Profile of a Family's Bimodal Bilingual Development

Deborah Chen Pichler, Mary Cecilia Conte, Patrice Creamer, Martin Dale-Hench, Elaine Gale, Linghui Gan, Corina Goodwin, Shengyun Gu, Kaj Kraus, Margaret Chui-Yi Lee, Diane Lillo-Martin, Jeffrey Levi Palmer, Bettie Petersen, and Meghan Shaw

1. Introduction

Deaf and hard of hearing children (henceforth DHH children) in hearing families experience an unusual context for first language acquisition, due to a lack of full access to the spoken language(s) used by their hearing parents. The consequences of this early period of restricted linguistic access on children's linguistic, cognitive, social and emotional development have been extensively documented (Hall 2017; Hall, Hall & Caselli 2019) and are highly variable, even for children who eventually benefit from cochlear implants or other hearing technology allowing them to access a spoken language. Conscious of these risks of delayed language exposure, a minority of hearing parents elect to learn a sign language to provide accessible language input to their DHH child (Jones & Roberts 2024). This arrangement creates yet another unusual acquisition context in which parents are novice second language (L2) learners of a language that their DHH child is acquiring as a first language (L1). Additionally, the vast majority of these hearing parents also continue to use their spoken language(s) with their

* Deborah Chen Pichler, Gallaudet University, deborah.pichler@gallaudet.edu; Mary Cecilia Conte, Gallaudet University; Patrice Creamer, CUNY Hunter College; Martin Dale-Hench, Gallaudet University; Elaine Gale, CUNY Hunter College, egale@hunter.cuny.edu; Linghui Gan, University of Connecticut; Corina Goodwin, University of Connecticut; Shengyun Gu, University of Connecticut; Kaj Kraus, Gallaudet University; Margaret Chui-Yi Lee, University of Connecticut; Diane Lillo-Martin, University of Connecticut, diane.lillo-martin@uconn.edu; Jeffrey Palmer, University of Connecticut; Bettie Petersen, University of Connecticut; and Meghan Shaw, University of Connecticut.

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DHH children, most of whom receive cochlear implants or other hearing technology from an early age.

The literature describing sign language development and use among hearing parents (usually mothers) with young DHH children is very limited. Early studies compared the quality and quantity of child-directed language across hearing and deaf mothers of DHH children. These studies generally found that despite hearing mothers' relative inexperience as signers, they behaved similarly to deaf mothers in many respects, commenting on objects that their DHH child was attending to (Spencer, Bodner-Johnson & Gutfreund 1992) and moving their signs into their child's visual field (Waxman & Spencer 1997). In contrast, hearing mothers averaged fewer signed utterances to their DHH children than deaf mothers and were less effective in the timing of their child-directed signing, often initiating signs before their child was looking at them (Spencer, Bodner-Johnson & Gutfreund 1992). These early studies are instructive, but they are also quite small and note considerable variability across individual parents. They presume that the signing of hearing parents is of “generally low quality” (Spencer & Harris 2006: 89) and contributes to slower sign language development for their DHH children, but they do not directly investigate the phonological or grammatical form of parental sign or potential relationships between parent and child signing.

The sobering assessment of hearing parents' sign quality appears to be supported by Lu et al. (2016) who report that hearing parents produced significantly fewer BSL vocabulary items and unique handshapes than deaf parents during naturalistic play with their 2-5 year old DHH children. The authors conclude that this impoverished BSL input from hearing parents negatively influenced their DHH children's BSL development, as evidenced by more non-responses on a picture-naming task than DHH peers with deaf parents, and fewer handshape contrasts. However, Caselli et al. (2021) find that early ASL expressive and receptive vocabulary development by DHH infants of hearing parents is on par with that of DHH children of deaf parents, provided the former are exposed to ASL by the age of 6 months. Further, Berger et al. (2024) tested hearing parents' comprehension and production of ASL and report that parental signing scores did not significantly predict their DHH children's vocabulary development until after 18 months, suggesting that early ASL (vocabulary) development is robust enough to withstand variability in the quality of parents’ ASL input, at least initially. These more recent studies suggest more encouraging outcomes for DHH children of hearing, signing parents, but many details of this developmental context remain undocumented and understudied. The current project longitudinally documents the phonological, lexical and syntactic development of both a hearing parent and her DHH child, for both ASL and (for the child) spoken English. Such detailed data is a prerequisite for a more comprehensive investigation of DHH children's bimodal bilingual trajectory in the context of L2 sign language input by hearing parents.

