CHALLENGING THE ORAL-ONLY NARRATIVE: ENHANCING EARLY SIGNED INPUT FOR DEAF CHILDREN WITH HEARING PARENTS

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Received: 04.11.2021.
Accepted: 13.09.2022.

REVIEW PAPER
UDK: 81'221.24-053.2
doi: https://doi.org/10.31299/hrri.58.si.1

Abstract: *Learning a language is, at its core, a process of noticing patterns in the language input surrounding the learner. Although many of these language patterns are complex and difficult for adult speakers/signers to recognize, infants are able to find and learn them from the youngest age, without explicit instruction. However, this impressive feat is dependent on children's early access to ample and well-formed input that displays the regular patterns of natural language. Such input is far from guaranteed for the great majority of deaf and hard of hearing (DHH) children, leading to well-documented difficulties and delays in linguistic development. Efforts to remedy this situation have focused disproportionately on amplifying DHH children's hearing levels, often through cochlear implants, as young as possible to facilitate early access to spoken language. Given the time required for cochlear implantation, its lack of guaranteed success, and the critical importance of exposing infants to quality language input as early as possible, a bimodal bilingual approach can optimize DHH infants' chances for on-time language development by providing them with both spoken and signed language input from the start. This paper addresses the common claim that signing with DHH children renders the task of learning spoken language more difficult, leading to delays and inferior language development, compared to DHH children in oral-only environments. That viewpoint has most recently been articulated by Geers et al. (2017a), which I will discuss as a representative of the many studies promoting an oral-only approach. Contrary to their claims that signing degrades the language input available to DHH children, recent research has demonstrated that the formidable pattern-finding skills of newborn infants extends to linguistic cues in both the spoken and signed modalities, and that the additional challenge of simultaneously acquiring two languages is offset by important "bilingual advantages." Of course, securing early access to high quality signed input for DHH children from hearing families requires considerable effort, especially since most hearing parents are still novice signers. This paper closes with some suggestions for how to address this challenge through partnerships between linguistics researchers and early intervention programs to support family-centered bimodal bilingual development for DHH children.*

Keywords: *sign language acquisition, deaf children, cochlear implants, bimodal bilingualism, early intervention, language input; infant perception*

1. INTRODUCTION

How do children learn language? This question is deceivingly simple, and we may be tempted to assume that the answer is simple as well. After all, the vast majority of children around the world learn language successfully, and most of them end up knowing more than one. Yet there are myriad factors that influence and shape language development, many of which are still poorly understood. The modern study of first language acquisition focuses on the child's linguistic environment as well as the internal capacities, which I take to be universal, that the child has at their disposal for the task of language learning. Both of these components are deeply affected by the context of deaf and hard of hearing (DHH) children growing up in hearing families who have no prior experience with deafness or sign language. These DHH children often experience an initial period of language deprivation during which their access to input in any language is severely restricted. Even under such adverse conditions, children's pattern-seeking capacity remains intact, allowing some DHH children to innovate surprisingly sophisticated communication systems known as *homesigns*, displaying to varying degrees structural features that are characteristic of natural languages (Goldin-Meadow, 2020). However, it is not

at all clear that language-deprived DHH universally create homesigns, or if they do, that these systems all reach the same levels of linguistic complexity (Koulidobrova and Chen Pichler, 2021). More generally, language learning outcomes for these DHH children in signed, spoken and written modalities are highly variable and lag behind those of their peers, a sober demonstration that it is very possible for language input to be so degraded and/or delayed that even children's most resilient innate language-learning capacities cannot fully compensate.

Many studies claim that signing DHH children from hearing families lag behind those adhering to an oralist philosophy in multiple domains, including spoken word recognition (Osberger & Fisher, 2000), speech perception (Kirk et al. 2002), speech intelligibility (Tobey et al. 2000), and expressive spoken language skills (Geers et al. 2003). These studies suffer from methodological flaws, detailed in Section 2.1, that are so critical, they cast serious doubt on the conclusion that sign language input actually obstructs language development (in either language) for DHH children in hearing families. Yet professionals influenced by these findings advise parents of DHH children to avoid signing and focus on a monolingual, spoken language (oralist) approach. Unlike the researchers cited earlier who carefully avoid stating *why* signing should lead to inferior language development, many professionals present their own interpretations of those findings as evidence that signing will demotivate DHH children from learning to speak, or slow their development by requiring them to attend to more than one language, in different modalities. Furthermore, parents are discouraged from signing by the implication that their non-native input will be insufficient to support their DHH child's sign language development and may even ultimately be detrimental to their spoken language development.

In reality, research on signing DHH children from hearing families is frustratingly vague on the nature of those children's exposure to signing (Dills and Hall, 2021). How early was sign language used with the DHH child? Who are the children's signing interlocutors, and what is their signing proficiency? What proportion of the child's input is in sign language, sign supported speech, or spoken language? What is the child's own signing proficiency? Serious investigation of these basic questions is key to answering the ultimate question of whether or not sign language is a beneficial option for DHH children in hearing families. In this paper, I ask what aspects of sign language are most valuable for hearing parents to master for their DHH child's *very early sign language development*, a question that to my knowledge has not yet been explored empirically. I look to the extensive literature on infant perception for clues about what features of early signed input might be the most important for establishing a strong foundation for subsequent development by DHH infants in hearing families.

Studies of hearing infants reveal that they are highly attuned to and able to track phonological and prosodic patterns of spoken languages (e.g. Nazzi and Mehler, 1998). They are also sensitive to recurring prosodic patterns of natural sign languages, a surprising result, given that they have no previous experience with signing (e.g. Brentari et al., 2011). Furthermore, studies on bilingual infants indicate significantly heightened and extended attention to visual cues that facilitate the task of learning two languages at once (e.g. Weikum et al., 2007). It appears that bilingual input triggers certain "bilingual advantages," which in turn help infants manage the additional demands of learning more than one target language. These results suggest that even in the context of spoken language acquisition, hearing infants attend to linguistically-relevant visual cues much more than previously assumed. The collective findings of these recent infant perception studies have obvious relevance for DHH children's bimodal bilingual development, and I will discuss them explicitly in that context, arguing that the logical next step is to expand these lines of investigation to include DHH children. Specifically, research should include DHH infants growing up in hearing families who have committed to learning and using a natural sign language in addition to their spoken language(s). Such families constitute a critical test case for informing the heated debate about whether early sign language

exposure helps or hurts DHH children's spoken language development.

The organization of this paper is as follows. Section 2 discusses Geers et al. (2017a), a recent publication that is representative of research used by professionals to justify an oral-only approach for DHH children. Central to these arguments is the strongly utilitarian view of signing as a tool, rather than a true language, and the idea that bimodal input will overwhelm the DHH child's already compromised ability to detect the linguistically relevant patterns that underlie language acquisition. That basic premise is challenged in section 3, beginning with the observation that natural human languages are organized around complex patterns that infant brains are designed to recognize from a very early age. I overview the impressive pattern-finding abilities that enable very young children to "break into" language learning during infancy, provided they have access to high quality linguistic input. These findings extend to bilingual contexts, where findings indicate that although linguistic patterns in bilingual input are quite complex, bilingual babies are equipped to manage them, provided (again) that their linguistic input is of high quality. Section 4 discusses the challenges of providing quality sign language input to all deaf children and explores strategies for enriching the quality of their sign language input, even for deaf children whose parents are new signers. The paper closes with a summary and some suggestions for future research in section 5.

