Code-blending with Depicting Signs

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Abstract

Bimodal bilinguals sometimes use code-blending, simultaneous production of (parts of) an utterance in both speech and sign. We ask what spoken language material is blended with entity and handling depicting signs (DS), representations of action that combine discrete components with iconic depictions of aspects of a referenced event in a gradient, analog manner. We test a semantic approach that DS may involve a demonstration, involving a predicate which selects for an iconic demonstrational argument, and adopt a syntactic analysis which crucially distinguishes between entity and handling DS. Given this analysis and our model of bilingualism, we expect DS to be blended with restricted structures: either iconic vocal gestures/demonstrations or with spoken language predicates. Further we predict that handling, but not entity, DS may occur in blends with subjects. Data from three hearing native bimodal bilinguals from the United States and one from Brazil support these predictions.

Keywords: bimodal bilingualism; code-blending; depicting signs; demonstration; semantics

Code-blending with Depicting Signs

1. Introduction

In this squib, we analyze production data from hearing bimodal bilinguals – adults whose native languages include a sign language and a spoken language. Bimodal bilinguals engage in a bilingual phenomenon akin to code-switching, but unique to the bimodal situation: code-blending (Emmorey, Giezen, & Gollan, 2016). In code-blending, aspects of a spoken and signed utterance are produced simultaneously; this is possible since the articulators of speech and sign are largely separate. Here we use the patterns of code-blending by bimodal bilinguals in the United States and Brazil to shed light on a longstanding theoretical question regarding the analysis of signs that often do not have a one-to-one correspondence with spoken words, which we refer to as 'depicting' signs or 'classifier constructions'.

Depicting signs (DS), also called "depicting verbs," "classifier predicates," or "classifier constructions," are extremely productive in nearly all sign languages of the world (Zwitserlood 2012). These signs participate fully in the grammar of sign languages and express information about an entity/referent, action or state, location, manner and/or temporal information all in one sign. It is the handshape that can be analyzed as a classifier morpheme (see discussion in Emmorey, 2003 and many others). The movement of the sign and the location in which it is produced contribute toward its interpretation by conveying information about movement, (relative) location, etc. While the handshape can be analyzed categorically, it has been argued that the other aspects of the sign depict (or, as we will see, demonstrate) their interpretation. Taken together, a classifier

construction involves a full predicate which includes a depictive component. Consider the American Sign Language (ASL) sentences in (1)-(2).[1]

(1) BOOK DS_b(fall-down) Entity

'The book fell down.'

(2) BOOK DS_fc(move-book) Handling

'Someone moved the book.'

The examples in (1)-(2) are illustrated in Figure 1.

----- Figure 1 about here ----

In (1), BOOK is the subject and the DS is the predicate, but unlike the English word *fall*, the predicate DS_b(fall-down) includes information about the noun class of the subject (a flat

[1] As is standard in sign linguistics, we annotate signs using uppercase glosses that are the nearest translation equivalents. DS is used for depicting signs, followed by a symbol indicating the handshape, and a description in parentheses of what is depicted. The description should not be understood as a word-for-word gloss of morphemic units. In examples with code-blending, signed and spoken elements produced simultaneously are lined up vertically within a box. Vocal gestures/ "sound effects" are prefaced by "s.e." and described using an approximation via English orthography. Where possible, glosses of ASL signs and names of DS handshapes are assigned by following those used in ASL Signbank (aslsignbank.haskins.yale.edu) and ASL-LEX (asl-lex.org).

object, indicated by the "b" handshape), the action (movement), and the direction of movement (downward); such examples can also convey information about the manner in which the movement took place (e.g., slowly or rapidly as indicated through the manner of the movement of the sign). Under a frequently used categorization proposed by Engberg-Pedersen (1993), this example is classified as an *entity DS* since the handshape itself represents a semantic class of entities (which function as the theme). In (2), there is an unspecified agent whose handling of the book is represented by the "fc" handshape; as in (1), the action and manner are indicated through the movement of the sign itself. Under Engberg-Pedersen's classification, these kinds of DS are categorized as *handling DS*. Other types of DS have their own properties, but for the sake of simplicity in this paper we focus only on entity and handling DS.

Of the relatively large amount of information associated with DS, some is morphemic and categorical (e.g., the handshape), but some information conveyed in DS iconically depicts aspects of a referenced event in a more gradient, analog manner (Emmorey & Herzig, 2003). Correct interpretation of DS also requires consideration of the position and the space of the signer and the referents in the signing context. The goal of the present study is to better understand how these multiple properties of DS in sign languages compose at the semantic and morphosyntactic levels through a unique lens: we will look at natural examples of code-blending involving DS and speech by hearing adult bimodal bilinguals. We do this under the assumption that code blends of sign and speech express a single proposition (Emmorey, Borinstein, Thompson, & Gollan, 2008), and are derived using a single structure which incorporates components of both languages (Lillo-Martin, Quadros, & Chen-Pichler, 2016), so the way that DS participate in blended productions can provide clues to the different components of these complex signs.

The bimodal bilingual participants in our study all identify as Codas ("Children of Deaf Adults") and simultaneously acquired either ASL and English or Brazilian Sign Language (Libras) and Brazilian Portuguese (BP) from their deaf signing families. One known hallmark of bimodal bilingual language production is combinations ("blends") of sign and speech, especially in the context of storytelling and narratives (Bishop, 2010; Emmorey et al., 2008). Code-blending with DS can be especially informative since these often do not have simple translations in speech; most code-blends involve translation equivalents, such as producing the word "bird" simultaneously with the sign BIRD (Emmorey et al., 2008), but not all code-blends are as straightforward, so understanding the way DS are blended with speech has the potential to inform our theories of both the structure of DS and the nature of bilingual language production.

2. Background and Predictions

2.1. Code-blending

Emmorey et al. (2008) coined the label 'code-blending' to capture similarities and differences to the much more widely-known code-switching. They adapted a multi-modal language production model and added an ASL Formulator distinct from but communicating with an English Formulator, within the broader context of how sign, gesture, speech, and non-manual components all contribute to express the content of a single Message Generator. This model and others share the notion that speech and sign express aspects of the same message.

