Bilingual Bimodal Hard-of-Hearing Children with a Forced Displacement Background in Germany: A Pilot Study on Morphosyntactic Developmental Trajectories of German Spoken Language and German Sign Language

Lina Abed Ibrahim, Solveig Chilla, Anne Wienholz, and Barbara Hänel-Faulhaber

1. Introduction and theoretical background

Bilingual children's communication skills in the language of schooling are fundamental to academic success and psychosocial well-being. Since 2015, a record number of over 300,000 school-age children with forced displacement biographies (henceforth FDB) have been integrated into the German school system, most of whom originate from Syria and Ukraine. This influx is also reflected in the rising numbers of deaf and hard-of-hearing multilingual learners with FDB at Deaf/hard-of-hearing schools in Germany, where these students face the dual challenge of navigating a new spoken/written language and a new sign language simultaneously (Marx et al., 2025).

A growing body of research has investigated the development of spoken L2 (second or any subsequent language) abilities in hearing first-generation bilingual students with FDB, with particular focus on L2 (complex) morphosyntax, given its importance for the development of literacy and school-related academic skills. A consistent finding is that, given more exposure to the societal language, students with FDB show better performance on (complex) morphosyntax, which appears to be more robust than L2 vocabulary (Hamann et al., 2020; Paradis et al., 2022). However, there is hardly any research investigating the development of L2 (complex) morphosyntax in both spoken and signed modalities of newly immigrated hard-of-hearing school-age children with FDB (Marx et al., 2025).

Ample research has shown that early and sustained access to high-quality linguistic input, irrespective of modality, is critical for the development of language and related cognitive-linguistic skills (e.g., working memory, executive

* Lina Abed Ibrahim, Solveig Chilla, Europa-Universität Flensburg, Anne Wienholz, University of Hamburg, Barbara Hänel-Faulhaber, University of Hamburg. Corresponding author: Lina Abed Ibrahim, Faculty II, Europa-Universität Flensburg, lina.abed-ibrahim@uni-flensburg.de. The research was carried out within the pilot project ZuSprache, financed by an EUF ZeBUSS Grant to S. Chilla and B. Hänel-Faulhaber, and the BiliSAT project ,financed by DFG Grants to S. Chilla (CH 1112/4-1) and C. Hamann (HA 2335/7-1). Our special thanks go to the participating children and their families and collaborating schools and speech language therapy centers.

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functions, theory of mind) that support later learning (Delcenserie et al., 2024; Hall et al., 2017; Mayberry et al., 2024). However, hard-of-hearing (HoH) children, i.e., those with mild to severe hearing loss, frequently experience constrained access to and reduced uptake of linguistic input. These limitations vary depending on factors including age of onset and severity of hearing loss, timing and consistency of audiological intervention, early language access, communicative modality, and the extent of immersion in bimodal bilingual educational contexts, i.e., sign and spoken/written language education (Mayberry et al., 2024; Werfel et al., 2022). The vast majority of HoH children are born to hearing, non-signing parents, who typically communicate via spoken language with no prior knowledge of sign language (Mitchell & Karchmer, 2004). Many of these children, therefore, experience substantial limitations or delays in the onset of exposure to accessible linguistic input. On the one hand, auditory access through hearing technology is often delayed, and/or spoken language cannot be adequately processed despite such technology. On the other hand, sustained exposure to a fully accessible sign language is frequently unavailable until enrolment in bimodal bilingual educational programs at school-age or later, resulting in late first language (L1) signers (Age of Onset (AoO) > 6; Hennies et al., 2016). In the absence of early sign language input, HoH children, especially those with more severe hearing loss, are at risk of experiencing language deprivation during a sensitive period of language development.

Delayed and impoverished access to linguistic input over time has adverse consequences for the development of the L1 and any subsequent language, across all levels of linguistic structure, including a fully accessible sign language (see Hänel-Faulhaber, 2017; Mayberry et al., 2024). However, aspects of (morpho)syntactic processing appear to be more vulnerable to effects of delayed primary language exposure than lexical-semantic ones (Malaia et al., 2020). Studies examining spoken morphosyntactic abilities of HoH children report difficulties across various morphosyntactic phenomena, with persistent challenges in children with delayed access to language and accompanying working memory deficits. Compared to same-age hearing peers, HoH children are cross-linguistically reported to have a lower mean length of utterance, exhibit higher rates of inconsistencies in their use of grammatical morphemes, and produce less complex sentences (Werfel et al., 2022). Although HoH children show progress over time, even those with less severe degrees of hearing loss still lag behind their hearing peers in the comprehension and production of complex syntactic structures, the processing of which requires reconstructing (hierarchical) non-local dependencies between grammatical elements, e.g., complement clauses, relative clauses, wh-questions, and topicalized sentences (Ruigendijk & Friedmann, 2017; Sztermann & Friedmann, 2024) and is more taxing on working memory (WM) resources. Such difficulties have also been reported for children with Developmental Language Disorder (DLD), who, given their weak linguistic representations and WM limitations, perform poorly on such constructions.

