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Bilingual Language Synthesis: Evidence from WH-Questions in Bimodal Bilinguals

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1. Introduction

In our research we are interested in addressing questions about how children develop as bilinguals, and in particular, how the languages of a bilingual interact. We approach these questions by examining the course of bilingual development for children who are *bimodal bilinguals* – children who use both a spoken language and a natural sign language. In the present study, our participants are *codas*, or hearing children growing up in households with Deaf users of a sign language. Such a language combination gives us a fresh view of bilingualism, and allows us to think about language architecture in new ways.

In this paper, we continue our investigation of the development of bimodal bilingualism (Chen Pichler et al. 2010, Lillo-Martin et al. 2010, Quadros et al. in press), presenting data on the structure of WH-questions in both the speech and the sign used by children simultaneously acquiring American Sign Language (ASL) and English, or Brazilian Sign Language (Libras) and Brazilian Portuguese (BP). We will show how our developing model of bilingual language architecture accounts for the cases we observe of apparent cross-linguistic influence as examples of *language synthesis*. Our findings support the conclusions of many others that the languages of a bilingual are continuously active and interact in multiple ways.

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1.1. Language Synthesis Model

The model we support builds on the Minimalist approach to code-switching proposed by MacSwan (2000). The core assumption of this model is that no special mechanisms are needed to account for bilingual knowledge – the computational system is assumed to be universal. As González-Vilbazo and López (in press) put it, "what is distinctive of bilingual speakers is that they have functional and lexical items belonging to two different lexica."

We differ from MacSwan, however, in adopting the framework of Distributed Morphology (DM; Halle & Marantz 1993). In this we agree with the approach of den Dikken (2011). As den Dikken explains, the DM approach provides for (at least) two loci in which code-switching can take place. When Vocabulary Items (VIs) are inserted (late in the derivation), a bilingual has a larger pool to choose from than a monolingual does (VIs from Language$_x$ plus VIs from Language$_y$), so Items from one language or the other might be used, leading to code-switching in the traditional sense. Additionally, in DM, Lexical Items (LIs; roots and morphemes) are the input to the syntactic derivation. A bilingual then also has more options for LIs than a monolingual does, and selection of a LI from one language or the other may have syntactic consequences. In this way, a bilingual might use aspects of the syntactic structure from one language, even if the words that are inserted come from the other language. We consider both this type of syntactic 'influence' as well as more traditional cases of code-switching to be instances of *language synthesis*. The bilingual DM model we assume is illustrated in Figure 1.

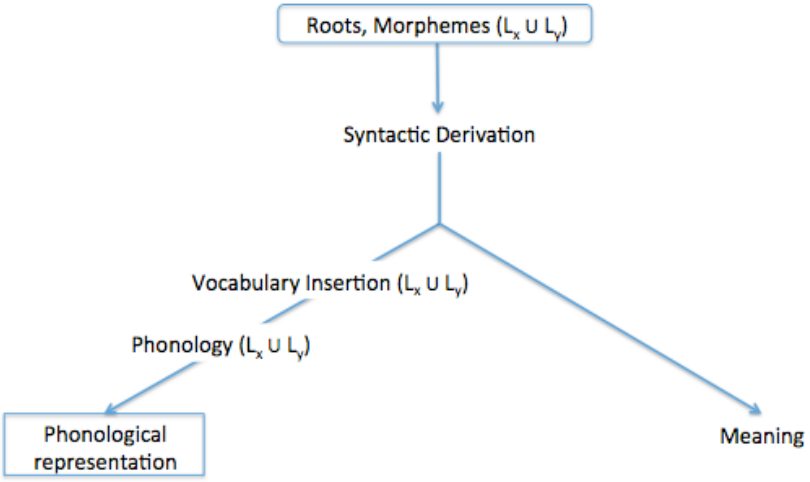

Figure 1. Bilingual language synthesis

Previous studies of adult bimodal bilinguals have indicated that in addition to code-switching and cross-linguistic influence, a third type of language

synthesis is possible: what Emmorey et al. (2008) call *code-blending*, referring to the simultaneous output of elements from both the sign language and the spoken language. This is not a forced attempt to communicate in both languages simultaneously, as in educational systems sometimes known as SimCom (simultaneous communication), but as natural an outcome of bilingualism as code-switching is. We have observed all three types of code synthesis in our studies of children who are developing as bimodal bilinguals.