It is worth clarifying from the onset that my disproportionate focus on prosody and phonology in this paper does not mean that lexical, morpho-syntactic or discourse knowledge are less important for sign language development. Intervention strategies targeting other aspects of sign language are clearly also needed, particularly at the syntactic level; hearing parents interviewed by Chen Pichler (2021) repeatedly named word order as an aspect of ASL that they found frustratingly hard to learn. However, given the challenges that hearing parents face as they attempt to learn to sign well, quickly, I am exploring here what might happen if we allowed parents to *initially* focus their attention mostly on prosody and phonology, two areas in which newborn infants happen to display impressive sensitivity.

2. ARGUMENTS AGAINST EARLY SIGN EXPOSURE AND THE UTILITARIAN VIEW OF SIGN LANGUAGE

The view that bimodal bilingualism is disadvantageous for DHH children has been prominent throughout history, and families of deaf children are commonly advised to adopt an oral-only approach for best outcomes. Proponents of the oral-only approach reason that DHH children face steep challenges in accessing and developing spoken language, requiring them to concentrate all their efforts in that area. As a more readily accessible alternative that is thus easier to learn than speech, signing is portrayed as a "crutch" that will render DHH children "lazy" by providing a shortcut to communication without doing the hard work of developing spoken language (Mathews, 2011). If proponents of this view accept sign language at all, it is only in a secondary, subordinate role to spoken language, as expressed in the statement below from Jane Madell, an influential and outspoken American pediatric audiologist.

(1) "...you can't learn spoken language and sign language at the same time...You can learn sign language as a teenager if you have learned oral language...But if you start teaching little kids sign language... they're going to get the visual and they're not going to respond to the listening." - Madell (2017)

The claim that one "can learn sign language as a teenager" illustrates another argument that is often repeated in support of an oral-only approach for DHH children. Ample research has demonstrated that spoken language acquisition is subject to "critical periods" early in life, when the human brain is especially primed for acquisition (Johnson and Newport, 1989; Mayberry, Lock, and Kazmi, 2002). If spoken language is the goal for DHH children, then they need access to spoken language input as soon as possible. In contrast, oral-only proponents frequently claim that the critical period for sign languages is longer than for spoken language (or nonexistent), as further illustrated by the statements below.

(2) "The window for a deaf child to acquire LSL (listening and spoken language) is much shorter than the window in which ASL can be acquired." - Goldberg & Sugar (2015)

(3) "The only way a child can later have a real choice about talking and/or signing, is if the brain pathways for spoken language are developed within the first few years of life. Signing can be learned later in life; talking cannot." - Madell (2016)

There is no empirical support for such claims. On the contrary, researchers have consistently documented adverse effects of delaying DHH children's exposure to sign language, negatively impacting their development in not only their sign language, but also their spoken/written language (Mayberry et al., 2002; Morford 2003; Clark et al., 2016). Furthermore, these critical period effects persist throughout the lifespan, even after decades of immersion in signing environments. Simply put, the "window" for optimal acquisition is short for any language, signed or spoken.

Underlying the characterization of sign languages as a "crutch" for DHH children and the claim that they are subject to a longer critical period is a strictly utilitarian view of sign languages that remains pervasive and highly entrenched in modern society. Sign languages are embraced as a tool, but rejected as language. This stance makes it possible for society to display unprecedented levels of enthusiasm towards signing, driving (hearing) enrollment in college/university ASL classes up by 432% from 1998 to 2002 (Welles, 2004) and spawning a ubiquitous parenting trend of signing with (hearing) babies, while simultaneously rejecting the use of sign languages with DHH infants. Ironically, the popularity of baby signs has especially reinforced the utilitarian view of sign languages, by presenting signs as temporary "bridges" to spoken language that are useful for communication until the child learns spoken words, at which point the signs are discontinued (Chen Pichler, 2016). With such an impoverished view of signing, it is no wonder that parents of DHH children are reluctant to rely on a sign language as a first language for their child.

2.1 Justification for an oral-only approach: Geers et al. (2017)

The utilitarian view of sign languages is also evident in much of the research cited by oral-only proponents to justify their position, as exemplified by the highly influential report published by Geers et al. (2017a). In a comparison of cochlear implanted children with and without exposure to signing, they reported that those who did not sign (the "No Sign" group) were much more likely than their signing counterparts (further subdivided into "Short-term" and "Long-term" signers) to achieve age-appropriate scores on measures of speech recognition, speech intelligibility, reading comprehension and a battery of spoken language skills (e.g. antonyms, nonliteral language, pragmatic judgment, sentence comprehension). Geers et al. concluded that parental signing is a critical factor contributing to language delays for deaf children, concluding that "children whose parents signed [with them] were statistically significantly more likely than children of nonsigning parents to exhibit spoken language delays in elementary grades and to fall behind age-mates in reading comprehension by late elementary grades" (2017a: 6). These language delays reportedly became greater the longer parents continued to sign. In an interview at her home university about the findings of the Geers et al. (2017a) study, Geers concluded that they "[affirm] the decision of many hearing parents who choose not to use sign language when their child receives a cochlear implant" (UT Dallas Office of Media Relations, 2017).

However, close examination of the Geers et al. (2017a) study reveals a number of methodological flaws that cast serious doubt on its findings. Many of these shortcomings were pointed out during a flurry of peer commentary posted by prominent sign language researchers on the website of the journal in which the original article appeared. First, children were assigned to the signing groups if their parents reported any of the following forms of signing being used "at least 10% of the time at home and/or in the child's intervention program: ASL, Total/Simultaneous Communication, baby sign, Signing Exact English, sign language, sign support or Pidgin sign" (Geers et al. 2017a: 2). With the exception of ASL

(and possibly the item puzzlingly labeled as "sign language"), none of these forms of signing exhibit the underlying structure and consistent organizational patterns of natural languages (Caselli, Hall and Lillo-Martin, 2017). Conflating ASL with artificial signing systems that violate grammatical principles found across natural sign languages, or baby signs that amount to little more than isolated vocabulary items, reflects the view of signing as a tool rather than an actual language. It is a methodological shortcoming common to many studies purporting to test the effect of signing on spoken language development (Fitzpatrick et al. 2016). Furthermore, Geers et al. (2017a) failed to verify whether the children in their signing groups actually acquired any signing proficiency themselves. Certainly, their 10% exposure threshold is very low; it is questionable how much signing most children would acquire with such minimal exposure, and Geers et al. do not report signing proficiency of the signing children in their study. If children fail to acquire the linguistic aspects of their signed input, it should not be surprising if they derive no linguistic benefit from it, either.

