in which the 4 quantiles of English language ability levels were separately analyzed. Knowledge of ASL syntax predicted knowledge of English syntax for each of the four ability levels. Also striking was how analogical reasoning in ASL was associated with English reading at every ability level. These results are strong support for cross-linguistic, cross-modality transfer in the domains of understanding English print including understanding English syntax.

The findings reviewed here parallel other studies showing relationships between ASL lexical knowledge and print decoding skills (e.g., Mayberry et al., 2011; Hrastinski and Wilbur, 2016; see also Hermans et al., 2008 for correlations between Signed Language of the Netherlands and reading Dutch).

Conclusions

Of the three types of bilingual curricula discussed by Drasgow (1993), the optimal method is to allow natural learning of signed language first, and then use signed language to teach the written language. This is the least frequently implemented method in the US and many other countries. Privileging dominant spoken languages has been standard practice for centuries (Lane, 1992; Lane et al., 1996; Greenwald, 2021). Because of this, Deaf students in the US experience a spoken English-centric education (Singleton and Meier, 2021), or are exposed to ASL and English simultaneously (see reviews in Howerton-Fox and Falk, 2019). This likely reflects cultural imperialism, viewing “deafness as deficient” (Cripps et al., 2020) and viewing signed languages as inferior to spoken languages (Henner and Robinson, 2021).

The point we have argued is a logical one, although also consistent with empirical data, reviewed in the prior section. No human can learn the print form of a novel, unknown language without using a known language to explain the vocabulary and grammar of the novel language. The logical result for Deaf children is that signed language must be used as the base language for learning. Does anyone not accept this logic? Cripps et al. (2020) note that indeed, consensus is lacking. They cite Luckner (2013), an expert in deaf education, who wrote: “...research demonstrating that deaf students who are deaf or hard of hearing develop reading skills differently from typical hearing students has not been produced...” (Luckner, 2013, p. 15).

Lack of consensus may occur because researchers vary whether their reference group is Deaf children who can gain information from speech vs, those Deaf children who

cannot acquire spoken language (Napoli et al., 2015). Does our position of “signed languages before spoken/written languages” thus only hold for those Deaf children for whom amplification and speech training fails to deliver proficiency in a spoken language? No. All Deaf and hard-of-hearing children can benefit from exposure to signed languages from birth.

To summarize the benefits of early exposure to signed languages:

- Bilingualism from birth is an advantage for children regardless of hearing status (D’Souza et al., 2020).
- While many Deaf and hard-of-hearing children may eventually do well in acquiring spoken language, no disadvantages occur for learning signed language while also being exposed to a spoken language *via* amplification or cochlear implants (Davidson et al., 2014).
- It is impossible to predict which Deaf children will eventually succeed with spoken language (Szagun and Stumper, 2012; Napoli et al., 2015).
- Because spoken language access is unreliable and requires intense investment, Deaf children need early access to signed language for basic cognitive and social development (Humphries et al., 2016; Swanwick, 2016).
- To eliminate language deprivation and increase academic achievement for Deaf individuals, the key path forward is to build consensus among Deaf educators to foster early signed language use.

English-centric Deaf education must be set aside. The field of Deaf education can elaborate views of Deaf education that are rooted in signed language, as described above and elsewhere (e.g., Schleper, 1997; Hrastinski and Wilbur, 2016; Supalla and Byrne, 2018; Hall et al., 2019; Czubek, 2021; Kourbetis and Karipi, 2021; Kuntze and Golos, 2021; Pagliaro and Kurz, 2021).

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In writing about multicultural education policy in US public schools, Valdés (2021) wrote, “Educating children in a language they neither speak nor understand is an enormous challenge.” This is the situation currently facing Deaf children, but worse. The typical hearing immigrant child has a first language that can be used as the basis for learning the second language. Deaf children deserve no less. Proficiency in signed language first, and then a classroom environment in which that fluent first language can be used to tackle the enormous challenge of learning a written language without knowing its spoken form.

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All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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