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## **Pointing and Eye-gaze in Bimodal Bilingual Language Development**

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### **1. Introduction**

The overarching research question for the current project is “How does pointing function (linguistically and para-linguistically) in sign languages, compared with co-speech pointing?” We address this issue by examining development in the pointing of children who are Bimodal Bilingual (Bibi). Bibi children naturally learn a sign language and a spoken language since they are hearing children with at least one Deaf parent. In our study we include children learning English and American Sign Language (ASL), or Brazilian Portuguese and Brazilian Sign Language (Libras). These children display what we call language synthesis (e.g., Lillo-Martin et al. 2012), i.e. the possibility for their languages to interact with each other. An instantiation of synthesis is found in code-blending where we witness the production of sign and speech simultaneously. In our data, this is especially common at young ages, but Emmorey et al. (2008) also observe it in adults. An example of pointing while code-blending is given in (1). (We use ‘IX’, for ‘index’, to gloss points.)



- (1)  
Sign Left Hand: TRUCKchin IX(book)  
Sign Right Hand: IX(book)  
Speech: I want truck  
“I want that truck book.” (BEN, 2;00)

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In discussions of language synthesis and blending, pointing occupies a central place thanks to its presence in both sign and speech. The nature, form, and use of pointing may overlap between speech and sign. Different characterizations of pointing exist based on specific research perspectives. For instance, according to Kita, “the prototypical pointing gesture is a communicative body movement that projects a vector from a body part. This vector indicates a certain direction, location or object (2003: 1)”. Kita’s definition for pointing is illustrative of the form and function of pointing, namely that it is a movement in the form of a vector used for the function of indicating a direction, location or object, although how these functions are indicated could be made more specific. In this sense, according to Butterworth “pointing is a deictic gesture used to reorient the attention of another person so that an object becomes the shared focus for attention (2003: 9)”. We observe that Butterworth makes the function of pointing clearer; namely, a strategy used for making an object the focus of shared attention. Sparaci shares the same intuition, adding in the attested social dimension: “pointing is a gesture used to direct one’s own or someone else’s attention at, to or upon something commonly used during social interactions” (2013: 180).

Pointing carries pronominal and other linguistic functions in sign languages (Meier & Lillo-Martin 2013 provide a summary). Because of the overlap between pointing in speech and sign, some have questioned its linguistic status in sign (e.g., Johnston 2013). For this reason, we are particularly interested in differences between pointing in speech versus sign. In the present study, we will be concerned in part with points to persons, as illustrated in Figure 1. We will also be considering points to objects and locations, two other very common uses of pointing in both sign and speech.



**Figure 1: Pronominal use of pointing**

Another characteristic of pointing in both sign and speech concerns eye-gaze. As is clear from Figure 1, in some instances of pointing the eye-gaze of the pointer is directed toward the same thing as the index finger, but in other cases it is not. The relationship between pointing and eye-gaze in signing has not been studied in great detail (see Neidle et al. 2000; Thompson et al. 2013; and Wilbur 2013 for important contributions). In the present paper, our focus will be on eye-gaze during pointing as a way to probe differences between pointing in sign and speech.

The specific research questions that we address in this part of our overall project are as follows: (i) Is pointing used for person, object, and location distinctions in Bibi children? and (ii) Does eye-gaze accompanying pointing serve different functions when signing and speaking?

The participants in this study are three Bibi children, two from the US and one from Brazil, as well as the adult interlocutors who play with the children during our observation sessions. All child participants have at least one Deaf parent and relatively equal exposure to both sign and spoken languages. Adult interlocutors in sign sessions are the child's Deaf parent or a Deaf research assistant. Adults in speech sessions are hearing signers. Table 1 summarizes the data used for answering the specific questions we asked.

