When grammars differ: Spanish-Basque bilinguals processing word order[☆]

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Abstract

Event-related potential studies on second language processing reveal that L1/L2 differences are due either to proficiency, age of acquisition or grammatical differences between L1 and L2 (Kotz, 2009). However, the relative impact of these and other factors in second language processing is still not well understood. Here we present evidence from behavioral and ERP experiments on Basque sentence word order processing by L1Spanish–L2Basque early bilinguals (Age of Aquisition = 3 years) with very high proficiency in their L2. Results reveal that these L2 speakers have a preference towards canonical Subject–Object–Verb word order, which they processed faster and with greater ease than non-canonical Object–Subject–Verb. This result converges with the processing preferences shown by natives and reported in Erdocia, Laka, Mestres-Missé & Rodríguez-Fornells (2009). However, electrophysiological measures associated to canonical (SOV) and non-canonical (OSV) sentences revealed a different pattern in the non-natives, as compared to that reported previously for natives. The non-native group elicited a P600 component that native group did not show when comparing S and O at sentence's second position. This pattern of results suggests that, despite high proficiency, non-native language processing recruits neural resources that are different from those employed in native languages.

Keywords: word order processing, bilingualism VO – OV languages, morphological processing, ERPs

1. Introduction

Recent studies in bilingual language processing reveal that the level of proficiency attained in the second language (L2), the age at which L2 is learned, and the degree of

similarity between first (L1) and the second language all have a significant impact on L2 processing (see van Hell & Tokowicz, 2010; Kotz, 2009; McLaughlin, Tanner, Pitkänen, Inoue, Valentine & Osterhout, 2010, for thorough reviews on L2 processing) . The aim of the present study is to further explore the impact that grammatical differences between the L1 and L2 of the bilinguals have on L2 language processing. To this end, we studied how early and very proficient L1Spanish-L2Basque bilinguals process word order variation in Basque, given that canonical word order in Spanish declarative sentences is Subject–Verb–Object (SVO), whereas in Basque it is Subject–Object–Verb (SOV).

Word order types constitute the most well established and frequently cited generalization in language typology (originally due to Greenberg, 1963). Basic or canonical word order tends to fall into two main types: SOV (about 48% of all languages in the world) or SVO (about 41%) (Dryer, 2011). Several studies have argued for distinct processing strategies as a function of basic word order (Hawkins, 1995, 1999, 2004; Hawkins, Dryer, Haspelmath, Newmeyer, Polinsky & Primus, 2002; Ueno & Polinsky, 2009; Yamashita & Chang, 2001; Gibson, Piantadosi, Brink, Bergen, Lim & Saxe, 2013; Pastor & Laka, 2013). These processing differences have been argued to stem from the central role played by the verb in sentence comprehension. In SVO languages, the number and type of arguments of the sentence is evaluated at verb position (Garnsey, Pearlmutter, Myers & Lotocky, 1997; Trueswell, Tanenhaus & Kello, 1993), and the interpretation and integration of displaced syntactic elements takes place also at the verb (Pickering, 1993; Pickering & Barry, 1991; Gibson & Hickok, 1993). In SOV languages, waiting for the verb should delay argument identification, and make these languages slower to process. There is, however, a well established cross-linguistic typological generalization: SOV languages generally have case morphology on the Noun Phrases (Greenberg, 1963; Dryer, 2011). The question we address in this paper is how L1 speakers of a VO language process word order in a second language of the OV type. To this end, we investigated early and very proficient L1Spanish–L2Basque bilinguals. Our working hypothesis is that processing aspects of a second language that differ fundamentally from the first language will recruit broader neural resources than those employed by native speakers, even at high levels of proficiency and at early ages of acquisition, particularly when those grammatical differences directly relate to processing strategies, as has been argued to be the case in VO versus OV languages. We hypothesize that native/non-native differences can be found even at high proficiency in the language when a basic typological trait (i.e. a syntactic parameter) of the L2 grammar is the opposite of the L1 grammar. Spanish–Basque bilingual populations are a good testing ground to investigate how typologically very different languages are processed by bilinguals. Spanish, like English, is head-initial language with SVO canonical word order in declarative sentences, while Basque, like Japanese, is a head-final language, with SOV as canonical order.

In order to explore word order processing preferences in Spanish–Basque bilinguals, we used behavioral measures (reading times and error rates) and event-related potentials (ERPs). In the ERP literature, three main components have been reported in relation to language processing: left anterior negativity (LAN), N400 and P600. LAN is a negative deflection of the wave occurring between 300 and 500 ms after the stimulus onset and distributed over the left and anterior sites of the scalp. It has been interpreted as an electrophysiological response to morphosyntactic processes that occurs when processing ungrammatical information (Münte, Heinze & Mangun, 1993) or syntactically complex structures (Fiebach, Schlesewsky & Friederici, 2002; Rösler, Pechmann, Streb, Röder &

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Hennighausen, 1998). According to other studies, it may also reflect a general index of working memory load (Kluender & Kutas, 1993). N400 is a negative-going wave occurring between 300 and 500 ms after the stimulus onset and distributed over centro-parietal sites of the scalp. It has generally been considered a response to semantic and pragmatic violations (Hagoort, Hald, Bastiaansen & Petersson, 2004; Kutas & Hillyard, 1980) or atypical thematic hierarchy (Bornkessel-Schlesewsky & Schlesewsky, 2009; Frisch & Schlesewsky, 2001). Finally, the P600 (also called syntactic positive shift) is a positive-going wave distributed over centro-parietal sites of the scalp starting approximately 500 ms after the stimulus onset and lasting about 300 ms. It is generally attributed to reanalysis or integration effects taking place when syntactically ungrammatical, ambiguous or complex information is being parsed (Kaan, Harris, Gibson & Holcomb, 2000; Osterhout & Holcomb, 1992; Phillips, Kazanina & Abada, 2005, for semantic P600 see Kim & Osterhout, 2005; Kuperberg, Holcomb, Sitnikova, Greve, Dale & Caplan, 2003). Late positive components have been also found over frontal locations and interpreted as processing difficulty related to revision processes or in non-preferred continuations within ambiguous contexts (Hagoort & Brown, 2000; Hagoort, Brown & Osterghout, 1999; Friederici, Hahne & Saddy, 2002, see also Kaan & Swaab 2003 for an overview).

ERPs have been employed to investigate differences between native and non-native language processing, at different levels of proficiency. Thus, for instance, Tokowicz & MacWhinney (2005) used ERPs to investigate whether and to what extent linguistic transfer from the native language modulates non-native processing at low levels of proficiency. They presented adult English speakers at early stages of learning Spanish with grammatical and ungrammatical constructions that were either similar in L1 and L2 (auxiliary verb omission), different in L1 and L2 (determiner number agreement) or unique for L2 (determiner gender agreement). The ERP signatures revealed a comparable P600 in the case of auxiliary omission and gender agreement, but no effect for determiner number agreement. The high error rates of these L2 learners (chance level), suggests that the results are mainly due to low proficiency in L2, though they suggest that L2 speakers are able to process new grammatical features at early stages of learning.

Ojima, Nakata & Kakigi (2005) investigated nonnative processing at high proficiency in L2, by considering how Japanese L2 speakers of English (AoA = 12 years) process subject-verb agreement in English and compared these results to those obtained with natives: a P600 effect was reported for natives, but no similar positive component for the proficient non-natives. According to the authors, the absence of the P600 component in the non-native speakers is due to the fact that Japanese lacks verb agreement. Similarly, Chen, Shu, Liu, Zhao & Li (2007) examined by means of ERPs subject-verb agreement processing in L1 Chinese proficient L2 speakers of English (AoA = 12 years) and contrasted these results with a control group of native English speakers. The latter group displayed a biphasic LAN-P600 pattern as a response to violations, whereas the L2 group showed a late negativity. The authors suggest that the distinct ERP responses are driven by the differences between Chinese and English (like Japanese, Chinese has no verb agreement), and conclude that L1 influences L2 processing. Sabourin & Stowe (2008) also investigated the effects of L1 on L2 processing in two types of grammatical and ungrammatical constructions: verb morphology and grammatical gender in Dutch. Three groups of participants took part in the study: native speakers of Dutch, German–Dutch and Romance–Dutch bilinguals (AoA > 14 years, all of them highly proficient in L2). Dutch native speakers and L1German–L2Dutch bilinguals showed a P600 component for both ungrammatical

