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Language Development and Deaf/Hard of Hearing Children

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Abstract: This article explores the available research literature on language development and language interventions among deaf and hard of hearing (d/hh) children. This literature is divided into two broad categories: Research on natural languages (specifically American Sign Language and spoken English) and research on communication systems (specifically iterations of signed English and cued speech). These bodies of literature are summarized, with special attention paid to intervention research and research exploring the impacts of language skills on literacy development. Findings indicate that there is generally a stronger research base on natural languages as compared to communication systems, though more studies in both categories are necessary. Additionally, there are very few intervention studies and even fewer that aim to intervene upon language with the explicit goal of impacting literacy; therefore, there is little known about whether and how interventions that aim to support language development may have direct or indirect impacts on literacy within this population. Further research on this topic, as well as replication studies and research with larger sample sizes, is strongly recommended.

Keywords: deaf; hard of hearing; language development; language and literacy; American Sign Language; listening and spoken language; signing systems; cued speech

1. Introduction

The question of language(s) used with and by deaf and hard of hearing (d/hh) children is long studied and complex. While strides have been made in our understanding of the modalities of language that d/hh children may use and the ways language can develop within this population, there is still a great deal about d/hh children and language that is unknown. Lingering questions regarding how to best support language development and provide intervention for those children who are showing signs of language delay and/or deprivation is of significance because of the life-long effects that language acquisition and proficiency can have on the eventual acquisition of literacy [1–4]. This has important implications for the ability to succeed in postsecondary education and/or the workplace. The vast majority of d/hh children are born into homes with hearing parents [5], and regardless of eventual dominant modality, they are likely to have limited access to language during the earliest period of their lives. This is true whether it is the result of time between birth and access to spoken language through the use of amplification (such as cochlear implants or hearing aids) [6] or the result of the absence of fluent American Sign Language (ASL) models in the home and community [7,8].

Researchers have long made the connection between language development and outcomes related to literacy (Literacy can be defined both broadly (encompassing methods of communication and understanding outside of print literacy) and more narrowly (focused specifically on reading and writing). Though there are many benefits to the broader definition, for the purposes of this review, we

explore specifically the narrow conceptualization of literacy through print.). It has been identified as an essential predictor of the reading skills of both hearing [1] and deaf students [2–4]. For children who are developing bilingually, there is evidence that development of their native language is an important tool for learning both language and literacy skills in their additional language(s) [9]. In addition, early language abilities have been linked to later academic outcomes beyond basic reading ability [10]. Due to the likelihood of delayed exposure to an accessible language among many d/hh children (regardless of modality), the importance of language for eventual academic success makes it an essential area for high quality research that has the potential to impact the education and lives of d/hh children.

In this article, we examine the available literature on language development, instruction, and intervention for d/hh children across modalities, with a special emphasis on the potential impacts of interventions in each area on later literacy development. As is true with all domains of research, each of the research strands included in this article has strengths, as well as areas that require further study. We conclude with recommendations for future research in the area of language development and intervention for d/hh learners. We begin, however, with an overview of language, language deprivation, and literacy outcomes among d/hh children.

2. Language Delay and Deprivation and Literacy

Historically, researchers frequently cited the hearing level of the d/hh child as the sole culprit for performance, or lack of performance, in a variety of areas, including literacy, theory of mind, and language development [11–15]. In recent years, however, some have posited that deprivation of language at early ages may be responsible for difficulties with later achievement in these areas rather than hearing loss itself [12,16]. This perspective allows for a broader consideration of languages and modalities and a wider array of strategies for meeting the needs of d/hh children and places special emphasis on the importance of language access at early ages.

Although the literature on language deprivation and its effects on academic outcomes such as literacy is in its early stages, researchers have examined the differences between d/hh students who had early versus late exposure to language for a number of years. Mayberry [17] and Mayberry and Lock [18], for instance, documented differences in language development and language outcomes for children who were exposed to ASL early in life as compared to those exposed to ASL later. However, such differences are not only present in those who go on to use ASL: there is also potential for children with even a mild to moderate hearing loss and who use primarily or only spoken language to experience the effects of language delay [19]. Other researchers have found a strong relationship between language proficiency (regardless of modality) and literacy among older d/hh learners [3,4,20–22]. Together, these bodies of literature suggest a strong need for accessible exposure to language from birth.