**Table 1: Children, their ages and the number of points coded for this study**

Child	Age	Target Language	# Child IX	# Adult IX
BEN (US)	2;00-2;06	ASL	182	233
	2;00-2;06	English	156	103
TOM (US)	1;11-2;06	ASL	47	--
	2;00-2;06	English	31	--
EDU (BR)	2;02-2;07	Libras	30	139
	2;00-2;09	BP	26	54

## 2. Study One: Pointing Classification

Previous studies on the development of co-speech pointing showed that pointing in non-signing hearing children starts as early as 9-12 months (e.g., Lock et al. 1990). Few studies have reported the use of pointing to self, addressee, or non-addressed persons; rather, pointing is toward objects in the context. In a study of the development of pointing in Deaf signing children, Petitto (1987) observed two Deaf children natively acquiring ASL. Both of these children avoided pointing to self and addressee between 12 and 18 months. One child resumed pointing to self and addressee at 21 months; the other resumed pointing to self and addressee at 26 months. Petitto concluded that lexical learning of pronouns (distinctions between persons) is required despite the apparent iconicity of ASL points. Similar results have been found for the development of Greek Sign Language by Hatzopoulou (2008), who investigated one Deaf signing child acquiring Greek Sign Language. Hatzopoulou observed a notable decrease in points to self/other persons at 16-20 months (1% of all points). This child's rate of points to persons increased to 10% at 20-27 months.

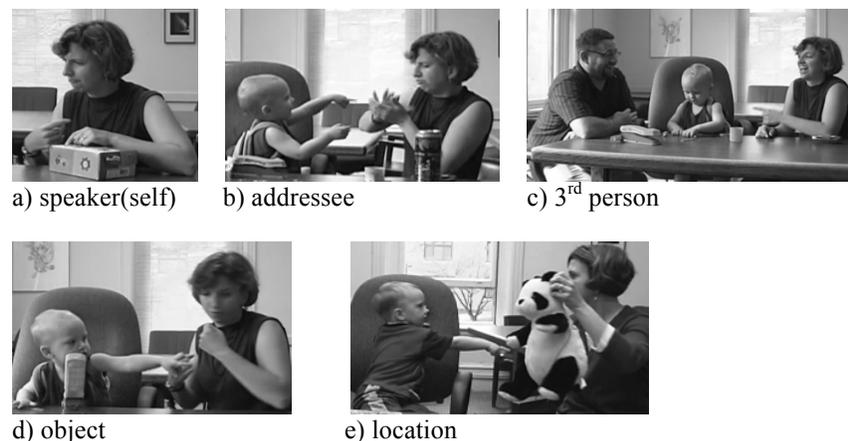
Studies on the development of pointing in bimodal bilingual children also exist. In one such study, Morgenstern et al. (2010) observed one hearing bilingual child, Illana, who was learning French Sign Language (LSF) and French simultaneously. Development of pointing in this child was compared with a monolingual Deaf child, Charlotte, learning LSF, and with one hearing monolingual child, Madeleine learning French. For these children, points to self

between ages 1 and 2 differed depending on the language(s) that they were learning. For the Deaf child learning LSF, pointing to self was frequent. For the hearing child learning both LSF and French at the same time, pointing to self was not so frequent. Pointing to self for the hearing child learning French was not attested.

Inspired by the findings of previous studies, we were curious to find out if and how person distinctions and other distinctions develop in our three bimodal bilingual children. For systematically investigating this classification question, we had the following more specific questions: (i) What do points of bimodal bilingual children refer to? ; (ii) Are there differences in the distribution of points across sign and speech target sessions? ; (iii) Are there differences in the distribution of points when speaking and signing? Note that questions (ii) and (iii) are separate questions that we wanted to pursue. The children we are working with are bimodal bilinguals. This means that they have the potential to sign during the speech sessions and to speak during the sign sessions (cf. Lillo-Martin et al. 2014). Therefore, a two-way grouping for one of the children is reported based on distributions of pointing by session target language (ii) and by speech vs. sign productions (iii).

## 2.1 Coding for Study One

We coded pointing for 5 different classification values: pointing to speaker(self), addressee, 3<sup>rd</sup> person, object and location. Figure 2 illustrates our coding with video-stills taken from the sessions with BEN:



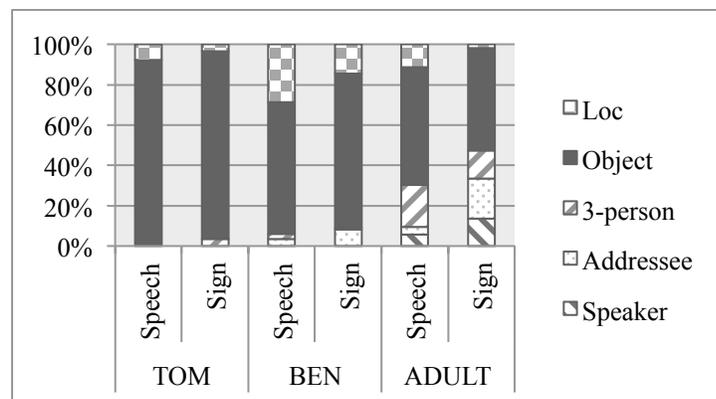
**Figure 2: Pointing classification values**

In Figure 2a, the Deaf parent of the Bibi child is pointing to herself. This is an instance of pointing to speaker(self). In Figure 2b, the Bibi child is pointing to his addressee, i.e. his mother in this instance. In Figure 2c, the Deaf mother and father are having a conversation and the mother is referring to the Bibi

child. This is an instance of pointing to a 3<sup>rd</sup> person. In Figure 2d, the Bibi child is pointing to a car. This is an instance of pointing to an object. Lastly, in Figure 2e, the Bibi child is pointing to a location, a location where he wants the toy panda to sit.

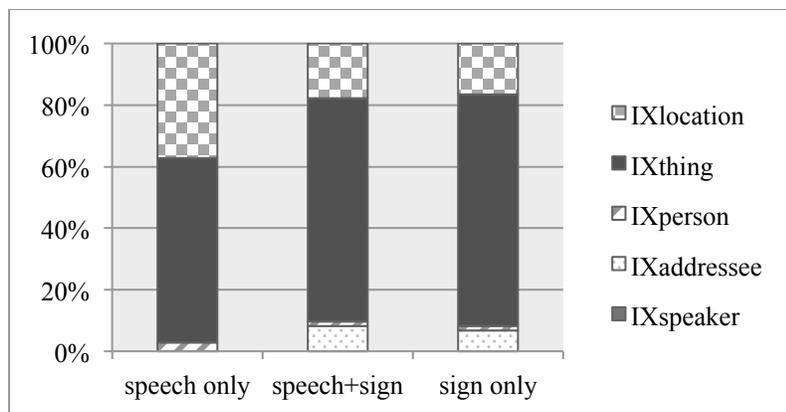
## 2.2 Findings for Study One

Chart 1 shows the classification results for the two US children, and the adults interacting with BEN. Results are presented separately according to the target language of the observation session. The chart shows that there are no points to self for these two children during the age range we coded (BEN 2;00-2;06; TOM 1;11-2;06). Pointing to the addressee is not present for TOM, while BEN has a few such pointings. Pointing to the third person is not present in TOM's speech, and it is infrequent in his sign, and in BEN's speech and sign. Pointing to objects and locations are more frequent for both children compared with pointing to persons. For the adults, we see instances of pointing to the self and addressee more in sign sessions and to the third person in speech sessions.



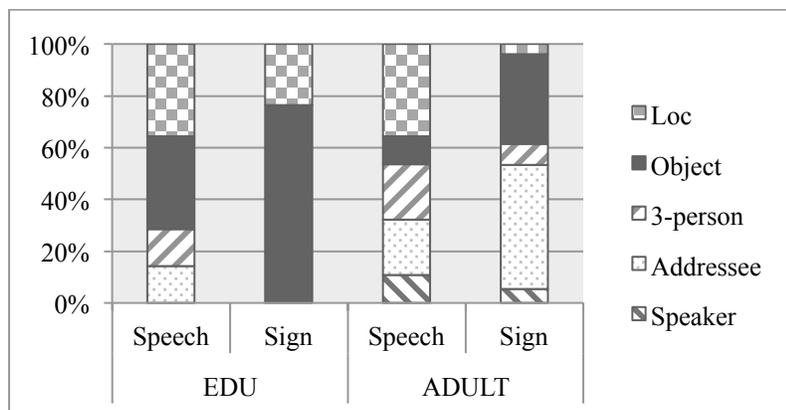
**Chart 1: Pointing classification results (US)**

As we noted earlier, since our children are bimodal bilinguals, they can speak in sign sessions and sign in speech sessions. Accordingly, we organized BEN's data by modality (speech only, speech+sign and sign only). It turned out that those instances when BEN pointed to his addressee occurred only when he was signing. Chart 2 shows BEN's data organized according to modality.