constructions tested. Romance speakers showed a P600 effect to violations of verb morphology (incorrect participle) but not to violations of grammatical gender. According to the authors, these findings suggest that given similar rule-governed processing routines in L1 and L2, as those in verb morphology, similar neural processing is possible for both languages. Phenomena that are different in L1 (Romance) and L2 (Dutch), however, do not result in similar processing, as indicated by the presence of the P600 effect in one case and its absence in another. These results indicate that proficient non-native speakers use different processing strategies from natives when dealing with linguistic phenomena that diverge from those in their native language. In a similar vein, Weber & Lavric (2008) tested whether the presence of comparable morphosyntactic features in L1 and L2 leads to similar electrophysiological profiles in natives versus non-natives. They measured ERPs while highly proficient German–English bilinguals (AoA > 10 years) and English natives read grammatical and ungrammatical sentences (i.e. *The door had been locked/*locks.*). Results showed that, in addition to the P600 component, verb morphology violations led to an enhanced N400 only in non-natives. The authors interpreted the differences between L1 and L2 ERP signatures as suggesting either that non-natives rely more on lexico-semantic strategies for the resolution of morphosyntactic violations, or that the weaker/slower morphological mechanisms in the non-native language lead to greater sentence wrap-up difficulties. Gillon Dowens, Vergara, Barber & Carreiras (2009) investigated aspects of morphosyntactic processing in L2 learners. They examined how native speakers of Spanish and highly proficient late English–Spanish bilinguals (AoA > 20 years) processed sentences containing grammatical and ungrammatical number and gender agreement within phrases (*los suelo* 'the$_{\text{MASC-PL}}$ floor$_{\text{MASC-SG}}$', *la suelo* 'the$_{\text{FEM-SG}}$ floor$_{\text{MASC-SG}}$') and between phrases (*el suelo*$_{\text{MASC-SG}}$ *está *planos*$_{\text{MASC-PL}}$ /*plana*$_{\text{FEM-SG}}$ 'the$_{\text{MASC-SG}}$ floor$_{\text{MASC-SG}}$ is flat$_{\text{MASC-PL/FEM-SG}}$'). Natives displayed a LAN-P600 pattern in response to both agreement violations at both positions; late L2 learners showed a similar ERP pattern in the within-phrase agreement violations, but only a P600 in the between-phrases agreement violations. Besides, significant amplitude and onset latency differences between the gender and the number violations were found in the non-native group in the between-phrases condition. As suggested by the authors, these results possibly reflect differences in the speed and depth of processing of these features by L2 speakers, even at high levels of proficiency, with number violations processed faster and in more depth than gender violations. Also, as revealed by the behavioral task, in the between-phrases conditions, L2 speakers committed more errors in gender than number, suggesting that they have more problems with the feature absent in their L1 (English).

In a follow-up study, Gillon Dowens, Guo, Guo, Barber & Carreiras (2011) used the same materials as in Gillon Dowens *et al.* (2009) to test number and gender processing in highly proficient Chinese speakers of Spanish (AoA > 18 years). Results revealed a P600 component as a response to both ungrammatical number and gender structures, followed by a very late sustained negativity at frontal electrodes. The authors interpreted these results as proof that features not present in the L1 can be acquired at higher stages of proficiency and argued that the cognitive manipulation of these features, however, may not be as automatic as in the case of native speakers, as suggested by the lack of the LAN component, present in the native group. In another study, Zawiszewski, Gutiérrez, Fernández & Laka (2011) investigated the relationship between grammatical differences and non-native language processing. To this purpose native speakers of Basque and highly proficient L1Spanish–L2Basque bilinguals (AoA = 3 years) were tested when process-

ing verb-agreement (similar in both languages) and case morphology (different in each language). Regarding verb-agreement, non-natives performed behavioral tasks with similar accuracy levels and displayed an equivalent biphasic N400-P600 pattern as response to the ungrammatical stimuli as natives (see also Zawiszewski & Friederici, 2009; Díaz, Sebastián-Gallés, Erdocia, Mueller & Laka, 2011). Regarding ergative case morphology, specific to Basque, behavioral and ERP measures revealed significant differences between native and non-native speakers: ungrammaticality elicited a broad negativity in both groups, but only the native group showed a P600 effect. According to the authors these results indicate that when L1 and L2 grammars differ with respect to core aspects of the grammar (i.e. case morphology), native versus non-native differences obtain despite high proficiency in the language and an early AoA.

More recently, Foucart & Frenck-Mestre (2012) investigated how English late learners of French who started learning French at secondary school (mean age of start of instruction: 13.4 years, mean length of formal learning: 8 years) and had been studying at a French university as Erasmus students for a mean of 3 months process gender agreement in their L2. To test this, they used noun-adjective (i.e. *chaises*$_{FEM}$ *vertes*$_{FEM}$ /*verts*$_{MASC}$ 'green chairs', Experiment 1), adjective-noun (i.e. *les anciennes*$_{FEM}$ /*anciens*$_{MASC}$ *montres*$_{FEM}$ 'old watches', Experiment 2) and predicative adjective constructions (i.e. *les pommes*$_{FEM}$ *sont vertes*$_{FEM}$ / *verts*$_{MASC}$ 'apples are green', Experiment 3 and Experiment 4). Data from noun-adjective processing revealed higher P600 amplitude as response to gender violations in the native than in the non-native group; processing adjective-noun constructions, non-natives displayed an N400 component whereas the native group showed a P600. The results from the Experiment 3 shows no ERP response to gender violation in the L2 speakers, while the natives displayed a classical P600 component. Finally, the results from the Experiment 4 (an eye-tracking study) revealed that both French natives and English–French learners displayed similar patterns when processing the experimental stimuli. Overall, these results indicate that although late L2 learners can acquire and process features absent in their L1, this is achieved by recruiting neural substrates that are different from those employed by natives, given that ERPs revealed electrophysiologically differentiated brain patterns between natives and non-natives.

Summarizing, the experimental data indicate that besides proficiency and AoA, the linguistic differences between L1 and L2 grammars also play a significant role in L2 syntactic processing. The picture that emerges from the literature (see van Hell & Tokowicz, 2010; McLaughlin *et al.*, 2010, for thorough reviews) suggests that low proficiency speakers elicit distinct ERP signatures regardless of whether the syntactic phenomena tested are present or absent in their native language. At high proficiency, however, native versus non-native differences obtain when syntactic property tested is either not available or otherwise specified in the native language of the bilingual speakers.

The present study

In the present study, we focus on an aspect of L2 processing that has not received much attention, namely L2 OV word order processing by L1 speakers of a VO language. To this end, we studied early and proficient Spanish–Basque bilinguals. Spanish and Basque differ along similar dimension as do English and Japanese: Spanish and English are both VO languages with no overt case morphology, while Japanese and Basque are both OV languages with case morphology (see examples in 1).

1. a. Emakume-a-k gizon-a ikusi du. BASQUE
   woman-det-erg man-det seen has
   'The woman saw the man'

   b. Josei-wa otoko-o mita. JAPANESE
   woman-top man-acc see
   'The woman saw the man'

   c. La mujer vio al hombre. SPANISH
   Det woman saw det man
   'The woman saw the man'

   d. The woman saw the man. ENGLISH

Regarding argument alignment, Basque is an ergative language (unlike Spanish, Japanese and English which are all nominative-accusative). In ergative languages subjects of intransitive clauses and objects of transitive clauses are grouped together in the same morphological class, and usually bear no overt case ending. Subjects of transitive clauses are grouped in a distinct morphological class, bearing an ergative case marker (Dixon, 1994; Johns, Massam & Ndayiragije, 2006, see examples in 2).