For various sign languages, studies employing different types of tasks to assess sentence processing in L2 signers with varying AoO and length of exposure

(LoE) to sign language have revealed that a late exposure to sign language, particularly when only beginning in school age or later, is associated with poorer performance on both simple and complex sentence structures, with more pronounced effects in the latter (e.g., Schönström & Hauser, 2022; Wienholz & Hänel-Faulhaber, 2026). Although both early and late signers demonstrate sensitivity to syntactic complexity effects, late L1 learners are reported to experience significant difficulties with structures that require reconstructing non-local dependencies. These structures, such as object relative clauses and questions, as well as modality-specific structures like role-shift and agreement with directional verbs, demand greater processing resources, which may be limited in HoH individuals (e.g., Hauser et al., 2021). Some studies even show stagnation at the basic clause level (Cheng & Mayberry, 2019; Mayberry et al., 2024).

HoH students with FDB constitute a particularly vulnerable group in multiple ways (e.g., Adams Lyngbäck & Andersson, 2023). Depending on their audiological profiles, access to linguistic input, and language-communication models during their upbringing, some have had access to a sign and/or spoken language from birth, while others have had limited and delayed access to any language and instead rely on, e.g., gestures or home signs. Flight and trauma can further restrict communication possibilities through the loss of familiar linguistic reference persons and preventing access to timely audiological intervention and sign language promoting programs (Marx et al., 2025). Consequently, many arrive in the host country with (very) limited spoken or signed L1 abilities, constituting instances of delayed L1 acquisition (Mayberry et al., 2024). It is also not given that older students have acquired reading and writing skills in their L1. Such biographies can impact the acquisition of any additional language and put the children at an increased risk of psychosocial difficulties (Holmström & Sivunen, 2022). Bimodal bilingualism is seen as a way of providing HoH children with immediate access to both a sign and a spoken language, reducing the risk of language deprivation (Hänel-Faulhaber & Weiglin, 2024). While the acquisition of spoken language may be only partially possible for HoH students, even with technical support, sign language is fully accessible to them. Empirical evidence documents the benefits of sign language exposure for the development of spoken language and/or the development and processing of written language (Hänel-Faulhaber et al., 2022; Pontecorvo et al., 2023).

In this pseudo-longitudinal, exploratory study, we investigate L2 morphosyntactic development in German Spoken Language (*Deutsche Lautsprache*: DLS) and German Sign Language (*Deutsche Gebärdensprache*: DGS) in five late successive (lL2) bilingual hard-of-hearing (BiHoH) children with FDB, who were enrolled in a bimodal bilingual special school for deaf and hard-of-hearing children. Using the LITMUS sentence repetition tasks for spoken German (DLS-SRT: Hamann et al., 2013) and German Sign Language (DGS-SRT-Kids: Wienholz et al., 2025; Wienholz & Hänel-Faulhaber, 2026), we focus on complex morphosyntax, a cross-linguistically vulnerable domain in atypical language development (Ruigendijk & Friedmann, 2017). The study follows a

mixed longitudinal design: spoken German will be assessed at two testing points (T1, T2) separated by 12-18 months, while performance on German Sign Language will be assessed at one testing point (T1). For the DLS-SRT, lL2_BiHoH children with FDB will be compared to five age-matched hearing bilingual children with similar forced displacement and L1 backgrounds, and to five bilingual children with DLD. The latter comparison is particularly relevant given reported similarities between unimodal HoH children and hearing children with DLD (cf. Tomblin et al., 2015). For the DGS-SRT-Kids, the BiHoH children with FDB will be compared to late signers without FDB. We will also compare the performance of the BiHoH children across the two modalities. Specifically, we ask whether late successive BiHoH children with FDB exhibit comparable L2 performance in the spoken and signed modalities, and whether performance varies with the structural complexity of the stimuli in the two repetition tasks.

2. Method

2.1. Participants

The study includes 20 school-age children. Relevant data on sociodemographic information, early and current language development, qualitative and quantitative aspects of language exposure, communication modality, and audiological history were collected using the extended version of the Questionnaire for Parents of Bilingual Children (PaBiQ, Tuller, 2015; see Hamann et al., 2020 for details) and a specialized hearing-loss questionnaire.

The primary test group in this study comprises five late successive bimodal bilingual hard-of-hearing children (lL2_BiHoH) with FDB, recruited from a special school for deaf and hard-of-hearing children in Northern Germany, where they were exposed to German Spoken Language and German Sign Language. All five lL2_BiHoH participants (B1–B5; ages in years and months at T1: 13;2, 12;2, 11;11, 13;1, 12;8) arrived in Germany as refugees. B2-B5 were exposed to Syrian Arabic from birth and used spoken language as their primary mode of communication. B1 was born to a hearing mother and a deaf father and, therefore, exposed to both spoken Iraqi and Arabic Sign Language at home, but was not instructed in sign language pre-migration. Given B1's severe to profound hearing loss and very limited spoken language abilities, sign language is B1's preferred mode of communication.