The important research documenting the effects of language delay or deprivation on literacy development is of paramount importance to the field. However, the research base is still limited in terms of our knowledge of language and communication interventions that may be most effective for those children who do not receive the ideal early language exposure. Below, we explore the development of and instruction in the most common modes of communication for d/hh children. We have broken these into two major areas: the use of natural languages, such as ASL and spoken English are explored first. These are grouped together because they are both languages that can be naturally acquired and are full and independent languages. Then, we examine what is known about systems that involve both spoken language and visual supports, specifically signed versions of English and cued speech. These are grouped together because they are systems of communication that have been created to support the learning of a natural language (English) among d/hh children. Neither of these are a language in their own right, but are tools that have the goal of making English more accessible and visual. Natural languages and visual systems differ in how they develop, but users of both have the goal of providing d/hh children with educational experiences that will support their development of both language and literacy skills.

3. Language Development

There are two main ways that d/hh children may be exposed to means of communication. The first is through natural languages, and the second is through communication systems. For d/hh children, natural languages may be signed (such as American Sign Language (ASL) or other signed languages that have developed naturally within deaf communities around the world), or spoken (such as English or other spoken languages that have developed naturally within broader communities around the world). Natural languages are created through communities of language users and can be considered as fundamentally different from systems of communication that were systematically created by a single person or group (such as the invented spoken language Esperanto) because of how they develop and are used. Below, we explore two natural languages that are commonly used with d/hh children: American Sign Language and spoken English.

3.1. American Sign Language and Spoken English

3.1.1. American Sign Language Development and Instruction

In this section, we summarize existing studies on the development of ASL skills among d/hh students and what is known about how this visual modality language may be related to literacy in an auditory modality language, English. Because our knowledge of and discourse around ASL has changed dramatically in recent years, this review focuses only on the research published on this topic within the last 20 years. The research in this area covers a wide range of methodologies, including qualitative studies [23] and single case design research [24,25], as well as larger quantitative group studies [3,26–29] and quasi-experimental studies [30,31]. Currently, there are no instances of direct replication or extension of studies in this area, which limits the ability to create more generalizable research-based conclusions about the role of ASL in literacy development and acquisition.

In the last 30 years, increasing attention has been paid to ASL, including how ASL tends to develop among children with early access to this visual language, and its impact on literacy and other academic outcomes [3,4,17]. According to the Gallaudet Research Institute, in 2010, 27.4% of d/hh were educated in classrooms that used sign language only, although 14.5% of classrooms reported using ASL regularly [32]. There has also been research on promising instructional interventions that may support language development in ASL among d/hh learners who do not have this early exposure to language [24,33]. There is evidence that the presence of a proficient ASL language model in the home is related to overall ASL proficiency because these models provide children with exposure to fluent use of the language in a naturalistic setting [27]. For both deaf and hearing children who have deaf parents, there is evidence that ASL develops naturally, as any language would [34]. Unlike spoken language, ASL proficiency does not seem to be related to socioeconomic status (SES) [28]. This is likely because ASL proficiency is related to having a fluent ASL model, and deaf adults and native ASL language models can be found at all SES levels, so this leaves limited room for SES to mediate this relationship.

Ultimately, higher levels of ASL proficiency have been linked with greater proficiency for isolated word reading skills [26], reading comprehension [3,4,28,35,36], features of academic writing [37], and vocabulary usage during writing [38]. Given the relationship between ASL proficiency among signing d/hh children and these vital skills, it is important to understand what is known about how to teach and foster the development of ASL among d/hh children who use this language. This is especially important since most d/hh children are born into homes with hearing parents who may not be proficient signers [8].

Few studies have examined the effectiveness of interventions aimed at improving ASL proficiency among d/hh learners (as opposed to teaching ASL to hearing second language learners). These include studies of learner characteristics, as well as studies examining instructional approaches for ASL development. For example, there is some evidence that child-level characteristics, such as flexibility in the use of cognitive and affective strategies for learning, is associated with greater improvement in ASL proficiency following intervention [39]. However, this is the only study that examines this type of

characteristic for language learning in ASL, and both replication of this finding and exploration of other child-level factors that may be relevant for ASL learning among d/hh children are necessary.