**Chart 2: Distribution of pointing classification according to modality for BEN**

Chart 3 shows the distribution of pointing classification for the Brazilian child, EDU. Similar to BEN and TOM, EDU does not have any pointing to self for the ages we investigated. He has some instances of pointing to the addressee and third person in his speech sessions in addition to pointing to locations and objects, while pointing to addressee and third persons are absent in his sign sessions. Brazilian adults show those pointings in both speech and sign.



**Chart 3: Pointing classification results (Brazil)**

To summarize the results of Study One, we observed that there are no points to self for any of the three children studied here. For BEN, the few points to addressee are all produced while signing whereas EDU's points to addressee come from his latest observation (2;09). We conclude that points to persons are infrequent – extending previous findings to *even older children* since the age range that we investigated is older than the ages reported in previous studies. We

will discuss the implications of these findings for the theories of sign language pointing and the issue of language synthesis in the discussion section. Before then, we will describe our second study in the following section.

### 3. Study Two: Eye-gaze

Broadly defined, eye-gaze is an act of looking at a thing, person or location. Some categorization of eye-gaze behavior seems to be necessary, though. Such a categorization can be made with a division into i) simple eye-gaze to the referent that the hand points to or ii) complex eye-gaze behavior in the form of a shift from the referent to which the hand points to the addressee or vice versa. In the latter kind, according to some researchers, eye-gaze is akin to manual pointing: “Many other forms of pointing may exist. Pointing may be performed using other body parts (e.g. head and/or eye movements, lip-protruding (Kendon, 2005; Enfield, 2001; Kendon & Versante, 2003, cited in Sparaci 2013: 180).” Clearly, eye-gaze shift may be regarded as an instance of pointing, used for establishing joint attention. Figure 3 illustrates an instance of eye-gaze shift from a location to the addressee:



**Figure 3: Gaze shift from a location to the addressee**

Lieberman et al. (2011, 2014) studied the use of eye-gaze with signs (not restricted to pointing) during book reading and playing with toys by Deaf signing children (with Deaf parents) versus Hearing English monolingual children. The four deaf signing children were between the ages 1;09 and 3;07. They found that gaze to the addressee was very common overall. They also detected quite a few instances of shifting gaze from addressee to object, or vice versa. Table 2 summarizes the results with Deaf children in their study (Lieberman et al. 2011: 9).

**Table 2: Percentage of time looking and total gaze shifts by child in Lieberman et al. (2011: 9)**

Child	Toys	Mother	Away	Total Gaze Shifts
C1 (1;9)	68%	31%	11%	65
C2 (2;1)	78%	20%	3%	57
C3 (3;6)	57%	32%	10%	99
C4 (3;7)	71%	26%	3%	77
MEAN	69%	27%	4%	75

Lieberman et al. (2011) compared the 4 Deaf signing children to 4 hearing children between ages 1;10 and 3;06. For the hearing group, gaze to addressee was almost nonexistent. Moreover, no gaze shifts occurred in this group of children. The results for hearing children in their study are given in Table 3. Based on the difference between Deaf and hearing children, Lieberman et al. concluded that eye-gaze shift is a modality-specific mechanism for joint attention in Deaf signing children.

**Table 3: Proportion of time spent looking by hearing children to each location across five minute interaction in Lieberman et al. (2011: 10)**

Child	Book	Parent	Away	Total Gaze Shifts
Naima (1;10)	99%	0%	1%	0
Violet (1;11)	93%	4%	3%	12
William (3;4)	94%	1%	5%	4
Lily (3;6)	60%	1%	39%	4
MEAN	87%	1%	12%	5