A third aspect of the Geers et al. (2017a) study that drew widespread criticism (e.g. Corina 2017) was their conclusion that sign exposure causes poor language outcomes simply because sign exposure correlated with poor outcomes in their data set. In the US and around the world, it is not uncommon for deaf children who fail to develop speech under oral-only programs to be transferred to programs where some form of signing is used. In these cases, children's exposure to signing is a result of their poor language development rather than the cause of it. There are also many other factors besides sign exposure that could have potentially impacted children's language development, including maternal education level, family socioeconomic status, children's age of cochlear implantation and (a related factor) the length of time children went without language input while waiting for implantation. Since Geers et al. (2017a) did not control for any of these factors, and could not randomly assign participant children into signing and No Sign groups, their conclusion that sign language exposure had in any way impeded children's spoken language outcomes is inappropriate.

A true test of how sign language affects DHH children's spoken language development requires examining those with substantial exposure to an actual sign language early in life, such as cochlear implant users[1] who have been exposed from birth to fluent sign language input from their Deaf, signing parents. Davidson et al. (2014) assessed ASL and English proficiency for a small group of these *bimodal bilingual* deaf children (sometimes referred to as *Deaf of Deaf with Cochlear Implants* or *DDCI*) and found their English scores to be within the range reported for hearing children with respect to expressive vocabulary, phonological awareness, articulation, productive syntax and general linguistic development. Importantly, DDCI children's scores were on average higher than those previously reported from cochlear implanted children adhering to oral-only approaches. Davidson et al. (2014) concluded that "natural sign language input does no harm and may mitigate negative effects of early auditory deprivation for spoken language development." Similar conclusions have emerged from a growing number of studies of DDCI children in various countries (Quadros et al. 2015, Mouvet et al. 2013, Rinaldi and Caselli 2014, Giezen et al. 2014, *inter alia*). Giezen (2011) concluded that "signed input should not be withheld from children with a CI, especially given its importance in stimulating early social and cognitive development, in the case of implant malfunctioning and in facilitating interactions with deaf peers without a CI. In fact, this speaks for *bilingualism in a spoken and a signed language as the ultimate goal in the rehabilitation and education of children with a CI"* (p. 280, emphasis added).

2.2 Challenges of L1 sign language acquisition from non-native parental sign language input

The findings from studies of DDCI children, though preliminary, offer compelling evidence that

[1] Hearing children of Deaf, signing parents (codas) could also be considered a test case for the effects of early sign language exposure on spoken language development, but their unfettered access to spoken language from birth makes them a less appropriate comparison group for deaf children who must access spoken language through technological amplification.

early and fluent exposure to a natural sign language does not impede spoken language development, and may in fact facilitate it, protecting children from the dangerous effects of early language deprivation in the 11 or more months prior to activation of a deaf child's cochlear implant. Natural sign languages provide infants with the complex linguistic patterns that their brains expect to encounter, and language acquisition can begin on schedule. However, this optimal scenario occurs with abundant, fluent sign language input, a commodity to which DDCI children have access from birth. In contrast, an estimated 95% of DHH children are born to hearing parents (Mitchell and Karchmer, 2004) who have no knowledge of any sign language and are understandably daunted by the prospect of having to learn one quickly. This fact is also increasingly cited as justification for not signing with DHH children, supported by the spurious argument that since sign languages are complex languages distinct from spoken languages, they are too difficult for hearing parents to learn. While Geers declares that her research team's results "should not be interpreted to suggest that we don't consider American Sign Language to be a real language," she adds that "[d]ifferences in syntax, phonology, and spatial information between ASL and spoken language limit simultaneous use of both languages" (Geers, Mitchell, Warner-Czyz,Wang and Eisenberg, 2017b), as if families would only ever consider using ASL simultaneously with English, rather than as an autonomous language. Thus she maintains that the composition of the study's "signing group" reflected "real-world situations across the United States, in which the majority of deaf children have hearing parents … who typically lack proficiency in ASL and cannot provide a language-rich environment in both ASL and spoken English" (quoted in Gensch, 2017).

While it is certainly true that second language acquisition of any language poses significant challenges to most adults, the ultimate question of whether hearing parents can provide DHH children with sufficient sign language input to support successful spoken and sign language development is still largely unexplored, for a variety of reasons (Chen Pichler, 2021). Very few hearing parents have the resources they need to learn how to sign in a manner that meets the visual needs of their DHH children, especially outside of urban areas (McKee and Vale, 2014). Families fortunate enough to live near schools for the Deaf might receive home visits from an early-intervention worker, but these visits typically only last about an hour a week. In the U.S., many colleges offer more substantial ASL instruction, but they are costly in both time and money, and do not teach the child-directed register of signing that is appropriate to use with young children (Napier, Leigh and Nann, 2007). Some family-centered ASL classes are tailored to the needs of parents with DHH children, but are of variable quality. Family-based ASL curricula exist, but none is yet widespread; even the most recognizable of these, the SKI-HI curriculum for ASL from the Deaf Mentor Curriculum (Pittman, 2001), is currently used in only a handful of states with Deaf Mentor Programs (Hamilton & Clark, 2020).

Given these conditions, even researchers supportive of early sign language have adopted a discouraging outlook. Knoors and Marschark (2012) lament "the unavailability (impossibility?) of fluent language models from an early age for deaf children with hearing parents" (p. 294) as one of the main obstacles to DHH children developing as successful bimodal bilinguals, while Mayer and Leigh (2010) remark that "[s]ignificantly delayed first language acquisition is likely to be a hallmark of L1 (sign language) learning by all deaf children whose hearing parents have no prior experience of deafness" (p. 179). Geers et al. (2017b) are correct that most hearing parents currently lack the resources needed to attain sign language proficiency that can in turn support optimal sign language development for their DHH child. However, it would be inappropriate and premature to interpret that fact as evidence that hearing parents *cannot* attain signing proficiency and therefore *should not* use sign language with their child. Ultimately, very little is known about hearing parents' potential to learn and use sign languages in a family context; they are rarely the subject of academic research, and even in programs specifically designed to teach hearing parents to sign, their learning is not systematically assessed, to avoid making them feel like they are being "tested" (Chen Pichler, 2021).

Whether hearing parents are capable of providing "a language-rich environment" to support their DHH children's bimodal bilingual development should thus be considered an empirical question still awaiting systematic investigation. Important questions include those proposed in (4).

(4) (a) How proficiently do hearing parents need to sign in order for their DHH children to achieve the successful language outcomes reported for DDCI children? (b) Is there a minimum sign language proficiency level below which parental signing becomes a liability rather than a benefit for their children's language development? (c) How can hearing parents who are still learning to sign optimize their signed input to provide patterned visual input that best supports DHH infants' early linguistic development?

These are urgent questions that must be answered if we hope to develop improved support for sign language learning among hearing parents and expand the benefits of bimodal bilingualism beyond children from Deaf-parented families. Answering questions (4a-b) will require careful tracking and analysis of parents' sign language proficiency,[2] as well as the spoken/written and sign language proficiency of their DHH children, a significant undertaking to which I will return in section 4. Answering question (4c) begins with understanding what patterned linguistic input young infants naturally attend to and how those patterns manifest in sign languages. Fortunately, this is an area that has recently attracted research attention, with encouraging results. The next section overviews research on newborn infants' sensitivity to subtle linguistic patterns of both spoken and sign languages, beginning at a remarkably young age. These findings challenge the notion of early sign language input as a "distraction" to spoken language development and suggest potential fruitful directions for parental sign language training.

