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Where the Eye Takes You: The Processing of Gender in Codeswitching

Donde nos lleva el ojo: el procesamiento del género en alternancia de códigos

RAQUEL FERNÁNDEZ FUERTES
TAMARA GÓMEZ CARRERO
ALEJANDRO MARTÍNEZ
(UNIVERSIDAD DE VALLADOLID)

Codeswitching is a powerful phenomenon to explore how the properties of the two language systems interact in the bilingual mind. This study focuses on codeswitching as a language contact situation by analyzing eye-tracking data recorded from a group of L1 Spanish – L2 English bilinguals. More specifically, and given that Spanish-English bilingual communities have been shown to exhibit an overwhelming tendency to produce determiner-noun switches (*la window / the ventana*), we formally explore the directionality of the switch and the type of implicit gender agreement mechanism in the case of Spanish determiner switches (*la/el window // el/la book*). Our results show that Spanish determiner switches as well as gender non-congruent Spanish determiner switches take significantly longer to process. We interpret these results in the light of formal proposals on gender representation and of previous empirical studies and argue that the strength of grammatical gender in the participants' L1 determines the switching processing costs.

Keywords: *English-Spanish codeswitching; grammatical gender; gender agreement; eye-tracking during reading*

La alternancia de códigos posee gran potencial para explorar cómo interactúan dos sistemas lingüísticos en la mente del bilingüe. Exploramos esta situación de lenguas en contacto a través de datos de seguimiento ocular de bilingües de español L1 e inglés L2. Dado que las comunidades bilingües inglés-español muestran una clara tendencia a producir alternancia entre determinante y nombre (*la window / the ventana*), desde un punto de vista formal analizamos la direccionalidad de la alternancia y el tipo de mecanismo de concordancia de género implícita que se produce en el caso del determinante español (*la/el window // el/la book*). Los resultados muestran que se tardan más en procesar tanto la alternancia con determinante español como la del determinante español sin género analógico. Interpretamos estos resultados a la luz de propuestas formales de representación del género y argumentamos que la gramaticalidad del género en la L1 de los participantes determina los costes de procesamiento en este tipo de alternancia.

Palabras clave: *alternancia de códigos inglés-español; género gramatical; concordancia de género; seguimiento ocular durante la lectura*

1. INTRODUCTION

Codeswitching has been used as a window to explore how the properties of the two language systems interact in the mind of the bilingual (e.g. Jorschick, Quick, Glässer,

Lieven & Tomasello, 2011; Arnaus, Eichler, Jansen, Patuto & Müller, 2012; Liceras, Fernández Fuertes & Klassen, 2016; Fairchild & van Hell, 2017; Valdés Kroff, Dussias, Gerfen, Perrotti & Bajo, 2017; Burkholder, 2018).

In this study we focus on codeswitching as a language contact situation, by analyzing experimental data elicited via the eye-tracking methodology from a group of adult bilinguals with Spanish as a first language (L1) and English as a second language (L2). More specifically, we focus on codeswitching between a determiner and a noun (1), given that Spanish-English bilingual communities have been shown to exhibit an overwhelming tendency to produce codeswitching at this grammatical point as the most common type of intra-sentential codeswitching (e.g. Pfaff, 1979; Poplack, 1980; Liceras, Fernández Fuertes, Perales, Pérez-Tattam & Spradlin, 2008; Herring, Deuchar, Parafita Couto & Moro Quintanilla, 2010; Valenzuela, Faure, Ramírez Trujillo, Barski, Pangtay & Diez, 2012; Valdés Kroff, 2016; Fernández Fuertes & Liceras, 2018; Johns, Valdés Kroff & Dussias, 2018). We formally explore the directionality of the switch, as in (2), and the type of implicit gender agreement mechanism in the case of Spanish determiner – English noun codeswitching, as in (3) and (4).

(1)	El hombre ha apagado		*el fire* very quickly
(2)	a.	la window	(Spanish determiner – English noun)
	b.	the ventana	(English determiner – Spanish noun)
(3)	a.	la_{F} $window_{F\ in\ SP}$	(gender congruent)
	b.	el_{M} $window_{F\ in\ SP}$	(gender non-congruent; default masculine)
(4)	a.	el_{M} $book_{M\ in\ SP}$	(gender congruent)
	b.	la_{F} $book_{M\ in\ SP}$	(gender non-congruent)
			[F=feminine; M=masculine; SP=Spanish]