In the current study, we investigate the forms of language synthesis observed in children's WH-questions. Our previous study of children's spontaneous production in their spoken languages (Quadros et al. in press) showed evidence for cross-linguistic influence at an early stage. Here, we summarize those results (section 2.1) and present the results of two elicited production studies with older children (sections 2.2 and 3.1), looking at both their spoken and their sign language output. We find evidence for synthesis in both directions, as predicted by the model. First, we briefly review the form of WH-questions in the four languages under investigation.

1.2. WH-Questions in English and BP

In both English and BP, WH-phrases typically are fronted in ordinary WH-questions to Spec, CP. In both spoken languages, WH-phrases may be left *in situ* in particular contexts – what Pires & Taylor (2007) call Common Ground questions. An example (one of many types) from Pires & Taylor is given in (1). BP is commonly considered to be less restrictive than English in the contexts in which *in situ* is available, but along with Pires & Taylor we will focus on Common Ground contexts in both languages.

(1)	A:	Mary ate a skunk.	B: Mary ate WHAT ↑ ?	Echo
	A:	*A Maria comeu um gambá.*	B: *A Maria comeu O QUÊ*↑ ?	Echo

1.3. WH-Questions in ASL and Libras

In both ASL and Libras, WH-phrases may appear in a wider variety of positions. Both languages permit WH-phrases to move to the sentence-initial position (2); to stay *in situ* in certain contexts, including Common Ground contexts (3), to be doubled, in both initial and final position – a structure used for emphasis (4), or to appear in the final position only (5). The latter structure may be ambiguous between an analysis involving *in situ* placement and an analysis along the lines of the emphatic form, with only the final copy surfacing (Nunes & Quadros 2007). In many cases, we will refer to this position as *in situ* / final, since it is usually not possible to disambiguate the analyses in our acquisition data.

(2) a. wh
WHO BUY CAR
'Who bought a car?'

b. wh
WHO YOU LIKE
'Who do you like?'

(5) wh
JOHN SEE WHO TODAY
'Who did John see today?'

(6) a. wh
WHO JOHN SEE WHO
'WHO did John see?'

b. wh
WHAT JOHN BUY WHAT
'WHAT did John buy?'

(7) a. wh
JOHN SEE WHO
'Who did John see?'

b. wh
BUY COFFEE WHERE
'Where did (you) buy coffee?'

2. Sign Language Structures in Speech

We look first at the possibility that structures coming from the sign language might appear in the spoken language of our bimodal bilingual participants. Such examples might include use of (non-fronted) WH-*in situ* with spoken English or BP which appears earlier or more frequently than with monolingual children, or WH-double structures in spoken English or BP, a structure not produced by monolinguals. Note that children's utterances at this stage of development are typically not long enough to allow us to distinguish between *in-situ* and final (emphatic) objects. Likewise, sentence-initial subjects might be fronted or *in-situ*. For this reason, we will use the labels '*in situ* / final' and 'initial' to describe these positions in their surface string senses.

2.1. Study 1: Spontaneous Production in English and BP

The data for this study are from video-taped naturalistic sessions of bimodal bilingual children, filmed on a weekly basis. Video sessions target the spoken language one week (involving hearing interlocutors) and the sign language the next week (involving Deaf or coda interlocutors). Although we encourage children to use the language targeted by the specific session, we do not force their language choices. All interlocutors are in fact bilingual, as are many of the filming environments (e.g. the child's home, or our studio at Gallaudet University), so code-blending is a very natural occurrence among both adults and children in our study. Table 1 below summarizes the ages of the two American and one Brazilian coda children (all males) analyzed for this study, and the number of utterances each contributed to the data set.