3. INFANTS ARE ATTUNED TO THE PATTERNS UNDERLYING NATURAL HUMAN LANGUAGES, BOTH SPOKEN AND SIGNED

Infants are born with sophisticated pattern-seeking abilities that are highly attuned to the systematic regularities of human languages. They are sensitive to and capable of tracking the linguistic patterns in the language input around them, extracting the basic grammatical rules of their *target language*, the language of their environment, without explicit guidance. The grammatical rules they deduce are not the rules of writing and "proper grammar" that are taught at school, but rather structural regularities that describe how members of the child's language community pronounce and use words, build sentences, and organize their discourse. Most people are not consciously aware of the grammatical rules that underlie their native language (that is the work of linguists!), yet as infants, their brains were able to extract those rules from the language input around them. This is true for all natural languages, whether spoken or signed, but the vast majority of language acquisition research focuses on hearing babies learning spoken languages, so I begin with that literature first.

3.1 Newborn discrimination and perceptual narrowing for spoken language

One well known example of infants' ability to track patterns from their linguistic input comes from newborn language discrimination studies. In the 1990's, researchers devised methods for testing whether newborn hearing babies could distinguish or *discriminate between* various pairs of spoken languages (Mehler and Christophe, 1995, Nazzi and Mehler, 1998). Babies sucked on a spe-

[2] Had Geers et al. (2017) documented details about the signing proficiency of the parents in their signing groups, that information would have been relevant to determining where points (4a) and (4b) fall along an ASL proficiency scale, since their signing skills are presumably either at or below point (4b). Parental signing is of course not the focus of Geers' research, and she has explicitly stated that the (2017) study "[did] not aim to examine the effects of proficient ASL exposure on outcomes in pediatric CI users. Rather, we investigated whether more focused spoken language exposure, free from distraction of manual signs, would provide a more attainable broad-based strategy for verbal language development" (quoted in Gensch, 2017). She does, however, concede that "[p]erhaps, if parents started signing early with their child, more dramatic language gains would be observed" (ibid).

cial pacifier connected to a computer that recorded their rate and strength of sucking. Each time they sucked hard enough, they triggered a loudspeaker to play a recording of a woman's voice speaking a sentence in a certain language, e.g. English, in the case of the French babies tested by Nazzi and Mehler (1998). Initially, the babies were intrigued by this spoken English and sucked enthusiastically to hear it again, but eventually they *habituated* and their sucking rate dropped. At this point, researchers switched the audio recording to a new voice, beginning the experimental phase of the study. The new voice spoke in a different language than the voice in the habituation phase, e.g. Japanese instead of English. In response, babies' sucking rate increased again, an indication that they were somehow able to discriminate English from Japanese. Crucially, babies who were switched to a new voice, but one that still spoke English, did not increase their rate of sucking. Similar results have been reported for hearing babies tested on a variety of spoken language pairs[3]. With age, babies' discrimination abilities become more specific to their language environment; while they continue to discriminate contrasts present in their native language(s), the may lose the ability to discriminate contrasts that exist in foreign languages, but not their own (Maye, Weiss and Aslin, 2008).

How are newborns able to distinguish between languages, even those that they have never heard before? Part of their success comes from linguistic experience. Even in utero, hearing fetuses can hear their mother's voices. Individual *phonemes* (consonant and vowel sounds) may be muffled and indistinct, but *prosodic patterns* involving stress, pitch, intonation, etc. of the mother's speech are still discernible, and hearing babies grow accustomed to them even before they are born. Every natural language has its particular prosodic patterns, and infants appear especially sensitive to this kind of information, keeping track of the particular rhythmic regularities of their target language. Beyond language discrimination, babies' knowledge of the prosodic patterns of their language also serves the important function of helping them "break into" lexical (vocabulary) learning. Much of the speech input that hearing babies receive consists of multiword utterances rather than words in isolation. Unlike written text, in which individual words are separated by blank spaces, running speech poses a greater challenge to determining the starting and ending points for each word. Babies recognize the prosodic cues that many languages use to signal ends of phrases and sentences (e.g. pauses, falling intonation, lengthening of the final syllable, etc.) and can use those cues to segment the speech stream into smaller phrases. From there, further segmenting of those phrase units into individual words is facilitated by babies' increasing awareness of the specific phonemes (sounds) and sound patterns of their target language.

There are an estimated 800 distinct phonemes across the world's spoken languages (Stilp and Assgari, 2015) but any given language uses only a small subset (e.g. both English and Croatian use an estimated 30-40 phonemes according to Jelaska (2004)). Initially, infants notice subtle differences between phonemes, even when those contrasts are important in other languages but not in their own. This ability is strongest in the first half year of life, then begins to change as a function of the language environment. Infants track the frequency with which specific phonemes occur in the language around them, and somewhere between 8-12 months, gradually shift their attention to only those sounds. Kuhl et al. (2006) demonstrated that Japanese and American infants were equally accurate in distinguishing the spoken syllable /ra/ from /la/ at 6-8 months, a distinction that Japanese adults do not make, since the two forms are interchangeable in Japanese. However, by 8-10 months, Japanese infants were less accurate in discriminating between the two forms, while the American infants became more accurate. Kuhl (2004) describes this process of perceptual narrowing as a transition from being "universal listeners" to "language bound listeners," who tune out patterns

[3] Some language pairs such as Dutch and English were not discriminated by babies, not even by the youngest ones. English and Dutch share very similar stress and intonation (prosodic) patterns, so this result demonstrated that although newborns are sensitive to rhythmic patterns, that sensitivity is still fairly broad. Once babies have acquired more experience with language sounds, around five months, knowledge of those sounds helps them discriminate between prosodically similar languages like English and Dutch.

that are not relevant to their own language so they can better focus[4] on the ones that are.

3.2 Discrimination of linguistic features of sign languages

On the one hand, it is astonishing to realize how sophisticated newborns are in their ability to detect and keep track of the subtle linguistic patterns distinguishing one spoken language from another. After all, babies at this age are cognitively immature and have short attention spans, characteristics that seem incompatible with the ability to track statistical regularities in their linguistic input. On the other hand, infants have no way of knowing what language environment they will be born into, so here is a clear benefit of being equipped with the ability to detect linguistic patterns that underlie any of the 6000+ extant languages. Extending this thinking, it is reasonable to predict that infants should also be born similarly equipped to detect linguistic nuances that occur among the world's signed languages that developed naturally in Deaf communities. Like natural spoken languages, natural sign languages are complex linguistic systems that display regular patterns of organization across all levels of language: phonology, morphology, lexicon, syntax and discourse. Decades of research on sign languages has demonstrated that certain linguistic patterns are the hallmark of all human languages, both signed and spoken. Humans are born expecting to encounter specific types of linguistic patterns in their input, and their brains are equipped to find those patterns, but can they recognize them when they are perceived visually rather than aurally?