Other researchers have focused their attention on the use of ASL modeling as a tool for intervening on ASL proficiency, including both using ASL narratives and modeling features of ASL during instruction. These studies have found that opportunities to engage in repeated viewings of ASL narratives has potential to supply d/hh students who sign with ASL language models [33] and that this in turn may support the development and increased use of more advanced ASL linguistic structures [24]. These studies suggest that access to ASL linguistic models may be supportive of linguistic development. This is an important finding considering that most d/hh children have hearing families [5] and may require access to language models other than their parents.

The use of ASL during intervention also appears to have the potential to not only support ASL development, but also literacy development. For instance, repeated viewings of ASL videos that include explicit instruction in literacy seemed to support improvement in early literacy skills among preschool-age d/hh children [23]. Similarly, when d/hh children were engaged in a shared book reading intervention implemented in ASL, researchers found a positive effect on both ASL proficiency, as well as emergent literacy skills [31]. In a small single case study of an older elementary student, the use of a dialogic reading approach in ASL appeared promising to support reading comprehension in informational texts, suggesting that interactive experiences about texts in ASL have the ability to improve understanding of these texts [25]. Similarly, the Strategic and Interactive Writing Intervention (SIWI) initiative, the only writing intervention specifically designed for d/hh learners, found that explicit focus on language development in the context of writing improved writing outcomes for d/hh learners [29,30,40], as well as reduced the use of ASL grammar in English writing [41,42].

Overall, these studies indicate that among d/hh children who communicate through ASL, greater levels of proficiency with the language are related to literacy outcomes. Although, there are few studies that intervene on ASL, though there is promise in the practice of having strong ASL models (both in person and virtually) to support ASL linguistic development. Finally, intervention studies suggest that supporting student access to text through the use of ASL in explicit and purposeful ways during literacy activities may support the development of more proficient reading and writing abilities among d/hh students who sign.

3.1.2. Spoken Language Development and Instruction

In this section, we summarize existing studies on the development of listening and spoken language (LSL) skills among d/hh students, beginning with predictors of proficiency and continuing with a summary of studies that explore the impact of various amplification strategies. We then consider potential influences on listening and spoken language development over time, and its relationship to literacy and language proficiency in general.

According to the Gallaudet Research Institute, in 2010, the majority of d/hh children in the United States were educated using spoken English only (53%) [32]. Because our knowledge of and discourse around how spoken language develops among d/hh children and the availability of technologies that may support access to speech have both changed dramatically in recent years, this review focuses only on the research published on this topic within the last 20 years. Among studies of language acquisition after cochlear implantation, study designs and salient participant demographics vary widely from longitudinal case studies of a single child [43], to short-term investigations with multiple children [44]. Some studies focus on participant language development from as early as seven months old [45], while others investigate the period immediately after implantation or several years after implantation up to ages 10–15 [20]. Other researchers focus on exposure to early intervention rather than age or time relative to implantation [46], and thus, include a range of ages and language histories within their samples. These differences in participant age, language history, age of implantation, and time after implantation are sensitive to differences in the exposure to language and language training among participants. Because of the diversity of language and implantation histories among children

with cochlear implants (CI), there are no instances of replication or direct extensions of previous studies, which makes it difficult to compare or accumulate findings in efforts to generate cohesive, research-based conclusions about the nature of language development in this diverse population.

However, there are some patterns related to language proficiency, the impact of CI and LSL on language acquisition, and the development of phonological awareness through spoken language and its impact on later reading. Findings from recent research suggest that purposeful interactions and early language exposure and learning are important for d/hh students to develop spoken language proficiency. Purposeful interactions with educators and family members impact the overall language outcomes of d/hh children regardless of when they were identified as having a hearing loss [46–48]. However, children who are identified with hearing loss earlier and provided with early intervention services at a younger age demonstrate more robust vocabulary knowledge compared to infants and toddlers identified and enrolled in intervention services later [46–49]. Likewise, in a study by Miller, Lederberg, and Easterbrooks (2013) of five emergent d/hh readers, the researchers demonstrated the effectiveness of explicit instruction in syllable and onset-rime awareness [50]. This suggests that purposeful interactions and early language exposure are important throughout development and that earlier exposure to these interactions is supportive of early language development. A higher volume of purposeful interactions and language exposure also supports the development of executive function skills. For example, Figueras and colleagues [51] (p. 374) argued that "the behavioral manifestations of EF [executive function] difficulties observable in deaf children are unlikely to be a consequence of deafness per se but rather result from the language delays that are a consequence of the deafness." This is similar to the language deprivation argument put forth by Hall and colleagues [12]. Therefore, the literature suggests that exposure and interactional experiences are key factors in early language and social development, regardless of how this exposure or experience is achieved or the modality in which it is delivered.