2. The Family ASL Project

The goal of the Family ASL project is to examine the path of language development for DHH children whose hearing parents opt for learning and using ASL at home with their DHH child (Lillo-Martin, Gale & Chen Pichler 2023). We assess the children's development of ASL, and if they are using spoken English, we assess that as well. In addition, we examine the development of ASL as a second language in a second modality (M2L2) by the parents. Our main interest is to document the linguistic development of DHH children and that of their parents, and to examine potential relationships between them.

The data for our study consist of case study analyses of individual families, as well as combined analyses grouping participants by age and other potential influencing variables. Both data collection and analysis are ongoing. In this paper, we present a subset of our results from one family case study: the family of DHH child 'Holly'.

3. Method

3.1. Participants

Holly was born profoundly deaf. She received bilateral cochlear implants at 20 months and used them consistently thereafter. Her mother reported that Holly's early input included primarily ASL and Sign-supported English. At the time they joined the study, Holly was 2;00. Holly's mother had started learning ASL prior to joining our study and at entry, self-rated her ASL comprehension as 'advanced' and her production as 'intermediate'.

3.2. Procedure

After joining the Family ASL study, Holly's family participated in an onboarding meeting followed by some initial information and data collection sessions. We then started the first period of ASL services, conducted remotely with a deaf ASL specialist who served as a role model representing the signing deaf community and provided language enhancing activities. ASL services were provided over the course of a year in 6 week-intervals: six weeks at a time with services, followed by six weeks with no services, etc. Holly and her mother engaged in all but 5 of the 24 planned sessions. During the family visits with Holly and her family, the ASL specialist provided tailored signing enrichment activities pulling from a variety of resources such as the SKI-HI Deaf Mentor Program (Pittman 2001), ASL at Home (Zarchy & Geer 2023), and free signing resources online (such as the Rocky Mountain Deaf School and Hands Land).

During the off weeks for ASL services and at the end of the year-long participation period, additional data collection sessions took place. In the next subsection we describe a subset of the measures administered and analyses conducted to date.

3.3. Measures and analyses

To permit us to assess development during the period of the project, Holly's family participated in several data collection procedures, described below. The first two assessments (Language Samples and ASL-PET) were administered weekly, although only (at most) quarterly results are reported here. The remaining assessments were administered three times over the course of the study (roughly at entry, mid-point, and end of the year).

A. Language Samples. Weekly, the family recorded a naturalistic language sample of approximately 30 minutes. The language samples allow us to observe the linguistic structures used by both Holly and her mother. We encouraged them to make the language samples as natural as possible, engaging in typical mother-child interactions such as playing with toys, looking at books, or having a snack.

The language samples are annotated using the program ELAN (Crasborn & Sloetjes 2008), which permits annotation of video information on multiple time-aligned tiers assigned to both the child and the adult. The primary annotation tiers relevant to the current discussion are described below.

- Free translation: A free translation corresponding to whatever is uttered in ASL and/or English.
- ASL right hand, ASL left hand: Signs are annotated according to the hand used (right, left, or both), to permit consideration of ASL constructions in which the two hands are used in complementary manner. Each sign is glossed using an ID gloss from ASL Signbank (https://aslsignbank.haskins.yale.edu/) (Hochgesang, Crasborn & Lillo-Martin 2021). Additional information is annotated following the SLAAASh project conventions 3.0 (Hochgesang 2022).
- English utterance. Spoken or whispered English words are transcribed following CHAT procedures (MacWhinney 2000), adapted for use in ELAN (Family ASL English Transcription Manual).