Audiometric testing indicated hearing loss ranging from moderate to severe. Although the hearing loss had been diagnosed in early childhood in their country of origin, none of the children received audiological intervention pre-migration, nor did they have systematic access to sign language prior to arrival in Germany. Because initial intervention and exposure to a fully accessible sign language did not begin until after migration, in their prepubescent years, the BiHoH children suffered a prolonged period of restricted or impoverished (early) language experience. After arriving in Germany, though not immediately, the BiHoH children underwent comprehensive audiological assessments and were fitted with hearing devices depending on the type and severity of their hearing loss (Table

1). The most recent aided audiometry indicated good aided hearing for B2, B3, and B5. In contrast, B1 demonstrated limited aided hearing in the right ear and profound hearing loss in the left ear. B4 showed insufficient aided hearing with progressive hearing loss.

Table 1: Demographic information of the bimodal bilingual late successive hard-of-hearing children with FDB

child	age at T1	age of audiolog. interven.	DLS_L2			DGS_L2		degree of hearing loss	early sign language exposure	technical aid
			AoO yrs.	LoE T1	LoE T2	AoO yrs.	LoE T1			
B1	12;2	CI: 7;2 HA: 11;11	10;5	21 (3)	31 (13)	10;5	21	severe to profound HL	yes	CI(R)/ HA(L)
B2	12;2	11;2	8;7	43 (12)	53 (21)	9;11	27	moderate to severe HL	no	bilateral HA
B3	11;11	HA: 5;4 CI: 7;0 (L), 11;0 (R)	7;4	55 (25)	66 (36)	7;4	55	severe to profound HL	no	bilateral HA→ bilateral CI
B4	13;1	8;11	7;7	66 (50)	78 (63)	7;7	66	severe progressive HL	0-24 mo.	bilateral HA/FM device
B5	12;8	7;9	7;2	66 (59)	85 (72)	7;2	66	moderate HL	no	bilateral HA

Notes. T1: 1st testing point, T2: 2nd testing point, AoO: age of onset of exposure to L2, LoE: length of L2 exposure, HA: hearing aid; FM: frequency modulating; length of exposure after most recent hearing aid fitting is given in brackets.

The BiHoH participants varied markedly in their prior schooling and in their spoken, signed, and written Arabic (Modern Standard Arabic) abilities. B1, B2, and B3 represent cases of severely restricted (early) language experience and limited formal education. Due to their untreated severe-to-profound hearing loss, the children were denied access to mainstream schooling in their country of origin and during transit, nor did they attend specialized schools for sign language pre-migration. They were also unable to participate in Arabic Sunday school in Germany. As a result, they have no Arabic literacy skills and demonstrate no (B1) or limited (B2 and B3) spoken Arabic abilities compared with same-age hearing peers. However, unlike B2 and B3, B1 was exposed to Arabic Sign Language via his signing deaf parent and, according to parental report, can communicate in Arabic Sign Language in domestic contexts. B4 did not attend school in Syria but was enrolled in an Arabic school for one year during transit in Turkey. B4 also attends an Arabic Sunday school in Germany and has basic literacy skills in Modern Standard Arabic. B4 likely received Arabic Sign Language input during infancy, as the child was born into a household with a deaf and a hearing parent; however, contact with the deaf father was limited to the first two years of life. In contrast, B5, who has moderate hearing loss, attended an Arabic-speaking kindergarten and attended grades 1 and 2 in Syria. B5's schooling was only briefly

interrupted because of a short transit period. Additionally, B5 attends Arabic Sunday school in Germany and engages in daily literacy-promoting activities in Arabic. All participants were first exposed to spoken German in special language classes or mainstream German schools between ages 7;2 and 10;5. Exposure to German Sign Language began after transfer to a special school for the deaf (i.e., bimodal bilingual education). Hence, they are classified as late successive or adolescent L2 learners of both DLS and DGS (Mayberry et al., 2024; Paradis et al., 2022).

At the first testing point (T1), the BiHoH children's performance in spoken German was compared to two groups: five age-matched, typically developing hearing unimodal bilingual children with FDB (A1, A2, A3, A4, A5), and five younger hearing unimodal bilingual children with DLD (BiDLD: C1, C2, C3, C4, C5; age range: 7;4-8;11). The participants of the typically-developing group were first exposed to L2 German at age 6 or older (AoO > 6;0), i.e., late successive typically-developing bilinguals (lL2_BiTD). Their length of exposure to L2 German (LoE_L2) ranged from 20 to 30 months, substantially less than in the BiHoH group. Four of them spoke Syrian Arabic (A1, A2, A3, and A5) and one Ukrainian (A4) as L1. The BiDLD children were first exposed to German around age three upon kindergarten entry (early successive bilinguals) and were comparable to the BiHoH children in LoE to the L2. For DGS, the BiHoH group was compared to an age-matched group of deaf and hard-of-hearing late signers who were born in Germany and first exposed to DGS in an educational setting at age six or older (AoO > 6;0). Unlike the lL2_BiHoH children, these late signers all received early hearing aid or cochlear implant fitting as well as speech and language intervention and did not experience an impoverished early language environment.