Focusing on the grammatical derivation and abstracting away from an actual production model, Donati & Branchini (2013) and Branchini & Donati (2016) consider whether code-blended productions (in Italian Sign Language (LIS) and Italian) represent the output of a single derivation combining aspects of sign and speech, or two independent parallel derivations, each of which can

result in a structure that is fully grammatical, including syntactic, morphological, and prosodic properties of the respective languages. They conclude (2016) that while some instances of code-blending are compatible with a single derivation, there are others that show the necessity of allowing for independent derivations according to the properties of each language separately.

In contrast to this conclusion, others have argued that since a single derivation is a theoretically simpler assumption, it would be advantageous to attempt to account for code-blending data using a single derivation as far as possible. This view is espoused in a model of bimodal bilingual language derivation called Language Synthesis, illustrated in Figure 2 (Koulidobrova, 2016; Lillo-Martin et al., 2016). While originally devised to account for apparent cross-linguistic effects observed in children (Koulidobrova, 2012; Lillo-Martin et al., 2010), the model has been extended to account for code-blending in children and adults (Lillo-Martin et al., 2016; Quadros et al., 2016a, 2016b; Quadros, 2017, 2018).

----- Figure 2 around here -----

Under this view, the derivation of bilingual sentences with code-blending or code-switching involves selection of abstract grammatical units (roots, features) from the resources of both languages, with vocabulary insertion and phonological output in either one, or, in the case of code-blending, in both languages simultaneously. The result is a single syntactic structure expressing a single semantic proposition, in a combination of signed and spoken words that may use syntactic elements from both languages. Under the Language Synthesis model, straightforward cases of code-blending are readily accommodated. The model allows Vocabulary Insertion of both spoken and signed words that are near translation equivalents, resulting in the most common form

of code-blending, called co-insertion. However, additional types of code-blending can also be generated, depending on the way each language lexicalizes the abstract units. For example, some verbs in ASL and Libras can be modified to indicate plurality of their internal argument, with different types of movement for individuated versus group objects (Klima & Bellugi, 1979 use the terms 'distributive' vs. 'multiple', respectively). In English and BP, these different objects would be expressed using different noun phrases, such as "each of them" vs. "all of them". A signed verb with distributive movement could be produced in a code-blend with a spoken verb and object NP using 'each', and a signed verb with the 'multiple' movement could be produced with a spoken verb and object NP using 'all'. Such differences between the speech and sign of code-blended utterances show that blending is not limited to simple lexical co-insertion. Importantly, the elements that are simultaneously produced in a code-blend are all parts of the same grammatical sub-structure. Furthermore, there is evidence that the temporal co-occurrence of blended elements is phase-bounded – only elements within a single derivational phase are candidates for being produced simultaneously (Berent, 2013; Gökgöz et al. under revision).

2.2. Depicting signs

In principle, there is no reason that Language Synthesis should not extend to code-blending with Depicting Signs, but given their multi-morphemic status that includes analog components, more precision is needed in specifying the syntax (and semantics) involved. Therefore, our goal in this paper is to start with proposals about the syntactic and semantic structure of DS that were developed based on monolingual signing. Then, we will use a combined syntactic/semantic theoretical analysis and the Language Synthesis model to predict what types of blending will occur when speech is combined with DS. Given our view that code-blended utterances involve a

single proposition and one derivation, we predict that only English or Brazilian Portuguese structures with similar properties to those found in depicting signs (in ASL or Libras) will be produced simultaneously with DS.

Previous analyses of DS have generally either (a) taken DS to be primarily gestural and emphasized their iconic components (Cogill-Koez, 2000; DeMatteo, 1977), or (b) modeled DS as a complex combination of many categorical morphemes emphasizing their discrete components (McDonald, 1982; Supalla, 1982). Emmorey and Herzig (2003) provided psycholinguistic evidence that both analyses were right in their own ways, but for different aspects of DS. In particular, they provide evidence that there is a gestural component to DS, in the sense that signers and sign-naïve participants behaved similarly when comprehending the location parameter of DS, and that DS production by signers involved gradient/continuous (versus categorical) expressions of location (see also Schembri, Jones, & Burnham, 2005). In contrast, it is clear that another aspect of DS, namely the correspondence between handshape and the class of referents represented, is discrete and linguistic, varying from sign language to sign language (Schembri et al., 2005; Zwitserlood, 2012). Furthermore, handling DS handshapes are treated categorically by signers, in contrast to non-signers (Sevickova Sehyr & Cormier, 2016), and the production of entity handshapes in DS engages left hemisphere language regions, but the production of gradient spatial locations within entity DS does not (Emmorey et al., 2013).

To capture the dual nature of DS as part linguistic and part gestural, Zucchi, Cecchetto, & Geraci (2012) proposed that a formal semantic composition of DS should include both components. This idea was developed further in Davidson (2015), in which the combination of discrete and gestural components of DS was analogized to speech reports such as “Mary said/was like, ‘I’m hungry!’” where a quotation depicts a speech event via a demonstration which is an

obligatory argument of the verbs *say* or *be like*. Davidson's proposal for DS is illustrated in example (3), which involves a DS that depicts the path movement of a vehicle moving up a hill. In her semantic analysis, the DS is based on a "light" verb without much of its own semantic content, which in the case of entity classifiers can be either *move* or *be-located*. The classifier handshape indicates that the verb takes an obligatory "demonstration" argument that depicts the event by illustrating the path of the vehicle, which in this case goes up a hill. The event depiction/demonstration is pronounced as the movement of the sign and potentially other components: for example, if the sign moves with a complex manner, or the facial expression of the signer indicates great effort, such communicative information would be analyzed as part of the (non-linguistic) demonstration, in this case, about the manner and effort of the car's movement.

(3) Light verb (e.g. *move*) and required demonstrational argument:

CAR DS_3(path movement upward)

'The car went like [path movement and other possible iconic features].'