There is great variability regarding the impact of cochlear implants on d/hh children's proficiency and rate of spoken language acquisition; however, the patterns of interactions and language exposure identified above are relevant to CI users, as well. Early identification and access to language impact language acquisition for CI users as they do for the general LSL population. For example, in a study by Figueras and colleagues [51], researchers found strong correlations between executive functioning and spoken language, but no difference between children who used CIs and those that did not. Similarly, Jones and colleagues [52] found that there was no difference in narrative performance between deaf children using hearing aids and those with CI. Further, they found that there was also not a difference based on hearing levels. However, it is documented that the volume of exposure to accessible auditory input produces great variability in results related to children's language acquisition [46,52]. Taken together, these findings again point to language access and interactions using meaningful language as the salient variables, not merely access to sound. This complex relationship between language, speech, and audition requires nuanced research into how this is related to literacy development.

The relationship between language proficiency and literacy outcomes is well documented [53]. Therefore, students with complex language histories often demonstrate difficulty when developing literacy. However, there are some areas of literacy where d/hh students demonstrate proficiency on par with hearing peers, such as written expression discourse and phonological awareness among young LSL users [22,54]. Many studies of literacy achievement examine subtest scores for isolated areas of literacy in order to better understand composite skills of literacy (e.g., phonological awareness, word recognition, vocabulary). For example, Goldberg and Lederberg (2015) found that d/hh preschool children who used amplification and had better phonemic awareness recalled more letter names and letter sounds than their peers with less developed phonemic awareness and that the preschoolers learned letter sounds partly through the use of phonological information contained in letter names [55]. However, Jones and colleagues [52] (p. 268) found that "deaf children showed equivalent performance to their hearing peers at the macro-level; however, performance on micro-level narrative skills was poorer, and less relevant and detailed answers were provided to the inferencing probe questions

than hearing peers." This suggests that relative weaknesses on some literacy-related subskills may not entirely be indicative of overall literacy proficiency among d/hh students using LSL because of differences in how language is perceived and processed. However, Nelson and Crumpton [22] (p. 342) demonstrated that "vocabulary awareness was the major predictor of d/hh students' [using LSL] listening comprehension, reading comprehension, and nonword spelling skills ... [and] phonemic awareness skills significantly contributed to their reading decoding.".

Overall, the evidence suggests that regardless of modality, language development has profound implications for the literacy development of d/hh children. Interventions that systematically use ASL to support reading (among signing d/hh students) seem to show promise, though more and rigorous research is needed to fully understand this complex relationship between languages and modalities. In general, earlier exposure to an accessible language seems to be key for supporting language development and later literacy skills. In the section that follows, we turn our attention to visual systems that have been invented with the purpose of supporting the English language development of d/hh children, specifically the research available on signed forms of English and on cued speech.

3.2. Systems Combining Spoken Language with Visual Codes

The second popular method for exposing d/hh children to a means of communication is through the use of invented communication systems that seek to represent English visually in order to make it more accessible to this population. There are two more frequently-used communication systems used with d/hh children. The first is the use of signed representations of English, which to greater and lesser extents use invented signs to express morphemes and words from English that did not have natural sign language equivalents. These systems also use signs borrowed from ASL, but which are presented in English word order. The second is cued speech, which is an invented system of hand positions placed systematically around the face to disambiguate phonemes in English to assist with speech reading.

3.2.1. Sign Systems' Development and Intervention

In this section, we explore the literature available on signing systems that were created and intended to be representations of English expressed via the visual modality. Unlike the research with ASL and spoken English, there has not been as much new research on sign systems in recent years. As a result, we included all available research on sign systems, how they develop, and interventions to support their use here. Sign systems are artificially-derived forms of English expressed using signs, some borrowed from ASL and some invented to differentiate between similar English words or to express words in English that did not previously have a sign equivalent [56,57]. There are a number of different sign systems, such as Signing Exact English, Seeing Essential English, Manually-Coded English, and Pidgin Sign English [56,57]. Though each of these systems has features that make it distinct from the others, they are all representations of English conveyed through the signing modality; therefore, we review the research available on each of them together. According to the Gallaudet Research Institute, in 2010, 12.1% of d/hh students were educated in classrooms that used sign-supported spoken language [32]. Though this statistic may under-represent the number of students who are taught using signed English, it is the nearest approximation available. The data-driven research available across all of these systems is somewhat dated, but includes single case intervention studies [58], small-scale pilot studies [59,60], larger group designs [61–63], surveys [64,65], and one quasi-experimental study [66]. While some researchers have completed studies with the intention of testing what type of communication is more accessible or preferable for use with d/hh children (signing systems, ASL, or written English), because the purpose of this article is to explore outcomes related to language development or impacts on literacy based on signing system usage, we do not include articles of this type in this review.