2.2. Materials

2.2.1 LITMUS sentence repetition task for spoken German (DLS-SRT)

The German LITMUS SRT (Hamann et al., 2013) was used to assess morphosyntactic abilities in spoken German. The task, originally developed for children aged 5;6 to 9;0, was constructed according to the LITMUS (Language Impairment Testing in Multilingual Settings) principles to disentangle DLD from typical language development in bilingual contexts. It features complex structures that cross-linguistic literature has identified as challenging for children with language disorders, such as object questions, relative clauses, and finite complement clauses. Additionally, it includes structurally simpler constructions that represent crucial milestones in the acquisition of German morphosyntax (e.g., the sentence bracket and topicalized constructions reflecting the V2/OV properties of German; Hamann et al., 2017). Syntactic complexity is operationalized in terms of (Wh-)movement, syntactic embedding, and movement intervention (NP-restriction) as an additional complexity factor. The sentences (15 conditions × 3 sentences each) are grouped into four levels of complexity depending on the number of complexity factors involved in deriving the constructions (see Abed Ibrahim & Hamann, 2024 for particulars). The test items

are presented aurally via a child-friendly PowerPoint in a pseudo-randomized order. The test administration takes between 5 and 10 minutes. Following Abed Ibrahim et al. (2024), responses were rated using the "correct target structure" scoring method, which disregards typical bilingual errors, e.g., lexical substitutions and certain case and gender errors, as long as they do not affect the realization of the targeted structure (see Hamann & Abed Ibrahim, 2017).

2.2.2. Sentence repetition task for German Sign Language (DGS-SRT Kids)

For assessment of morphosyntactic abilities in DGS, we applied the DGS-SRT-Kids (Wienholz et al., 2025; see also Wienholz & Hänel-Faulhaber, 2026), a newly developed sentence repetition task for DGS. The DGS-SRT-Kids was developed following the LITMUS principles and targets children aged 4-13 years with the aim of differentiating between deaf and hard-of-hearing children with different language learning trajectories. The current version of the test contains 19 DGS sentences varying in length and complexity. Sentence length is defined based on the number of individual signs contained in each sentence (short, medium, long). The degree of complexity is determined by corresponding variations in morphosyntactic structure (simple, medium, complex), considering sign language-specific aspects for this categorization. These aspects include, for example, the use of the signing space, the use of different classifiers, i.e., handshapes to represent physical or visual-geometric properties of objects, and the use of simultaneity and constructed action, i.e., a discourse strategy in sign languages for role-taking. The complexity levels were controlled regarding sentence length, so that the degree of difficulty of the complexity levels did not correlate with the ability to remember longer sentences (Hamann & Abed Ibrahim, 2017). The task takes approximately 10 minutes to complete. The children's responses are videotaped and subsequently evaluated offline using a special, elaborate evaluation scheme. In the evaluation, all signs in the presented sentences were assessed individually according to whether the sign was produced and whether this production was correct or incorrect, to finally calculate the proportion of correct signs in relation to the maximum number of signs (Wienholz et al., 2025; Wienholz & Hänel-Faulhaber, 2026).

3. Results

IBM SPSS 29 (IBM Corp., 2026) was used for statistical analyses. Nonparametric tests were chosen because of the small sample size and violations of normality in all cases, as indicated by the Shapiro–Wilk test (all $p < .05$). At T1, we first compared the overall performance of the BiHoH children with the respective control groups for each modality (DLS: lL2_BiTD, BiDLD; DGS: late signers). Next, we examined performance on structures with varying levels of structural complexity in the DLS and DGS tasks and compared the lL2_BiHoH children's performance across modalities. Because longitudinal data are available

only for the DLS-SRT, morphosyntactic growth for lL2_BiHoH participants will be investigated only for the spoken modality.

3.1. Morphosyntactic abilities in spoken German (DLS-SRT)

At T1, a Kruskal-Wallis-H test revealed a significant effect of group on performance in DLS-SRT scored by "correct target structure" ($H = 11.1$, $p < .05$). Overall, lL2_BiHoH children had significantly lower scores than their hearing peers, who performed above chance within only 30 months of L2 exposure (lL2_BiTD vs. lL2_BiHoH: $U = 0.000$, $p < .01$, $r = .825$). At the group level, lL2_BiHoH children did not differ significantly from the BiDLD group ($U = 3.000$, $p > .05$). Substantial interindividual variation was observed among the lL2_BiHoH children: one child performed near chance, while the other four children showed floor or near floor effects at both testing points with no or only a slight improvement over time (see Figure 1 & Figure 2).