In particular, when codeswitching happens within a Determiner Phrase (DP), the directionality of the switch can yield two possible options: Spanish determiner + English noun switches, as in (2a), or English determiner + Spanish noun switches, as in (2b). In the case of Spanish determiner DP switches, the implementation of a gender agreement mechanism between the Spanish determiner and the Spanish translation equivalent of the English noun can result into, at least, three possible structures. Following Otheguy and Lapidus (2003, 2005), the analogical criterion involves the instantiation of an implicit gender agreement mechanism by means of which switches like those in (3a) and (4a) are gender congruent because the Spanish determiner agrees in gender with the Spanish translation equivalent of the English noun (feminine in (3a) and masculine in (4a)). If the analogical criterion is not enforced, then a gender non-congruent switch appears and, for instance, a Spanish masculine determiner combines with an English noun whose translation equivalent in Spanish is feminine (as in (3b)); or a Spanish feminine determiner combines with an English noun whose translation equivalent in Spanish is masculine (as in (4b)). A third option would be the use of masculine as default (Roca, 1989) which, in the case of English-Spanish DP switches, involves the combination of a Spanish masculine default determiner with an English noun (as in 3b). In order to address these two issues (i.e. directionality and gender agreement mechanisms) in the case of English-Spanish switched DPs, we have gathered experimental data from a group of L1 Spanish L2 English adult bilinguals. We have used the eye-tracking methodology which will allow us to discuss how speakers process Spanish gender in an online reading task.

This article is organized as follows. In section 2, we provide an account on formal and empirical proposals on codeswitching. Taking previous research as a point of departure, in section 3 we set the research questions that will guide our analyses. In

section 4, we describe the participants as well as the methodology and stimuli we have used. In section 5, we present the data, the analyses and the results obtained. Finally, in section 6, we discuss and interpret where the eye has taken us and we comment on future research.

2. FORMAL AND EMPIRICAL ACCOUNTS ON CODESWITCHING

The same principles that constrain individual grammars have been said to also constrain codeswitching. This has been argued for both within pre-minimalist premises as well as within the minimalist program and distributed morphology constructs (e.g. pre-minimalist premises: Sankoff & Poplack, 1981; Woolford, 1983; DiSciullo, Muysken & Singh, 1986; Myers-Scotton, 1993, 1997; Belazi, Rubin & Toribio, 1994; among many others; e.g. minimalist and distributed morphology premises: MacSwan, 1999, 2000, 2009; Liceras et al., 2008; González-Vilbazo & López, 2011; Lohndal, 2013; Alexiadou, Lohndal, Åfarli & Grimstad, 2015; Lillo-Martin, Müller & Chen Pichler, 2016).

In the analysis of gender in codeswitched determiner-noun structures, different formal linguistics proposals have been put forward and tested against empirical data in order to explain the way bilingual grammars interact. Two of these proposals are of special relevance for the present study: the Grammatical Features Spell-Out Hypothesis and the Gender Double-Feature Valuation Mechanism.

Liceras, Spradlin and Fernández Fuertes (2005) and Liceras et al. (2008) proposed the Grammatical Features Spell-out Hypothesis in order to capture the preference for Spanish determiner switches in the spontaneous production of simultaneous bilingual children and adults. The Grammatical Features Spell-out Hypothesis reflects how features are represented in the mind of bilinguals and, more specifically, how the strength that gender features have in Spanish, as opposed to their absence in English, is in fact what shapes these simultaneous bilinguals' preferences when producing switched DPs. While this hypothesis seems to be guiding the spontaneous production of simultaneous bilingual children and adults (e.g. Liceras et al., 2005, 2008; Jorschick et al., 2011), the analyses on experimental judgment data show the speakers' preference for English determiner switches (e.g. Liceras et al., 2016; Fernández Fuertes & Liceras, 2018; Gómez Carrero, Fernández Fuertes & Martínez, 2018).

In the case of on-line experimental data, Litcofsky and van Hell (2017) show that, although L1 Spanish – L2 English bilingual adults exhibit switching costs in both code-switching directions in a self-paced reading task, rates were higher when switching from English into Spanish ((2b) versus (2a)). Opposing results are shown in a picture-naming task where L1 English – heritage Spanish bilingual adults were slower when confronted with a Spanish determiner switch ((2a) versus (2b)) (Fairchild & van Hell, 2017).

Processing constraints may be at stake here since spontaneous production and experimental (judgment or eye-tracking) data are different in nature and could trigger different mechanisms that make the bilingual speaker resort to other strategies. One such strategy is what Liceras et al. (2008) referred to as the Gender Double-Feature Valuation Mechanism when discussing the gender preferences in the judgment of switched DPs. This strategy formally captures how the two gender features in DPs (i.e. the inherent gender feature in the noun and the gender agreement feature in the determiner) are valued and how this valuation is deeply rooted in the mind of (monolingual and bilingual) L1 Spanish speakers. The fact that this valuation process takes place in Spanish DPs makes these speakers enforce the same strategy in the case of Spanish determiner – English noun switches which involves the preference for gender congruent (i.e. (3a) and (4a)) versus non-congruent switches (i.e. (3b) and (4b)). In fact, while English-Spanish

bilinguals prefer English determiner switches as opposed to Spanish determiner switches (against the Grammatical Features Spell-out Hypothesis), gender congruent Spanish determiner switches are found to be favored over English determiner switches in the case of off-line experimental data (e.g. Liceras et al., 2008; Valenzuela et al., 2012). Spanish masculine default determiner switches are also favored especially by Spanish non-native speakers.