Table 1. Bimodal Bilingual participants

Name	Languages	Age Range	# Sessions	# Utterances
Ben	ASL/Eng	1;11-3;03	18	~6000
Tom	ASL/Eng	1;11-4;05	31	~6000
Igor	Libras/BP	2;01-3;02	7	~3000

We compared the production of WH-questions from ASL/English bilingual participants with those produced by four English monolingual children in the CHILDES database (MacWhinney 2000), as detailed in Table 2. We coded data from Adam and Nina ourselves; for Eve and Naomi, we refer to Tieu's (2010) reported counts of their WH-production.

Table 2. Monolingual English data

Name	Age Range	# Sessions	# Utterances
Adam	2;03-2;11	12	~10,000
Eve	1;06-2;03	20	
Naomi	1;03-4;09	93	~12,000
Nina	1;11-2;11	38	~22,000

For monolingual BP, we rely on data for two children reported in the literature: the child Gabriela studied by Sikansi (1999), and the child N studied by Grolla (2005), as described in Table 3.

Table 3. Monolingual BP data

Name	Age Range	# Sessions
Gabriela	2;04-3;10	26
N	2;00-4;00	53

Videos for the bimodal bilingual children were transcribed and searched for occurrence of WH-phrases. Lines with WH-phrases were coded in conjunction with a review of the accompanying audio/video segments. Usable utterances were coded as WH-initial, WH-*in-situ*/final, or WH-doubled. "WH+that" utterances were excluded as formulaic.

For the data from Adam and Nina, files were reviewed using CLAN and categorized in the same way as for the bilingual participants, except that the analysis was based on the printed transcripts only. For Eve and Naomi, we rely on Tieu's (2010; p.7) report that they "produced no *what*-in-situ questions." For the BP data from Gabriela and N, we rely on results reported by Sikansi (1999) and Grolla (2005), respectively.

The results of our analysis for English and BP data up to the age of 2;11 are reported in Table 4, where we present the proportion use of sentence-initial, *in-situ* / final, or double WH-elements, and the age of the earliest *in-situ* / final WH-elements observed in our sample. The monolingual children use sentence-initial WH-structures almost exclusively; the bilinguals use a small but noticeably higher percentage of *in-situ* / final and double constructions. Furthermore, the WH *in-situ* structures emerge earlier in the bilinguals' speech than in that of their monolingual counterparts. Single sample t-test shows significant differences between Ben and English monolinguals ($p < .0001$), between Tom and English monolinguals ($p < .0001$), and between Igor and BP

monolinguals ($p < .05$) in the use of non-initial structures. Importantly, many of these structures, such as those illustrated in (8-10), are used in regular direct question contexts, not 'echo' or Common Ground contexts.

Table 4. Results up to 2;11

Participant	Sentence-initial	*In situ* / final	Double	Earliest *in situ* / final
Ben	.865	.02	.115	2;00
Tom	.92	.07	0	2;04
Igor	.94	.01	.05	2;01
Adam	.998	.002	0	2;08
Eve	1.0	0	0	--
Naomi	1.0	0	0	--
Nina	.993	.007	0	2;09
Gabriela	1.0	0	0	--
N	1.0	0	0	(3;09)

(8) a. Mommy where? (Ben 2;00) *in situ/final*
b. Bug go where? (Tom 2;04)

(9) a. Where balloon where? (Ben 2;02) *doubling*

(10) a. Que eu quero que? (Igor 2;01) *doubling* (BP)

After 2;11, Ben and Tom continue to use some WH-*in-situ*, but no doubles. Adam produces more (generally licit) WH-*in-situ* starting around 3;02 (Tieu 2010). Igor stops using non-fronted WH (through the end of the period of coded data, 3;02). Grolla (2005) reports that the first use of WH-*in-situ* for N is at 3;09.