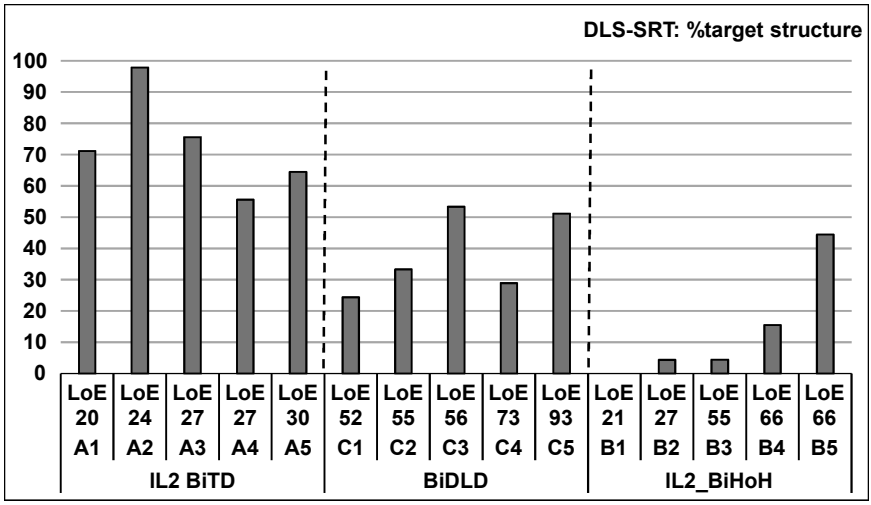

Figure 1: German LITMUS DLS-SRT: % correct target structure (LoE: length of exposure to L2 in months)

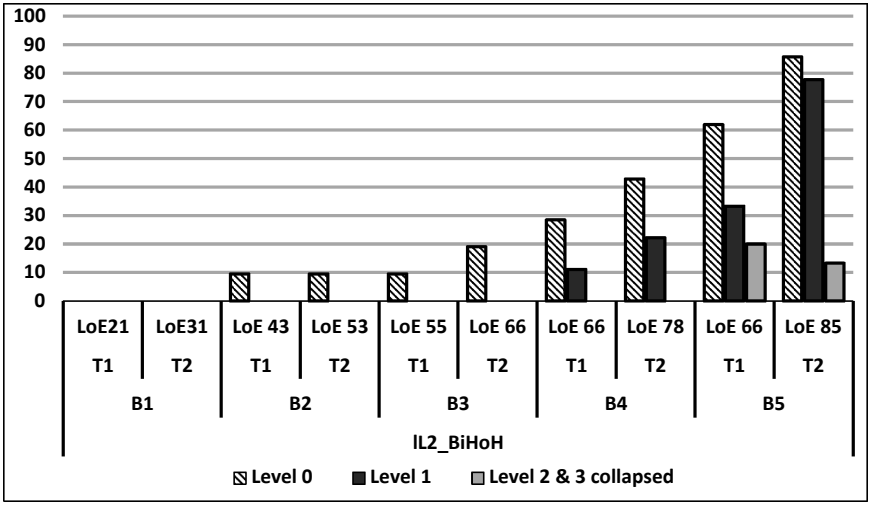

Figure 2: German LITMUS-SRT: % correct target structure for sentences grouped by level of structural complexity

Next, we examined lL2_BiHoH children's individual performance on DLS-SRT sentences, grouped by structural complexity at both testing points (T1 and T2). Because Level 3 contained only one sentence type (object relatives with an intervening NP), Levels 2 and 3 were combined. The individual results across complexity levels are shown in Figure 2. At both testing points (10-month interval), B1, B2, and B3 showed floor or near-floor performance (~10% correct) across all complexity levels, with no (B2) or minimal (B3: 10% to 20%) improvement over time. B1's data was dominated by zero responses at T1 and T2, whereas B2 and B3 mainly produced sentential fragments (partial repetitions) with missing structural and lexical elements. At T2, sentential fragments were still predominantly present in B2's and B3's responses, but these fragments retained more lexical and structural elements of the elicited sentences, see (1). Monoclausal responses, i.e., producing a main clause instead of an embedded structure, were also observed, see (2) for an example.

(1) Target structure: object relative clause with intervention

Ich sehe den Vogel, den der Pinguin weckt
I_{nom} see $the_{acc\text{-}m}$ bird $who_{acc\text{-}m}$ $the_{nom\text{-}m}$ penguin wakes up
'I see the bird, who(m) the penguin wakes up'

Child response (T1)	**Child response (T2)**
Ich sehe	Ich sehe Vogel Pinguin we(ck)t
I_{nom} see	I_{nom} see bird penguin wakes up

(2) Target structure: object relative clause without intervention

Die Frau sieht den Pinguin, den sie streicheln will
The$_{nom-f}$ woman sees, the$_{acc-m}$ penguin the$_{acc-m}$ she pet wants
'The woman sees the penguin who(m) she wants to pet'

Child response (T2):

Die Frau sieht ein Pinguin und schreit
The$_{nom-f}$ woman sees a$_{nom-m}$ penguin and yells

For B4, an improvement was observed for Level 0 (29% to 43%) and Level 1 structures involving Wh-movement (11.1% to 22.2%). At T1, the prevailing error type was sentential fragments. By T2, sentential fragments decreased while monoclausal responses increased. There were also unsuccessful embedding attempts and instances of double case marking on subject and object DPs in noncanonical word orders, such as topicalizations and object relative clauses, see (3) for an example.

B5 demonstrated the most advanced spoken morphosyntactic abilities within the lL2_BiHoH group and showed significant morphosyntactic growth from T1 to T2. Level 0 accuracy rose from 62% to 85% (mastery) at T2. Performance on Level 1 structures involving syntactic movement and embedding also improved substantially (33% to 77%). Yet, no improvement was observed for Levels 2 and 3, which feature multiple complexity aspects. Unlike the other BiHoH children, B5 produced no sentential fragments and rarely monoclausal responses. At T1, B5 omitted functional elements (e.g., complementizers, relative pronouns) and made case errors; by T2, omissions had disappeared. Remaining errors at T2 were mainly double accusative or accusative/dative markings in computationally more complex constructions featuring two or more complexity factors (e.g., subject and object relative clauses; see example 3). Relative clauses with a resumptive element occurred as well.