When it comes to on-line experimental data, L1 English – heritage Spanish bilingual adults have been shown to use the gender of the Spanish determiner as a cue for the anticipation of the upcoming noun in a visual world paradigm task (Valdés-Kroff et al., 2017). In particular, it seems that there is an asymmetric gender effect in processing in that only the feminine determiner is exploited as a cue to identify an upcoming noun. These studies seem to point to two crucial facts in the case of determiner – noun switches. First, the elicitation technique may be making speakers resort to different strategies when implementing (or cancelling the implementation of) gender agreement mechanisms. This may account for the difference between naturalistic and experimental data. Second, the status gender features have in the mind of the different profiles of bilingual speakers may be behind their own preferences. This may explain the difference between L1 Spanish bilinguals and L2 Spanish bilinguals.

In order to shed light into this debate and to address both directionality and gender agreement mechanisms, we have collected processing data while a group of L1 Spanish – L2 English adult bilinguals read codeswitched structures. In particular, this study seeks to offer a double contribution to the studies on languages in contact, in general, and those on codeswitching, in particular: on the one hand, it sheds further light on the formal accounts on codeswitching that place the focus on the formal features of the languages involved in the switch and that attribute the bilingual speakers' preferences to the strength these features have in the bilingual mind; and, on the other hand, it contributes new online data (eye-tracking during reading) which complement data elicited via the eye-tracking methodology using a different task.

3. RESEARCH QUESTIONS

The specific research questions we set to address are the following two:

1) Which directionality in codeswitched DPs would be easier to process for these bilinguals? As per the Grammatical Features Spell-out Hypothesis, Spanish determiner switches (5a) should be processed faster than English determiner switches (5b). This would also be in line with previous online experimental studies (Litcofsky & van Hell, 2017). However, if we take into account the type of data being elicited, English determiner switches should be in fact processed faster in that no gender agreement valuation mechanism has to be implemented, as English determiners do not trigger such agreement process.

   (5) a. el book
   b. the libro

2) Which gender agreement mechanism would be easier to process for these bilinguals? Given the status of Spanish as the L1 of these bilinguals, switches abiding by the analogical criterion (6a) may be processed faster as it involves applying to switched DPs the same type of grammatical mechanism that would

apply in the case of Spanish DPs. This involves higher processing costs when participants encounter a switched DP in which the analogical criterion is violated (6b). A more economical option in terms of processing would be to use the masculine as a default option (6c) where the gender valuation mechanism is underspecified.

(6) a. el book [+AC]
b. la book [-AC]
c. el window masculine default

[AC=analogical criterion]

4. METHODOLOGY

4.1 *Participants*

A group of 19 L1 Spanish – L2 English bilingual adults from Spain have participated in this experiment (14 female, 5 male) with a mean age of 27.74 (mode=25; ranging from 18 to 50 years old; SD=9.03). Their proficiency level in English has been measured using a pen and paper version of the Quick Oxford Placement Test (UCLES, 2001) and their levels ranged between B2 and C1 as per the Common European Framework of Reference for Languages. These bilinguals have been born and brought up in Spain in a social context in which codeswitching is not a common practice. However, potentially all bilinguals (and not only bilinguals who use codeswitching on a daily basis, that is, codeswitchers) can codeswitch and have intuitions about switched structures (see Fernández Fuertes & Liceras, 2018). In fact, what is being investigated is the internal knowledge these speakers have of their two grammars and how these grammars interact.

4.2 *The eye-tracking during reading task: stimuli and procedure*

Stimuli consist of 156 items of which 48 are experimental items, 54 are distractors and 54 are fillers. For the target experimental items, there are six conditions, as in (7), which result in six different lists so that each participant only sees one condition per experimental item. An example of an experimental is shown in Table 1:

(7)

condition	*AC*	*example*
MM	[+AC]	el book
MF	[-AC]	el window
FF	[+AC]	la window
FM	[-AC]	la book
DM		the libro
DF		the ventana

[M=masculine; F=feminine; D=English determiner; AC=analogical criterion]

