Development of Syntax in Spoken English by Bimodal Bilingual Deaf Children: Comparison with Hearing Bilinguals and Monolinguals

Shuyan Wang, Margaret Chui Yi Lee, Diane Lillo-Martin, and Deborah Chen Pichler

1. Introduction

Unlike typically hearing children, when a deaf or hard of hearing (DHH) child is born, their access to spoken language input is too limited for typical spoken language development to occur. If the DHH child's family knows and uses a natural sign language, the child will generally follow a typical developmental path in that language (Chen Pichler et al., 2018; Lillo-Martin & Henner, 2021). However, in the vast majority of cases, DHH children are born to hearing families who have no knowledge of deafness or sign languages (Mitchell & Karchmer, 2004). It may take several months before the diagnosis is confirmed, during which time the child experiences a lack of accessible linguistic input (Hall, 2017).

Many parents may choose to pursue spoken language with their DHH child, taking advantage of recent advances in hearing technology, such as hearing aids and cochlear implants (CIs). In some cases, hearing parents also elect to learn a natural sign language, such as American Sign Language (ASL), and expose their child to it. Since hearing technology does not fully restore hearing, and there is a great deal of variability in outcomes for DHH children using spoken language, using a sign language together with spoken language provides a child with the opportunity to become a *bimodal bilingual*, someone who uses two languages in two different modalities (spoken and signed).

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We gratefully acknowledge the participating families and the full FamilyASL research team for their time and commitment. We also thank the reviewers and audiences at BUCLD 50, as well as members of the Acqui Lab at the University of Connecticut, for their valuable feedback and insightful comments. This work was funded by the National Institute on Deafness and Other Communication Disorders of the National Institutes of Health under Award Number R01DC016901. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

 Proceedings of the 50th annual Boston University Conference on Language Development, ed. Romi Hill et al., 853-863. Somerville, MA: Cascadilla Press.

However, relatively little is known about sign and spoken language development for DHH children with hearing parents pursuing this approach. Some practitioners advise parents against using sign language, under the belief that doing so would impair the development of speech. Evidence against this belief has been presented in the area of vocabulary development: Pontecorvo et al. (2023) found that DHH children with a strong ASL vocabulary were more likely to have spoken English vocabulary sizes comparable to norms for typically hearing monolingual children. What about the development of morphology and syntax? What does the grammatical development of bimodal bilingual DHH children look like in those domains? One previous study found that bimodal bilingual DHH children with deaf, signing parents (and ASL input from birth) had spoken language developmental patterns comparable to those of hearing bimodal bilingual children, exhibiting typical bilingualism effects overall (Goodwin & Lillo-Martin, 2023). Here, we extend this line of research to examine spoken English syntactic development by bimodal bilingual DHH children whose hearing parents are only just learning to sign with them.

2. Longitudinal Study

The present study investigates the syntactic development of spoken English in bimodal bilingual DHH children acquiring both ASL and English, and further examines how their developmental trajectories converge with or diverge from those of unimodal bilingual children (using two spoken languages). The data analyzed here come from our larger project, *Family American Sign Language (FASL)* (Lillo-Martin et al., 2023), which examines families with deaf children and hearing parents who have elected to incorporate ASL as one of their family languages. This project explores how parents and children jointly acquire ASL, as well as the children's developmental outcomes in English and other domains.

2.1. Participants

We selected five of the first DHH children from the FASL project for analysis. Background information for each child is provided in Table 1. All five children were fitted with cochlear implants or other hearing aids at an early stage and received early exposure to spoken English and signing (from birth to 8 months of age). The observation periods for these children ranged from 2;02 to 4;01.

To establish an appropriate basis for comparison, we searched for unimodal bilingual datasets involving longitudinal observations within a comparable age range and with English as the dominant language. Based on these criteria, we selected three hearing Mandarin-English bilingual children from the CHILDES database (MacWhinney, 2000; Mai et al., 2024), all of whom were American-born Chinese children growing up in the United States. Each child received early exposure to both English and Mandarin (see Table 2). Their longitudinal language samples, spanning ages 2;00 to 4;11, were analyzed to parallel the developmental period examined in our DHH sample.