### 3.1 Coding for Study Two

In order to understand eye-gaze behavior of Bibi children, we coded for three gaze values: a) gaze to the addressee, b) gaze to a referent other than the addressee (i.e. object/person/location) all coded as object, and c) shifts from addressee to object or vice versa. Figure 4 illustrates these values for coding:



a) gaze to addressee



b) gaze to object

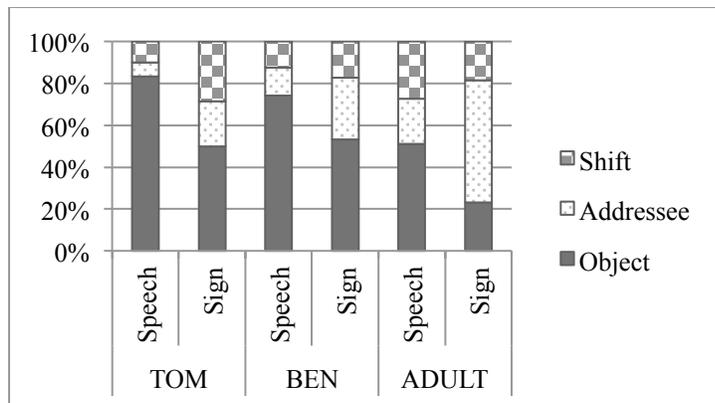


c. gaze shift from object to addressee

**Figure 4: Eye-gaze values**

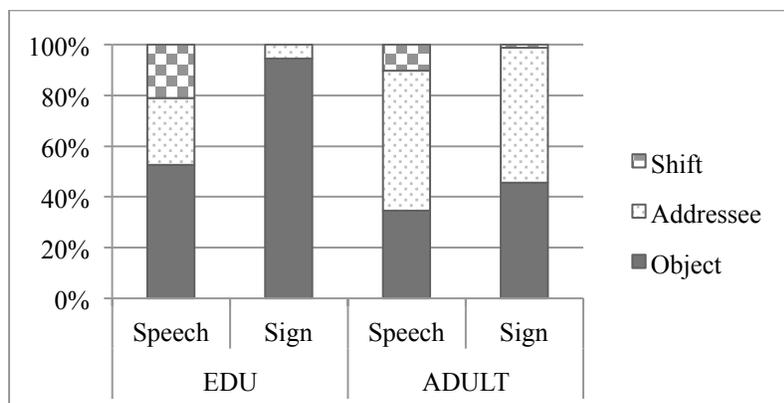
### 3.2 Findings for Study Two

Chart 4 shows the eye-gaze results for the two Bibi children from the US compared with the adults interacting with BEN in the last two columns.



**Chart 4: Eye-gaze results (US)**

Chart 5 shows the eye-gaze results for the Brazilian Bibi child compared with the adults interacting with him:



**Chart 5: Eye-gaze results (Brazil)**

Our results show that Bibi children used gaze to the addressee more than the hearing children in the Lieberman et al. study. US children gazed to addressee more in sign target sessions than in speech target sessions. Bibi children also used gaze shifts. The BR child used gaze to addressee and eye-gaze shifts during speech target only in the oldest session (2;09).

#### 4. Discussion

The first specific research question that we asked at the beginning of this paper was “Is pointing used for person, object, and location distinctions in Bibi children?” The answer to this question is *yes*, but points to persons are

infrequent and points to self are not yet present. This finding contributes to theoretical discussions of pointing in sign language (SL) research. Some researchers claim that the full range of 1st, 2nd and 3rd person features is available for some SLs, for instance Catalan Sign Language (LSC, Barberà 2012) and Croatian Sign Language (HZJ, Alibašić 2003; Alibašić and Wilbur 2006). However, some other researchers claim that there is no grammatical distinction between 2nd and 3rd person; in other words, 1st and non-1st is the crucial distinction (Meier, 1990; Lillo-Martin and Meier 2011). Still, others offer a system whereby there is no need for 1st, 2nd or 3rd person constructs at all since a single pronominal sign which is bound by a unique referential index (i, j, k, ... n) given to a referential expression each time one is introduced is sufficient (Lillo-Martin and Klima 1990). Our finding is in line with the second proposal for the classification of pronouns in ASL since there is a two-way grouping with respect to classification, 1st person (which does not show up at the age group we looked at) vs. non-1st (2nd and 3rd persons) which although infrequent does show up.