Recently, researchers of infant perception have expanded their investigations to include natural sign languages, although participants are still almost exclusively hearing rather than deaf babies. A subset of these studies focuses on reactions of hearing infants and toddlers who are sign-naïve (i.e. with no previous exposure to any natural sign language) as they watch various types of signed input. At a very broad level, Krentz and Corina (2008) reported that hearing 6-month old sign-naïve infants looked longer at videos of a woman signing a story in American Sign Language (ASL) than at videos showing the same woman telling a story through pantomime. 10-month old babies, however, showed no preference for one video or the other. Although both ASL and pantomime present complex visual patterns, ASL is a natural language, while pantomime is not. Krentz and Corina drew parallels between their findings and existing claims that hearing infants have an early speech-specific bias, preferring the sound of human speech over complex but non-linguistic sounds (Vouloumanos and Werker, 2004), and concluded that this preference is better characterized as *language*-specific, predisposing infants towards complex *linguistic* signals of either modality.

Other sign language researchers have also reported that hearing infants display surprising sensitivity to prosodic patterns in natural sign languages. As mentioned previously, prosody in signed languages is visual; movements of the hands, face and torso contribute to an overall rhythm or intonation. Brentari, González, Seidl and Wilbur (2011) demonstrated that hearing infants are able to detect small prosodic differences between otherwise similar strings of ASL signs, even in the absence of any previous exposure to ASL or another sign language, at the relatively late age of 9-months. More recently, Stone, Petitto and Bosworth (2018) found that hearing infants are sensitive to prosodic differences in signing, even without seeing the signer's face, a highly important source of visual prosody. Many natural sign languages include a system for fingerspelling, a manual representation of the spelling or phonetic form of the local written language. Depending on the handshapes, movements and orientation of the individual fingerspelled subunits that make up a given fingerspelled word, the overall prosody of that word can range from very well-formed (e.g. the letter sequences transitioning easily from one handshape to the next) while others are more articulatorily awkward (e.g. the transitions between

[4] Although perceptual narrowing seems at first glance to be a loss of a desirable skill, this specialization is important, as it frees up cognitive resources for more advanced learning of the target language. For instance, Jansson-Verkasalo et al. (2010) reported that premature babies who continue to discriminate non-native contrasts at 12 months displayed delays in vocabulary and morphological development at 2 years.

some handshapes are choppy or less fluid). In natural, skilled signing, the latter undergo phonological modification that improves their overall prosodic shape. Stone et al. (2018) intentionally preserved ill-formed fingerspelled sequences and showed them to 6- and 12-month old hearing infants, alongside fingerspelled sequences that were prosodically well-formed. 6-month old infants looked longer at videos of well-formed fingerspelling, indicating a preference for those forms, while 12-month old infants looked at both well-formed and ill-formed videos for similar durations.

The results of the Stone et al. (2018) study, consistent with those of the studies mentioned earlier, constitute early evidence that young infants are predisposed to seek out and find complex linguistic patterns in their input, even in languages that they have never encountered before. Importantly, this language-specific bias is universal and amodal, not reliant on any specific modality. However, sensitivity to the visual linguistic patterns of signed languages appears subject to the same perceptual narrowing observed for spoken languages; by about ten months of age, the hearing infants in these studies were no longer sensitive to the subtle visual patterns that their younger counterparts noticed.

Most recently, Blau (in preparation) conducted the first discrimination test including both hearing, non-signing infants and deaf infants exposed to a natural sign language. Building on previous reports of deaf signers' difficulty in acquiring or understanding invented signing systems (e.g. Supalla 1991; Tevenal & Villanueva 2009; Scott & Henner 2021), Blau played videos of a Deaf woman signing either ASL or Signed Exact English (SEE) to babies between the ages of 5 to 18 months. Both hearing and deaf babies attended to the ASL videos longer than to the SEE videos, an indication that they both noticed a difference between the two types of signing, preferring ASL over SEE. Detailed prosodic analysis of the ASL and SEE produced by the Deaf model reveals notable differences that infants seem to exploit to distinguish natural sign languages from invented signing systems.

3.3 Bilingual advantage for learning more than one language: Enhanced sensitivity to visual patterns

In light of the perceptual narrowing process just discussed in the previous sub-section, one might be tempted to conclude that bilingual babies are at a disadvantage for language acquisition compared to monolingual babies. If language acquisition boils down to the ability to notice and track important but subtle linguistic patterns in the target language, this task is multiplied for children learning more than one target language, and perhaps their language acquisition is less efficient as a result. As discussed in section 2, this is essentially the perspective advanced by Geers et al. (2017b:4), who characterize sign language exposure as a "distraction of manual signs" for children with cochlear implants who are trying to learn a spoken language.

Although monolingualism is considered by many to be the ideal norm for first language acquisition, monolinguals are actually in the minority among the world's population (Harris and Nelson, 1992). In most parts of the world, humans encounter bilingual or multilingual input from an early age. Such input is indeed more complex than monolingual input, but research has repeatedly demonstrated that babies' are nonetheless up to the task, aided by extra sensitivity that develops in bilingual or multilingual environments. These so-called "bilingual advantages" come online early in infancy. For instance, Spanish and Catalan are prosodically very similar, potentially causing delays in discrimination for bilingual infants exposed to both from birth. Yet these bilingual babies successfully discriminate Spanish and Catalan by four months of age, the same age as monolingual Spanish- or Catalan-exposed babies (Bosch and Sebastián-Gallés, 2001). To distinguish between two rhythmically similar languages, bilingual children capitalize on additional cues that could help in spoken language discrimination, including visual cues. We have already seen in the previous subsection that young babies are sensitive to visual prosodic patterns in sign languages, even without any previous sign language exposure. Weikum et al. (2007) demonstrated that 4- and 6-month old monolingual (English) and

bilingual (French and English) infants were able to discriminate English and French, based solely on silent videos of a bilingual woman's face as she reads passages in one or the other language. However, by 8 months only the bilingual infants continued to discriminate accurately. More remarkably, 8-month old bilingual Spanish-Catalan babies who had not been previously exposed to either French or English were also able to discriminate these languages based on soundless videos, while their monolingual Spanish or Catalan counterparts were not (Sebastián-Gallés et al. 2012).

Extending this line of investigation to natural sign languages for the first time, Nácar García et al. (2016) tested the impact of bilingualism on infants' ability to discriminate between two unfamiliar sign languages, Japanese Sign Language (JSL) and British Sign Language (BSL). Hearing 8-month old bilingual infants (Catalan and Spanish) with no previous exposure to any sign language successfully discriminated between JSL and BSL, but their monolingual counterparts (Catalan or Spanish) did not. A follow-up study tested bilingual infants using JSL and BSL videos that were slightly blurred, such that the Deaf signer's facial features were obscured while rhythmic patterns of the body, arms and hands remained discernable. Hearing 8-month old bilingual infants (Catalan and Spanish) were unable to discriminate JSL and BSL under the blurred condition, consistent with previous findings by Weikum et al. (2007) and Sebastián-Gallés, Albareda-Castellot, Weikum and Werker (2012) that pointed to bilingual infants paying particular attention to cues on the face, especially the mouth. Finally, Nácar García (2016) tested adult non-signers (both monolingual and bilingual) and deaf adult ASL signers with no previous experience with either JSL or BSL and reported that only the ASL signers were able to discriminate the two sign languages. These results, while perhaps unsurprising, emphasize that bilinguals' increased attentiveness to visual (especial facial) cues for language discrimination do not extend beyond infancy, although importantly, previous experience with one natural sign language allows even adults to discriminate between two unfamiliar sign languages.