Table 1: DHH bimodal bilingual children

Child	Chronological age over observation period	Gender	Hearing technology	Age of exposure to signing
Ellie	2;02~3;00	Female	Bilateral CI (1;08)	2 months
Nayla	2;06~3;03	Female	Bilateral CI (2;02)	8 months
April	2;07~3;00	Female	CI (left ear) + BAHA (right ear) (1;04)	Birth
Yeira	3;02~4;00	Female	Hearing Aids (0;08)	Birth
Haven	3;02~4;01	Female	Bilateral CI (1;00)	4 months

Table 2: Hearing unimodal bilingual children

Child	Chronological age over observation period	Gender	Early language inputs
Luna	2;00-4;11	Female	English/Mandarin (English in nursery from 9 months old)
Avia	2;08-3;09	Female	English/Mandarin (One parent-one language at home; started a bilingual daycare at 2;05 (to 4;11))
Winston	3;00-3;07	Male	English/Mandarin & Cantonese (Mandarin and Cantonese at home; started English monolingual daycare at 1;08)

2.2. Method

Longitudinal naturalistic language samples were collected from the five DHH children. Each child participated in video-recorded 30-minute adult-child play sessions, during which spontaneous interaction served as the primary source of linguistic data. All parents were hearing and were acquiring ASL as a second language. As part of their training, parents were instructed to use whichever language (English or ASL) they felt most comfortable with. As a result, the recordings contained a mix of spoken English and ASL. The current analyses consider spoken English only.

Sessions at roughly monthly intervals were selected for analysis. These sessions were transcribed using CLAN-compatible CHAT conventions (MacWhinney, 2025). Transcribers underwent project-specific training in CHAT/CLAN procedures. The transcripts were independently checked and corrected by a second trained transcriber. Data collection and transcription followed the ethical guidelines approved for the FASL project, including informed consent from all participating families.

The three hearing unimodal Mandarin-English bilingual children were drawn from the CHCC corpus in CHILDES (MacWhinney, 2000; Mai et al., 2024). Each child was recorded monthly in naturalistic interactions with both Mandarin-speaking and English-speaking interlocutors. Consequently, each recording session had a designated target language (either English or Mandarin), although occasional cross-language utterances occurred. For the present study, we analyzed only the English sessions to align with the spoken English data considered for the DHH bimodal bilingual children.

We examined the variety and complexity of children's English syntactic structures using KIDEVAL (Ratner & MacWhinney, 2016) and the Index of Productive Syntax (IPSyn; Scarborough, 1990). KIDEVAL automatically analyzes CHAT-formatted language samples and provides a comprehensive set of measures, including lexical indices (e.g., word types and tokens) and syntactic indices (e.g., IPSyn-C scores). For the purposes of the present study, we extracted and analyzed the IPSyn-C syntactic measures which evaluate children's productive syntax across four subscales (noun phrases, verb phrases, question/negation structures, and sentence structures) based on the first 50 qualified utterances in each session.

2.3. Results

We analyzed the data along two dimensions: (i) children's overall IPSyn scores and (ii) the age of acquisition of each specific syntactic structure included in the IPSyn. We first examined the groups' overall performance. The DHH children's IPSyn scores ranged from 19 to 51 across the observed sessions (from 26 months to 49 months). A linear mixed-effects model, with IPSyn score as the dependent variable, age in months as a fixed effect, and subject as a random intercept, revealed that age significantly predicted the DHH children's IPSyn performance ($\beta = .823$, $p < .001$). In other words, their overall IPSyn scores increased reliably with age (see Figure 1).

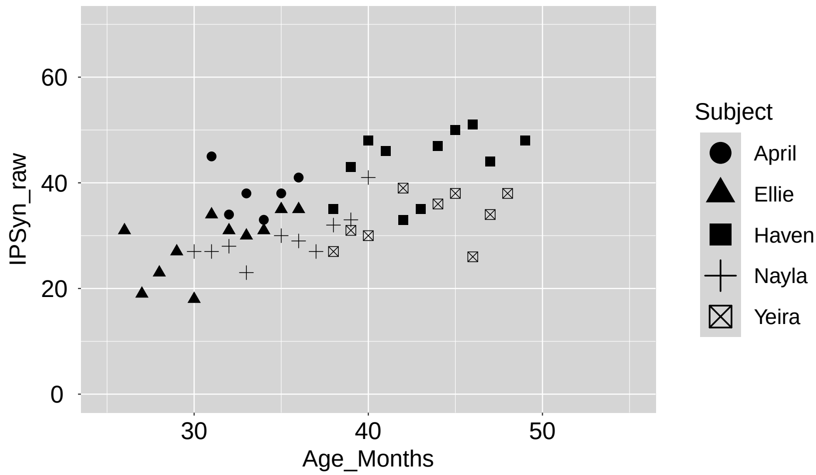

Figure 1: IPSyn score for bimodal bilinguals

The KIDEVAL program also provides a z-score for each session, representing the number of standard deviations each score deviates from the mean of typically developing monolingual English-speaking children at comparable ages. As shown in Figure 2, the majority of sessions were below the mean but still within 1.5 standard deviations of the monolingual mean, indicating that the DHH children's English syntactic development was broadly within the same range as that of typically developing monolingual peers.