The purpose of sign systems was to support the development of English language skills among d/hh students [67]. The reasoning behind this was that because d/hh children did not have auditory access to English, providing a pathway to English that relied on the eyes instead of the ears may provide the accessible input necessary for language acquisition [56]. Some researchers specifically felt that the use of signing systems held particular promise for conveying English morphemes [57]. This resulted in a great deal of debate among researchers and others, starting in earnest regarding whether the potential exists to learn an auditory language through visual channels [66–70].

Some have argued that a contact version of a signed English system may be useful in codeswitching between ASL and print English or for teaching English grammar [64,69], or as a tool to support communication among children with cochlear implants [64]. However, others have posited that signed English systems used in classrooms are frequently ungrammatical in both English and in ASL, thus sending a confusing linguistic message to children [65,71]. In fact, in a study of preschool-age children, researchers found that d/hh students interacted more during a storytelling activity that was in ASL or contained ASL-like signing as compared to storytelling activities using strict signed English [72]. There is also evidence that teachers using signed English tended to use fewer complex grammatical structures as compared to teachers who were just speaking in English [73]. This could be due to the cognitive strain of attempting to use multiple modalities of expression simultaneously. Critically, evidence has shown that even among teachers who had high levels of proficiency in signed English, at best, they were found to be only 86% accurate in their representation of English using this system [67]. Like all languages and communication systems, there is an issue of complete and accessible opportunities for exposure among d/hh children for signed English.

Overall, there have been a limited number of studies that systematically examined the relationship between signing systems and English knowledge or reading comprehension. Studies investigating the impact of using signing systems on literacy achievement have produced mixed results. For instance, one study found a correlation between signed English proficiency and reading comprehension [57]. However, other studies suggested that poor achievement in English syntactical knowledge among d/hh children who were educated using a signed English system meant that signed English was ineffective at supporting the development of English syntactic understanding [60]. Others have found that students raised in signed English environments showed typical development in terms of lexical and syntactic skills, but a significant deficit in morphological knowledge, an important facet of language development [58]. Longitudinally, time in a signed English program was not predictive of English skill among a group of d/hh students, suggesting that exposure over time to signed English may not support the development of English grammatical understanding [59].

More recently, researchers found significant variability in the overall language and literacy abilities of d/hh learners who use signed English, ranging from two standard deviations below the mean to at or above the mean [61]. Problematically, in this line of research, assessments of language development (i.e., the Clinical Evaluation of Language Fundamentals [CELF]) administered using simultaneous communication were found to be predictive of reading scores, but these findings cannot distinguish between the effects of mastery of signed English versus general mastery of English [62]. Therefore, it is difficult to ascertain whether signing systems specifically are related to these scores.

In perhaps the only study explicitly examining the effects of an intervention using signed English, Bennett and colleagues [56] found using single case research that four children were able to correctly articulate signed English sentences following English grammar after an intervention that explicitly taught English grammatical structures via simultaneous communication. Unfortunately, this study did not include a measure of comprehension, meaning that participants could have learned to copy the pattern without necessarily acquiring a deeper understanding of the syntax. Similarly, incorporating signed English pictures into written texts appeared to increase d/hh students' comprehension; however, it is unclear whether it was the presence of the signs at all compared to the signs specifically being signed English that provided the scaffolding students needed to access the texts.

The research exploring signed English systems is limited in that, although colloquially, many in the field use the term signed English as a "catch-all" for all signing systems, these studies explored different manifestations of signed English systems that may be more or less comparable to one another. In general, the findings do not tell a generalizable story: some found higher achievement in some areas after instruction in signed English, while others found lower achievement or areas of significant difficulty. In many cases, it is difficult to tease apart the effect of the presence of signs in general versus the specific use of signed English as the causal factor contributing to children's development of English knowledge.