2.2. Study 2: Elicited Production in English and BP

In addition to naturalistic data, we have also collected experimental data from our bimodal bilingual participants. WH-structures were elicited from five ASL/English bilinguals (between the ages of 5;01 and 6;00, including both Ben and Tom) and two Libras/BP bilinguals (ages 4;09 and 7;04) using a modified version of the elicited production methodology developed by Thornton (1990). This methodology involves two experimenters, one acting as a storyteller and the other as a knowledgeable anthropomorphic cat who prefers to talk to children rather than to adults, as illustrated in Figure 2.

Figure 2. Set-up for elicited production of WH-questions

Using props, the storyteller tells a short story, then prompts the child to ask the cat for missing information. The prompt is carefully designed to encourage the child to use a specific WH-word, in either a short- or long-distance question, without giving away the actual target form. An example of a prompt targeting the short-distance object WH-question *What will SpongeBob eat?* is provided in (11) below.

(11) Storyteller: "It's lunch time under the sea. SpongeBob is very hungry! He could eat this pineapple or this banana. Hmm, I don't really know what SpongeBob will like better, but I know he will eat something. Ask the cat what."

Children's responses were coded for position of the WH-element (initial vs. final vs. doubled) and WH-question type (short- vs. long-distance; subject vs. object vs. adjunct). The ASL/English bilinguals' production of English WH-questions was overwhelmingly sentence-initial, for all WH-question types, as shown in Figure 3A. The Libras/BP bilinguals' elicited production of BP WH-questions was also consistently WH-initial; all WH-questions produced by both children exhibited WH-initial position, as shown in Figure 3B. Examples of children's productions are given in (12)-(13).

(12) What does SpongeBob eat? (Val, 5;01)
Who's gonna take a bath first? (Tom, 6;00)
Sylvie, where do you think Phineas and Ferb could go to for lunch? (Ben, 6;00)

(13) O que ele vai comer? (Pedro, 4;09)
('What is he going to eat?')
Quem você pensa que a mulher Mulher Maravilha vai resgatar primeiro? (Bela, 7;04)
('Who do you think that Wonder Woman is going to rescue first?)

