

## The simultaneous production of two grammars: Evidence from bimodal bilinguals

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**Abstract.** A debated issue in psycholinguistics is whether both languages are active in the bilingual mind that hosts them. We examined this issue in bimodal bilinguals, i.e., individuals competent in one spoken language and one sign language. Signed productions and story-telling data pertaining to declaratives, wh-questions, and negatives from Iranian bilingual speakers of Khuzestani Arabic and Sadat Tawaher Sign Language confirm that they produce two different grammars simultaneously, one via their vocal tract and the other on their hands. This finding provides support for these bilinguals' double active representation of languages, suspension of articulatory constraints, lack of inhibition, and processing costs.

**Keywords.** bimodal bilingualism; code blending; modality; sign language; spoken language

**1. Introduction.** Competence in two (or more) languages is known as bilingualism (or multilingualism) and is extremely widespread in the world. There exist a multitude of unanswered questions about the bilingual mind. One of the debated issues in psycholinguistic research pertains to how the brain handles the two languages and whether or not both languages are active in the bilingual mind (Donati 2021). In other words, the question is whether, when a bilingual speaker is actively using one language, the other language is also active. For a long time, answers to this question were sought from bilingual individuals who can speak two languages. The idea was that code-switching, i.e., the ability to switch from one language to another, whether mid-sentence (example 1) or across clause boundaries (example 2), provides evidence that both languages are active.

- (1) I need some *agua*.
- (2) I need some water because *yo tengo sed*.

This type of bilingualism in which the individual possesses competence in two spoken languages is referred to as *unimodal* bilingualism since both languages are of the same modality, i.e., they are in the oral modality as they are both spoken. However, since unimodal bilinguals have one tongue (or vocal tract), they can produce only one word at a time, a physical constraint which is impossible for them to overcome. Thus, unimodal bilinguals have only one output channel and their linguistic production is inevitably sequential. Therefore, unimodal bilinguals' ability to code-switch might not constitute an ideal type of evidence for the active status of both languages.

Thus, due to the above limitations of the data from unimodal bilinguals, it has been argued that answers to the question of the status of the languages in the bilingual speaker's mind had better be examined with a different type of bilingual population: *bimodal* bilinguals. These are individuals who are competent in one spoken and one signed language (Abutalebi & Clahsen 2016). The reasoning is that the availability of two independent articulatory channels, namely the hands and the vocal tract, can at least theoretically enable bimodal bilinguals to produce two

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different grammars simultaneously, one grammar via each output channel (Donati, 2021). Therefore, unlike unimodal bilinguals, bimodal bilinguals are not faced with the above-mentioned physical constraint and their production is not sequential; rather, they can potentially opt to use their extraordinary ability to simultaneously produce two grammars via speech and sign, a phenomenon referred to as *code-blending* (Emmorey, Grabowski, McCullough, Damasio, Ponto, Hichwa & Bellugi 2003). It has been suggested that an ideal and a very specific, but also rare, population for research on bimodal bilingualism are Codas or Kodas (Children / Kids of Deaf Adults) since these individuals are normally balanced, i.e., equally proficient, in their competence in both their spoken and signed language (Donati 2021).

Previous research has shown that bimodal bilinguals tend to simultaneously conform to the grammar of both the spoken language and the signed language if the two languages follow the same word order (e.g., Dutch & Sign Language of the Netherlands (NGT), Baker & Van den Boogaerde 2008) but not if the languages are typologically different (e.g., Italian & Italian Sign Language (LIS), Branchini & Donati 2016). For instance, Branchini and Donati's (2016) study of bimodal bilinguals' simultaneous production of negative and wh-question strings in Italian, a head-initial language, and LIS, a head-final language, showed that words and signs in these two languages mismatched in their order:

- (3) Mismatching alignment of words and signs for negation in Italian / LIS (Example 13 from Branchini & Donati 2016: 11):

Italian: Non ho capito  
not have.1SG understand.PTCP

LIS: UNDERSTAND NEG NOT  
'I don't understand.'

- (4) Mismatching alignment of words and signs for wh-questions in Italian / LIS (Example 14 from Branchini & Donati 2016: 11):

Italian: Cosa ha mangiato la rana?  
what have.3SG eat-PTCP the frog

LIS: FROG EAT WH WHAT  
'What did the frog eat?'