∃e[(moving(e) & theme (car, e) & demonstration([path movement and other features], e)]

The important parts of this formal semantic analysis for our current purposes are that the DS is a predicate (in contrast to the subject in (3), which is the non-depicting lexical sign CAR), and that this predicate obligatorily involves a demonstrational/iconic/gestural argument (the movement/location), and a discrete component (the 3 handshape referring to vehicles).

At the level of formal syntactic theory, Benedicto & Brentari (2004) proposed a structure for entity and handling depicting signs designed to capture syntactic alternations involving internal and external arguments of the verbs. They show that entity and handling DS are associated with

different thematic structures and therefore different syntactic structures. In particular, while both entity and handling DS are associated with grammatical predicates, syntactic subjects have different status in these two types, such that the full morphosyntactic structure of a handling DS includes an agentive subject, while entity DS do not. Figure 3 shows syntactic structures for the two kinds of DS based directly on the proposal by Benedicto & Brentari, with the addition of Davidson's formal semantics at each step, as well as an English translation.

----- Figure 3 about here -----

One important feature of Davidson's (2015) formal semantic analysis is that DS are necessarily *predicates*, and not full *clauses*. Although they are predicates, they can stand alone as a full sentence in ASL and Libras because these languages generally allow arguments (including subjects) to be unpronounced. In other words, this flexibility in the use of null arguments is not a particular property of DS in ASL or Libras but rather of all verbs (see also Koulidobrova, 2017).

2.3. Code-blended structures with DS

The syntactic/semantic analysis of DS presented in Figure 3 combined with the Language Synthesis view of code-blending leads to the expectation that it should be possible to produce DS simultaneously with a spoken language predicate, i.e. an English or BP verbal structure, such as a main verb, the verb and a direct object, or the verb and modifiers (e.g. adverbs, prepositional phrases). The syntactic/semantic analysis shown in Figure 3 and (3) also has a gestural/demonstrational argument within the predicate introduced by the classifier (DS)

projection f_2. Given this structure, we expect to see demonstrational components like vocal gestures in speech to co-occur more frequently with a DS than with non-depicting signs.

In addition, this model leads to differing predictions for code-blending that involves entity versus handling DS. Handling DS are more complex than entity DS, having a higher functional projection that introduces an agent (Benedicto & Brentari, 2004). This agent is introduced in the structure as the specifier of the f_1 projection, which we take to be comparable to *v*, and thus a phase head. When the f_1P/*v*P is spelled out, the agentive subject of a handling DS can thus be code-blended with the complex DS structure. In contrast, the surface subject generated within the VP of an entity DS must raise out to the specifier of TP, and, we assume, without crossing a phase boundary since there is no f_1P/*v*P. At spell-out, the subject can be pronounced in speech and sign in its surface structure position, which is separated from the DS. In sum, verb phrase material (verb, object, preposition, adverbials) and vocal gestures (as a realization of the demonstration) are both instances of spoken structure that can be blended with DS; however, to the extent that subjects appear at all in DS blends, our model predicts that subjects can be blended with handling, but not entity DS.

3. Method

3.1. Participants

For this study, we investigated the language production of one adult bimodal bilingual from Brazil and three from the United States. All participants had Deaf parents and acquired either Libras or ASL from birth, and moreover, all participants had significant contact with the Deaf community, and they have remained proficient signers. They also had contact with their respective spoken languages: Brazilian Portuguese (BP) and English (Eng), at school and in most other places in their

environment. Characteristics of individual participants are presented in Table 1, including whether or not they worked as a professional, certified interpreter, as well as ratings of the participants' skill in both their sign language and their spoken language on a scale of 1 (poor) to 7 (fluent) (self-assigned in the case of the U.S. participants; the rating of the Brazilian participant was performed by a fluent native bimodal bilingual, the first author). Table 1 also provides summary statistics for the productions analyzed, as described in section 3.3.

Table 1. Participant characteristics and overview of language samples, including the number of depicting signs (entity and handling DS) and other verbs in each sample, produced in sign only ("sign") or with speech ("bimodal").

Codas		**Sign rating**	**Speech rating**	**Inter-preter?**	**# DS**		**# Other verbs**	
					Sign	**Bimodal**	**Sign**	**Bimodal**
USA	B2	6	7	no	4	5	3	46
	M4	7	7	yes	5	22	1	56
	M5	7	7	yes	10	7	12	88
BR	FB	5	7	no	7	11	3	37

3.2. Data collection

The language samples from the U.S. and Brazil were both previously existing data sets collected for separate purposes, and so some aspects of language elicitation differed. In the U.S., participants were given overt instructions that they would be interacting with another bimodal bilingual and that they could use any combination of sign and speech that felt natural. They interacted with each other spontaneously and addressed questions that were given to them in writing; in addition, they

viewed a seven-minute cartoon, “Canary Row”, and retold it to their bilingual interlocutor. The analyses presented here are based on the cartoon retelling, which lasted three to five minutes for each participant. In Brazil, the participant also viewed and retold a story to another bimodal bilingual, this time a two-minute segment of a Charlie Chaplin movie.

3.3. Data coding

Each participant’s narrative production was fully transcribed for speech and sign, and a free translation was assigned to each utterance taking into consideration aspects of both languages in the case of code-blending.

We began by analyzing the sign language verbs produced by the participants. Only utterances containing a signed verb (including DS) were further analyzed. We categorized each analyzed utterance for the mode of communication: unimodal (sign only: no spoken words were produced simultaneously with the signs) or bilingual (sign with at least one spoken word). Next, we extracted all entity and handling DS. Following Benedicto & Brentari (2004), DS were categorized as entity if they represented a moving theme, and as handling if they represented an agent handling an object or instrument.

Finally, we focused on the blending that occurred with DS, and categorized the grammatical function(s) of the spoken words that were produced along with the DS: subject, verb, object, preposition, other. Note that in some cases, more than one category applies, such as when a DS is blended with both a verb and a preposition. We also noted any occurrences of vocal depictions (sound effects) produced with DS (not counted as bimodal word/sign combinations, but reported below). For the purposes of counting as a code-blended utterance, spoken words had to

be produced during the movement of the DS itself, not during transitional movement leading up to or following the sign.