2. a. gizon-a etorri da
   man-det arrived is
   'the man arrived'

   b. emakume-a-k gizon-a ikusi du
   woman-det-erg man-det seen has
   'the woman saw the man'

In the present study we explore structural ambiguity resolution taking advantage of a homophony that occurs in Basque Noun-Phrase morphology. The form of the plural determiner is the morpheme *-ak*, and the combination of the singular determiner (morpheme-*a*) and the ergative case morpheme (*-k*) yields the same *-ak* segment sequence. Consequently, and given free word order, an ambiguity arises whereby sequences like (3a) and (3b), which are homophonous can be interpreted as a canonical SOV sentence (3a) or as a non-canonical OSV sentence (3b):

3. a. Emakume-a-k gizon-ak ikusi ditu
   woman-det(sg)-erg man-det(pl) seen has
   'the woman saw the men'

   b. Emakume-ak gizon-a-k ikusi ditu
   woman-det(pl) man-det(sg)-erg seen has
   'the man saw the women'

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In a previous study, Erdocia *et al.* (2009) investigated sentence word order processing by native speakers of Basque in a series of behavioral (self-paced reading times) experiments and found that processing canonical SOV word order is faster and easier than processing the non-canonical OSV word order for these speakers. ERP data corroborated these findings: OSV sentences showed increasing negativities at both subject and object positions and a P600 effect at verb position. These results were interpreted as signaling a higher processing cost for OSV in comparison with the canonical SOV word order. Additionally, morphologically ambiguous sequences that could be interpreted either as OSV or SOV showed that native speakers apply a default strategy and process them as canonical SOV sentences, ignoring the OSV possibility. Only when the ambiguous sequences were disambiguated favoring an OSV interpretation, a long lasting negative effect was found at disambiguation point.

Taking the results from Erdocia *et al.* (2009) as background, the aim of the current study is to investigate the extent to which the basic word order and lack of case morphology in L1 (Spanish) influences L2 (Basque) processing in very proficient and early bilingual speakers. Here, we report the results of behavioral and ERP experiments, involving online reading of canonical (SOV) and non-canonical (OSV) sentences in Basque. Further, we report the processing preferences of these speakers when they confront ambiguous sentences with subject-first and object-first interpretations.

According to results from previous studies on L2 processing, our hypothesis is that native versus non-native differences will obtain when processing aspects of L2 absent in their L1 (case morphology, ergativity, OV word order), even at high proficiency and early AoA. We expect highly proficient L2 speakers of Basque to display different ERP patterns in comparison to the native group, reflecting a different neural recruitment in each group. In particular, if our hypothesis is correct L1 Spanish speakers of Basque will require more processing resources revealed by ERP components that signal revision processes like P600.

2. Experiment 1

In order to test how early and proficient L1 Spanish–L2 Basque bilinguals process canonical and non-canonical word orders in Basque, we first ran a behavioral self-paced reading experiment. In addition, this experiment sought to investigate the processing of fully ambiguous sentences in Basque in order to determine whether early proficient Spanish–Basque bilinguals would display the same bias towards SOV sentences as natives do.

Participants

Twenty-one early proficient Spanish-Basque bilinguals (mean age 21.2, SD $\pm$ 3.1; 16 female; AoA = 3 y.o. $\pm$ 0.5) took part in the study. All of them were undergraduate students at the University of the Basque Country (UPV/EHU) and were paid for their participation. All participants had obtained the highest proficiency certificate in Basque (equivalent to C1 level in the Common European Framework) by the time of testing (see Table 1 for details). All participants had normal or corrected to normal vision.

Table 1: Language history and self assessed proficiency for participants in Experiment 1

	L2 speakers of Basque (n = 21)	
Age	21.2 (3.1)	
AoA of Basque	3 (0.5)	
Sex (no. of males)	5	
Relative use of language		
Before primary school (0–3 years)	6.2 (1.1)	
Primary school (4–12 years)		
Home	6.2 (1.2)	
School	2.7 (1.6)	
Others	5.4 (1.2)	
Secondary school (12–18 years)		
Home	6.2 (1.3)	
School	2.8 (1.6)	
Others	5.1 (1.2)	
At time of testing		
Home	5.9 (1.7)	
University/work	3.0 (1.7)	
Others	4.6 (1.4)	
Self-rated proficiency	Basque	Spanish
Comprehension	1.14 (0.4)	1 (0)
Speaking	1.42 (0.5)	1.09 (0.3)
Reading	1.14 (0.4)	1.09 (0.3)
Writing	1.33 (0.6)	1.33 (0.6)

The following seven-point scale was applied for measuring the relative use of language: 1 = I speak only Basque, 2 = I speak mostly Basque, 3 = I speak Basque 75 % of the time, 4 = I speak Basque and Spanish with similar frequency, 5 = I speak Spanish 75 % of the time, 6 = I speak mostly Spanish, 7 = only Spanish. Proficiency level was determined by using the following four-point scale: 1 = native-like proficiency, 2 = full proficiency, 3 = working proficiency, 4 = limited proficiency. SDs values are in parentheses.

Methods and Materials

The experimental stimuli consisted of Basque sentences with subject, object and verb in two different orders: SOV and OSV. In order to investigate processing preferences in more detail, we took advantage of a morphological ambiguity of Basque and generated fully ambiguous sequences. In Basque, Noun Phrases ending in -ak are ambiguous between a singular subject or a plural object reading.

All in all, we systematically generated 100 SOV and 100 OSV sentences where S and O were singular, 100 SOV and 100 OSV sentences where S and O were plural, and 100 fully ambiguous sentences that could be interpreted either as SOV or OSV (see Table 2). In Basque, ambiguously marked elements could be interpreted as singular S or as plural O; hence, the plural conditions were introduced in the experiment in order to compare them with the ambiguous condition. The lexical material in the sentences was controlled for length and frequency by means of the Basque Frequency Dictionary (Landa, Sarasola & Salaburu, 2011, freely available at http://www.ehu.es/ehg/ehme/). The comparison between the mean length of the lexical material used as Subject and Object was not significant [S = 6.9 letters ± 1.9; O = 7 $\pm$ 2.1 (t = -0.4)]. The mean frequency for the nouns used as S in the experiment was 23.12 (per million), and for O, the frequency was 34.48 (per million). No significant differences were found when comparing word frequency between

Subjects and Objects ($t = $ -1.86, $P > .05$).

Recall that 4a, 4d and 4e are ambiguous at first DP position. Sentences 4a and 4d are disambiguated at second determiner phrase (DP) position. In the case of 4a the resulting structure is SOV and in the case of 4d the resulting structure is OSV. Only sentences like 4e are fully ambiguous between an SOV or OSV interpretation because both DP constituents carry the ambiguous -*ak* ending.

We created 100 filler sentences, which were also presented in the experiment. Half of the fillers were intransitive sentences, and the remaining 50 fillers were ditransitive sentences where the subject was omitted and O and indirect Object were manifest (varying in their sequential order). Stimuli were divided into five lists. Sentences were randomized (Latin Square) and one version of each item was assigned to one of the five lists. Each list contained 20 sentences from each experimental condition plus 100 filler sentences. The stimuli in the lists were randomized and the lists were balanced across participants. The experimental items were presented along with 16 practice trials (two sentences of each condition and six fillers) to verify that participants understood the instructions of the experiment. All experimental sentences and fillers were four words long.

Table 2: Sentence types used in the self paced reading experiment

	EXPERIMENT 1	
	CANONICAL S_{SG}-O_{SG}-V	*NON-CANONICAL O_{SG}-S_{SG}-V*
Singular arguments	4a. Emakume-ak gizon-a ikusi du Woman-the(S) man-the(O) seen has(V) 'The woman has seen the man'	4b. Gizon-a emakume-ak ikusi du. Man-the(O) woman-the(S) seen has(V) 'The woman has seen the man'
	CANONICAL S_{PL}-O_{PL}-V	*NON-CANONICAL O_{PL}-S_{PL}-V*
Plural arguments	4c. Emakume-ek gizon-ak ikusi dituzte Women-the(S) men-the(O) seen have(V) 'The women have seen the men'	4d. Gizon-ak emakume-ek ikusi dituzte Men-the(O) women-the(S) seen have(V) 'The women have seen the men'
	FULLY AMBIGUOUS	
Ambiguous	4e. Gizon-ak emakume-ak ikusi ditu Man-the(S/O) woman-the(S/O) seen has(V) 'The man has seen the women' or 'The woman has seen the men'	

Two sentence types arrange the elements of the sentences in SOV word order, two sentences were OSV and one was fully ambiguous meaning that without any prosodic cue SOV and OSV interpretation were equally plausible.
S subject, *O* object, *V* verb, *SG* singular, *PL* plural.