The bilingual studies summarized in this subsection underscore infants' ability to detect and track both acoustic and visual patterns that are relevant for language learning. Even spoken language is naturally multimodal, and humans are highly attuned to linguistically relevant cues in both modalities. While all babies attend to visual linguistic patterns early in infancy, bilingual babies demonstrate enhanced attentiveness, for a longer period of time, compared to monolingual babies. This extra sensitivity to visual information constitutes an important "bilingual advantage," offsetting the relatively greater challenges that infants face when their environment includes input in two target languages instead of just one.

4. SOME PROPOSALS FOR OPTIMIZING SIGN LANGUAGE INPUT FOR DHH CHILDREN IN HEARING FAMILIES

The studies summarized in the previous sections are just a sample of research demonstrating the complex but regular patterns that underlie all human languages; infants' brains expect to encounter these patterns in their linguistic input and recognize them even without instruction. For the majority of deaf and hard of hearing children, who have insufficient access to the spoken language(s) of their hearing non-signing parents, providing them with well-structured language input through a natural sign language requires intentional and concerted effort from multiple parties. Even if hearing parents opt to begin learning a sign language as soon as their child is identified as DHH, the task of achieving proficiency, on top of the demands of parenting a new baby and typically with far less regular and structured instruction than classroom learners receive, is immensely challenging. In the face of such conditions, what can be done to optimize learning conditions for both hearing parents and their DHH infants? The findings from infant perception research summarized in section 3, along with the sparse existing research on signing DHH children from hearing families, point to several potentially promising directions for parents' initial foray into sign language learning, summarized below.

(5) Proposals for hearing parents of DHH children emerging from recent research:
   (a) Choose a natural sign language, not sign supported speech or an invented signed system.
   (b) Prioritize child-directed signing that accentuates prosodic and phonological patterns.
   (c) Involve Deaf adults.
   (d) Collaborate between parents, practitioners, and researchers.

These proposals have yet to be tested as an ensemble, although early intervention experts have advocated for all of them to various degrees. In the following subsections, I will detail (5a-d) in turn, including brief discussion of relevant research findings for each proposal.

4.1 Choose a natural sign language, not sign supported speech or an invented signed system

As discussed earlier, a pervasive utilitarian perspective on signing has led to the perception, even in the research community, that natural sign languages are interchangeable with other forms of signing that do not rise to the status of languages. Baby signs, invented sign systems (e.g. Signed Croatian, Manually Coded English) and sign-supported speech (e.g. SimCom) are appealing to parents as more attainable forms of signing, as they essentially involve using signed vocabulary items with spoken language grammar, but existing research reveals that they are difficult for DHH children to acquire (Supalla, 1991; Scott and Henner, 2021). A hearing parent may have the impression of signing fluently when they are able to accompany spoken Croatian sentences with Croatian Sign Language (HZJ) signs for all the main content words, but a DHH viewer accesses only a sporadic visual signal that does not consistently adhere to the systematic phonological, prosodic, or grammatical patterns that characterize natural sign languages. Such signed utterances are not only greatly impoverished, conveying less information than the accompanying Croatian speech, they are also harder to parse (see Johnson et al. 1989 and Scott & Henner, 2021 for particularly enlightening discussion of this phenomenon), due to an absence of the prosodic patterns that babies attend to in the infant perception research discussed in section 3. Given how sensitive we now know that even newborn infants are to recurrent linguistic structures of their input, natural sign languages offer the most optimal input for aligning with the patterns that they expect to detect.

In a rare study documenting outcomes of parents' use of a natural sign language versus an invented sign system, Hoiting and Slobin (2002) report superior results from training hearing parents of DHH children in Sign Language of the Netherlands (NGT) rather than Signed Dutch, a system of sign supported speech. Freed from the constraints of matching their signing to the grammatical structure of spoken Dutch, NGT-signing parents were able exploit the flexible word order of that sign language to engage in simple but very natural conversational exchanges with their deaf toddlers within just a few months of NGT classes. In turn, deaf toddlers raised by NGT-signing parents produced on average more multi-sign utterances, more questions and complex verbs (all indicators of grammatical complexity) and more sentence variety in their signing, compared to children raised in Signed Dutch, who may not hear well enough to fully access the linguistic patterns underlying the spoken Dutch portion of their input. More recently, Caselli et al. (2021) reported that DHH children from hearing parents who were exposed to ASL in the first 6 months of life achieved receptive and expressive vocabulary growth on par with their DHH peers from signing, deaf families. These encouraging findings suggest that with the proper training and support, parents can provide sign language input that supports their DHH children's early language development.

4.2 Prioritize child-directed signing that accentuates prosodic and phonological patterns

Acquiring any second language is challenging for adult learners, and hearing parents are justifiably daunted by the prospect of learning "a completely new, alien language" (Scambler, from Napoli et al. 2015) from zero, as quickly as possible. However, it may be that not all aspects of signing are equally

important, at least at the very initial stages of the DHH infant's life. During the critical first years after birth, when we know babies are most sensitive to phonological and prosodic patterns of their input, parents might be able to focus their efforts on producing simple signed utterances with accurate phonology and fluent prosodic organization, putting off more advanced vocabulary and complex grammar learning until later. Phonological errors are plentiful among sign language learners, and there is some evidence that phonology is a particularly weak area for hearing learners, who may need explicit training to support their development of phonological awareness and accuracy (Rosen, 2004; Bochner, Christie, Hauser, and Searls, 2011). Phonologically impoverished parental input may adversely affect DHH children's sign development. In a comparison of deaf 2-5 year-olds with signing, hearing parents or signing, deaf parents, Lu, Jones and Morgan (2016) reported lower BSL vocabulary scores and a smaller phonological repertoire (fewer unique handshapes) from the former group. This gap was strongly correlated with the number of unique handshape types produced by parents in spontaneous signing, leading the researchers to the sobering conclusion that "non-optimal" signed input exerts a negative influence on DHH children's BSL phonological development, even when exposure begins at an early age.

However, it is worth noting that the hearing parents studied by Lu et al. (2016) were still beginner BSL learners, perhaps lacking awareness of — and consequently, attention to— signed phonology. In a survey of signing hearing parents by Chen Pichler (2021) that asked which aspects of ASL were easy vs. difficult to learn, about two-thirds (16 out of 26) rated "accurate pronunciation" of signs as "not difficult" or "very easy," but comments in follow-up interviews revealed significant misconceptions about sign language phonology. One parent commented that ASL was easier to learn than a spoken L2, because one didn't have to worry about pronunciation. Another worried that slight inaccuracies in form might have outsized consequences for meaning, and that she might inadvertently say "something completely wrong because my fingertip was curled in." The reality of sign language phonology lies somewhere in between these two extremes; optimal sign input should conform to the phonological patterns that infants' brains expect to see, but as in any natural language, those patterns allow for a degree of variation before meaning is impacted. As first-time signers, parents may require explicit training to recognize where those boundaries lie.