Table 1: ***Sample item: book$_M$ - window$_F$***

Condition	***AC***	***Target DP***	***Pre-target***	***Target***	***Post-target***
MM	[+AC]	el book	El niño está leyendo	el book	for the first time
MF	[-AC]	el window	El señor está arreglando	el window	with a hammer
FF	[+AC]	la window	El señor está	la window	with a

			arreglando		hammer
FM	[-AC]	la book	El niño está leyendo	la book	for the first time
DM	--	the libro	The boy is reading	the libro	por primera vez
DF	--	the ventana	The man is fixing	the ventana	con un martillo

Each item contains four target nouns, two in English (*book* and *window*, as in Table 1 above) and two in Spanish (*libro* 'book' and *ventana* 'window', as in Table 1). In the case of the English nouns, two appear in DPs where the analogical criterion is enforced (e.g. *el book* because *el* is masculine and *book* is masculine in Spanish, i.e. *libro*); and the other two in DPs where the analogical criterion is not met (e.g. *la book*). In the case of the Spanish nouns, one is masculine (e.g. *libro* 'book') and one is feminine (e.g. *ventana* 'window'). This yields six experimental sentences per item.

Each experimental sentence is constructed as follows: four pre-target words, two target words and two to four post-target words. The target DP is in direct object position and the post-target is an adjunct. The target nouns are [-animate], [+concrete] nouns and they involve no cognates, no body parts and no words beginning with a vowel in either language or with an l- in English. The target nouns were selected using the EsPal database (Duchon, Perea, Sebastián-Gallés, Martí & Carreiras, 2013) and the SUBTLEX-ESP database (Cuetos, González-Nosti, Barbón & Brysbaert. 2011) for Spanish and the SUBTLEXus database (Brysbaert & New, 2009) for English. Frequency analyses for the nouns used in each DP have been performed. An independent, two-tailed t-test for frequency between masculine and feminine Spanish nouns has shown no significant results ($t(94) = 0.959$, $p = .345$). The same analysis has been performed for the English words with masculine Spanish translation equivalents and feminine Spanish translation equivalents which has rendered no significant results ($t(94) = -1.144$, $p = .256$).

In order to avoid participants' perception of what the real task was about, both distractors and fillers are used. Distractors consist of sentences involving a switch between a DP subject and the verb. They are eight to ten word long (similar to the length of experimental sentences) and target nouns are never part of the distractor sentences. Half of the sentences (n=27) start in English and the other half in Spanish, as shown in (8):

(8) a. *El mono* has a banana in its hands
'The monkey has a banana in its hands'
b. *The kids* llegan a la escuela en bicicleta
'The kids get to school by bike'

Fillers are monolingual sentences containing a noun-noun compound. Half of the sentences (n=27) are in Spanish and the other half in English, as in (9). As with the distractors, filler sentences are eight to ten word long (similar to the length of experimental sentences) and target nouns are never part of the filler sentences. The compound appears in initial, mid or final position and this is balanced across the task.

(9) a. En este árbol los niños encontraron a la *abeja reina*
'In this tree the children found the queen bee'
b. The boys saw a *pirate flag* next to their neighborhood

In order to keep participants' attention on the task, yes-no comprehension questions follow half of the fillers (n=27) and half of the distractors (n=27) but never the

experimental items. The language of the questions matches the language in which the sentence ends: if the sentence ends in English, the comprehension question is in English, as in (10a) and (10c); if in Spanish, the question is in Spanish, as in (10b).

(10) a. Distractor:
El mono has a banana in its hands
Comprehension question: Does the monkey have a banana in its legs?
Expected answer: NO

b. Distractor:
The kids llegan a la escuela en bicicleta
Comprehension question: ¿Llegan los niños a la escuela en bicicleta?
'Do kids get to school by bike?'
Expected answer: YES

c. Filler:
The boys saw a pirate flag next to their neighborhood
Comprehension question: Did the boys see a Viking flag?
Expected answer: NO

Participants have been asked to perform a sentence comprehension task. They have been tested individually in a quiet room using an EyeLink Portable Duo that sampled eye movements at 1000 Hz (with the head free-to-move) using the corneal reflection of the participant's right eye. Button presses have been recorded using a gamepad response device. Ethical approval from the University of Valladolid was obtained [protocol approval ref. PI 19-1461]. Before the task and after a 9-point calibration (average error below 0.5°), participants have done a practice session to ensure that they have understood the task. The practice session involves sentences with codeswitching at other grammatical points different from that of the target. In the practice session, each participant has read a total of nine sentences, three of which are followed by a yes-no comprehension question. These questions follow the same language pattern as the comprehension questions in the main task; that is, sentences ending in English are followed by a question in English, and those ending in Spanish are followed by a question in Spanish.