Procedure

Reading times were obtained by presenting the materials to the participants using the Self-Paced Reading moving window paradigm (Just, Carpenter & Wooley, 1982) by means of EXPE program (Pallier, Dupoux & Jeannin, 1997). Participants read the sentences word by word in a computer screen. In order to move from one word to the next, participants had to press the space bar of the computer keyboard. The time they needed to read each word was recorded. When participants read the entire sentence, a comprehension question appeared on the screen. The task, which consisted in answering a yes/no question, allowed us to ensure that participants had understood the sentences they read. For instance, for the sentences in Table 2, the question would be *is it true that a woman*

has seen a man?. The word order of the comprehension question was SOV and was kept constant across the experiment. Participants answered the questions using numbers 1 and 2 of the keyboard (balanced across participants) and they did not receive feedback. In the case of fully ambiguous sentences like 1e the comprehension task allowed us to investigate whether the participants had a preference to interpret fully ambiguous sentences as SOV. Although there was no wrong answer to the ambiguous comprehension question, for the purpose of analysis we gave the value 1 (*correct*) to the SOV interpretation and the value 0 (*incorrect*) to OSV interpretation, even though both interpretations are allowed. We measured the reading time of every constituent of the sentences, the errors and the time required to perform the comprehension task.

Results

The overall ANOVA comparing the global reading times (RT) and the comprehension tasks following sentences (CT) revealed significant differences between conditions (RT: $F_1(4, 80) = 7.09$, $P(\text{HF}) < .001$; $F_2(4, 396) = 49.42$, $P(\text{HF}) < .001$ and CT: $F_1(4, 80) = 12.5$, $P(\text{HF}) < .001$; $F_2(4, 396) = 338.04$, $P(\text{HF}) < .001$). Further pair-wise comparisons revealed that SOV sentences were read significantly faster than OSV sentences (see Table 3 for details). No differences were observed when comparing the global reading times of ambiguous sentences with global reading times of plural canonical and non-canonical sentence types.

In addition to the global RT and CT analyses, the word-by-word comparison of SOV and OSV sentence word orders showed that objects were read faster than subjects at first and at second position in both singular and plural conditions (see Table 3; Fig. 1bc). Subsequent analyses showed significant interactions between DP1 and DP2, revealing that parsing the Subject after the Object increases reading time (singular arguments: $F_1(1, 20) = 18.549$, $P(\text{HF}) < .001$, $F_2(1, 99) = 8.37$, $P(\text{HF}) < .005$ plural arguments: $F_1(1, 20) = 14.595$, $P(\text{HF}) < .001$, $F_2(1, 99) = 5.24$, $P(\text{HF}) < .03$). Word-by-word differences remained significant until the last word of the sentence in the singular conditions and until the verb position in the plural conditions. As for the fully ambiguous sentences, they were systematically processed as SOV sentences; no interaction was observed between SOV and ambiguous conditions when comparing DP1 and DP2. On the other hand, when comparing DP1 and DP2 of ambiguous condition and DP1 and DP2 of unambiguous non-canonical OSV condition, the resulting interaction was significant ($F_1(1, 20) = 11.535$; $P(\text{HF}) < .004$, $F_2(1, 99) = 4.07$, $P(\text{HF}) < .05$), indicating that reading the subject after the object increased reading time in the unambiguous but not in the ambiguous condition.

Concerning error rates, non-native participants made more errors when answering the questions about OSV sentences than d answering questions about SOV sentences, both in the singular and the plural conditions (see Table 3 for details).

2.1. Interim discussion

Behavioral results reveal that non-native highly proficient speakers of Basque process SOV sentences faster and easier than OSV sentences. They also processed SOV/OSV ambiguous sentences as SOV. These results indicate that L1Spanish–L2Basque bilinguals display the same SOV-preference shown by native speakers in Erdocia *et al.* (2009). Though the experimental materials and design used in the present study were similar to those in Erdocia *et al.* (2009), we avoided direct comparison between both data sets because of certain differences between experimental designs: In the present experiment five

Table 3: Results of the Experiment 1 comparing SOV, OSV and ambiguous sentences.

		DP1	DP2	VERB	AUX	TOTAL	ERRORS
(A)	S_{SG}-O_{SG}-V	868 (±268)	976 (±246)	726 (±209)	656 (±198)	3126 (±815)	3.4 (±2.3)
	O_{SG}-S_{SG}-V	816 (±259)	1026 (±378)	816 (±238)	874 (±426)	3633 (±1081)	7.7 (±5.1)
	S_{PL}-O_{PL}-V	927 (±299)	992 (±365)	742 (±218)	757 (±285)	3419 (±989)	2.8 (±2)
	O_{PL}-S_{PL}-V	872 (±302)	1096 (±401)	738 (±270)	857 (±373)	3609 (±1215)	5.2 (±4.4)
	AMB	886 (±296)	973 (±341)	770 (±254)	965 (±441)	3595 (±1143)	4.5 (±2.2)
(B)	S_{SG}-O_{SG}-V vs. O_{SG}-S_{SG}-V	t=2.3.*	t=-3.5,**	t=-3.7, **	t=-3.7, ***	t=-4.4, ***	t=-5.3, ***
	S_{PL}-O_{PL}-V vs. O_{PL}-S_{PL}-V	t=2.14,*	t= -2.79, *	t=-1.45, NS	t=-2.53, *	t=-2.23, *	t=-3.42, **
BY	S_{PL}-O_{PL}-V vs. AMB	t=-1.44, NS	t=-0.58, NS	t=-0.86, NS	t=3.33, **	t=1.70, NS	t=3.83,**
SUBJECT	O_{PL}-S_{PL}-V vs. AMB	t=0.56, NS	t=-2.91, **	t=-0.50, NS	t=1,66, NS	t=-0.12, NS	t=0.67, NS
(C)	S_{SG}-O_{SG}-V vs. O_{SG}-S_{SG}-V	t=1.87, NS	t=-3.62,***	t=2.59, *	t=-5,79,***	t=-3.62, ***	t=-11,47, ***
	S_{PL}-O_{PL}-V vs. O_{PL}-S_{PL}-V	t=1.40, NS	t=-2.60, *	t=-1.42, NS	t=-2.81, **	t=-1.91, NS	t=-6,74, ***
BY	S_{PL}-O_{PL}-V vs. AMB	t=1.45, NS	t=0.57, NS	t=-1.02, NS	t=-4.30, ***	t=-1.25, NS	t=-3.26, **
ITEM	O_{PL}-S_{PL}-V vs. AMB	t=0.26, NS	t=2.83, **	t=0.33, NS	t=-1.71, NS	t=0.68, NS	t=2.80, **

We summarized the mean reaction times for every word of every sentence type, and the significances of the pairwise comparison (t-test). In the upper part of the table (A), the averages of reading times in milliseconds and the standard deviation in parenthesis are shown for the first Determiner Phrase (DP1), for the second DP (DP2), for the verb, for the auxiliary (AUX) and for the whole sentence (Total). Mean errors are out of 20 (sentences per condition). In the middle and lower part, the comparison between conditions is presented (B: by subject, C: by item).

S_{SG} = Singular subject; S_{PL} = Plural subject; O_{SG} = Singular object; O_{PL} = Plural object; V= Verb; AMB = Ambiguous condition; NS = No significiant; $p < .05 = *$, $p < .01 = **$, $p < .001 = ***$.

conditions were tested, while Erdocia *et al.* (2009) ran two separate experiments (two conditions in Experiment 1 and three conditions in Experiment 2). The behavioral results reveal similar preferences for native and highly proficient non-native speakers of Basque.

The finding that L1 and proficient L2 speakers have the same word order preferences does not necessarily imply that L1 and L2 processing recruit the same neural resources; as is well known in the ERP literature, electrophysiological measures of language processing often reveal affects that are not detectable by behavioral measures. Thus, in order to investigate L2 word order processing in more detail, we conducted an ERP experiment.

3. Experiment 2

On top of the behavioral experiment, an ERP experiment was carried out in order to measure the electrophysiological responses of non-native speakers of Basque while reading SOV and OSV sentences in Basque.