Hearing parents' attention to phonology would likely benefit from training in the signing style known as child-directed signing (CDS). Analysis of CDS produced by fluent Deaf signers reveals a higher proportion of repeated signs with larger and slower movements and exaggerated nonmanual expressions (Erting, Prezioso and O'Grandy Hynes, 1990). Fluent signers also adjust their signing location to stay within young children's frequently shifting line of sight (Pizer, Shaw and Meier, 2008). Together, these modifications accentuate both phonological and prosodic (rhythmic and non manual) patterns of the sign language, making them easier to notice. Child-directed language is also particularly engaging to babies, another important advantage for DHH children who may have restricted access to language input. Masataka (2000) reported that, given the choice between watching the same signer producing child-directed Japanese Sign Language (which Masataka terms "motherese") or adult-directed JSL, 6-month old hearing (non-signing) and deaf (signing) infants both attended longer and were more responsive to the CDS video. He concluded that "[w]hen a particular patterned input is expressed as motherese, it may play an important role in enhancing infants' acquisition of the basic forms of signed language" (p. 22). Again, hearing parents may benefit from explicit training in how to recognize and produce child-directed signing as a way to enhance the signed input they provide to their DHH children. Here, reports of parent coaching interventions aimed at enhancing the quality of spoken language input that hearing parents provide to their hearing infants is both relevant and encouraging. Ramírez, Lytle and Kuhl (2020) found that explicit parental training led to a significant increase in turn-taking between parent and child, and a significant increase in parents' use of CDS. These increases

An ASL rhyme consisting of a repeated V-handshape across each sign, meaning roughly, "Look, there are two raccoons walking along together!".

in turn correlated with infants' language growth during the study period.

Another potentially beneficial practice observed between Deaf, fluent signing parents and their young children is the use of language play, including the manipulation of signed phonological patterns into rhythmic visual "rhymes," consisting of signs that share one or more parameters, the sublexical features of signs (handshape, location, movement, and/or orientation) (Holcomb, Golos, Moses and Broadrick, 2021:2). For instance, the ASL sequence in (6) features a recurring V-handshape in each of the signs (Open Access Creative Commons license from Holcomb and Wolbers, 2020).

The recurrence of the V-handshape presents multiple opportunities to observe the phonological form of this handshape, while also drawing attention to various movements, locations and orientations that can co-occur with it. Prosodically, the signs are produced with a regular, rhythmic beat that is easy to copy and extend to other rhyme sequences. Holcomb et al. (2021) reported that deaf 4-6 year-old preschoolers who engaged in daily ASL rhyming activities for two months made positive gains beyond the control group in their metalinguistic analysis of signs, as measured by ASL phonological awareness tests, which require children to visualize different ASL signs then pick out those that match in one or more parameters.

Teachers who administered the rhyming training for the Holcomb et al. (2021) study recounted how much their students enjoyed these activities and memorized the rhymes, spontaneously producing them even outside of class. Sign rhymes are highly compatible with the child-directed signing style, so including training in both of these areas in sign language curricula for hearing families not only has the potential to improve the phonological and prosodic accuracy of parents' signing, but also offers them an entertaining activity for engaging their young DHH young children (as well as hearing siblings) in important metalinguistic development. Strong metalinguistic skills are valuable not only for sign language development, but also reading development. MacQuarrie and Abbott (2013) reported significant correlations between DHH children's phonological awareness in ASL and their reading skills in English. In contrast, DHH students' English reading skills did not correlate with their (generally low) phonological awareness for spoken English (MacQuarrie and Parilla, 2009), suggesting that "although these students were not proficient in spoken English and spoken-language PA (phonological awareness), L1 ASL phonological awareness is related to L2 word-level reading and comprehension measure in this population" (MacQuarrie and Abbott, 2013:94).

4.3 Involve Deaf adults

While signing parents are critical to maintaining a visually accessible language environment at home, it is misleading to characterize them as the sole source of their child's sign language input, implying that their child's ultimate signing proficiency will be limited by their own signing proficiency. Comparisons to hearing children of immigrant parents are instructive in this respect: the phonology and grammar of my spoken English, for instance, resembles the English of my teach-

ers and peers rather than my Taiwanese parents' second-language English. Fluent signers from the Deaf community play a crucial role in strengthening the signed input that young DHH children receive, particularly in the early stages of their parents' sign language development. Even for parents who already sign well, outside signers expose DHH children to natural variation that helps them distinguish patterns that occur in the target language as a whole from patterns that are unique to their parents' signing. Variation in input is critical for optimal development of a home language by heritage speakers (Gollan, Starr and Ferreira, 2015) who, like DHH children in hearing families that sign, are learning a minority home language from a limited number of speakers.

The signing, hearing parents surveyed by Chen Pichler (2021) were uniform in their opinion that "becoming a good signer requires being involved in the Deaf community." Follow-up interviews emphasized the crucial role that Deaf adults played in offering unique guidance to these hearing parents as they navigated daunting social, cultural and linguistic challenges of raising a signing DHH child. One hearing parent commented on the many insights on raising her Deaf child that she learned from Deaf adults, things "that I never would have thought of" as a hearing person who had never experienced how DHH people perceive and experience the world. Gale (2020) cites prominent voices such as the Joint Committee on Infant Hearing in the U.S. and FCEI International (Family- Centered Early Intervention) who now formally recommend that parents of DHH infants have opportunities to meet Deaf adults as soon as possible after their child's diagnosis. Deaf adults should be involved at all levels of the early intervention process as "valuable collaborators [who] share personal experiences, teach visual strategies, and show possibilities" of counter-narratives to the medical perspective of deafness that regards DHH people as deficient (Gale, 2020:226).

4.4 Collaborate between parents, practitioners, and researchers

The question of how to best support language development by DHH children has long been a major concern and focus for many parties. Obviously, this question looms especially large for parents of DHH children, who have the most intimate knowledge of what works or does not work for their child, and who exchange their experiences with one another through parent groups and online forums. Practitioners and early intervention staff who work with these families also possess valuable insights from teaching families sign language, assessing child development, and recommending and observing outcomes of different interventions. Finally, researchers have access to a wealth of academic studies related to deafness, language acquisition and childhood development from a wide range of disciplines, and are thus well-placed to identify practices described in the research literature that could theoretically benefit hearing families with DHH children. However, interactions between researchers on one side and parents and early interventionists on the other are rare and often one-way (e.g. workshops in which researchers impart their academic knowledge to the "less informed public"). Establishing a new model in which each party contributes their insights more equally can bring advancements in many new domains, such as the development of innovative intervention services and improved family curricula for learning sign language (Napier et al. 2007).