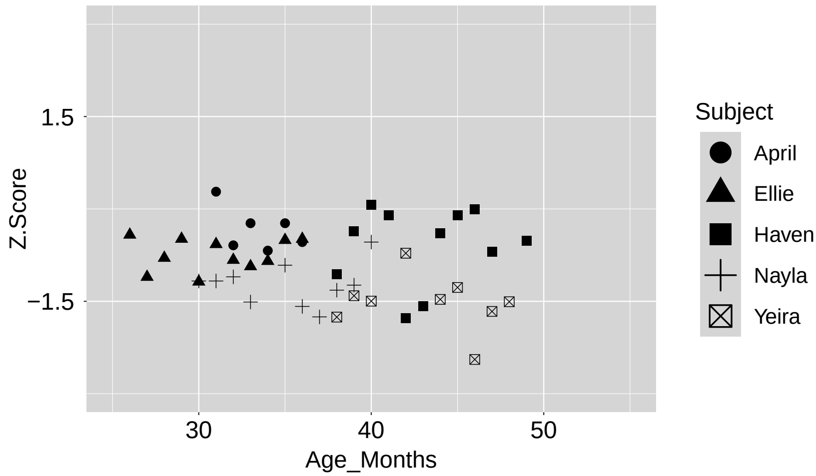

Figure 2: Z-score for bimodal bilinguals

The hearing Mandarin-English children's IPSyn scores ranged from 17 to 65 across the observed sessions (from 33 months to 51 months, see Figure 3). A linear mixed-effects model, with IPSyn score as the dependent variable, age in months as a fixed effect, and subject as a random intercept, did not reveal any significant age effect ($\beta = .271$, $p = .697$).

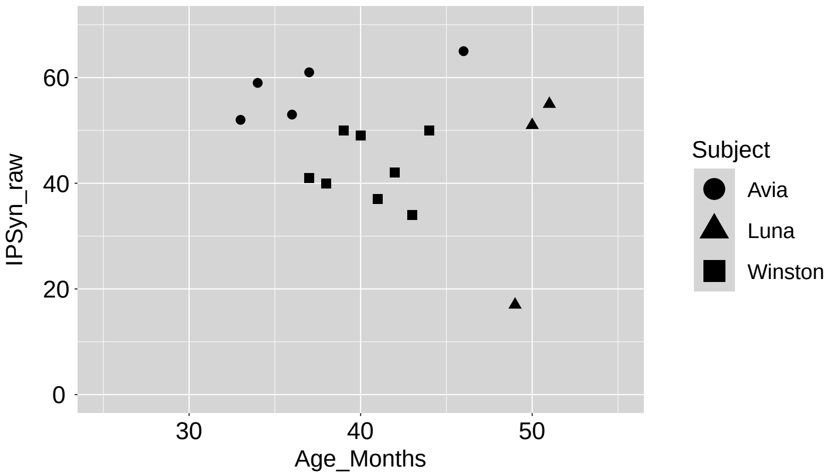

Figure 3: IPSyn score for unimodal bilinguals

As illustrated in Figure 4, the majority of sessions fell within 1.5 standard deviations of the monolingual mean, indicating that the Mandarin-English bilingual children's English syntactic development was also within the same range as that of typically developing monolingual peers. In fact, one child (Avia) was well above the mean of monolinguals.