Participants

Twenty-three early proficient Spanish–Basque bilinguals who did not participate in Experiment 1 took part in this experiment. Data from one participant were excluded from analysis due to the excessive eye-movements; thus data of 22 participants were submitted to statistical analyses (15 female; mean age 21.4, SD ±4.2, AoA of L2 = 3 years, SD ±0.4). As in Experiment 1, all participants were undergraduate students at the University of the Basque Country (UPV/EHU) and were paid for their participation. They were highly proficient speakers of Basque and they had obtained the highest proficiency certificate in Basque (equivalent to C1 level in the Common European Framework) by the time of testing. All participants were right handed (Edinburgh Handedness Inventory; Oldfield, 1971) and they had normal or corrected to normal vision. Participants filled out the questionnaire
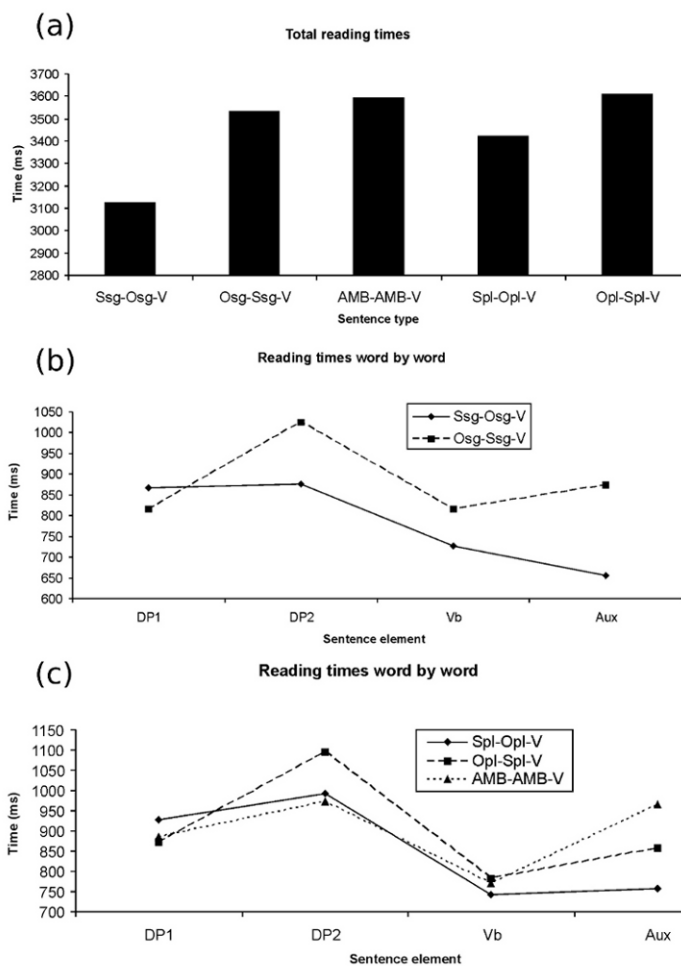
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Figure 1: Results of the Experiment 1. (a) The overall reading times of each sentence type are depicted. (b) The word by word reading time of S_{SG}-O_{SG}-V and O_{SG}-S_{SG}-V conditions are plotted. (c) Word by word reading time of S_{PL}-O_{PL}-V, O_{PL}-S_{PL}-V, and fully ambiguous sentences are shown

about their linguistic habits and their self-confidence in L1 and L2 (see Table 4 for details).

Methods and Materials

A total of 704 sentences were generated. 176 sentences were unambiguous and had the canonical SOV word order, 176 had the non-canonical OSV order, 176 sentences were temporally ambiguous with SOV order and 176 sentences were temporally ambiguous and had OSV word order. Four lists were generated so that every participant read 44 sentences

Table 4: *Language history and self assessed proficiency for participants in Experiment 2*

	L2 speakers of Basque (n = 22)	
Age	21.4 (4.2)	
AoA of Basque	3 (0.4)	
Sex (no. of males)	8	
Relative use of language		
Before primary school (0–3 years)	6.8 (0.6)	
Primary school (4–12 years)		
Home	6.6 (0.6)	
School	3.2 (1.9)	
Others	5.4 (1)	
Secondary school (12–18 years)		
Home	5.8 (1.6)	
School	3.2 (1.8)	
Others	4.9 (1)	
At time of testing		
Home	5.8 (1.5)	
University/work	3 (1.7)	
Others	4.7 (1)	
Self-rated proficiency	Basque	Spanish
Comprehension	1.04 (0.2)	1 (0)
Speaking	1.6 (0.5)	1.17 (0.4)
Reading	1.13 (0.3)	1.04 (0.2)
Writing	1.6 (0.5)	1.3 (0.4)

The following seven-point scale was applied for measuring the relative use of language: 1 = I speak only Basque, 2 = I speak mostly Basque, 3 = I speak Basque 75 % of the time, 4 = I speak Basque and Spanish with similar frequency, 5 = I speak Spanish 75 % of the time, 6 = I speak mostly Spanish, 7 = only Spanish. Proficiency level was determined by using the following four-point scale: 1 = native-like proficiency, 2 = full proficiency, 3 = working proficiency, 4 = limited proficiency. SDs values are in parentheses.

of each experimental condition. As in the previous experiment, we used the ambiguous *-ak* ending in Basque in order to construct fully ambiguous sequences that could be interpreted either as SOV or OSV. However, and unlike in Experiment 1, the sentences were disambiguated at verb position by world knowledge, so that 176 ambiguous sentences were disambiguated as SOV and 176 ambiguous sentences were disambiguated as OSV (see Table 5). In order to better visualize the ERP effects, we introduced a postpositional phrase (PP) between the two DP constituents in every sentence, which prevented possible ERP effects contamination across constituents and avoided list interpretations where constituents could be considered as coordinated elements. The PPs preceding the Objects in the SOV condition and preceding the Subjects in the OSV condition were the same, as in the sentence "Otsoek *mendian* ardiak jan dituzte" meaning '*In the mountain* the wolves have eaten sheep'. The lexical material of the sentences was controlled in length and frequency (Basque Frequency Dictionary). The difference of the mean length of the nouns used as S and O was not significant (S = 6.7 letters, O = 6.3 letters; $t = 1.8$). As for the frequency, no significant differences were observed when comparing the nouns used as subject and object (S = 61.5 per million, O = 69.3 per million, $t = $ -0.47).

Table 5: Sample of materials used in the Experiment 2.

	CANONICAL SOV	NON-CANONICAL OSV
EXPERIMENT 2		
Unambiguous	5a. Otso-ek ardi-ak jan dituzte Wolf-the(S) sheep-the(O) eat have(V) 'The wolves have eaten the sheep'	5b. Ardi-a otso-ak jan du Sheep-the(O) wolf-the(S) eat has(V) 'The wolf has eaten the sheep'
Temporally ambiguous	5c. Otso-ak ardi-ak jan ditu Wolf-the(S/O)sheep-the(S/O) eat has(V) 'The wolf has eaten the sheep' 'The women have seen the men'	5d. Ardi-ak otso-ak jan ditu Sheep-the(S/O) wolf-the(S/O) eat has(V) Men-the(O) women-the(S) seen have(V) 'The wolf has eaten the sheep'

ERP procedure

We registered ERPs (30–35 min each session) while participants read sentences word-by-word. Participants were told that the task was to carefully read the sentences presented and to correctly answer the comprehension questions concerning the sentences they had read. The words appeared automatically in the middle of the screen until the sentence finished (word duration $=250$ ms; inter stimulus interval $=250$ ms). In order to control the attention of the participants during the experiment, every eight sentence a sentence fragment was displayed in the middle of the screen. Participants' task was to decide whether or not the fragment had been presented in any of the preceding eight sentences. This fragment remained on the screen until participants pressed one of the response buttons.

The EEG signal was recorded using a BrainAmp amplifier and the Brain Vision recorder software (Brain Products GmbH, Munich, Germany). ERPs were recorded from the scalp using tin electrodes mounted in an electrocap (Electro-Cap International, Inc.) and located at 58 standard positions (Fp1/2, Fpz, F4A/5A, F5/6, F1/2, Fz, C5A/6A, C1A/2A, CZA, C5/6, C1/2, Cz, F3A/4A, F7/8, F3/4, C3A/4A, PZA, T3/4, C3/4, T3L/4L, C3P/4P, P5/6, P1/2, CB1/2B, P1P/2P, Pz, TCP1/2, C1P/2P, T5/6, P3/4, P3P/4P, PZP, O1/2, Oz). EEG data was referenced on-line to the right mastoid, and rereferenced off-line to the mean of the activity at the two mastoid electrodes. Vertical and horizontal eye movements were monitored with an electrode at the infraorbital and an electrode at the outer canthus of the right eye. Electrode impedances were kept below 5 kΩ. The electrophysiological signals were filtered offline with a bandpass of 0.01–50 Hz (half-amplitude cut-offs) and digitized at a rate of 250 Hz. The artifact rejection was done automatically by means of the maximum difference (100 μV) of values intervals (1,000 ms). In such cases 100 ms before and 300 ms after the event was rejected from the analysis. The μV range was established between -500 and 500 μV. If the amplitude was higher or lower than such range 100 ms before the event and 300 ms after the event was rejected. The baseline was corrected taking into consideration 200 ms previous of the stimulus onset.