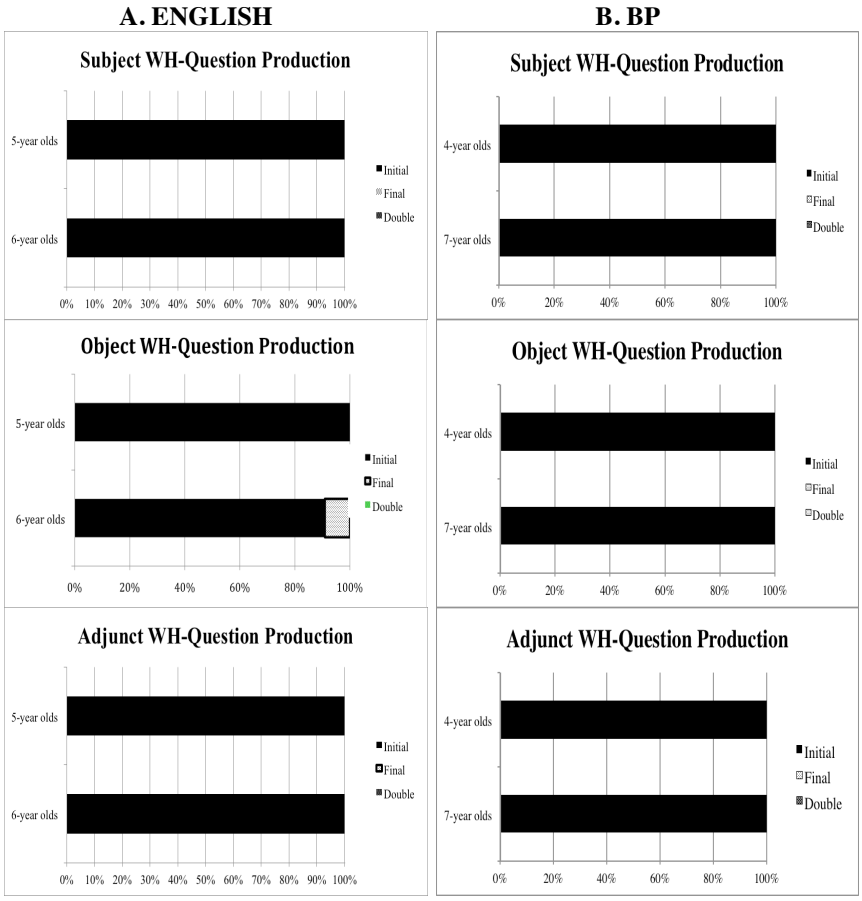

Figure 3: A. English WH-questions elicited from ASL/English bilinguals
B. BP WH-questions elicited from Libras/BP bilinguals

2.3. Discussion

The results of the elicited production task (Study 2) indicate that all of the bimodal bilingual children have mastered the WH-initial structures typical to English and BP. Their spontaneous production data (Study 1) also suggest a strong preference for WH-initial. However, we are especially interested in the examples of non-initial (final and double) English and BP WH-questions (produced in non-Common Ground contexts). Such structures are not normally available in English and BP, but are allowed in ASL and Libras, suggesting to us that some type of cross-linguistic influence from the sign language into the spoken language is occurring for these bilingual children. The language architecture model we proposed earlier accounts for this type of language synthesis between speech and sign, and predicts that it should be possible in

either direction. We now turn to our investigation of cross-linguistic influence from spoken English and BP into ASL and Libras.

3. Spoken Language Structures in Sign

We focus now on the sign language productions by our participants. Since the primary WH-question form used in the spoken languages is sentence-initial, and the sign languages also permit this structure, we cannot decide from the simple existence of WH-fronting in the children's sign language whether there is any bilingualism effect. However, we know from previous research that Deaf native signing children produce double structures in their spontaneous production as early as 2;0 (Lillo-Martin & Quadros 2006). Furthermore, in elicited production, 5- and 6-year-olds use double and final structures productively (Lillo-Martin 2000). Then, we will look at whether the bilingual children differ from Deaf children in the proportion of use of the different WH-question structures permitted by their sign languages to see whether there is any evidence of apparent cross-linguistic influence. We also look to see whether there are any other signs of cross-linguistic influence, such as blending, mouthing, or the use of other spoken-language structures.

3.1. Study 3: Elicited Production in ASL and Libras

In this study, we used the same elicited production methodology presented in Study 2, except that the prompts were all given using ASL or Libras, and the children were encouraged to respond using their sign language. The results from 6 bimodal bilingual participants in the US, ages 5;03-7;09, are given in Figure 4A. The results from 3 bimodal bilingual participants in Brazil, ages 4;09-7;04, are given in Figure 4B. Examples of children's productions are given in (14)-(15).

(14) WHAT POSS(cat) NAME (Zig, 5;03)
('What's your name?')
WHAT WILL IX(squidward) EAT DRINK (Lex, 5;08)
('What will Squidward eat or drink?')
WHAT IX(cat) THINK SHOULD IX(bear) IX(buzz) TAKE-CARE-OF FEED FOOD WHAT (Ben, 5;10)
('Who do you think should take care of and feed these guys?')
HOW IX(P&F) WANT GO TO MUSEUM IX(car) fs(or) IX(skateboard) (Pet, 6;02)
('How do they want to go to the museum, by car or skateboard?')
WHO BATH FIRST (Ric, 7;09)
('Who will take a bath first?')