5. EYE-TRACKING DATA ANALYSES: MEASURES AND RESULTS

Three eye-tracking measures have been extracted for the analyses we present below: a) total fixation duration; b) gaze duration; and c) regression path duration. Total fixation duration consists on the sum of all fixations in a region, including both forward and regressive movements; gaze duration is defined as the sum of all fixations in a region, from first entering the region until leaving that region; and regression path duration is the sum of all fixations in a target region from first entering the region until moving to the right of the region, including the fixations made during any regression to earlier parts of the sentence before moving past the right boundary of the region (Clifton, Staud & Rayner, 2007). The three measures have been calculated for two interest regions: the first target region involves the determiner and four characters preceding the determiner; and the second target region involves the target noun. The first target region has been so established because the target element in this case (i.e. the determiner) is a very short

category in length and it is a functional category. This has a crucial consequence for us: the processing of the determiner category as such is mostly lost, as some participants did not even fix on the determiner (46% of exclusion). In order to reduce the rate of exclusion, we have included the four previous characters to the determiner as part of this target region because of the potential parafoveal looks participants could make. By doing so, we have only lost 19% of the data. The significant results obtained per eye-tracking measure and target region are discussed in detail below. Analyses of pre-target and post-target regions have also been performed and the results confirm those in the two interest regions. We address below these results, first focusing on directionality and then on the gender agreement mechanisms. All the statistical tests were interpreted on a significance level of 0.05.

In the case of the directionality of the switch (e.g. Spanish determiner + English noun, as in (5a) above, and English determiner + Spanish noun, as in (5b)), results appear in Figure 1 to Figure 3 and in Examples (11) below:

(11) a. The boy is reading *the libro* por primera vez
'The boy is reading the book for the first time'
b. El niño está leyendo *el book* for the first time
'The boy is reading the book for the first time'

When total fixation duration is considered, Figure 1 shows that, when focusing on the determiner, English determiners are significantly longer fixated (M= 194 ms; SD=22.21) than Spanish determiners (M= 181ms; SD=29.14), and this is significantly so (t(18)=2.085, p=.052). That is, English determiner switches seem to be harder to process when compared to Spanish determiner switches. In the case of the noun, English nouns are fixated longer (M= 330ms; SD=85.40) than Spanish nouns (M= 359ms; SD=107.23) but this difference is non-significant (t(18)=-1.887, p=.075).

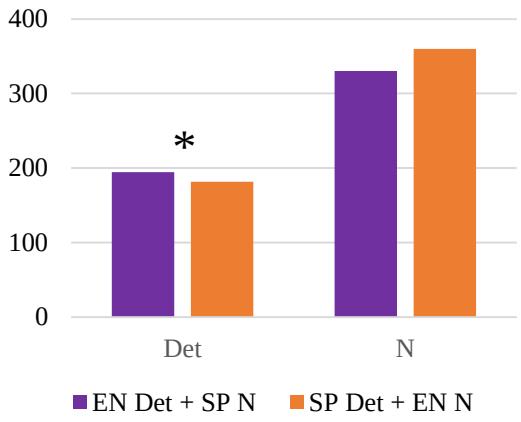

Figure 1: ***Directionality and total fixation duration. Determiner and noun interest regions***

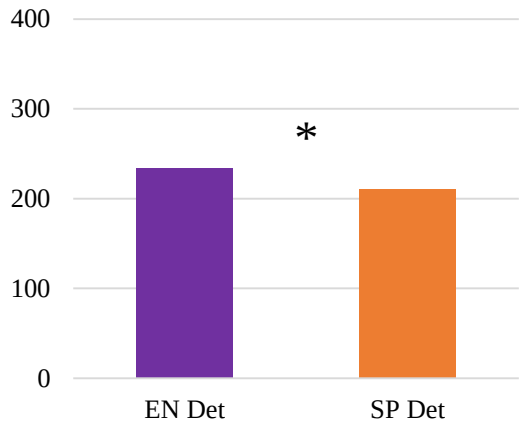

Figure 2: ***Directionality and gaze duration. Determiner interest region***

When gaze duration (also referred to as first pass reading time) is considered in the case of the determiner interest area (Figure 2), the same results appear: English determiners are longer fixated (M= 234 ms; SD=50.98) than Spanish determiners (M=

210 ms; SD=61.49) before any regressive or progressive fixation and this is statistically significant (t(18)=3.064 p=.007).

For the noun interest area in the case of regression path duration (i.e. go past time) (Figure 3), results further point to English nouns being significantly longer fixated (t(18)=3.714, p=.002; English noun: M= 298 ms; SD=64.16; Spanish noun: M= 339 ms; SD=99.78).