3.2.2. Cued Speech Development and Interventions

Cued speech is a combination of speech reading and hand placements around the face and mouth that was designed to facilitate communication through speech for d/hh children. Unlike the research with ASL and spoken English, there has not been as much new research on cued speech in recent years. As a result, we included all available research on cued speech, how it develops, and interventions to support its use. According to the Gallaudet Research Institute, as of 2010, only 5% of d/hh children in the United States received cued speech services in K–12 schooling [32]. This system specifically strives to disambiguate between sounds that cannot be differentiated through speech reading alone (i.e., /p/ and /b/). Although cued speech has been a tool used with d/hh children since the 1960s, there is presently not enough research on how the ability to use cued speech develops or what impact the use of cued speech may have on the language and literacy outcomes for individuals who use it. The studies available are case studies [74–76], neuroscientific [77], small or pilot studies [78], and group designs [79–82].

Researchers have attempted to understand the way that cued speech is processed in the brains of users. In perhaps the only study of its kind, Aparicio and colleagues [76] found through fMRI imaging that cued speech appeared to be processed in pathways that are classically associated with speech processing and also makes use of pathways that are related to visual and motion processing. Research has found that d/hh adults who use cued speech have better speech reading skills than d/hh adults who used spoken language only [80], which is unsurprising, but important, as it is the goal of cued speech to improve access to spoken language for d/hh individuals. However, others have found that, even though cued speech seemed to support speech reading, the intelligibility of a cued speech-interpreted message was still lower than the intelligibility of a hearing person listening to a spoken message [77]. As far as the authors are aware, there has been no attempt to compare the intelligibility of messages across multiple languages, modalities, and/or communication systems.

One recent study attempted to disambiguate the effects of early versus late exposure to cued speech combined with early versus late cochlear implantation and how each combination (i.e., early cued speech + early cochlear implantation; early cued speech + late cochlear implantation; late cued speech + early cochlear implantation; or late cued speech + late cochlear implantation) affected literacy. In this study, the effects of early exposure to cued speech were noted only in spelling ability, and these effects seemed to disappear over time [81]. It may be important to note that despite characterizations of d/hh learners in the study as having early or late exposure to cued speech, none of the participants in this study were exposed to cueing before age two, and many had inconsistent exposure to cued speech that was not comparable across or even within participants (for instance, with heavy use at age two, less use after one year, and increased use again at school entry), making it difficult to understand the effects of what could truly be considered early and consistent exposure to cued speech.

One study compared literacy subskills with d/hh learners who used cued speech with those who used ASL or communicated orally and found that those who used spoken language or cued speech had better ability to detect phonemes than users of ASL [82]. Others have found that early exposure to cued speech was related to the ability to read pseudo-words [79] and that when producing rhymes, d/hh young adults who used cued speech seemed to rely more on phonology for rhyme generation, while those who did not use cued speech seemed to rely more on orthography [82].

Additionally, there have been some studies that investigate the global abilities of cued speech users. Several studies found users of cued speech to perform at or above average on assessments of literacy [75,76,78]. However, these studies included only a small number of cued speech users (between one and eight) and did not include comparison groups of d/hh children who used other types of communication methods. A case study following one young child with a cochlear implant who used cued speech found that although her development of phonemic awareness and vocabulary was similar to hearing children of the same age, she had difficulty with grammatical development [73].

Overall, it seems to be true that cued speech can provide support to spoken language phonemes, and thus assist in phonemic awareness, spelling, and decoding. However, there are no longitudinal studies the authors are aware of that expressly look at the longitudinal relationships between these skills. There is no evidence that cued speech supports English grammatical development and even some evidence of difficulty with English grammar associated with its use [74].

4. Recommendations for Future Research

Though the available research documenting the development of language proficiency among d/hh children and the importance of language for the development of later skills has grown, there are still numerous areas that require further study. Across all languages, modalities, and systems, the number of intervention studies is extremely limited. More studies, larger sample sizes, and replication studies are necessary across all domains. We also argue that there is a need for studies that cut across modalities. Especially in terms of interventions, there can be value in understanding not only whether, but for which subgroups of d/hh children are particular interventions most effective.

Overall, we know that the majority of d/hh children are not born into homes with deaf parents who can serve as fluent ASL language models [8]. Similarly, contrived signing systems and the use of cued speech will require direct instruction for children, parents, and teachers. d/hh children who ultimately use spoken language will also require training in the optimal use of amplification devices and speech therapy to expand their ability to produce and understand speech. For these reasons, increased intervention research is needed for all potential approaches to communication with d/hh learners.