(15) CADÊ IX(AgenteP) FUGIR (Pedro, 4;09)
('Where did Agent P escape to?')
CADÊ LAVAR IX(porquinho1) IX(porquinho2) IX(porquinho3)
IX(porquinho4) CADÊ (Pedro, 4;09)
('Who does the washing, Piggy-1, Piggy-2, Piggy-3, or Piggy-4?')
CADÊ PRECISAR IX(mulher-maravilha) (Kat, 4;09)
('What does Wonder Woman need?')
O-QUE+ IX(Bob-Esponja) FS(bob) COMER (Bela, 7;04)
('What does SpongeBob eat?')
O-QUE IX(gato) QUER AJUDAR... BEBÊ BANHO (Bela, 7;04)
('Who do you want to help the baby bathe?')

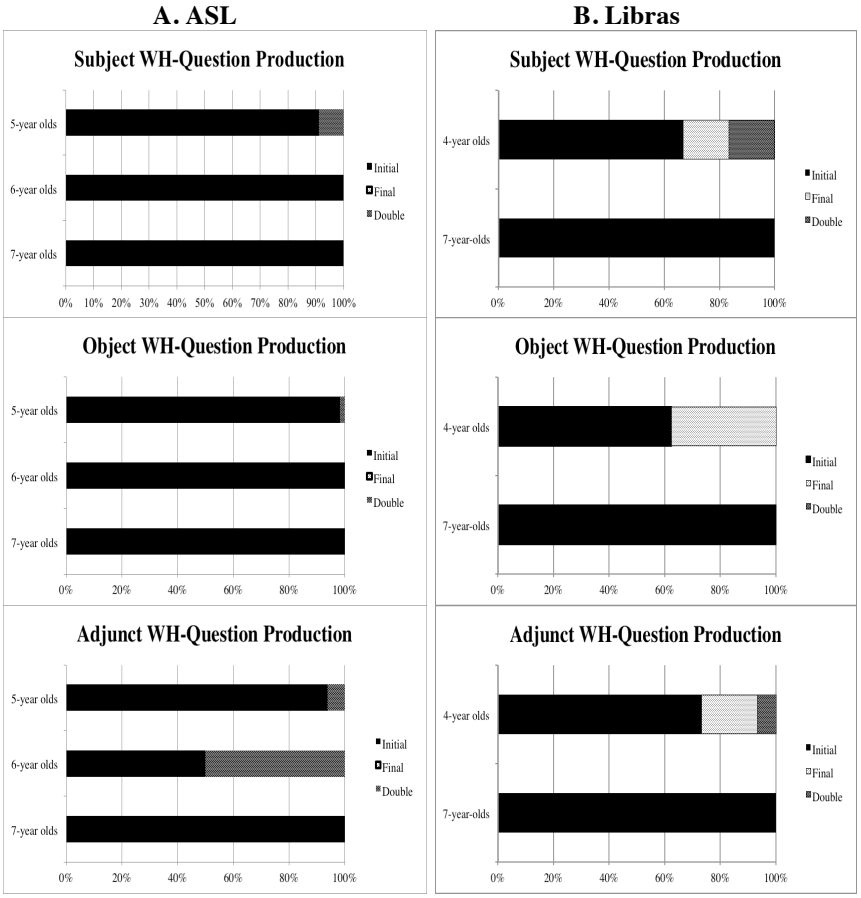

Figure 4: A. ASL WH-questions elicited from ASL/English bilinguals
B. Libras WH-questions elicited from Libras/BP bilinguals

As a comparison, we present the results from a comparable study by Lillo-Martin (2000) of 17 Deaf native signers, ages 4;01-6;09, in Figure 5.