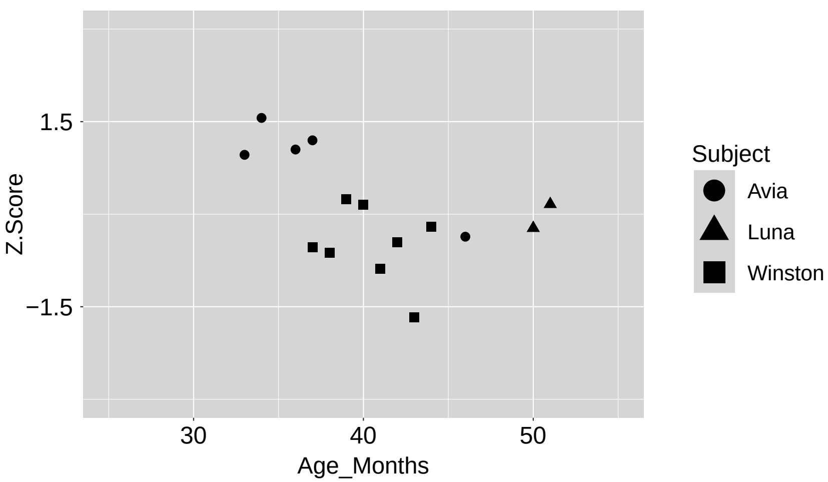

Figure 4: Z-score for unimodal bilinguals

We next combined the two bilingual groups to examine whether language group (bimodal vs. unimodal) modulated overall IPSyn performance. A linear mixed-effects model, with IPSyn score as the dependent variable, age in months and language group as fixed effects, and subject as a random intercept, revealed a significant main effect of age ($\beta = .718$, $p = .003$) but no significant main effect of language group ($\beta = -9.014$, $p = .215$). This pattern indicates that overall syntactic diversity and complexity increased with age across both groups, with no reliable difference between bimodal and unimodal bilingual children. When the interaction between age and language group was added to the model, no significant interaction was observed ($\beta = .503$, $p = .336$), suggesting that the developmental trajectories of IPSyn growth over time did not differ between the two bilingual groups.

To further characterize the developmental trajectories of syntactic acquisition in DHH bimodal bilingual children, we examined the age of acquisition (AoA) for each syntactic structure included in the IPSyn and compared these patterns with those observed in unimodal bilingual children. Importantly, AoA was not calculated separately for each individual child. Instead, children within the same language group were aggregated, and the AoA for each syntactic structure was defined at the group level. Specifically, for each language group, the AoA of a given structure was operationalized as the earliest age at which that structure was attested in the language samples of any child within the group. This group-level operationalization was adopted due to sparse longitudinal sampling and the limited number of observations per age point, and it allows us to focus on cross-group differences in developmental ordering rather than individual variability.

Based on the group-level AoA, we calculated the number of syntactic structures produced by each bilingual group by 34 months and 42 months, respectively. As shown in Table 3, the two bilingual groups had acquired a comparable number of structures at both ages across all four IPSyn subscales: noun phrases, verb phrases, question/negation structures, and sentence structures. This pattern indicates that by approximately 3-4 years of age, bimodal and unimodal bilingual children exhibited similar levels of syntactic diversity and complexity in English.

Table 3: Number of structures acquired by each bilingual group at 34 months old and at 42 months old.

	Bimodal Bilinguals		**Unimodal Bilinguals**	
	34 Months	**42 Months**	**34 Months**	**42 Months**
Noun Phrases (n = 8)	8	8	8	8
Verb Phrases (n = 16)	13	14	12	15
Questions/ Negation (n = 6)	4	6	4	5
Sentences (n = 18)	15	17	14	16

Despite the overall similarities, we further examined whether the AoA of individual syntactic structures differed between the two bilingual groups. Specifically, we compared the group-level AoA for each IPSyn structure and identified structures showing a relative delay in one group compared to the other, defined as an acquisition gap greater than three months (> 3 months). For the DHH bimodal bilingual group, two structures were identified as relatively delayed compared to the hearing unimodal bilingual group: V17 Certain bound morphemes (e.g., *re-do*, *brave-ly*) and S19 Fronted and centered subordinate clauses (e.g., *the one I like best is*). However, these findings should be interpreted with caution, as the sample size here was relatively small. Moreover, both structures are known to be extremely low in frequency in the spontaneous speech of typically hearing monolingual English-acquiring children at comparable ages. For example, Altenberg et al. (2018) examined IPSyn measures in 10 monolingual English-acquiring children at 30 months and 10 at 42 months and found that only one child at each age produced the V17 structure, and only a single 42-month-old child produced the S19 structure, and only once. Such sparse attestation limits the reliability of corpus-based estimates of the AoA for these constructions (see also Wang et al., 2022). Consequently, the relative delay observed for these structures in the DHH bimodal bilingual group should not be taken as evidence of a meaningful developmental concern, and we therefore refrain from overinterpreting these differences.

For the hearing unimodal bilingual group, twelve structures were identified as relatively delayed compared to the DHH bimodal bilingual group. As with the previous comparison, the majority of these structures (10 out of 12) are extremely low in frequency in the spontaneous production of typically developing monolingual English-acquiring children at comparable ages (Altenberg et al., 2018). Only two structures showed more consistent representation in the monolingual data reported by Altenberg et al. (2018): S8 Simple infinitives (e.g., *I like to swim*) and S9 *let/make/help/watch* + V constructions (e.g., *Help it stand*).