Branchini and Donati (2016) provide a classification of code-blending along four lines: completeness, grammar, interpretation, and alignment. In terms of grammar, which is what this paper is concerned with, Branchini and Donati (2016) posit that the spoken and signed items are either dependent or independent. The independent strings can be congruent (i.e., same word order) or incongruent (i.e., different word orders). In the dependent strings, on the other hand, either the sign language dictates the word order (i.e., sign-based order) or the spoken language does so (i.e., speech-based order). Thus, in terms of linearization, if the two (signed and spoken) strings happen to follow the same order or one language happens to dictate the word order to be followed, they are said to be a congruent lexicalization as in (5) (Donati & Branchini 2013) while if they display different orders, they have incongruent lexicalization as in (6).

- (5) Congruent lexicalization (Example 39 from Donati & Branchini 2013: 116)  
 Italian: Lei sa tutto  
           she know.3SG everything  
 LIS: IX KNOW ALL  
 ‘She knows everything.’
- (6) Incongruent lexicalization (Example 43 from Donati & Branchini 2013: 118)  
 Italian: Chi ha chiamato?  
           who have.3SG call.PTCP  
 LIS: CALL WHO  
 ‘Who has called?’

In the current study, we examined whether bimodal bilinguals of Khuzestani Arabic (KhA) and a young sign language Sadat Tawaher Sign Language (STSL) adhere to (i) the grammar of the spoken language (speech-based blend), (ii) the grammar of the signed language (sign-based blend), or (iii) simultaneously produced two different grammars (incongruent blend) when they sign.

**2. Conditions for the current study.** The following criteria need to be met for the results of the study to be reliable. First, the participants need to be balanced bimodal bilinguals of KhA and STSL. This condition is met as all the participants have used STSL since birth as their only way of communication with the deaf person. They also use KhA daily for communication with other hearing members. Second, it is crucial that the participants speak when they sign. Otherwise, there would be no bimodal bilingual data in the first place. In the current study, all the participants used speech along their signing. Finally, the two languages need to be typologically different for the comparison to be doable. For instance, if both languages use SVO order, then it is impossible to investigate whether the participants’ speech and sign are congruent or incongruent. KhA and STSL exhibit different word orders in negation, wh-questions, and perfective aspectual marking. KhA and STSL thus only partially overlap in their grammatical system in that both use SVO and SOV. The next section provides an overview of the syntax of KhA and STSL.

**3. Overview of the syntax of KhA & STSL.** In this section, we present a brief description of KhA and STSL to familiarize the reader with these two languages and to provide evidence that these languages are typologically different and thus constitute a solid basis for bimodal bilingual productions.

3.1. KHUZESTANI ARABIC (KHA). KhA is a southern Mesopotamian Bedouin-type dialect of Arabic spoken in the province of Khuzestan in southwestern Iran (Leitner 2022) – see Figure 1. KhA is a minority dialect and, unlike many other dialects of Arabic, is highly under-examined. Until very recently, there existed very few descriptions of KhA with the most recent dialectological contribution to KhA being Leitner (2022).

KhA is a pro-drop dialect and has a relatively flexible word order. The most common word order is SVO although other word order possibilities include SOV, OSV, and, less commonly, VSO and VOS. Furthermore, in any order with a definite object preceding the verb (i.e., OSV, VOS, and SOV), a resumptive pronoun that exhibits gender and person agreement with that object is required. KhA also has gender (masculine and feminine), number (singular and plural), and person (first, second, and third) distinctions.



Figure 1. Khuzestan ([Wikipedia](#))

Furthermore, KhA has verbal predicates (i.e., those with a main lexical verb other than *fan* ‘was’) and verbless predicates (i.e., those with the present tense form of the verb *fan* ‘was’). KhA has prepositions, adjectives follow nouns, and adverbs seem to appear freely in most positions in the sentence. Yes/No questions are formed by a rising intonation pattern. Wh-questions are formed with some wh-words fronted to sentence-initial position (e.g., when, where, how, subject who) or to preverbal position (e.g., subject or object what) while other wh-words remain in situ (e.g., object whom, example 7). Furthermore, negation markers and modal verbs appear in preverbal position (example 8). Altogether, these data show that KhA is head-initial.

(7) əl-bət əl-wælæd; kun ma-t-fuf-æh; (SO-Modal-Neg-V)  
 the-girl the-boy must neg-IMPRF-3SF-see-him  
 ‘The boy, the girl must not see him.’

(8) əl-bət ʃaf-æt-mæn (SV-Wh)  
 the-girl see-3SF.PRF-whom  
 ‘Whom did the girl see?’