4. Results

4.1. Verb production

Table 1 provides the number of verbs produced by each participant with separate counts for DS (entity and handling only) and other predicates[2] produced unimodally (sign only), compared to those produced bimodally. The contexts in which the data were collected effectively induced code-blending, since 86% of predicates overall were produced bimodally. Like the other predicates, the handling and entity DS predicates were predominantly code-blended. However, the overall rate of code-blending in (handling and entity) DS predicates (63%) is significantly lower than the overall rate of code-blending in the other predicates (92%) (Fisher's Exact Test $p<.0001$). We turn now to the question of what kinds of elements were code-blended with DS.

4.2 Where does code-blending occur?

One relevant factor in code-blending involves timing: In an earlier study, Emmorey et al. (2008) observed that bimodal bilinguals usually produce a code-blended word together with the lexical movement of a sign (see also Emmorey, Petrich & Gollan, 2012). We take this tight coordination in timing to be the default case, and therefore interpret cases of misalignment as indicative of some

[2] The other predicates include both non-DS signs and a few DS signs that are not entity or handling DS.

sort of structural differentiation between sign and speech. For example, there were some cases where speech was produced when the hands were in transition or held in the initial position of the DS before its path movement begins, such as the utterance in (4), where the conjunction and the subject of the second clause are spoken before the movement of the DS which is produced together with the verb phrase, as shown in the box indicating code-blending. This utterance could straightforwardly be analyzed as an example of a DS code-blended with an English verb phrase, but at first blush it may also be argued to include the subject as well, given that the hands were moving up into position for the DS during the production of the spoken words 'and he'. However, the *movement* of the DS sign itself begins with the spoken word 'hits', and across the examples in our study, spoken words that are produced during the *path movement* of the DS are considered to be code-blended with the DS.

(4) Timing of code-blending (entity DS) M4

ASL: WRONG FIGURE-OUT DS_1(hit-wall-forcefully)

Eng: he mis- calculates and he hits the wall

'he miscalculates and hits the wall'

The prosody of a sentence can also be adjusted resulting in tight timing between a sign and a word. For example, in (5) there is a pause in the speech while the participant begins to produce the DS, and the production of the spoken word 'hits' is delayed so that it co-occurs with the downward movement of the DS and the rest of the phrase continues fluently.

(5) Prosody adjustment for code-blending (entity DS) M4

ASL: DS(fall-on-top)

Eng: but it hits him on the head

'but it hits him on the head'

In other cases, speech is dropped entirely, such that DS are produced unimodally within a larger bilingual utterance. This is a code-switch instead of code-blend, which may be typically done when two structures are not easily integrated (Emmorey et al. 2008). Example (6) illustrates this phenomenon: code-blending occurs before and after the first DS, and speech is suspended during DS production.

(6) Speech suspended during DS (entity DS) M5

ASL: WHO IX(building) DS_S(head-look-out) WINDOW SQUARE DS_S(head-look-out)

Eng: and who there? window

'and who's there, peering out of the window?'

In some of these cases when there is no speech produced along with the DS, there may be still be movements of the body, facial expressions, and other aspects of demonstration, as captured by Davidson's (2015) proposal. For example, in (6), while the hands show a round object (the head) popping up over a flat object (the window ledge), the signer's head also pops up and eyes gaze around, which isn't captured in the English gloss. These demonstrations may also be conveyed through vocalizations, as in (7). In this example, the signer produces a large throwing motion

together with head movement that would be appropriate to demonstrate throwing a cat out a window.

(7) Demonstration with DS (handling DS) B2

ASL: DS(throw-out-suddenly) WINDOW CAT

Eng: next thing s.e.: pfff out the window goes the cat

'Next thing that happens, (Sylvester) gets thrown out the window.'

As indicated in the English tier of (7), while there are not spoken words produced with the DS, there is a sound effect, which we gloss as "s.e." (sound effect) and "pfff" (approximately the action taken by producing the English phonemes /p/ followed immediately by a long /f/). These vocalizations are another kind of demonstration that appear frequently with DS (13% of the DS in our data occur with sound effects). Another example of this sort of demonstrative content is given in (8). In comparison, sound effects occur rarely with non-DS verbs: our entire data set included only one example of a sound effect with a non-DS sign (DROOL), out of 246 non-DS signs.

(8) DS with sound effects (entity DS) FB

Libras: DS_a(bater-no-vidro-quebrar)

DS_a(hit-and-break-the-glass)

BP: s.e.: pfff

(a pedra) bateu no vidro e quebrou o vidro.

'(the stone) hit the glass and broke it'

Now that we have a better sense for the timing and constraints on code-blending linguistic and nonlinguistic material, we next turn to describing the grammatical categories of spoken words that were blended with DS.

4.3. Grammatical categories blended with DS

We classified the syntactic category of the spoken words that occurred with a DS in participants' productions. Histograms representing the raw counts of each category for entity versus handling DS are found in Figure 4 for the U.S. participants (Top), and for the Brazilian participant (Bottom). Notably, for both types of DS the most common parts of speech that were produced in a code-blend were verb phrase elements (verbs, objects, and prepositions), as illustrated in examples (9) for ASL-English (the first DS) and (10) for Libras-BP. This result is consistent with syntactic and semantic analyses of DS as predicates.

----- Figure 4 about here -----

(9) Blending of verb, object, particle (handling DS) M4

ASL:	DS_a(uncover-cage)		GRANNY	IX(cage)	DS_cx(hold-umbrella-hit)	AGAIN
Eng:	takes off the cover	and	granny's	there	she beats him	again

'… (he) takes the cover off the birdcage and granny is there and she hits him again.'