(3) Target structure: Topicalization:

Den Arzt fotografiert der Bauer gerne
The$_{acc-m}$ doctor photographs the$_{nom-m}$ farmer gladly
'The farmer likes to photograph the doctor'

Child response (double object marking)

Dem Arzt fotografiert **den** Bauer gerne
The$_{dat-m}$ doctor photographs the$_{acc-m}$ farmer gladly

3.2. Morphosyntactic abilities in German Sign Language (DGS-SRT-KIDS)

With respect to morphosyntactic abilities in DGS, a pattern similar to that observed in the DLS-SRT emerged, with the L2_BiHoH group showing substantial inter-individual variation (Figures 3 & 4). Notably, except for B5, all L2_BiHoH children performed better on the sign-language task than on the

spoken-language task, but this difference did not reach statistical significance (Wilcoxon signed-rank test: $Z = .674$; $p = .500$).

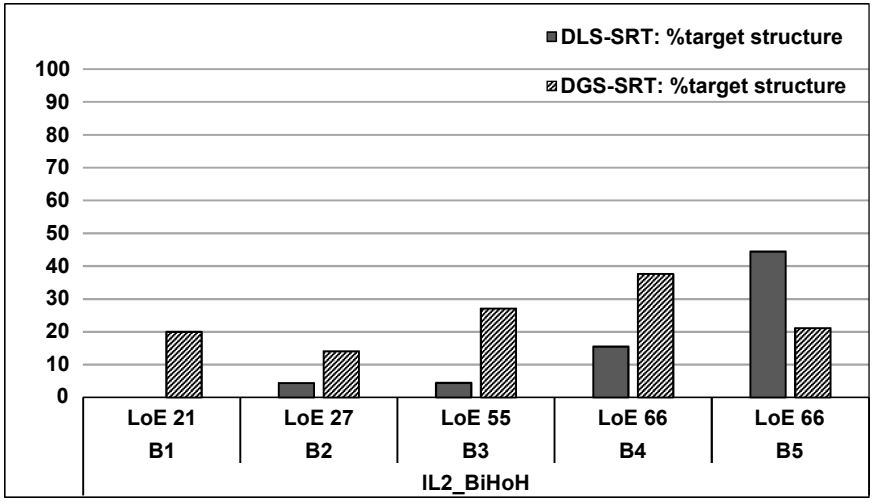

Figure 3: LITMUS DLS-SRT vs. DGS-SRT: % correct target structure (lL2_BiHoH)

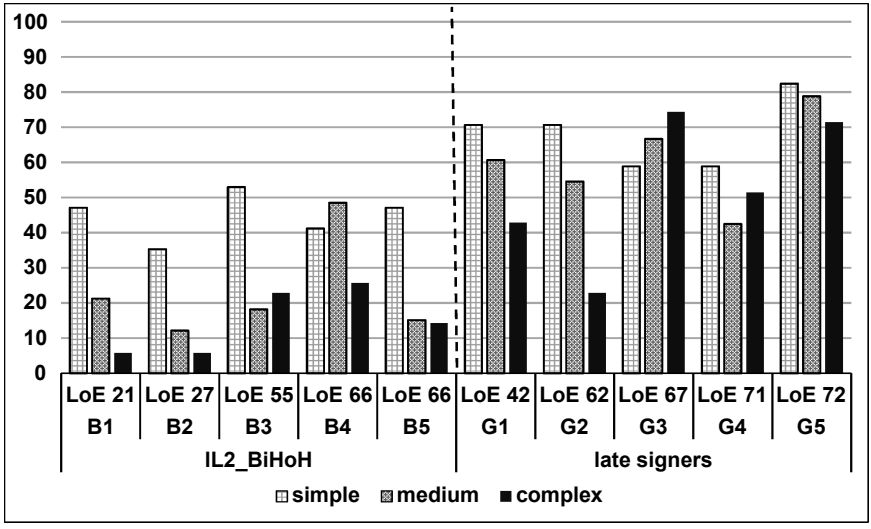

Figure 4: DGS-SRT-Kids: lL2_BiHoH vs. late signers: %correct target structure grouped by level of structural complexity

Comparing DGS performance of L2_BiHoH children with that of late signers revealed significant differences in overall performance between the groups with

a large effect size ($U = 0.000$, $p < .01$, $r = .825$). A close inspection of individual performance on the different structural-complexity levels (Figure 4) showed that L2_BiHoH children performed within the late signers' range on easy constructions but significantly worse on medium and complex constructions (medium: $U = 1.000$, $p < .05$, $r = .759$; complex: $U = 1.500$, $p < .05$, $r = .731$).