3.2. SADAT TAWAHER SIGN LANGUAGE (STSL). STSL is a sign language system that emerged naturally and spontaneously in a small village named *Sadat Tawaher* located in the province of Khuzestan in southwestern Iran approximately sixty years ago after a man named *Hanash* lost his hearing. This man’s family had no history of genetic deafness nor were there any other deaf people in *Sadat Tawaher*. Hanash was most likely single at the time and living with his own parents and siblings but got married soon after he became deaf and was married for at least 25 years until his wife passed away 32 years ago (as of 2024). Since Hanash’s oldest child, now 55, does not remember when his father became deaf, we infer that his deafness must have occurred at least 55 years ago. Hanash had not gone to school and thus had no reading or writing literacy; however, since by the time he lost his hearing he had already fully mastered his native language (KhA), he could speak normally. Therefore, Hanash never signed but used speech to communicate with others. We will refer to the sign language as *Sadat Tawaher Sign Language (STSL)*. Today, everyone in Sadat Tawaher is hearing and, to the best of our knowledge, no other sign language system has ever been in use in this town. There was no deaf school near Sadat Tawaher when Hanash lost his hearing nor did his family and friends have any access to deaf education. Thus, his family had to creatively devise a sign system of their own to communicate with him. Note that, because of Hanash’s illiteracy, writing to him was not an option. This sign system was later learned by his extended family, neighbors, and friends. Later, this sign system was acquired by Hanash’s own children as their native language. His children also learned KhA simultaneously as their spoken mother tongue. The following generations have acquired STSL: (i) Hanash’s own family and friends as a second language as soon as he became deaf, (ii) his

children as one of their native languages, and (iii) his grandchildren also as one of their first languages. The data for the current study were collected from Hanash’s children, grandchildren, and his daughter-in-law, all of whom except for his daughter-in-law acquired STSL as their native language alongside KhA since birth. His daughter-in-law has signed STSL for 30 years since she married Hanash’s oldest son and is extremely fluent in it.

STSL uses SVO as its most common word order (example 9). SOV is also allowed but is less common (example 10). Furthermore, STSL allows argument omission in context and is therefore pro-drop. As for interrogatives, yes/no questions are formed with brow raise and wh-questions by inserting in sentence-final position a wh-sign which might be accompanied by brow furrow (example 11). Negative markers and completive aspect markers also appear in sentence-final position (examples 12 & 13, respectively). Most of these data show that STSL is head-final.

(9) BOY EAT APPLE (SVO)

(10) BOY APPLE EAT (SOV)  
‘The boy is eating an apple.’

(11) BOY EAT **WHAT?**  
‘What is the boy eating?’

(12) BOY EAT APPLE **NOT**  
‘The boy is not eating the apple.’

(13) BOY EAT APPLE **FINISH**  
‘The boy ate the apple.’

Given the typological differences between KhA and STSL demonstrated by the above examples, we can see that a comparison of the two in bilingual bimodal simultaneous productions can be informative with respect to the theoretical debate, to which we now turn.

**4. Research question.** Given that the participants regularly speak and sign at the same time from lifelong habit, the current study is motivated by one main research question: Do bimodal bilinguals of KhA and STSL use the same word order or different word orders in speech and sign?

**5. Methodology.** This section describes the participants, data, and data collection procedure.

5.1. DATA. We used two data collection methods in this study: (a) signed sentence productions and (b) stories as described below. The total number of sentences was 617 sentences (499 sentences from the signed productions and 118 from the stories).

5.1.1. SENTENCE PRODUCTIONS. For signed sentence productions, we constructed 36 affirmative declarative sentences, 32 wh-interrogatives, and 35 negative declarative sentences in KhA and asked the participants to sign them as naturally as possible the way they would to the deaf person. These sentences consisted of sentences with intransitive verbs, transitive verbs, (di)transitive verbs, classifier constructions, and locatives. The interrogatives and negatives were constructed based on the affirmative sentences. However, at times some participants failed to sign some sentences, resulting in the final number of sentences being 499 for the final analysis (instead of 515). Examples of each sentence type are provided below:

(14) affirmative declarative: əl-wadəm həs<sup>h</sup>dæt                      ʃələb  
the-people harvest.3SM.PRF rice  
‘The people harvested rice.’