(10) Blending of the verb, object (handling DS) FB

Libras:	DS_bl(pegar-pedra)
	DS_bl(pick-up-stone)
BP:	pega pedra
	pick up stone

(ele) pega a pedra

‘(he) picks up the stone’

As for the category of subject, we observed the predicted asymmetry between entity and handling DS, especially in the ASL-English participants. Handling DS in ASL did occur simultaneously with code-blended spoken subjects in English, as illustrated by (9) and (11); there was one such example in Libras-BP; this difference may simply be due to individual participant differences between the Brazilian participant and the American participants. In contrast, for entity DS, there were no instances of a code-blended subject in ASL-English or in Libras-BP. The difference between code-blending of subjects with entity and handling DS in ASL-English is significant by Fisher’s Exact Test ($p<.01$); for Libras-BP, the difference was not significant.

(11) Blend that includes subject (handling DS) B2

ASL:	DS_bl(climb-up-gutter)
Eng:	so he climbs up that

‘he climbs up the gutter by holding the pipe’

5. Discussion and Conclusion

In this study, we used the Language Synthesis model together with Davidson's analysis of DS to predict the linguistic structures of code-blending with DS produced by fluent adult bimodal bilinguals from Brazil and the United States. Our first finding is that, frequently, DS occur without any accompanying speech at all (see Table 1); across all participants, 37% of entity and handling DS were produced in sign only, whereas only 8% of other verbs were produced only in sign. Second, among the code-blending cases without spoken words, DS were sometimes accompanied by vocal sound effects. Both of these results suggest that some aspect of DS may not have a lexical or phrasal equivalence in the spoken language lexicon. This pattern of the code-blends would, on its own, suggest support for gestural analyses of some component of DS. However, we also found a significant number of code-blends in which DS occur with Portuguese or English lexical items in speech. A very large proportion of these examples were predicational (verb phrase) material: many were just verbs on their own, others were verbs with locational information such as prepositional phrases, and some were locational information without verbs. Crucially, we found a distinction between entity DS and handling DS – only the handling DS allowed (agentive) subjects to be code-blended with the DS; for the entity DS, although there were some cases in which the subject was spoken, it was always articulated before the lexical movement of DS itself was articulated, as illustrated in (4) and (5).

The finding that when DS occur in code-blends, the spoken material is either predicational or gestural (sound effects) supports an analysis of DS as having two parts, one gestural/imagistic and the other linguistic/symbolic. This analysis is in the spirit of semantic analyses by both Zucchi, Cecchetto and Geraci (2012) and Davidson (2015), who suggest that DS are verbs that include an additional pictorial argument.

There are, however, several remaining questions raised by our findings that should be addressed in future research. First, our proposed contrast between entity and handling DS could be extended to unaccusative versus transitive predicates; to the extent that surface subjects behave similarly, the analysis presented here would make the same prediction for code-blending. Since our analysis conflates syntactic and thematic contrasts between the predicate types, it could also be of interest to test possible cases where these can be dissociated.

Furthermore, as indicated in the background (section 2), the Language Synthesis model can only capture limited types of divergence in structure between speech and sign, while others have argued that a complete independence of derivation must be assumed to account for certain types of code-blending (Branchini & Donati, 2016). Further research to determine whether there are constraints on such divergence and whether the Language Synthesis model can account for them is currently in progress.

In conclusion, we have used bimodal bilingual code-blending not only as an object of study itself, but as a window into the structure of an especially complex aspect of linguistic analysis in sign languages: depicting signs. This analysis was led by specific predictions of the Language Synthesis model of bilingualism. Because we found code-blends of DS which involve nonlinguistic material, we find this to be support for a gestural component in DS, unlike in the typical lexicon of spoken languages. However, we also found many other examples of DS code-blended with discrete grammatical material, and this material overwhelmingly served the semantic role of predicate and syntactic role of verb phrase. We take this pattern to support analyses of DS as predicates ("classifier predicates"), and in particular predicates that involve an argument that is imagistic (Zucchi et al. 2012; Davidson 2015). We hope that future analyses will illuminate the role of grammatical modifiers in DS, and the simultaneity that is especially pervasive in DS.

However, these are general and complex issues in sign language linguistics and are not unique to the analysis of DS. More generally, we anticipate that the combination of morphemic and gesture content seen in code-blended DS will increase discussion related to other linguistic phenomenon that combine these elements across multiple languages and/or modalities.

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References

Benedicto, E., & Brentari, D. (2004). Where did all the arguments go? Argument-changing properties of classifiers in ASL. *Natural Language and Linguistic Theory*, *22*, 743–810.

Berent, G. P. (2013). Sign language–spoken language bilingualism and the derivation of bimodally mixed sentences. In T. K. Bhatia & W. C. Ritchie (eds.), *The Handbook of Bilingualism and Multilingualism, Second Edition*, 351-374. Malden, MA: Blackwell.

Bishop, M. (2010). Happen can't hear: An analysis of code-blends in hearing, native signers of American Sign Language. *Sign Language Studies, 11(2),* 205-240.

Branchini, C. & Donati, C. (2016). Assessing lexicalism through bimodal eyes. Glossa: a journal of general linguistics 1(1): 48. 1–30.

Cogill-Koez, D. (2000). Signed language classifier predicates: Linguistic structures or schematic visual representation? *Sign Language & Linguistics, 3(2),* 153-207.

Davidson, K. (2015). Quotation, demonstration, and iconicity. *Linguistics and Philosophy, 38,* 477–520.

Donati, C. & Branchini, C. (2013). Challenging linearization: simultaneous mixing in the production of bimodal bilinguals. In T. Biberauer & I. Roberts (eds.), *Challenges to linearization* (pp. 93-128). Berlin: De Gruyter Mouton.

Emmorey, K. (ed.) (2003). *Perspectives on Classifier Constructions in Signed Languages*. Mahwah, NJ: Erlbaum.

Emmorey, K., & Herzig, M. (2003). Categorical versus gradient properties of classifier constructions in ASL. In K. Emmorey (ed.), *Perspectives on Classifier Constructions in Signed Languages* (pp. 221-246). Mahwah, NJ: Erlbaum.

Emmorey, K., Borinstein, H.B. Thompson, R. & Gollan, T.H. (2008). Bimodal bilingualism. *Bilingualism: Language and Cognition, 11(1),* 43–61.