Examining performance on simple sentences revealed similarities between lL2_BiHoH children and late signers in that both retained the target structure but often produced signs with execution errors, e.g., inconsistencies in the handshape, as shown in (4). For more complex structures, the lL2_BiHoH and late signers produced more and different types of errors. In Example (5), the late signing child G1 reversed the starting and end point of the sign INVITE, rendering a slight variation in sentence meaning. While the better performing BiHoH child, B4, retained the sentence structure and only demonstrated minor execution errors, the lower-performing BiHoH child, B2, replaced the sign INVITE with an unrelated sign and also produced signs with minor execution errors. Additionally, both lL2_BiHoH signers did not produce the nonmanual component on the sign WHY. In deaf children acquiring a sign language from birth, these nonmanual markings are often only acquired at a later stage of language development.

4. Target structure: simple sentence:

MEIN BRUDER BUCH KAUFEN[1]
MY BROTHER BOOK BUY
'My brother buys a book'

Child response: BiHoH (B2)

#MEIN BRUDER BUCH #KAUFEN
#MY BROTHER BOOK #BUY
'My brother buys a book'

[1]Notational conventions: signs are glossed in small caps. A '#' preceding a sign indicates that the sign was produced with at least one execution error. Subscripts indicate areas in the signing space: 're' indicates an area on the right-hand side of the signer and '1' indicates the area at the body of the signer, i.e., first person. Lines above a sign indicate that the manual sign is accompanied by a nonmanual marking with 'br' specifying brow raise.

5. Target structure: complex sentence:

br

KIND$_{IXre}$ $_1$EINLAD$_{re}$ WARUM WIR-BEIDE FREUND
CHILD$_{IXre}$ $_1$INVITE$_{re}$ WHY BOTH FRIEND
'The child invites me because we are friends'

Child response: late signer (G1)

br

#KIND$_{IXre}$ $_{re}$EINLAD$_1$ WARUM WIR-BEIDE FREUND
#CHILD$_{IXre}$ $_{re}$INVITE$_1$ WHY BOTH FRIEND
'I invite the child because we are friends'

Child response: lL2_ BiHoH (B4)

#KIND$_{IXre}$ #$_1$EINLAD$_{re}$ WARUM WIR-BEIDE FREUND
#CHILD$_{IXre}$ #$_1$INVITE$_{re}$ WHY BOTH FRIEND
'The child invites me because we are friends'

Child response: lL2_BiHoH (B2)

#KIND$_{IXre}$ ZUSAMMEN WARUM #WIR-BEIDE FREUND
#CHILD$_{IXre}$ TOGETHER WHY #BOTH FRIEND
'The child together because we are friends'

4. Discussion and conclusion

The study examined the development of sentence-level abilities in HoH late successive bimodal bilingual children with FDB acquiring spoken German and German Sign Language in a bimodal bilingual educational setting after prolonged periods of reduced linguistic input, using sentence-repetition tasks in both modalities. Our results showed that late successive BiHoH children encountered considerable difficulties in both spoken and signed sentence repetition tasks, performing significantly more poorly than hearing refugee BiTD peers and late signers without FDB (Figures 1 & 3), despite some having similar or considerably longer LoE to L2 in the respective modality. On the DLS-SRT, all BiHoHs except B5 performed more poorly than the BiDLD children and exhibited similar error patterns. Unlike the relatively homogeneous performance of lL2_BiTD, BiDLD, and late signer groups, lL2_BiHoH children demonstrated substantial interindividual and cross-modal heterogeneity, with better performance observed for BiHoH children with less restricted early language access and more cumulative linguistic experience. This confirms that BiHoH children with FDB incur additional language learning challenges given their restricted or delayed onset of exposure to accessible language input (Hall et al., 2017; Mayberry et al., 2024), making them a particularly vulnerable bilingual group among the student population (Lyngbäck & Andersson, 2023; Marx et al., 2025).

Despite marked difficulties on the DLS-SRT and protracted development relative to hearing peers, most BiHoH children showed morphosyntactic growth in spoken language as a function of longer L2 exposure following hearing-aid

fitting. However, improvement was mainly evident for simple monoclausal structures, while embedded constructions and structures with non-local dependencies remained problematic even after years of L2 exposure. Interestingly, most of the BiHoH children, particularly those with more severe audiological profiles, performed better on DGS-SRT than DLS-SRT. They nevertheless differed from late signers, who had not experienced early language deprivation, especially on the more complex constructions of the DGS-SRT. Consistent with previous studies, target-structure preservation decreased in both groups with increasing complexity (Cheng & Mayberry, 2019; Schönström & Hauser, 2022; Wienholz & Hänel-Faulhaber, 2026). However, syntactic-complexity effects were substantially more pronounced in the BiHoH group, who resembled late signers on simple structures but struggled with medium and complex structures, exhibiting unique error patterns not observed in the late signer group. This corroborates prior findings of persistent cross-modal difficulties in complex morphosyntax among HoH children with delayed language access, and the resulting limitations in working-memory resources necessary for processing such constructions (Cheng & Mayberry, 2019; Malaia et al., 2020; Ruigendijk & Friedmann, 2017; Szterman & Friedmann, 2024).