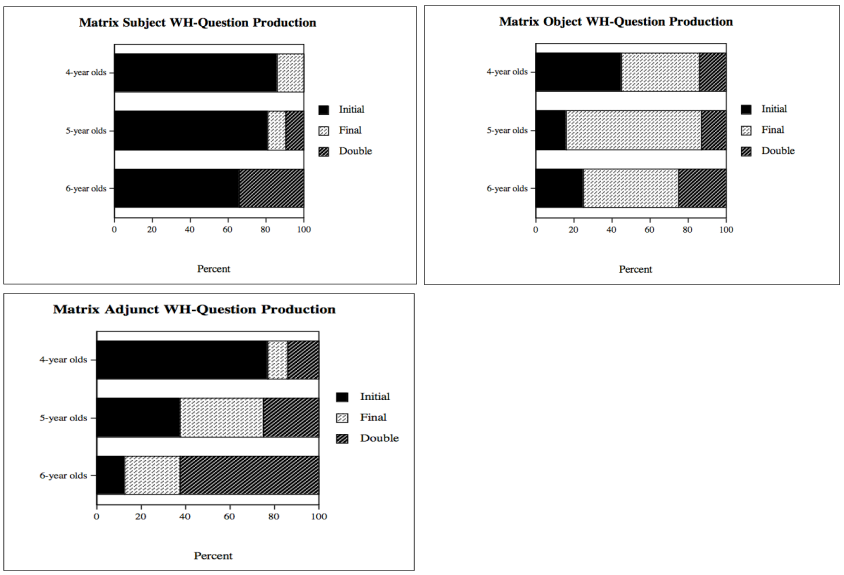

Figure 5: ASL WH-questions elicited from ASL native signers

3.2. Discussion

The results from Study 3 show strong evidence of spoken language structures in the children's signing. Unlike Deaf signers, the hearing bimodal bilingual signers produced a high proportion of WH-initial structures for all sentence types at all ages. In addition, we observed other (not quantified) evidence of spoken language influence in the bimodal bilinguals' signing, including frequent mouthing and instances of spoken language word order (e.g., use of overt prepositions).

4. General Discussion

The data reported here indicate that the WH-constructions of bimodal bilingual chilren we observed differ noticeably from those of their monolingual counterparts in several respects. Study 1 found that bimodal bilinguals spontaneously produced more non-fronted WH-structures than their English- and BP-speaking counterparts, and from an earlier age. Because non-fronted WH-structures are less restricted in ASL and Libras than in English and BP, we take any elevated frequency of these structures as potential instances of sign language structures being used with spoken language vocabulary items. Study 2 examined English and BP production of WH-structures at older ages and found

that they reliably use WH-initial structures by 4;0, as is appropriate for their spoken languages. Finally, Study 3 found an overwhelming tendency for bimodal bilingual children to use WH-initial structures in their elicited production of ASL and Libras, in contrast to monolingual deaf controls who used a greater proportion of non-WH-initial structures. We take this pattern, in conjunction with frequent mouthing or whispering of English or BP while signing, as indication of influence from bimodal biligual children's spoken language on their sign language.

We categorize all of the above patterns as instances of language synthesis, and they fall naturally from the model of the language architecture that we propose. Selection of Roots and Morphemes from L_x and L_y can lead to syntactic 'transfer,' while selection of Vocabulary Items from L_x and L_y can lead to code 'switching.' Children do not need to "outgrow" such language synthesis effects; there is evidence that they persist into adulthood. For instance, previous researchers have investigated *coda talk*, the production by adult bimodal bilinguals of "grammatical structures [that] often follow ASL, not English, a sort of 'spoken ASL,'" (Bishop 2010:207). Coda talk is frequently observed in sociolinguistic contexts that are heavily ASL/English bilingual, such as Coda gatherings. As mentioned earlier, many of our data collection sessions take place in strongly bilingual locations, with bilingual interlocutors, creating a sociolinguistic context in which language synthesis between sign and speech is very appropriate. Over time, the children undoubtedly develop their ability to judge which sociolinguistic conditions are appropriate for language synthesis, and which are not. Under our model, language synthesis is not confined to developmental stages, but remains a feature of the adult grammar as well. Furthermore, athough developed through investigation of bimodal bilinguals, we expect that the model should apply equally well to cases of language synthesis in unimodal bilinguals.

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