Selected language samples were analyzed in the following ways.

i. <u>Modality counts</u>. Each utterance was coded for modality using three options: sign only, speech only, or bimodal (both sign and speech are present in a single utterance, no matter how much was expressed in either language). (For more information about bimodal language production by children and adults, see, among others, Chen Pichler, Lee & Lillo-Martin 2014; Chen Pichler, Lillo-Martin & Palmer 2018; Lillo-Martin, Gagne & Chen Pichler 2022; Lillo-Martin, Quadros & Chen Pichler 2016)
ii. <u>ASL IPSyn (Index of Productive Syntax)</u>. Adult ASL utterances were analyzed using the ASL-IPSyn (Lillo-Martin, Goodwin & Prunier 2017). This measure is an adaptation of the English IPSyn developed by Scarborough (1990). The ASL-IPSyn contains a list

of common ASL morpho-syntactic structures. Each transcript is searched for the occurrence of these structures. One point is given if the structure occurs once; two points if it occurs at least two times.

iii. English IPSyn, English MLUm. Child English utterances were analyzed using the KidEval function of CLAN (Ratner & MacWhinney 2016). KidEval automatically calculates various measures of spoken English language development and compares them to a hearing, monolingual English-speaking reference database constructed from the overall CHILDES database (MacWhinney 2000) (https://childes.talkbank.org). KidEval compares each individual transcript to children of a similar age in the reference database, which is split into 6-month age intervals. KidEval provides the database group mean and standard deviation for each measure, as well as information about how much the comparison child's score differs from the database mean in terms of standard deviations.

B. ASL-PET (ASL Phonological Elicitation Task). We designed the ASL-PET to study phonological development of both adult and child participants (Gu et al. 2024). The stimuli for the task consist of 150 ASL signs, distributed among 50 sets of 12 signs, with each individual sign appearing 4 times across the 50 sets. Crucially, sign iconicity and complexity are balanced for each set. Participants watch a video demonstrating a different set of signs every week. In the videos, each sign appears twice, then participants are instructed to copy the sign as accurately as they can. We scored participant sign production for accuracy at the feature level. This method has rarely been used in the past but has recently been shown to be informative for phonological development (Gu et al. 2022; Lutzenberger et al. 2023).

C. ASL-CDI (ASL Communicative Development Inventory). We use two forms (Forms A and B) of a 100-sign adaptation of the ASL-CDI 2.0 (Caselli, Lieberman & Pyers 2020), developed by selecting items from the full ASL-CDI in roughly equal proportions for each semantic category. The resulting 100 items are administered as a Qualtrics survey. Holly's mother completed the ASL-CDI three times over the course of 50 weeks, following Form B the first time, and Form A the second and times. She chose from the following options to describe her and Holly's knowledge of each sign: 'understands (the sign)', 'understands and signs (the sign)', 'uses a different sign (for this sign)', or 'doesn't know this sign'. We restrict our current analysis to only items which Holly or her mother 'understands and signs.'

D. Eng-CDI (English Communicative Development Inventory). We use two versions of the 100-item short form of the English MacArthur-Bates Communicative Development Inventory (Fenson et al. 2000). Holly's mother completed the Eng-CDI three times (Form A the first time, then Form B the second and third times), reporting which of the 100 English words on the list Holly understands and says (parents are instructed to check words even if their child's pronunciation is not completely target-like).

E. VCSL (Visual Communication and Sign Language checklist). The VCSL (Simms, Baker & Clark 2013) is a commonly used measure for assessing language and communication development in DHH children. It consists of a checklist of typical visual communication and ASL behaviors organized into expected age bands. For our research purposes, it was administered by team members who reviewed the relevant items with Holly's mother, and recorded her reports of whether each item was 'not yet emerging', 'emerging', 'inconsistent(ly) use(d)' or 'mastered'. For our report here, we use the partial-credit Rasch model described by Allen and Morere (2022).

4. Results

The results of the ASL assessments for Holly's mother are shown in Table 1, and the ASL and English results for Holly are shown in Table 2.

Table 1. Adult Results

		Child's age			
Task	**Domain**	**2;00-2;02**	**2;03-2;05**	**2;06-2;08**	**2;09-3;00**
Modality	Proportion sign		3	0	99
	Proportion speech		26	24	0
	Proportion bimodal		71	76	1
ASL IPSyn (146 max)	Syntactic diversity	57	66		81
ASL-PET (% correct)	Phonological accuracy	94		91	95
ASL CDI (/100)	Vocabulary knowledge	94		93	93