Participant	Sentence type					
	affirmative declaratives		wh-interrogatives		negative declaratives	
	Match	Mismatch	Match	Mismatch	Match	Mismatch
#1	26/36	10/36	13/31	18/31	0/32	32/32
	72%	28%	42%	58%	0%	100%
#2	30/36	6/36	9/28	19/28	0/33	33/33
	83%	17%	32%	68%	0%	100%
#3	11/36	25/36	12/32	20/32	0/33	33/33
	30.5%	69.5%	37.5%	62.5%	0%	100%
#4	23/36	13/36	13/31	18/31	0/32	32/32
	64%	36%	42%	58%	0%	100%
#5	24/36	12/36	13/32	19/32	0/35	35/35
	67%	33%	41%	59%	0%	100%
Total	114/180	66/180	60/154	94/154	0/165	165/165
	63%	37%	39%	61%	0%	100%
Total	Congruent lexicalizations			Incongruent lexicalizations		
	174 / 499 (35%)			325 / 499 (65%)		

Table 1. Congruent & incongruent lexicalizations across sentence types (sentence productions)

Participant	Sentence type					
	affirmative declaratives		wh-interrogatives		negative declaratives	
	Match	Mismatch	Match	Mismatch	Match	Mismatch
#1	22/26	4/26	3/5	2/5	0/7	7/7
	84.6%	15.4%	60%	40%	0%	100%
#2	24/37	13/37	3/7	4/7	0/15	13/13
	64.8%	35.2%	42.8%	57.2%	0%	100%
#3	11/14	3/14	2/4	2/4	0/5	5/5
	78.6%	21.4%	50%	50%	0%	100%
Total	57/77	20/77	8/16	8/16	0/25	25/25
	74%	26%	50%	50%	0%	100%
Total	Congruent lexicalizations			Incongruent lexicalizations		
	65/118 (55.1%)			53/118 (44.9%)		

Table 2. Congruent & incongruent lexicalizations across sentence types (stories)

- (18) Mismatching alignment of speech & sign strings in affirmative declaratives:

**KhA:** məʃæ l-əl-ʕərəs  
 go.3SM.PRF to-the-wedding  
 ‘[He] went to the wedding.’



**STSL:** WEDDING GO

Second, we see both match (68/170 ; 40%) and mismatch (102/170 ; 60%) in wh-interrogatives. The congruent lexicalizations in such constructions are due to the fact that KhA and STSL overlap in how they form wh-interrogatives in that STSL places wh-signs in sentence-final position only while in KhA, some wh-words are fronted to sentence-initial position (e.g., *wyian* ‘where’, *yamta* ‘when’, and *f-* ‘what’) while other wh-words remain in situ (e.g., ‘whom’) which sometimes happens to be the sentence-final position.

- (19) Matching alignment of speech & sign strings in wh-interrogative sentences:

**KhA:** əl-wələd zæʕʕa- mæn  
 the-boy push.3SM.PRF whom  
 ‘Whom did the boy push?’



**STSL:** BOY PUSH WHO

- (20) Mismatching alignment of speech & sign strings in wh-interrogative sentences:

**KhA:** əl-færax ʃ-ətʔæh l-əl-bət  
 the-boy what-give.3SM.PRF to-the-girl  
 ‘What did the boy give the girl?’



**STSL:** BOY GIVE GIRL WHAT

Finally, when negation is involved, there is complete mismatch of speech and sign orders (190/190 ; 100%): KhA negators appear only preverbally (i.e., S-Neg-VO, SO-Neg-V, etc.)

while STSL places the negative markers in sentence-final position (i.e., SVO-Neg, SOV-Neg, etc.).

(21) Mismatching alignment of speech & sign strings in negative declarative sentences:

**KhA:** əf-ʃæləb ma-tʰəfær ən-næhær  
 the-dog NEG-jump.3SM.PRF the-creek  
 ‘The dog did not jump over the creek.’



STSL: DOG CREEK JUMP NEG

One last point to be made here is that in quite a few sentences, the misalignments between the speech and sign strings occurred in more than one location in the sentence as can be seen in the following example:

(22) Mismatching alignment of speech & sign strings in more than one location in the sentence:

**KhA:** əl-gufyiæh ma-hi hædr əl-iktab  
 the-cell phone NEG-she under the-book  
 ‘The cell phone is not under the book.’



STSL: PHONE BOOK UNDER NEG

To summarize, overall, out of 617 sentences from both sentence productions and story-telling data and across all three sentence types (i.e., declaratives, wh-questions, and negatives), there were 239 congruent lexicalizations (38.7%) and 378 incongruent lexicalizations (61.3%).