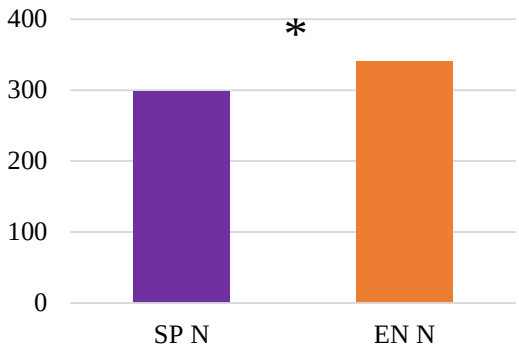

Figure 3: ***Directionality and regression path duration. Noun interest region***

These data point to clear directionality effects in that English determiner switches, as in (11a), are harder to process when compared to Spanish determiner switches, as in (11b), for these speakers.

The analyses corresponding to gender agreement mechanisms, and, in particular to the analogical criterion (i.e. [+AC], as in (6a) above, versus [-AC], as in (6b)), appear in Figure 4 to Figure 6 and Examples (12):

(12) a. El niño está leyendo *el book* for the first time
'The boy is reading the-masculine book for the first time'
b. El niño está leyendo *la book* for the first time
'The boy is reading the-feminine book for the first time'

As in Figure 4, English nouns are significantly longer fixated when there is no gender congruency between the Spanish determiner and the translation equivalent of the English noun (i.e. [-AC] DPs; M= 388ms; SD=124.65) when compared to gender-congruent switches (i.e. [+AC] DPs; M= 331 ms; SD=96.06). ANOVAs reveal this difference to be significant (F(1,18)=15.928, p=.001). The same result appears in the case of regression path duration (Figure 5) for the noun interest region (F(1,18)=4.485, p=.048; [+AC] English noun: M= 324 ms; SD=95.98; [-AC] English noun: M= 355ms; SD=113.30). No significant differences appear in the case of the determiner.

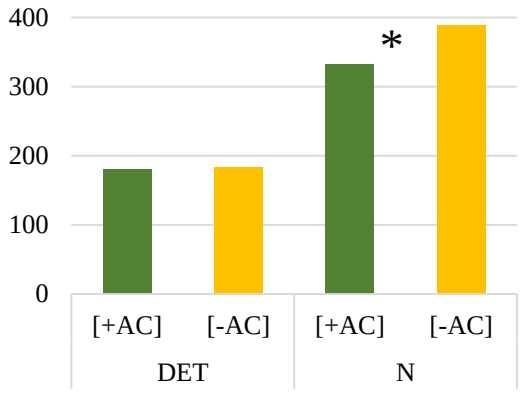

Figure 4: ***AC and total fixation duration. Determiner and noun interest regions***

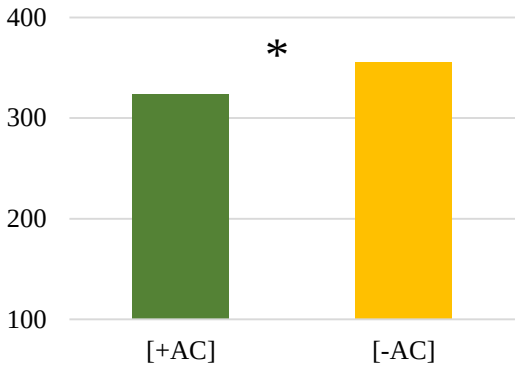

Figure 5: ***AC and regression path duration. Noun interest region***

However, when focusing on the determiner, gaze duration measures (Figure 6) show that the difference between [+AC] DPs (English determiner: M= 214 ms; SD=60.87) and [-AC] DPs (English determiner: M= 205ms; SD=77.80) is non-significant (F(1,18)=0,302, p=.589).

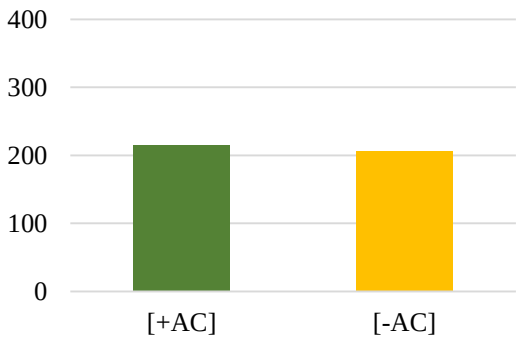

Figure 6: ***AC and gaze duration. Determiner interest region***

These data point to an effect of the analogical criterion in that these speakers take longer to process Spanish determiner switches that are not gender congruent, as in (12b), when compared to Spanish determiner switches in which gender agreement is enforced between the Spanish determiner and the translation equivalent of the English noun, as in (12a).