We can take the content of the current paper as a point of departure to illustrate how this new collaborative model might work. This paper developed in response to questions from hearing parents and early intervention workers about how well hearing parents must sign in order to support their DHH children's language development. A growing body of infant perception research has pointed to phonology and prosody as being particularly important to infants' linguistic development in the first year of life. At the same time, researchers have also identified a weak phonological foundation as the source of many critical period effects among Deaf adults who learned neither a signed nor spoken language early in life. Together, these findings make the theoretical prediction that hearing parents who sign early with their DHH children, with accurate prosody and phonology, can support a strong foundation for their DHH children's language development, possibly even while those parents are

still developing other aspects of their sign language (syntax, morphology, discourse). But what exactly are the phonological and prosodic patterns that are most relevant? Answering this question requires discussion with early intervention professionals who are familiar with parents' signing. Once potential patterns have been identified, these professions can work together with researchers (or even more ideally, as researcher-practitioners, trained in both domains) to design studies that systematically track parents' development of those patterns and the impact of their proficiency on their DHH child's engagement, comprehension and production. As participants in these studies, parents can offer valuable feedback on crucial factors that are often overlooked during the design of research studies, such as the real-life feasibility of proposed interventions. For instance, are the proposed activities short enough to be incorporated into their very busy lives? Are they easy and engaging enough for everyone in the family to participate, including hearing siblings, so that no one feels left out? A study is only as good as its participants' ability to complete the target tasks, so feasibility feedback is crucial to successful research.

Additionally, parents are in a privileged position for noticing responses from their DHH child that might indicate unexpected factors that the research designers need to consider. For example, a parent might notice that their child shows no interest in signed rhymes unless they are accompanied by spoken English, perhaps because their child is accustomed to bimodal input. The research team must then carefully consider whether to amend study protocols to allow bimodal production of rhymes and how that change would impact their research questions (e.g. voicing English equivalents for the ASL signs might increase child attentiveness, but also render the mouth unavailable for producing other nonmanual signals that could be prosodically important).

Although there has been a long history of searching for the best ways to support language development in families with DHH children, researchers have only just recently begun examining parents' sign language proficiency and its correlation with their DHH children's ASL development. Initial findings are that young DHH children with age-appropriate ASL vocabulary development do not necessarily have parents who can provide high quality or quantity signed input (Hall et al. 2022; Berger and Pyers, 2022). Parental ASL proficiency influences child ASL development after the age of 18 months, but until then, it appears that even children of novice signers can achieve on-time early ASL vocabulary development (Berger and Pyers, 2022). These encouraging findings suggest that at the very earliest stages of DHH children's sign language development, rich interactions (e.g. establishing effective visual joint attention, engaging language play, simple turn-taking) may be of more critical importance than actual linguistic content, allowing parents a little more time to improve their sign language proficiency while still laying a good foundation for their child's first language development. In this article, I have focused on prosody and phonology as domains that are particularly implicated in the earliest stage of both L1 acquisition (e.g. infants' keen sensitivity to fine phonological and prosodic patterns early in life) and L2 acquisition (e.g. L2 signers' purported insensitivity to phonological contrasts in ASL). Of course, later stages of sign development will call for a focus on lexical or syntactic proficiency, which I have not discussed here. Whatever the stage of language development, closer collaboration between parents, practitioners and researchers offers the best chances for helping hearing parents to ensure optimal language input for their HH children during the critical first years of life.

5. SUMMARY AND SOME FUTURE DIRECTIONS

In this paper, we have considered some of the subtle phonological and prosodic patterns that underlie human languages, both spoken and signed. We have examined the remarkable abilities of young infants to notice and track these linguistic patterns, skills that allow them distinguish between languages (or between language and non-language), segment the streams of language around them into smaller subunits in preparation for lexical learning, and deduce many rules of their native language even without explicit instruction. Babies are sensitive to a broad range of language-specific

patterns, and although research on infant perception of sign languages is still limited, studies so far suggest that this pattern-finding ability is amodal, applying to natural languages in both spoken and signed modalities. Furthermore, we have seen that exposing babies to more than one natural language at a time triggers a variety of so-called bilingual advantages that provide the additional support needed to handle the complexities of bilingual acquisition.

The findings of these infant perception studies call into question the conclusions of Geers et al. (2017a) and other studies claiming that early sign language exposure leads to poor spoken language development. Although research on DHH babies' early language perception is still in its infancy, there is no a priori reason to expect that they are not born with the same sensitivities to linguistic patterns observed in hearing babies. That is to say, we expect that DHH babies, like hearing babies, are sensitive to linguistic patterns that characterize natural sign languages, and that they can use this sensitivity to successfully extract grammatical rules from sign language input. We also expect that bimodal bilingual DHH children are aided by the same bilingual advantages observed among spoken language bilinguals, attending to multimodal cues in their language environment longer than their monolingual counterparts. This early ability to integrate visual information with auditory information has clear advantages for bimodal bilingual learners and likely contributes to the positive learning outcomes reported so far for DDCI children. Those cochlear implant users are true bilinguals, a population that has not been included in studies like Geers et al. (2017a).

Of course, successful bimodal bilingual development ultimately depends on the availability of well-formed, fluent input in both a natural spoken language and a natural sign language, and this remains the greatest challenge that faces DHH children worldwide. The medical perspective of deafness and utilitarian view of sign languages have conspired to place the burden of communicative accommodation on DHH people, who are expected to learn spoken language by any means necessary in order to interact in a hearing society. Although in recent years, ambitious proposals for reversing this expectation have emerged, e.g. through universal instruction of a natural sign language to all hearing children, allowing them to communicate with DHH people (Brereton, 2008; Bowman-Smart, Gyngell and Morgan, 2019), widespread adoption of such practices is still a long way off. In the meantime, more research attention should focus on hearing parents' development of a natural sign language to better understand how to optimize the quality and quantity of the signed input they provide their DHH children.

I have outlined a proposal to disproportionately focus parents' attention on accurate phonological and prosodic signing at the very initial stage of learning (for both themselves and their DHH babies), given infants' well-documented sensitivity in these domains during their critical first year of language acquisition. The degree to which an initial focus on phonology benefits parents' sign language fluency and lays a foundation for subsequent lexical and syntactic development remains an empirical question that has only just begun to be explored, but preliminary results from the most recent studies have been encouraging. Since the majority of relevant infant perception research has been conducted on hearing infants, there is still a great need for expanding investigation to DHH infants. Similarly, the literature on interventions targeting phonological awareness and other metalinguistic skills for sign languages, and their impact on more advanced linguistic development is still very sparse; additional research in this area will lead to more options for parents and teachers of DHH children. These are only two of many domains that should be investigated to answer the fundamental question of how well hearing parents must learn to sign in order to support their DHH children's language development, detailed in (4a-c) above. Once we have a better understanding of what features of sign language input are most critical to early development, we can tailor family sign language curricula to facilitate their acquisition by hearing parents, then observe language outcomes for DHH children. Until this important groundwork has been laid, statements about sign language not benefitting DHH children from hearing families remain premature and potentially very harmful.

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