**7. Discussion.** In all the sentences, both from sentence productions and stories, the participants followed the grammars of both the spoken language and the signed language. By doing so, the participants’ spoken and signed strings were sometimes aligned especially in the affirmative declaratives and sometimes mismatched especially in the case of negatives. Thus, in the case of mismatching speech and sign strings, the participants simultaneously produced two different word orders. Therefore, the only type of blend observed was that of incongruent blend. Three points are of interest in this regard. First, although the signers know KhA as their mother tongue and although the deaf person’s mother tongue is also KhA, their signed strings did not reflect the grammar of KhA. This finding clearly shows that STSL is not a copied version of KhA. Second, although the participants use only STSL to communicate with the deaf person who is not able to

hear any of their speech, they did not make their speech grammar conform to that of their signing. Finally, the participants' speech and sign exhibited different grammatical structures.

One more point is in order. The fact that the participants opted to use speech along with their sign in the first place is very interesting. They clearly did not have to do so. Instead, they could have chosen to use sign only. We are not sure at this point why they opted to accompany their sign with speech. It is possible that speech simply comes naturally to the participants while they sign since they use speech most of the time and signing is limited to only occasions when they need to communicate with the deaf person. Another reason could be that they use speech to facilitate comprehension for the deaf person since he also knows KhA and might be able to lip-read. This remains a speculation, however, and needs to be confirmed.

Our findings are thus in line with the results of previous research. Previous research on bimodal bilinguals of various spoken and signed languages (e.g., English-American Sign Language by Emmorey et al. 2012; French-Quebec Sign Language (Langue des signes québécoise or Langue des signes du Québec, LSQ by Petitto et al. 2001; Dutch-NGT by van den Bogaerde & Baker 2005; Portuguese-Libras by Lillo-Martin & Müller de Quadros 2009; Italian-Italian Sign Language by Donati & Branchini 2013, among many others) has shown that bimodal bilinguals prefer code-blending to code-switching (i.e., alternating between speech and sign). Summarizing previous research on bilingualism, Donati (2021) notes that there is “growing consensus that bilinguals do not ‘switch off’ the language that they are not using, even when it would be beneficial to do so” (p. 621).

**8. Conclusion.** The findings confirm that bimodal bilinguals not only can but actively do spontaneously produce two different grammars simultaneously. Moreover, they provide clear evidence for bimodal bilinguals' preference for code-blending over code-switching (e.g., English-ASL, Emmorey, Grabowski, McCullough, Damasio, Ponto, Hichwa & Bellugi 2003). Our results thus have implications for the architecture of the bilingual mind and what it can achieve. Specifically, bilinguals do in fact seem to have double active representation of languages, confirming previous research (e.g., Donati 2021). Furthermore, these bilinguals avoid costly inhibitory control and additional processing costs by taking advantage of the suspension of articulatory constraints.

Interestingly, some recent studies have reported the existence of a bimodal intentional communicative system in captive chimpanzees (e.g., Hopkins, Tagliabue & Leavens 2007). It has been argued that this system was preceded by communicative gestures in the common ancestor of humans and chimpanzees (Meguerditchian, Cochet & Vauclair 2011). In conclusion, the findings might provide support for the historical connections between gesture and speech and for a single integrated communication system that oversees both vocal and gestural communication.

The current study is the first examination of bimodal bilingualism in KhA and STSL and thus suffers from a number of limitations which we hope to address in future research. In our analysis, we did not consider the timing of the speech and sign alignments. Furthermore, all the sentences that we analyzed were simple and short. In future research, we will include extended chunks of discourse, especially from the story-telling data. Additionally, there might be issues of translation equivalents. Some research (e.g., Emmorey, Luk, Pyers & Bialystok 2008) has shown that signers might use non-equivalent forms of blending, i.e., they might at times say one thing but sign something else (e.g., saying ‘*I don't want to eat*’ but signing ‘*I'm full*’). We will investigate this issue in the future as well. Finally, there needs to be a larger sample of sentences before firm conclusions can be drawn although the number of sentences in the current study provides a big enough corpus to draw preliminary results and to find recurring patterns. More data might

show patterns of cross-modal influence from speech to sign and sign to speech as has been found in previous research (e.g., Emmorey et al. 2003).

### Abbreviations

1	1st person
2	2nd person
3	3rd person
F	Feminine
IMPRF	Imperfective
IX	Index
KhA	Khuzestani Arabic
LIS	Italian Sign Language
LSQ	French-Quebec Sign Language
M	Masculine
Neg	Negative
NGT	Sign Language of the Netherlands
PRF	Perfective
PTCP	Participle
S	Singular
STSL	Sadat Tawaher Sign Language

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