Table 2. Child Results

		Child's age			
Task	**Domain**	**2;00-2;02**	**2;03-2;05**	**2;06-2;08**	**2;09-3;00**
Modality	Proportion sign		18	10	14
	Proportion speech		16	28	56
	Proportion bimodal		56	62	30
ASL-PET (% correct)	Phonological accuracy	69		80	86
ASL CDI (/100)	Vocabulary knowledge	75		92	93
VCSL (scaled)	Visual communication	62		65	69
Eng IPSyn (118 max)	Syntactic diversity	29	26	35	41
Eng MLUm	Syntactic complexity	1.7	2.0	2.2	3.9
Eng CDI (/100)	Vocabulary knowledge		47	86	100

5. Discussion

Holly's mother had already developed conversational proficiency in ASL upon entry to our study, confirmed by her high scores on our initial assessment of her ASL phonology (94% correct) and vocabulary knowledge (94/100 items). Since these scores were near ceiling from the start of our study, it is not surprising that they did not increase over the course of her 50-week participation. On the other hand, her use of diverse ASL morpho-syntactic structures did increase over the year, rising from a score of 57 to 81 (this is a criterion referenced assessment; we do not have adult comparison data at this time).

Over much of the period of study, our Modality count analysis shows that Holly's mother produced a high proportion of bimodal utterances, as well as speech-only utterances, rather than sign-only utterances. Although we have not conducted a thorough analysis of this observation, we note that Holly's mother frequently used 'full blending', in which the full content of an utterance is produced in both sign and speech. This practice may reflect a desire to provide input to Holly in both ASL and English, since she was using bilateral cochlear implants. In the last session that we analyzed, Holly's mother switched to 99% sign only. Because our current Modality analysis only covers a subset of all language samples, we cannot yet know whether the high proportion of sign-only utterances in the final session was a unique occurrence, or whether she began transitioning intentionally to more sign-only use. Whatever the case, Modality counts for Holly herself show that her use of bimodal and speech-only utterances predominated over the analyzed sessions, with speech-only seeing a boost toward the end of the year.

From the start of the study at two years old and over the course of the year of observation, Holly's language development in both ASL and English is very good. Her initial score of 62 on the VCSL is more than one standard deviation above the mean for her age group as reported by Allen & Morere (2022), and the scores from our second and third administration of this measure are similarly high. Holly's overall phonological accuracy in ASL also steadily increased from 69% to 86% over the year, and her ASL vocabulary similarly increased from 75 to 93 out of 100 signs.

In English, Holly also showed impressive development. Her vocabulary as assessed by the English CDI increased from 47 to 100 out of 100 words. The analysis of her spontaneous production data shows her MLU in morphemes growing from 1.7 to 3.9, and her English IPSyn score rose from 29 to 41. A recent study of English development by bimodal bilingual children with exposure to ASL from deaf parents (Goodwin & Lillo-Martin 2023) also used KidEval to evaluate spontaneous production data. Holly's MLUm and her IPSyn scores were within or above the range observed for the children in that study at every age analyzed.

Overall, we can see that Holly's home ASL input was sufficiently rich to support her ASL development, which in turn did not prevent English development (Pontecorvo et al. 2023). For both parent and child, utterances involving signing (sign+bimodal) consistently made up the majority of analyzed sessions, confirming previous reports that hearing parents committed to a bimodal bilingual approach can sustain a home environment conducive to their deaf child's early ASL and English development, even as L2 signers (Lu, Jones & Morgan 2016; Caselli, Pyers & Lieberman 2021; Chen Pichler 2021; Lieberman, Mitchiner & Pontecorvo 2024).

6. Conclusions

This case study follows the English and ASL development of a DHH child, "Holly," who with her hearing mother received ASL services over the course of one year. During that time, Holly's phonological accuracy and vocabulary in ASL, as well as her vocabulary, syntactic complexity, and syntactic diversity in English improved. While Holly's mother did not show similar increases in all aspects of her ASL development, this is likely due to the fact that she had already attained conversational ASL proficiency by the start of this study. Our modality analyses document a change in language use and language mixing by Holly's mother, moving from a preference for bimodal utterances in earlier sessions to almost complete unimodal ASL in the final language sample. While the current report covers only a small sample of our data, our observations so far point to Holly's early ASL and English development progressing at a healthy pace without apparent negative impact from her bimodal bilingual language environment. In fact, she may well be benefitting from the rich linguistic input in two modalities. This study strengthens existing arguments that early access to ASL for deaf children from hearing parents supports successful bimodal bilingual development.

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