Emmorey, K., McCullough, S., Mehta, S.H., Ponto, L.B., & Grabowski, T.J. (2013). The biology of linguistic expression impacts neural correlates for spatial language. *Journal of Cognitive Neuroscience, 25*(4), 517-533.

Emmorey, K., Petrich, J.A.F., & Gollan, T.H. (2012). Bilingual processing of ASL-English code-blends: The consequences of accessing two lexical representations simultaneously. *Journal of Memory and Language*, 67, 199-210.

Emmorey, K., Giezen, M.R., & Gollan, T.H. (2016). Psycholinguistic, cognitive, and neural implications of bimodal bilingualism. *Bilingualism: Language and Cognition, 19*(2), 223-242.

Engberg-Pedersen, E. (1993). *Space in Danish Sign Language*, Signum Verlag, Hamburg

Koulidobrova, E. (2012). When the quiet *surfaces: 'Transfer of Argument Omission in the Speech of ASL-English Bilinguals*. PhD Dissertation. University of Connecticut. Storrs.

Koulidobrova, E. (2016). Argument omission in ASL-English bilinguals: Language interaction effects in bimodal bilingualism. *Linguistic Approaches to Bilingualism.* Advance online publication.

Koulidobrova, E. (2017). Elide me bare: Null arguments in American Sign Language. *Natural Language and Linguistic Theory,* 35, 397–446.

Lillo-Martin, D., Quadros, R.M.de & Chen Pichler, D. (2016). The development of bimodal bilingualism: Implications for linguistic theory. *Linguistic Approaches to Bilingualism, 6(6),* 719-755.

Peirce, C. S. (1931). In C. Hartshorne & P. Weiss (Eds.), *Collected papers of Charles Sanders* Peirce (Vols. 1–6). Cambridge, MA: Harvard University Press.

Quadros, R. M. de. (2017). *Língua de herança: língua brasileira de sinais.* Porto Alegre: Editora Penso.

Quadros, R. M. de. (2018). Bimodal Bilingual Heritage Signers: A Balancing Act of Languages and Modalities. *Sign Language Studies, 18(3),* 355-384.

Quadros, R. M. de, Lillo-Martin, D. & Emmorey, K. (2016a). As línguas de bilíngues bimodais. *Revista de Estudos Linguísticos da Universidade do Porto, 11*, 139-160.

Quadros, R. M. de, Lillo-Martin, D. & Chen Pichler, D. (2016b). Bimodal Bilingualism: Sign Language and Spoken Language. In M. Marschark & P. E. Spencer (Eds.), *The Oxford Handbook of Deaf Studies in Language: Research, Policy, and Practice* (pp. 181-196). Oxford, UK: Oxford University Press.

Schembri, A., Jones, C., & Burnham, D. (2005). Comparing action gestures and classifier verbs of motion: Evidence from Australian Sign Language, Taiwan Sign Language, and nonsigners' gestures without speech. *Journal of Deaf Studies and Deaf Education*, *10*(3), 272-290.

Sehyr, Z. S., & Cormier, K. (2016). Perceptual categorization of handling handshapes in British Sign Language. *Language and Cognition,* 8, 501-532.

Zucchi, S., Cecchetto C., & Geraci, C. (2012). Event descriptions and classifier predicates in sign languages. Presentation FEAST in Venice, 21 June 2011.

Zwitserlood, I. (2012). Classifiers. In R. Pfau, M. Steinbach, & B. Woll (Eds.), *Sign language: An international handbook* (pp. 158–185). Berlin: Mouton de Gruyter.

Figure Captions

Figure 1. Entity and handling DS examples from American Sign Language.

Figure 2. Synthesis Model (Lillo-Martin, Quadros and Chen Pichler, 2016).

Figure 3. Formal syntactic/semantic structure of A) handling and B) whole entity DS.

Figure 4. Distribution of spoken elements code-blended with DS.