ERP data analysis

Fifty-four electrodes were grouped in nine regions of interest (ROI), six electrodes per ROI: left anterior ROI (LANTE: F3, F3A, F5, F7, C3A, C5A), right anterior ROI (RANTE: F4, F4A, F6, F8, C4A, C6A), left medium ROI (LMD: T3, T3L, TCP1, C3, C3P, C5), right medium ROI (RMD: T4, T4L, TCP2, C4, C4P, C6), left posterior ROI (LPOST: T5, P3, P3P, P5, CB1, 01), right posterior ROI (RPOST: T6, P4, P4P, P6,

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CB2, 02), middle anterior ROI (MLANT: Fz, F1, F2, CZA, C1A, C2A), middle medium ROI (MLMD: Cz, C1, C2, C1P, C2P, PZA), and middle posterior ROI (MLPOS: Pz, P1, P2, PzP, P1P, P2P). Stimulus-locked ERPs were averaged for epochs of 1,200 ms starting 200 ms prior to the stimulus. Based on the predictions made considering the previous experiments in the literature (Rösler *et al.*, 1998; Matzke, Mai, Nager, Rüsseler & Münte, 2002; Bornkessel & Friederici, 2002; Hagiwara, Soshi, Ishihara & Imanaka, 2007; Erdocia *et al.*, 2009) (i) 300–500 ms and (ii) 600–800 time windows were chosen for the analyses, roughly corresponding to LAN/400 and P600 components previously reported in the literature. For statistical purposes, pairwise ANOVAs were conducted comparing (i) SOV and OSV sentences, and (ii) ambiguous SOV/OSV sentences. These pairwise ANOVAs were carried out at *Lateral* locations including sentence type (ST) (2 levels: SOV and OSV), hemisphere (H) (2 levels: left and right) and anterior/posterior (AP) (3 levels: anterior, medium and posterior) factors. The ANOVA for *Midline* locations included only sentence type and anterior/posterior factors. For all statistical effects involving two or more degrees of freedom in the numerator, the Huynh–Feldt epsilon was used to correct for possible violations of the sphericity assumption. The *P* value after the correction is reported as well.

Results

Results from the comprehension task showed that participants performed with high accuracy (mean percentage of incorrect responses, 17 % ±10.4), as expected given their high proficiency in Basque. As for the electrophysiological data, after the baseline correction epochs with artifacts were rejected, which resulted in the exclusion of approximately 26 % of the trials, equally distributed over all conditions ($F(3, 63) = 0.83$; $P(\text{HF}) > .48$).

Comparing SOV and OSV sentences. The direct comparison between SOV and OSV sentences at sentence initial position (Fig. 2) between 300 and 500 ms showed a ST × H × AP interaction ($F(2, 42) = 6.77$, $P(\text{HF}) < .004$). The following Manova analysis (by ST) revealed that the difference between SOV and OSV condition was significant over the left-frontal ($F(1, 21) = 4.44$, $P < .05$) but not over the other sites of the scalp (all *P* values > .1). The analysis carried out between 300 and 500 ms over midline electrodes revealed higher negativity for the OSV condition as compared to the SOV condition (ST: $F(1, 21) = 10.150$, $P(\text{HF}) < .004$. No statistically significant effects were found between 600 and 800 ms over lateral and midline ROIs. At sentence second DP position (Fig. 3), no significant effects were found within 300–500 ms time window. At 600–800 ms time window, a statistical trend was observed (ST × H × AP interaction: $F(2, 42) = 3.12$, $P(\text{HF}) = .054$). The subsequent analyses (by ST) revealed that the positivity elicited by the Subjects of OSV sentences in comparison to the Objects of SOV sentences was more pronounced over the right and frontal ($F(1, 21) = 3.38$; $P < .08$) than all other regions (all *P* values >.12). As for the ambiguous sentences, no significant ERP effects were observed at the first two DP positions. At disambiguation position (V), the repeated-measures ANOVA showed a significant interaction between sentences type and hemisphere (ST x H, $F(1,22) = 7.33$ $P(\text{HF}) < 0.01$) between 600 and 800 milliseconds (Fig. 4).

At verb position, no effect was observed in 300–500 ms and 600–800 ms time windows. Finally, at Auxiliary position no statistically significant effects were found in any of the analyzed time-windows.

Comparing SOV/OSV ambiguous sentences. The analyses carried out at DP1, DP2 and Verb position did not show any significant difference when comparing SOV and OSV
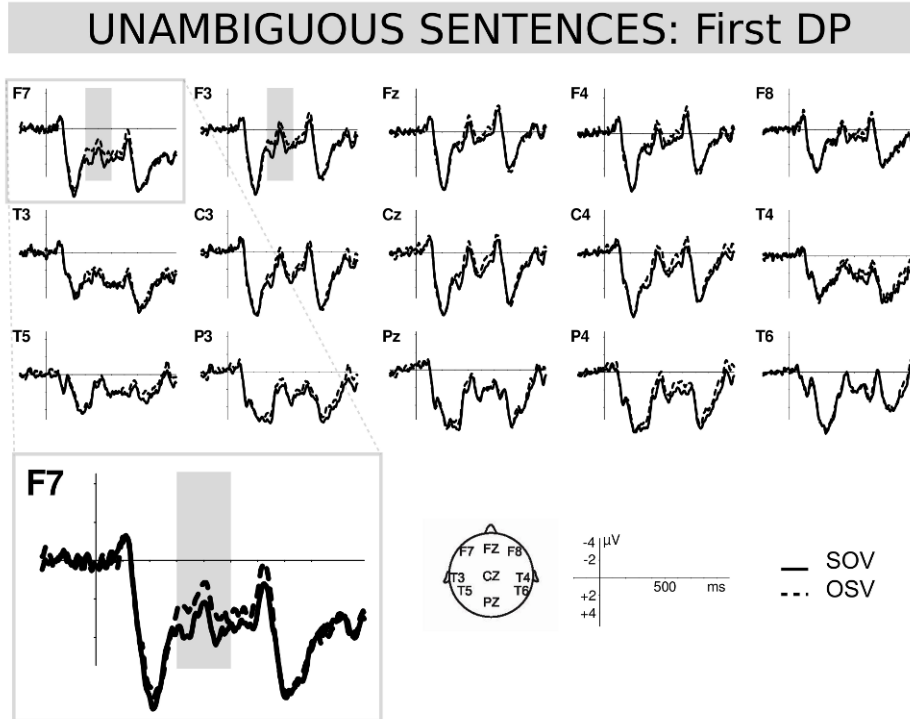
UNAMBIGUOUS SENTENCES: First DP

Figure 2: Unambiguous SOV (continued lines) and OSV (dashed lines) comparison at sentence initial position

sentences. The analyses of the 300–500 ms time window at the Auxiliary position revealed larger negativity in the OSV than SOV condition, distributed mostly over central and posterior sites of the scalp (see Fig. 4), which was confirmed by a ST $\times$ AP interaction (*lateral*: $F(2, 42) = 4.38$, $P(\text{HF})<.042$; *midline*: $F(2, 42) = 4.13$ $P(\text{HF})<.05$). However, subsequent Manova analyses (by ST) showed no significant effect.

Comparing all SOV sentences. In order to explore L2 processing of case morphology, we further compared ambiguous and non-ambiguous SOV sentences. This comparison also allowed us to test whether the ambiguous sentences were processed in the same way as unambiguous SOV sentences. Statistical results showed no differences at first DP position. At second DP position, however, frontal negativity (midline location, 300–500 ms, ST $\times$ AP, $F(2, 42) = 5.64$, $P(\text{HF})<.02$) was observed. Subsequent Manova analyses (by ST) confirmed that the effect was more prominent in the ambiguous than in the non-ambiguous SOV condition and larger over frontal than medium and posterior locations (frontal: $F(1, 21) = 5.44$; $P < .03$, medium: $F(1, 21) = .31$, $P > .58$; posterior: $F(1, 21) = .07$, $P > .78$). No statistically significant effects were observed at Vb and Aux positions in any of the time windows.