When considering masculine as a default option in comparison to gender congruent switches (i.e. [+AC]), the results we obtained are represented in Figure 7 to Figure 9 and illustrated in Examples (13):

(13) a. El señor está arreglando *la window* with a hammer
'The man is fixing the-feminine window with a hammer'
b. El señor está arreglando *el window* with a hammer
'The man is fixing the-masculine default window with a hammer'

As in Figure 7, English nouns are significantly longer fixated when the preceding Spanish determiner is masculine and the Spanish translation equivalent is feminine (i.e. masculine as default option) (t(18)=2.554; p=.020; [+AC] English noun: M= 331 ms;

SD=97.07; [-AC] feminine English noun: M= 391 ms; SD=129.40). No significant differences appear in the case of the determiner.

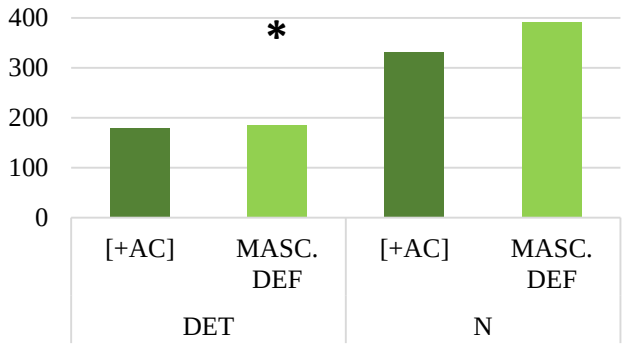

Figure 7: ***Default masculine and total fixation duration. Determiner and noun interest regions***

The analysis of gaze duration in the determiner interest region (Figure 8) and of regression path duration in the noun interest region (Figure 9) shows no significant differences. That is, in the case of the determiner (Figure 8), Spanish matching determiners (M= 214 ms; SD=60.87) compared to Spanish default masculine determiners (M= 211ms; SD=77.74) show similar results (t(18)=0,314, p=.833). As in Figure 9 for the noun interest region, [+AC] English nouns (M= 324 ms; SD=95.98) compared to feminine English nouns with Spanish default masculine determiner (M= 347ms; SD=101.59) show similar results, too (t(18)=-1,115, p=.289).

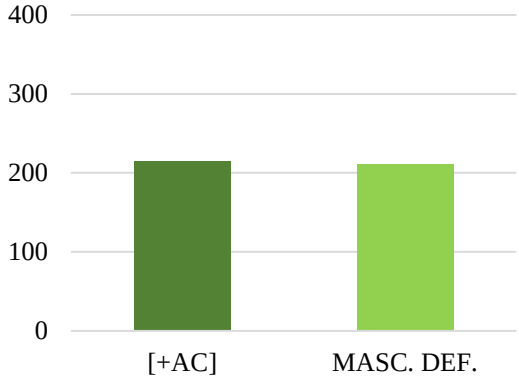

Figure 8: ***Default masculine and gaze duration. Determiner interest region***

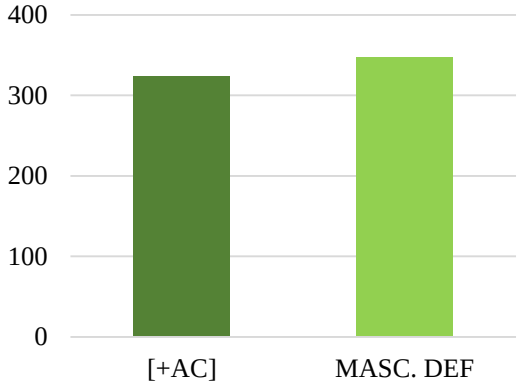

Figure 9: ***Default masculine and regression path duration. Noun interest region***

These data point to a lack of effect of the masculine as a default option in the processing data of these speakers in that masculine default switches, as in (13b), take longer to process than Spanish determiner switches that are gender congruent, as in (13a).

A summary of the significant results obtained per target region and per eye-tracking measure described above appears in Table 2:

Table 2: ***Summary of results per eye-tracking measure and interest region***

	Interest area 1: determiner	Interest area 2: noun
Total fixation duration	Directionality: • longer fixations on English determiner switches *the ventana > la window*	Gender agreement mechanisms: • longer fixations on [-AC] switches *el window > la window* • longer fixations on MF DPs *el window > la window* *el book*
Gaze duration	Directionality: • longer fixations on English determiner switches *the ventana > la window*	--
Regression path duration	Directionality: • longer fixations on English determiner switches *the ventana > la window*	Directionality: • longer fixations on Spanish determiner switches *la window > the ventana* Gender agreement mechanisms: • longer fixations on [-AC] switches *el window > la window*

6. WHERE THE EYE HAS TAKEN US: CONCLUSIONS AND FURTHER RESEARCH

In the present study we address codeswitching processing costs in the case of English-Spanish switched DPs considering that long fixations and regressions are typically linked to how hard it is to process a category (Dussias, Valdés Kroff, Johns & Villegas, 2019; Clifton & Staub, 2011; Clifton et al., 2007; Staub & Rayner, 2007; Rayner, 1998). More specifically, we test two formal proposals in order to further contribute to shed light on how the two grammars of the bilinguals interact: the Grammatical Features Spell-Out Hypothesis and the Gender Double-Feature Valuation Mechanism.