3. Discussion

The present study examined the syntactic development of spoken English in DHH bimodal bilingual children acquiring both ASL and English and compared their developmental trajectories with those of hearing unimodal bilingual children. Using longitudinal language samples and IPSyn-based analyses, we evaluated both overall syntactic productivity/complexity and the AoA of individual structures. Across multiple analytic dimensions, our results revealed substantial similarities between the two bilingual groups, suggesting broadly comparable trajectories of English syntactic development during the preschool years.

In terms of overall IPSyn scores, the DHH bimodal bilingual children in our study exhibited clear age-related growth. Although their IPSyn scores were generally below the monolingual mean, they still consistently fell within the range (1.5 standard deviations) of typically developing monolingual English-speaking peers, indicating broadly typical syntactic development. For the typically hearing unimodal bilingual children, their overall IPSyn scores were generally good and also fell within the range of monolingual peers. However, due to their relatively small sample size and substantial individual variation, no robust age-related growth was observed for unimodal bilingual children. These findings provide converging evidence that the DHH bimodal bilingual children in our study did not demonstrate any significant delays in English syntax at preschool ages, and their developmental trajectories were broadly comparable to those by hearing unimodal bilingual children.

Analyses of structure-level AoA further support this conclusion. By 34 and 42 months, the two bilingual groups had acquired a comparable number of syntactic structures across all subscales, indicating similar levels of syntactic diversity and complexity by approximately 3-4 years of age. At the level of individual structures, group differences in AoA were observed, with each bilingual group showing relative delays in different constructions. Notably, the DHH bimodal bilingual children exhibited relative delays in certain bound morphemes and in some types of subordinate clauses (e.g., subject relative clauses). These findings are broadly consistent with previous research on English syntactic development in DHH children. For example, Werfel et al. (2021), examining spontaneous production of complex syntax across multiple contexts, reported that subordinate clauses were consistently more challenging for 4-year-old DHH children than for age-matched typically hearing peers. Importantly, the DHH participants in their study had little or no exposure to a signed language. The present findings extend this pattern by suggesting that challenges with subordinate clauses may persist even in DHH bimodal bilingual children who receive early exposure to sign language. At the same time, caution is warranted in interpreting these delays. Both constructions identified here are extremely low in frequency in monolingual acquisition data, which together with the current small sample size constrains the reliability of corpus analysis. Therefore, further research with larger samples and more fine-grained measures is needed before concluding that these structures represent areas of persistent vulnerability for DHH bimodal bilingual children.

For hearing unimodal Mandarin-English bilingual children, a greater number of structures (n = 12) were identified as relatively delayed. As with the previous analyses, the majority of these constructions are extremely low in frequency in the spontaneous production of monolingual English-acquiring peers, which limits the interpretability of these apparent delays. Moreover, relative to the DHH bimodal bilingual group, the unimodal bilingual group contributed substantially fewer data points, further reducing statistical stability at the structure level. Accordingly, we refrain from overinterpreting these differences, and additional research with larger and more densely sampled datasets is required before drawing firm conclusions about structure-specific vulnerabilities in either bilingual group.

4. Conclusion

The present study examined the development of spoken English syntax in DHH bimodal bilingual children acquiring both ASL and English and compared their trajectories with those of hearing unimodal bilingual children. Across multiple measures, including overall IPSyn scores and structure-level ages of acquisition, our findings reveal largely comparable patterns of syntactic development between the two bilingual groups during the preschool years. Importantly, DHH bimodal bilingual children showed clear age-related growth in English syntactic productivity, with performance falling within the range of typically developing monolingual peers, and without evidence of systematic delay relative to hearing bilingual children. These results provide further evidence that early exposure to a sign language does not hinder the development of spoken language syntax in DHH children. Furthermore, our findings underscore the importance of analyzing DHH children as bilinguals and comparing them to appropriate bilingual peers, rather than exclusively to monolingual norms. At the same time, larger and more densely sampled longitudinal datasets are needed to better characterize individual variability and to increase the reliability of structure-level analyses. In addition, future work should also move beyond global indices such as IPSyn to examine the proportional use and developmental trajectories of specific syntactic constructions. Finally, further research is needed to investigate the sources of apparent structure-specific delays, including potential cross-linguistic and cross-modal influences between ASL and English, as well as the role of input frequency and distribution.

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Proceedings of the 50th annual Boston University Conference on Language Development

edited by Romi Hill, Xinhan Jiang, Danutham Worapipat, and Aditya Yedetore

Cascadilla Press Somerville, MA 2026

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ISSN 1080-692X
ISBN 978-1-57473-047-0 (2 volume set, paperback)

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