Comparing all OSV sentences. We also compared ambiguous and non-ambiguous OSV
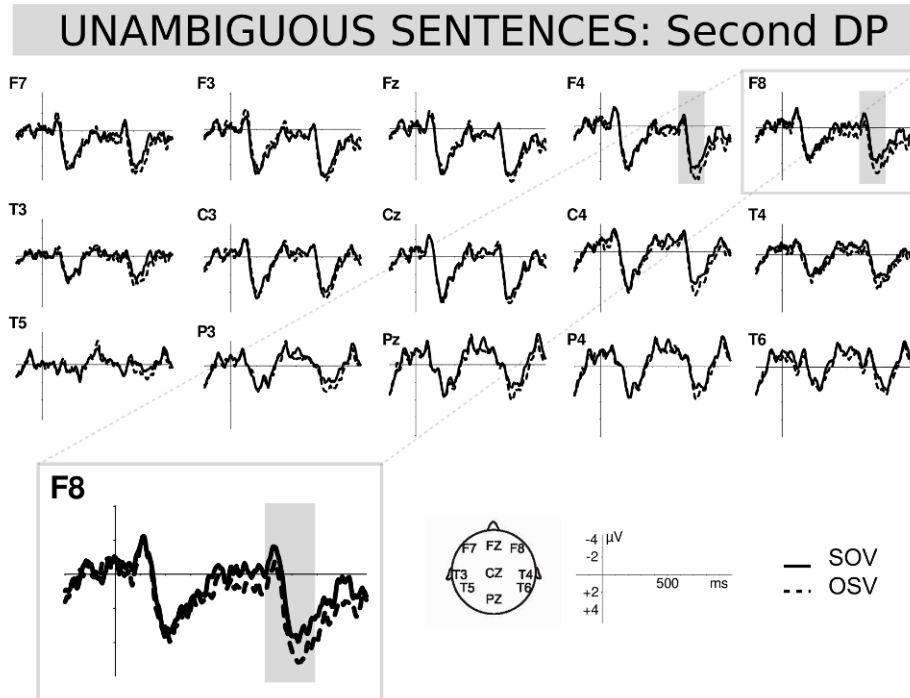
UNAMBIGUOUS SENTENCES: Second DP

Figure 3: Unambiguous SOV (continued lines) and OSV (dashed lines) comparison at second DP position

sentences. At sentence first position, unambiguous Objects (*ardi-a* 'sheep$_{OBJ-SG}$') revealed a frontal negativity between 300–500 ms (*lateral* locations, $F(2, 42) = 5.31$, $P(HF) < .025$) when compared to the ambiguous O (*ardi-ak* 'sheep$_{SUBJ-SG/OBJ-PL}$'). Further analyses showed that this negativity was more prominent over frontal ($F(1, 21) = 2.97$, $P = .09$) than medium ($F(1, 21) = 0.37$, $P > .5$) or posterior ($F(1, 21) = 0.06$, $P > .8$) regions of the scalp. In the 600–800 ms time window, DP1 comparison revealed a ST $\times$ H $\times$ AP interaction ($F(2, 42) = 4.39$; $P(HF) < .035$) which was not driven by ST factor as revealed the follow-up Manova analyses. At second DP, Vb and Aux positions no significant results were observed.

Native versus non-native comparison. In order to determine to what extent the ERP pattern elicited by the L2 speakers corresponded to that reported by Erdocia *et al.* (2009) for natives, we carried out an additional between-group analysis, in which both data sets were compared. With respect to the materials used in both studies, some differences were observed. First, the amount of sentences per condition read by each participant in our study was 44 whereas in Erdocia *et al.* (2009), participants read 60 sentences per condition. On the other hand, the length of the postpositional phrase introduced between the DP1 and DP2 was also different; therefore, the sentences of the present experiment were five word
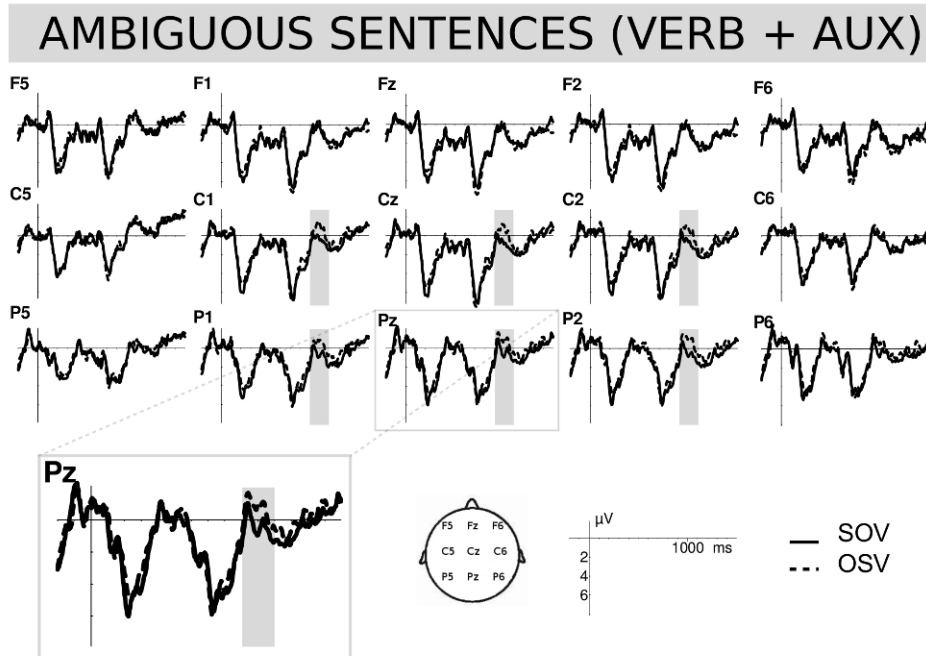
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Figure 4: Ambiguous SOV (continued lines) and OSV (dashed lines) comparison at verb + auxiliary position

long while in the experiment with natives, Erdocia *et al.* (2009) used seven word long sentences. All in all, both studies make use of the same experimental conditions which affords comparison, even if the outcome must be taken with caution. Regarding the first DP, no differences between groups were observed at any time window. At the second DP position statistical analyses revealed a significant ST $\times$ H $\times$ AP $\times$ GROUP interaction between the 600–800 ms ($F(2, 84) = 4.51$, $P(\text{HF}) = .014$). The step-down analyses of this interaction (by ST) revealed larger positivity for OSV than for SOV sentences over right-anterior sites in non-natives ($F(1, 42) = 4.94$, $P < .04$), but not in the native group ($F(1, 42) = 0.01$, $P = .98$). No further differences were found between groups at verb position.

The analysis of the SOV/OSV ambiguous sentences at the first DP position revealed a significant ST $\times$ H $\times$ AP $\times$ GROUP interaction ($F(2, 84) = 3.82$, $P(\text{HF}) < .04$) between 600 and 800 ms. However, further analyses by ST factor yielded no statistically significant results, indicating that this interaction was not driven by the ST factor. The comparison of the mean amplitudes at the second DP, the Verb and the Aux positions did not reveal any significant interactions involving GROUP factor.

Summary of the results. In sum, ERP results revealed that for highly proficient L2 speakers of Basque, OSV sentences were harder to process than SOV sentences, as revealed by early negativity (LAN) at first DP position, followed by frontal late positiv-

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ity at the second DP (P600). When processing SOV/OSV ambiguous sentences, central negativity (N400) was found at Aux position for the sentences disambiguated as OSV in comparison to those disambiguated as SOV. In order to explore the extent to which case morphology aids sentence processing, we run a double comparison: (a) on the one hand, we compared both ambiguous and unambiguous SOV sentences, and (b) on the other hand we compared ambiguous and unambiguous OSV sentences. The first comparison revealed a larger negativity for the ambiguous second DP, whereas the second one revealed a larger negativity for the unambiguous sentence initial O. In addition, the comparison between the native group studied by Erdocia et al. (2009) and the non-native participants from the current study showed similar ERP results at first DP, verb and auxiliary position. However, when processing unambiguous canonical SOV and non-canonical OSV sentences at second DP position, non-natives showed a P600 component not observed in natives. Finally, the comparison of the ambiguous sentences showed no differences between the native and non-native groups.