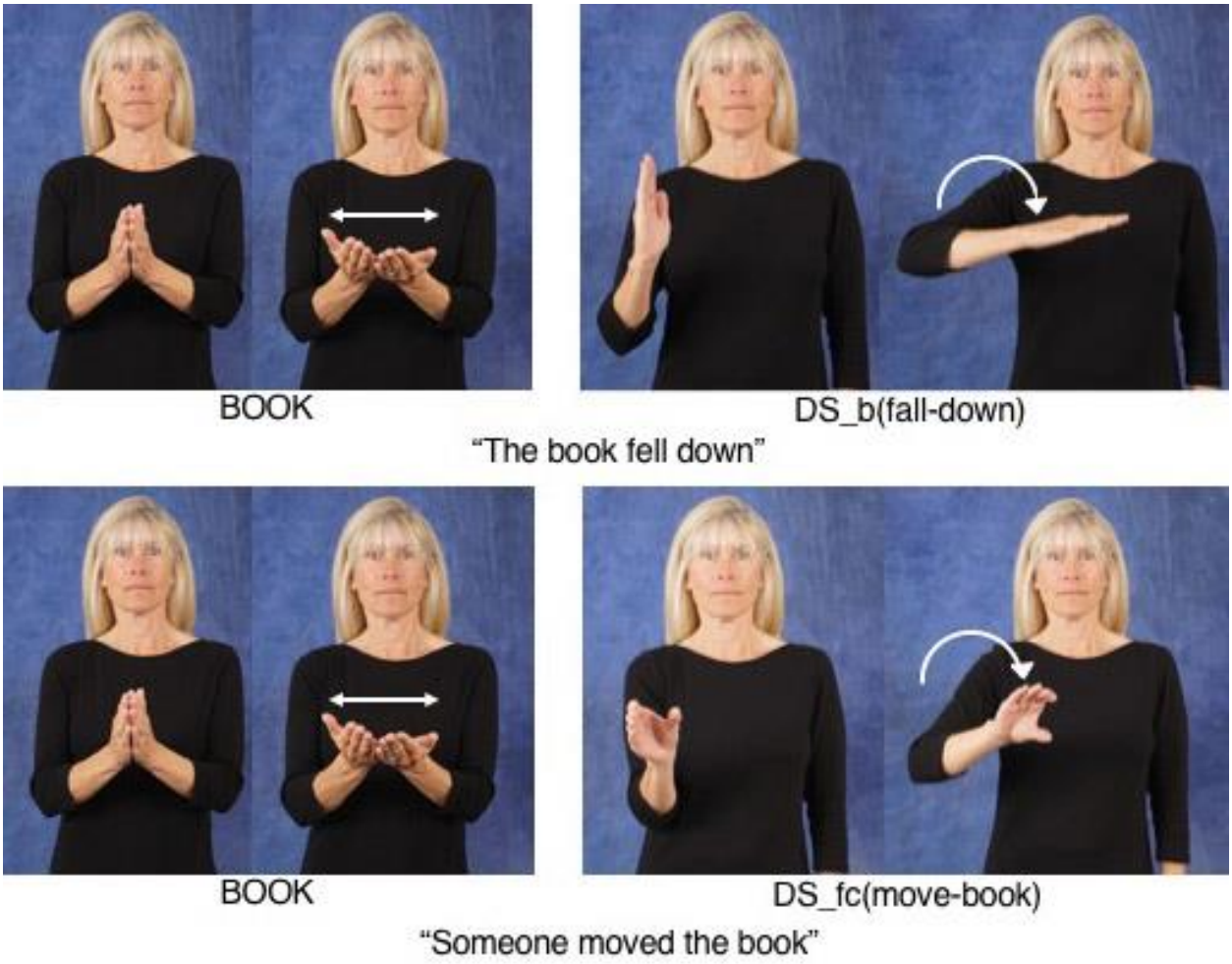


Figure 1. Entity and handling DS examples from American Sign Language.

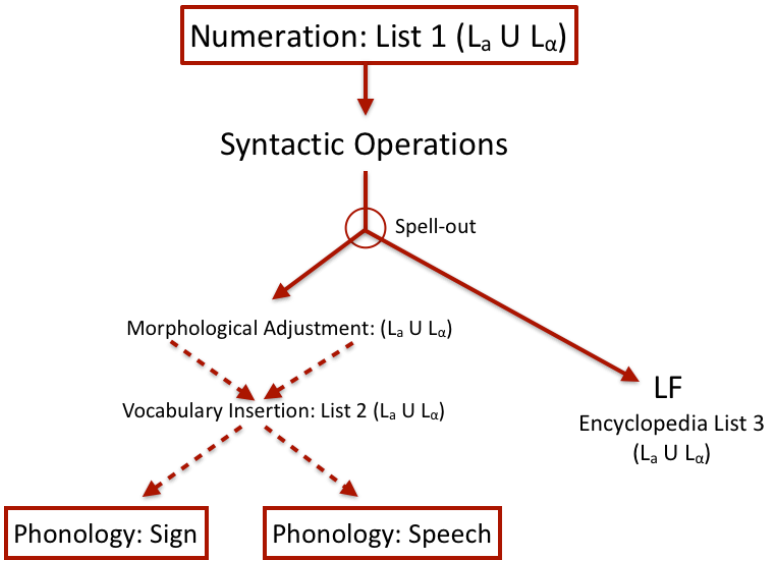


Figure 2. Synthesis Model (Lillo-Martin, Quadros and Chen Pichler, 2016)