Our preliminary findings revealed distinct severity profiles among late successive BiHoH children, attributable to differences in their auditory history and modality-specific cumulative language experience. B1 only produced zero responses on the DLS-SRT at both testing points but correctly repeated 49% of the simple and 20% of the medium complexity-level items on the DGS-SRT, despite having the shortest L2 exposure in the BiHoH group (LoE: 21 mo. at T1). B1's cross-modal asymmetry and floor performance on the DLS-SRT can be attributed to the child's severe audiological profile, prolonged restricted access to spoken-language input, and relatively short exposure to DLS following his most recent hearing-aid fitting. Even with hearing devices, the latest aided audiometry test indicated limited binaural hearing, which explains his preference for the signed modality and the inability to repeat the aurally presented DLS-SRT stimuli. B1's better performance on the DGS-SRT, despite the short LoE, can be ascribed to earlier sign-language exposure from his signing father, which likely protected against early language deprivation.

B2 exhibited the weakest cross-modal profile in the lL2_BiHoH group, with near-floor performance on DLS-SRT and the DGS-SRT. In the DLS-SRT, B2 primarily produced ungrammatical sentential fragments at both testing points, even for the simplest constructions. Despite slightly better performance on DGS-SRT, B2 correctly repeated only 33% of simple constructions and failed to repeat more complex ones, indicating stagnation at the basic clause level in both modalities. This poor performance likely reflects the child's severely impoverished overall linguistic experience: profound hearing loss in infancy, very late auditory intervention (11;2 years), delayed exposure to sign language, lack of schooling from early through middle childhood, and overall limited L1 abilities. Moreover, B2 had a relatively short length of exposure to both DLS and DGS compared with the rest of the BiHoH group. A similar cross-modal pattern was observed for B3, who, like B2, had a restricted cumulative linguistic experience.

B3 also did not appear to show meaningful morphosyntactic growth from T1 to T2, despite having significantly more exposure to DLS than B1 and B2 (LoE at T1: 55 mo.). At T2, B3 was able to correctly repeat less than 20% of Level 0 sentences and did not produce any embedded structures or structures involving non-local dependencies. Interestingly, B3 outperformed B2 on DGS-SRT, especially simple structures (53% correct). Nevertheless, the child still struggled with medium and complex DGS items (medium: 19%; complex: 21%), indicating persistent cross-modal difficulties with complex morpho-syntax.

As to B4, despite a similar degree of pre-intervention hearing loss to B1–B3, B4 performed better on both the DGS-SRT and the DLS-SRT, with better results in DGS than in DLS. Notably, B4 showed the best DGS performance among the BiHoH group. For the DLS-SRT, despite improvement on Level 0 structures at T2, the child continued to avoid embedding and syntactic movement, producing monoclausals and sentential fragments and thus resembling the BiDLD group (Szterman & Friedmann, 2014). Interestingly, despite struggling with complex structures on the DGS-SRT, B4 outperformed the other BiHoH children on simple and medium-complexity DGS items, resembling late signers at those levels. A possible explanation for B4's better performance is that B4 has had substantially more exposure to the DLS and DGS post intervention than B1, B2, and B3. In contrast to the latter BiHoH children, B4 received some formal education in the L1 and was reported to have better L1 abilities. Similar to B1, B4 was born to a deaf father. Hence, B4 has likely received early sign language input in the L1, which could have played a protective role against early language deprivation (Mayberry et al., 2024).

B5 showed the greatest progress in DLS development among the BiHoH group, performing similarly to hearing lL2_BiTD children with 27 months of DLS exposure and outperforming the BiDLD group. At T2, B5 produced embedded structures and demonstrated error patterns attested in typically developing hearing unimodal bilingual children, e.g., incorrect or double case markings and the insertion of a resumptive clitic in object relatives, indicative of problems of thematic role assignment paired with good syntactic structure-building abilities (Szterman & Friedman, 2014). Hence, B5 could be assumed to be approaching hearing BiTD children in his DLS morphosyntactic development, yet at a much slower pace. In contrast to DLS-STR, B5 showed a relatively poor performance on DGS-SRT (20%), mainly correctly producing simple structures. This unexpected asymmetry is likely to reflect the child's current patterns of language use. According to PaBiQ, B5 uses spoken language for most communicative purposes and has limited interactions in DGS. Compared to the other BiHoH children, B5 has less severe hearing loss and has a richer early and cumulative (spoken) language experience. Moreover, B5 had the longest LoE to L2, has advanced spoken L1 abilities and literacy skills, and engages in L1 literacy-promoting activities daily.

Taken together, the examples above indicate that early, sustained exposure to accessible language input, regardless of modality, plays a crucial role in the development of any subsequent language (cf. Hall et al., 2017; Mayberry et al., 2024). Furthermore, they show that language growth remains possible despite

restricted initial language experiences. Importantly, the results showed that BiHoH children with severe audiological profiles performed better on DGS than on DLS. This is encouraging, as it underscores the importance of providing access to sign language while BiHoH students are learning a new spoken language. While acquisition of L2 spoken German may be only partially possible for BiHoH children with FDB, even with technical support, DGS is fully accessible and helps foster communicative abilities in these children, thereby increasing their chances of better educational outcomes.

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