4. Discussion

We have presented the results of a set of behavioral and ERP experiments exploring the impact of L1 on L2 processing. In particular, we sought to determine whether L2 speakers of an OV language whose L1 is a VO language would display different word order preferences and processing patterns as compared to OV natives.

Given the results reported in a variety of studies on L2 processing at various levels of proficiency (i.e. Ojima *et al.*, 2005; Chen *et al.*, 2007) our working hypothesis was that L1/L2 differences would obtain in proficient early bilinguals when the tested materials involved core differences in the grammar of their L1 and L2. In this particular case, since the basic word order in the L1 (Spanish, VO) and in the L2 (Basque, OV) differs, and both grammars also differ regarding case morphology (present in Basque and absent in Spanish), we expected differences in the way sentence word order was processed by these L2 speakers as compared to natives.

The results of the Experiment 1 showed that L1Spanish–L2Basque bilinguals behaved like natives (see Erdocia et al. 2009) in preferring SOV sentences to OSV sentences, which showed longer RTs and more errors in comprehension. L2 speakers of Basque also behaved like natives when processing SOV/OSV ambiguous sentences, which they systematically parsed as SOV, ignoring the available OSV possibility. Besides, the interactions between word order and DP1/DP2 positions observed when comparing SOV and OSV indicated that reading *object-before-subject* sequences increased reading times. Similarly, when comparing the ambiguous sequences and the OSV sentences, the significant interaction between word order and DP1/DP2 positions further suggests that SOV/OSV ambiguous sentences are processed as SOV. Similar effects were observed for L1 speakers of Basque (Erdocia *et al.*, 2009). These similarities in word order processing preferences correlate with the high proficiency achieved by these L2 speakers, and it reveals there is no transfer from L1 to L2 in the pattern of word order preferences.

As for the ERP experiment, at first DP position a LAN component was found when comparing OSV and SOV sentences. This finding suggests that processing a syntactically displaced element (O in OSV) is costly (Felser, Clahsen & Münte, 2003; Matzke *et al.*, 2002; Rösler *et al.*, 1998). However, when comparing OSV/SOV ambiguous conditions, non-native speakers did not show any significant difference at sentence initial DP position.

Moreover, when comparing ambiguous sentence initial DPs (DPs ending in -*ak*) with unambiguous sentence initial Subjects (DPs ending in -*ek*), no significant effect was observed either, presumably because participants parsed all ambiguous sentence-initial DPs as Subjects, a result obtained also in other studies of sentence processing in Basque, such as Carreiras, Duñabeitia, Vergara, de la Cruz-Pavía & Laka (2010) and Yetano, Duñabeitia & Laka (2011). But when comparing OSV conditions, a larger frontal negativity was observed for the unambiguous DP1 (-*a*), than for the S/O ambiguous DP1 (-*ak*), suggesting a higher processing cost for the Object than for the Subject, and suggesting that non-natives processed ambiguous DPs (ending in -*ak*) as Subjects.

At second DP position, comparing SOV and OSV conditions, non-native speakers displayed a late frontal positivity, not observed in Erdocia *et al.* (2009). In the ERP literature, frontal positivities have been interpreted as a response to non-preferred or complex grammatical continuations(Hagoort *et al.*, 1999; Hagoort & Brown, 2000; Frisch & Schlesewsky, 2001). As suggested by Kaan & Swaab (2003), these frontal positivities may also reflect a revision of the preceding phrase structure, which in our case is the first DP of the sentence. As expected, the comparison between the SOV/OSV ambiguous conditions yielded no significant results at DP2 position. However, when comparing both ambiguous and unambiguous SOV conditions, a larger frontal negative effect was observed for the ambiguous condition. This result suggests that L2 speakers distinguished between unambiguous and ambiguous S–O sequences. Thus, apparently, syntactic processing of ambiguities is recognizable and it is not cost-free. This conclusion was also drawn by Frisch et al. (2002), who observed a P600 component in native speakers of German when comparing ambiguous and unambiguous sequence processing. The frontal negativity observed in our study might indicate the difficulty L2 speakers encounter at this point: processing an ambiguous constituent, which can be either the S or the O of the sentence, is harder than processing an unambiguous DP.

On the other hand, the comparison of the second DP in SOV and OSV conditions revealed a statistical difference between natives and non-natives. The frontal P600 observed in the non-native group, absent in natives, indicates that L2 speakers recruit different neural mechanisms when processing the Object in OSV sentences. These results converge with previous findings in the literature indicating that highly proficient L2 bilinguals are indistinguishable from natives when shared grammatical aspects are processed, as is the case with verb agreement in Basque and Spanish (Zawiszewski *et al.*, 2011) or in German and Italian (Rossi, Gugler & Hahne, 2006), where a N400-P600 pattern obtains in L1Basque–L2Spanish and L1Spanish– L2Basque groups and LAN-P600 effects are found in L1German–L2Italian and L1Italian– L2German bilinguals. However, when the L1 grammar significantly diverges from the L2 grammar, as for instance when English verb agreement is processed by Chinese natives (Chen *et al.*, 2007), or when SOV word order is processed by L1Spanish–L2Basque bilinguals, then different brain responses obtain even at high levels of proficiency and an early AoA. In the present study, the canonical order of our non-native speakers' L1 was SVO (Spanish, head-initial), while the canonical word order of their L2 was SOV (Basque, head-final). The frontal P600 elicited by non-natives at DP2 position of OSV, in comparison with the negativity reported for natives at the same position reveals a difference in processing strategies between the native and non-native group.

At sentence final position (verb and auxiliary) of unambiguous conditions, a significant trend was observed between 700 and 900 ms in L2Basque speakers (ST $\times$ H: $F(1, 21) =$

3.59, $P(\text{HF}) < .072$). The comparison between non-natives and natives was not significant, suggesting that for non-natives as well as for the natives (Erdocia *et al.*, 2009; Felser *et al.*, 2003; Fiebach *et al.*, 2002, among others) the processing cost increases equally at verb position in order to recover the required syntactic information of non-canonical conditions.

In fully ambiguous contexts (examples 2c and 2d), and unlike natives (Erdocia *et al.*, 2009) the non-natives did not show any ERP component related to processing difficulty at the disambiguation point. However, they elicited a negative component later at auxiliary position. The latency and distribution of the negativity suggests an N400, which could reflect reanalysis processes taking place when word order information is disambiguated by means of world knowledge (see also Hagoort *et al.*, 2004).

In sum, our results suggest that basic and systematic dimensions of linguistic variation, such as the VO/OV divide, can lead to differences in language processing for L2 versus L1 speakers, even for those L2 speakers who acquire their second language early and master it to a high proficiency degree. Similarly to the results obtained by Ojima *et al.* (2005), and Chen *et al.* (2007), our findings indicate that proficient L2 speakers do not always employ the same strategies for sentence comprehension as natives when processing aspects of grammar that differ from those in their native language.

The present ERP results converge with this general picture. The contrast obtained can hardly be attributed to lack of proficiency in L2, because the non-native participants were highly proficient bilinguals, whose behavioral performance displayed the same general processing preferences as that reported for natives. Nevertheless, electrophysiological measures revealed differences related to the underlying syntactic processing. These differences are most likely due to the parametric differences between the two languages (VO/OV). Finally, our results make it clear that investigating different bilingual populations and expanding this line of research to other multilingual populations or to languages with different orthographic, morphological, grammatical or phonological characteristics can provide new evidence on how the second languages are processed in and what the possible differences come from.

5. Conclusion

Our data lend support to the hypothesis that core typological differences such as the VO/OV type can be a relevant factor behind L1/ L2 differences in syntactic computation by early and proficient bilinguals, as revealed by a distinct processing signature elicited by L2 speakers, different from that of natives. Whether this distinct signature is due to an effect of transfer of processing strategies from the native language onto the non-native one, or whether it is due to a difficulty to acquire the divergent grammatical features of the second language by the bilingual, and the extent to which these two possibilities are mutually exclusive or necessarily concurrent cannot be determined given the available evidence, and future work is required to further unravel the ultimate nature of this grammatical difference effect.

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