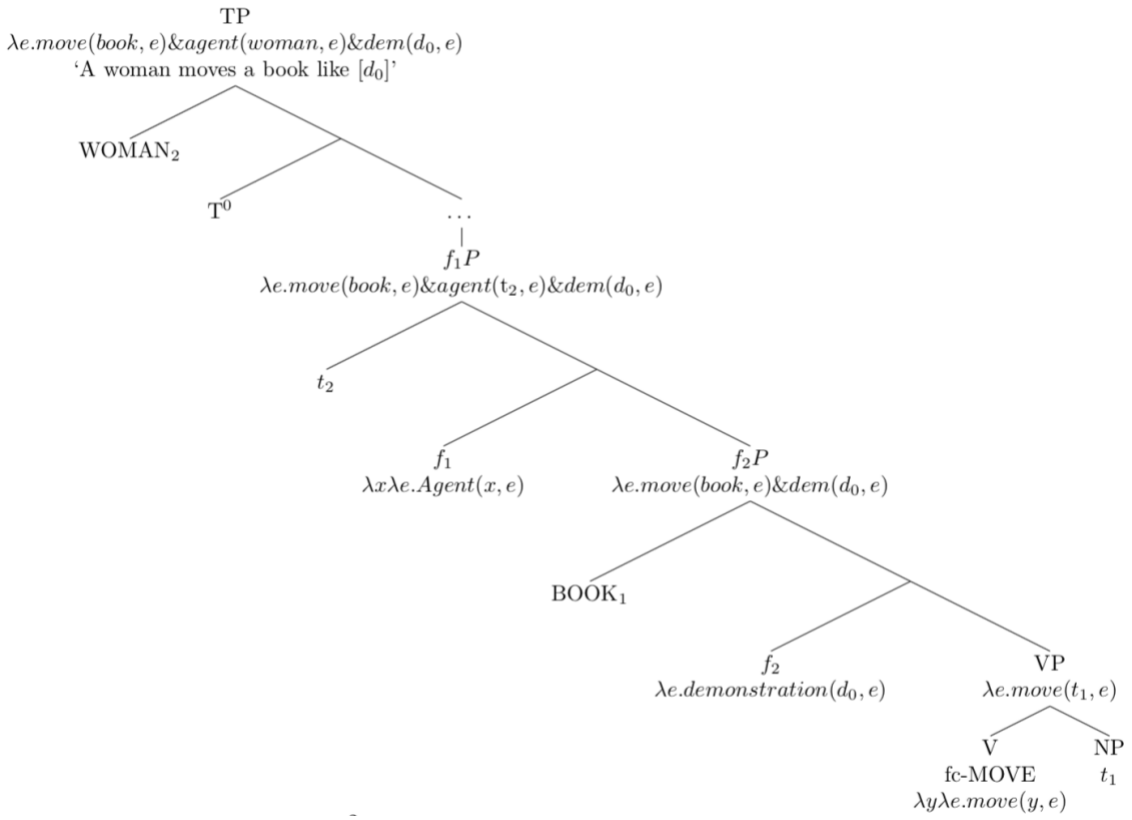


Figure 3a. Formal syntactic/semantic structure of handling DS

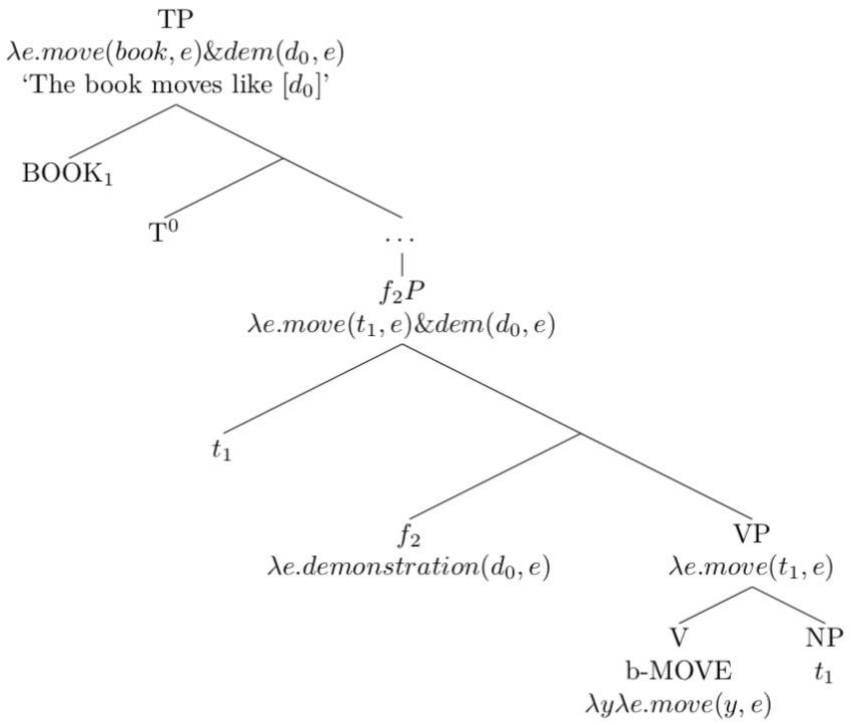
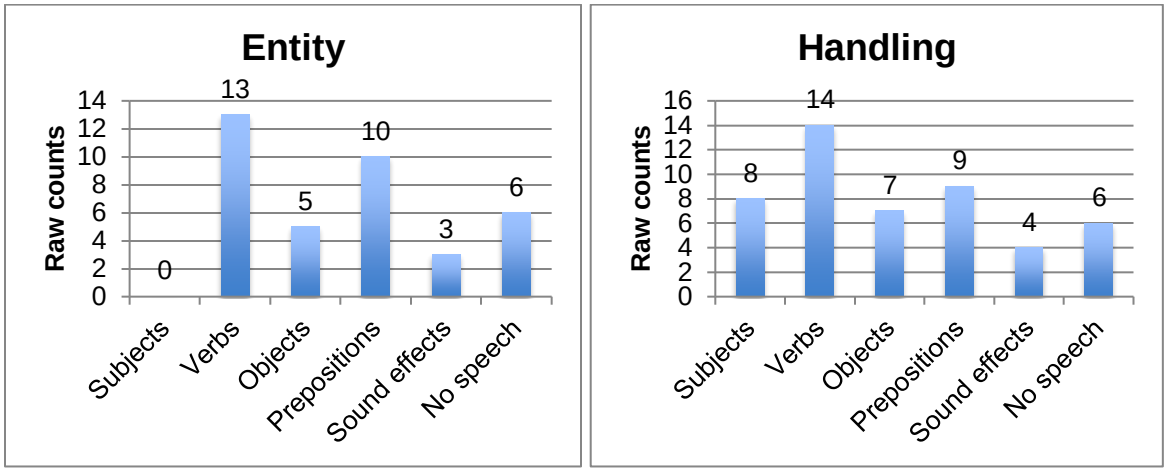
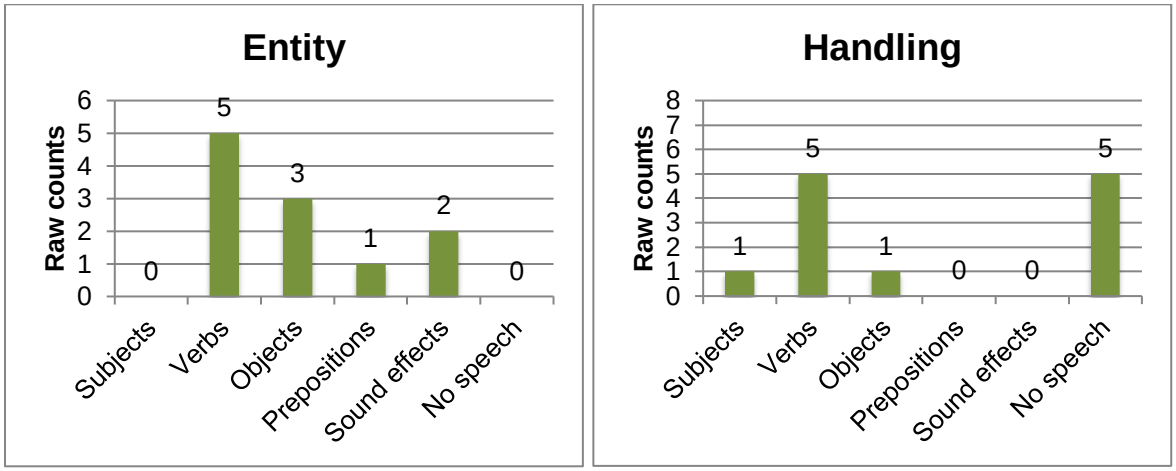


Figure 3b. Formal syntactic/semantic structure of whole entity DS



US participants



Brazilian participant

Figure 4. Parts of speech blended with DS.