One of the biggest challenges in reviewing this literature was a lack of research that intervened upon language with the intent of impacting literacy skills (rather than research that happened to use a specific language for communication during a literacy intervention). In the authors' opinion, an additional broad area in need of research moving forward is research that studies the longitudinal effects of intervening upon language (this is especially important for d/hh children who, as noted in the Introduction, are likely to be in environments where they may have delayed or incomplete access to the language being dominantly used in their homes and classrooms) and whether the effects of such intervention can be seen in terms of later literacy (and other academic) skills. This may be especially important in ASL, as currently, many schools do not provide d/hh children with systematic instruction in ASL (akin to how both hearing and d/hh children are taught English) despite the availability of standards for ASL teaching. Even among those schools that do, there is no current systematic research on what this instruction looks like or what its impacts might be.

There are also specific areas within languages and modalities that would benefit from further research. For instance, our understanding of the natural development of ASL does not explore the ways in which more advanced features develop, as well as the timeline for their development. Purposeful sampling of d/hh children with deaf parents and longitudinally following their linguistic development could provide researchers and teachers with invaluable information regarding the natural progression of more advanced features of ASL proficiency. Similarly, previous research related to spoken language development with d/hh children investigated speech production abilities and the development of certain speech skills. Future research in this area could extend this work by investigating language development, as speech and language are not synonymous.

Additionally, much of the intervention research on both ASL and spoken English can be considered piecemeal: there are few interventions that aim to develop overall language proficiency. Instead, the

tendency is toward interventions that are highly specialized on small subskills that are related to one language or the other. Though these are valuable, future research might endeavor to combine interventions to create an approach that develops language proficiency on a more global scale. Additionally, these interventions frequently are not evaluated for whether and how they improve a child's overall ability to produce and understand language, though this is the ultimate goal of language development interventions. Instead, they again focus on the development of linguistic subskills, which may contribute to overall language proficiency, but research is needed to ascertain whether these interventions are having a measurable effect on overall language skills in addition to these smaller skills. Perhaps a more holistic intervention on language development could also result in an intervention that has the potential to support measurable gains in overall language development especially among d/hh learners who have hearing parents (who do not use or are not proficient in ASL), but are being educated primarily in ASL. This may be a valuable area for future research.

There is little available research documenting signed English systems, how they can be developed, and what their impact is on broader outcomes. Some suggest a potential relationship between signing systems and components of literacy (for instance, phonological awareness, [81]); however, there is a need for more high-quality research on whether sign systems have the potential to support overall literacy ability. It has been argued, for instance, that the incorporation of signed English visuals or the use of signed English during instruction supported literacy achievement [56,62]. However, due to the designs of many of the studies, it is not clear whether the change in scores noted was due to signed English per se or due to the addition of sign language as a broader construct into instruction. Additionally, a great deal of the research that currently explores signed English is dated, and given the rate of change found in the populations of children in schools who are d/hh, past findings may no longer be relevant for the students who are currently being taught. Future research that more rigorously teases apart the effects of signs writ large versus signed versions of English specifically is necessary.

Finally, cued speech is also a practice that is still used with d/hh learners, but requires more research. The most robust research indicates that there is a relationship between the use of cued speech and phonology, which can be thought to support related literacy skills such as decoding and encoding [79,82]. However, there is no evidence that directly connects the use of cued speech per se to stronger literacy outcomes more generally; future research should endeavor to include children who use cued speech alongside those with other communication modalities or languages and to follow their development over time to not only understand how those who use cued speech develop in their literacy skills, but also to understand their development in context with other d/hh learners.

5. Conclusions

Language and communication are pressing issues for the education of d/hh students and have historically been among the most studied areas in deaf education research. Despite the attention these areas have received, there is an abundance of lingering questions regarding language development, the potential role of communication systems, and the best mechanisms for improving the overall language and literacy skills of d/hh learners. It is absolutely essential for the field to continue to disentangle the effects of various language and communication backgrounds while being mindful of the competing effects of home lives, educational settings, and opportunities (or lack thereof) for engaging with language and experiences that may also influence academic outcomes. Only through this type of thoughtful and thorough engagement with research can we truly understand the language and literacy needs of d/hh students and how to meet those needs effectively in the classroom.

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