In terms of directionality, data show that processing costs increase in the determiner region in the case of English determiner – Spanish noun switches, as in (5b) (*the libro*), and in the noun region in the case of Spanish determiner – English noun switches, as in (5a) (*el book*). The fact that processing costs are always higher in the case of both the English determiner and the English noun could in fact be linked to the L2 status English has for the bilingual participants in our experiment (i.e. L1 Spanish – L2 English bilingual adults). Furthermore, in the case of Spanish determiner – English noun switches (e.g. *el book*), the enforcement of the Gender Double-Feature Valuation Mechanism could well explain such delay in processing. That is, for these speakers for whom gender agreement occurs not only in the case of Spanish DPs but also in the case of switched DPs where Spanish provides the determiner category, a two-step operation takes place: first, the retrieval of the Spanish noun as a translation equivalent of the English noun (*book > libro*); and second, the need to perform the necessary agreement operations. This is more costly than having to process an English determiner – Spanish noun switch (e.g. *the libro*) where no such two-step grammatical operation takes place. That is, the L1 status Spanish has for these bilingual adults delays processing in this case. Our results are, therefore, in line with those in Litcofsky and van Hell (2017) whose participants are also L1 Spanish – L2 English bilinguals. Taking this into account, we would like to propose a further instantiation of the Grammatical Features Spell-out Hypothesis. In particular, this hypothesis was initially proposed to account for the fact that Spanish determiner switches are favored in naturalistic production over English determiner switches because it is in Spanish determiner switches where features are more

grammaticized (i.e. gender features are present in the Spanish determiner but not in the English determiner) (Liceras et al., 2005; Liceras et al., 2008). That is, it is the Spanish determiner switch the one that has more grammatical information relevant for the computational component. While we believe this is so, we need to extend it to non-naturalistic data. Therefore, if we take the same rationale and apply it in the case of online processing data, this would necessarily result in longer processing times in the case of Spanish determiner switches. This is in fact what our data show. That is, our data abide by an adaptation of the Grammatical Features Spell-out Hypothesis to online processing data.

In the case of Spanish determiner switches and the type of gender agreement mechanism which is easier to process by these bilingual participants, gender congruent switches (i.e. [+AC]; la_{feminine} $window_{SP\ feminine}$ / $el_{\text{masculine}}$ $book_{SP\ masculine}$) are processed faster than both gender non-congruent switches (i.e. [-AC]; $el_{\text{masculine}}$ $window_{SP\ feminine}$ / $la_{feminine}$ $book_{SP\ masculine}$) and switches with masculine default gender (i.e. el_{default} $window_{\text{SP feminine}}$). As pointed above, regression path duration measures show that English nouns take longer to process because a two-step operation is implemented. This means that when performing the second operation (i.e. the Gender Double-Feature Valuation Mechanism), it is less costly when gender feature valuation is successful, parallel to what happens in an all-Spanish DP (e.g. *el libro* 'the book'). Therefore, in this particular case, the L1 status Spanish has for these bilinguals actually accelerates processing when it comes to processing gender agreement mechanisms. These results are in line with the gender agreement preferences shown in previous off-line experimental studies (e.g. Liceras et al., 2008; Valenzuela et al., 2012).

These eye-tracking during reading data show that the high computational value that gender features have in the mind of L1 Spanish – L2 English adult bilinguals delays their processing of Spanish determiner switches when compared to English determiner switches; and that, at the same time, accelerates the processing of Spanish [+AC] determiner switches when compared to Spanish [-AC] determiner switches. That is, the representational value that gender features have is actually guiding these speakers' processing of switched DPs.

These results make further work point to, at least, two different directions that we would like to address in subsequent studies. If our proposal regarding both directionality and gender agreement mechanisms is on the right track, similar results should be obtained when testing L1 Spanish – L2 English bilingual children as well as L1 Spanish – L1 English bilingual children and adults. Regardless of whether we are testing sequential or simultaneous bilinguals, the L1 status of Spanish would make these bilinguals' processing strategies similar to the participants in the present investigation. However, a difference should be observed if processing data are obtained from L1 English – L2 Spanish bilinguals and possibly also in the case of L1 English – heritage Spanish bilinguals. On a different note, the eye-tracking reading data we have obtained in the case of gender agreement mechanisms could be compared to visual world paradigm data where participants are also forced to make a choice between different gender congruent and non-congruent switches. This will help obtain a more complete picture of how gender features are represented in the grammars of English-Spanish bilingual speakers.

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