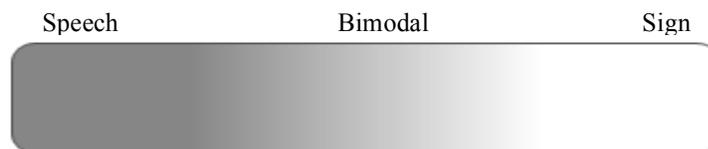
One may wonder whether 1st person forms develop late altogether both in speech and sign, which would explain why we don't see pointing to the self in sign. Our database shows that 1st person forms are present in speech (alongside 2nd and 3rd persons). (2) provides several examples for the use of 1st person forms in the speech of BEN and TOM:

(2) The use of English 1st person forms from BEN and TOM

I want get it (BEN, 2;00)	I no[=?don't] want one (TOM, 1;11)
We're playing (BEN, 2;00)	I sweeping[?] (TOM, 1;11)
more ball to me (BEN, 2;03)	I'm all# done done (TOM, 1;11)
I find this one (BEN, 2;03)	I jump (TOM, 2;06)
me cut it (BEN, 2;03)	I no reading (TOM, 2;06)
me babies me baby (BEN, 2;03)	me stir spoon (TOM, 2;06)
I stuck it no more (BEN, 2;03)	me Batman[?] (TOM, 2;06)
We're playing (BEN, 2;00)	I need to stirring it (TOM, 2;06)
I'll cut (BEN, 2;03)	I make chicken (TOM, 2;06)
I cut first (BEN, 2;03)	I baking[?](TOM, 2;06)
I dropped my cookie[?] (BEN,2;03)	I didn't this (TOM, 2;06)
I see the cow (BEN, 2;06)	I go on bicycle me (TOM, 2;06)
I see the big helicopter (BEN, 2;06)	I build a house (TOM, 2;06)
I see doggie (BEN, 2;06)	I put in there's pot (TOM, 2;06)
I put it right in the trashcan (BEN, 2;06)	I fixed[?] it[_] (TOM, 2;06)
I did it (BEN, 2;06)	it match[?] me (TOM, 2;06)
I hear it my[/] my mommy (BEN, 2;06)	I love fish (TOM, 2;06)
I found this (BEN, 2;06)	and I stirred it up (TOM, 2;06)
I help this (BEN, 2;06)	look[?] at[?] me (TOM, 2;06)

One may also wonder why we observe late development with the 1st person form rather than the non-1st person form? After all, if the division is between 1st and non-1st, wouldn't it be easier to point to self anyways? We will briefly discuss this curiosity. Note to start with that the explanation cannot be to do with a lack of the 1st person pronoun in adult input. In our study and several others, adults do use points to themselves (Petitto 1987, Johnston 2013). Eliminating this possibility of the lack of input, we can entertain two thoughts about what may be the reason. Thought 1 is based on the suggestion that ASL is a null-argument language (Lillo-Martin 1986). Dropping an argument is ruled by recoverability and recovering 1st person may be easier. That's to say 1st person forms are dropped because they can be recovered more easily. In this regard, we don't expect complete absence of the 1st person. It is predicted to show up under certain linguistic conditions such as emphasis and contrast. The two phenomena may be interrelated. We are in the process of checking this relation in development. Then this possibility is still an open-ended inquiry. The second thought about what may be the reason is a familiar idea from acquisition literature. There may be a "U-shape" development for pointing, as also presented in Petitto's (1987) work. According to Petitto, there is an early start with an un-analyzed gestural period, where person forms are not analyzed. This early period is followed by a transition period where children discover that pointing is integral into their linguistic sign system. For some reason, children avoid pointing to persons during this period. The transition period is ultimately followed by a period of fully developed person distinctions (just after some reversal errors). Under this second scenario, children in our study may be going through a transition period during which they are figuring out person distinctions in sign and specifically avoiding the first person form in their pointing.

The second specific question that we asked, namely, "Does eye-gaze accompanying pointing serve different functions when signing and speaking?" finds an affirmative answer as well. Bibi children use eye-gaze to addressee and eye-gaze shift from addressee to object and vice versa. This finding shows that bimodal bilingual children are not like monolinguals of either language – bilingualism adds possibilities through language synthesis. In other words, if our hearing Bibi participants behaved like hearing monolinguals during speech target sessions, we would expect them not to use gaze to the addressee or gaze shifts in these sessions, contrary to our findings. We attribute this to the unique nature of bimodal bilingualism, which permits an enhancement of language 'synthesis' (Emmorey et al. 2008; Lillo-Martin et al. 2010) as we represent in Figure 5:



**Figure 5: Language synthesis**

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